AMERICAN ELECTRIC POWER SERVICE CORPORATION

Donald C. Cook Nuclear Plant

RADIOLOGICAL ENVIRONMENTAL MONITORING

Annual Report

1981

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Submitted by
EBERLINE INSTRUMENT CORPORATION
Midwest Facility
West Chicago, Illinois

DONALD C. COOK NUCLEAR PLANT

OPERATIONAL ENVIRONMENTAL RADIOLOGICAL SURVEILLANCE PROGRAM

Annual Report

JANUARY 1 - DECEMBER 31, 1981

Prepared for

AMERICAN ELECTRIC POWER SERVICE CORPORATION

By

EBERLINE INSTRUMENT CORPORATION
NUCLEAR SERVICES DIVISION - MIDWEST FACILITIES
245 WEST ROOSEVELT ROAD
BLDG. 2, SUITE 9
WEST CHICAGO, IL 60185

as a contractor to

AMERICAN ELECTRIC POWER SERVICE CORPORATION

Compiled by: Kathryn A. Kohl
Kathryn A. Kohl, Administrator

Written, Reviewed and Approved by: Chung King Liu
Chung-King Liu, PhD, Manager

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SECTION 1

PREFACE

ABSTRACT

This report presents the data obtained from the analyses of environmental samples collected for the American Electric Power Service Corporation Donald C. Cook Nuclear Station Environmental Radiological Surveillance Program for the period 01 January 1981 through 31 December 1981.

The activity present above the detection limits in the routinely collected sample media was observed to be of natural and atmospheric origin. The results show that the radiation dose to a member of the general population did not exceed the technical specifications of 1% of the 10 CFR 20 limit during 1981.

INTRODUCTION

The Donald C. Cook Nuclear Station of American Electric Power Service Corporation consists of two Westinghouse PWR units (Unit 1 and Unit 2). Each unit consists of a pressurized water reactor (PWR) which generates about 3250 megawatts (MW) of heat to generate about 1100 MW of electricity. The station is located in Benton Harbor, Michigan.

The D.C. Cook Plant utilizes a pressurized water reactor with a radwaste hold-up and treatment system that has been designed to keep radioactive releases to as low as is practicable levels. However, small quantities of noble gases and radioiodine may be released to Lake Michigan. The quantities of radionuclides released to the environment are expected to be miniscule and insignificant as a source of potential exposure to flora and fauna in the area. However, direct radiation exposure to man and radionuclide accumulations in various components of food chains to man will be carefully monitored.

The environmental radiological monitoring program is intended to serve the following purposes:

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.

The basic approach for the Donald C. Cook Nuclear Plant is to control the release of radioactive material at levels far below that which would be expected to cause detrimental impact on the environment. The environmental radioactivity surveillance program will be closely coordinated with conditions of plant operation and subject to periodic review.

Levels of environmental radioactivity are subject to change for reasons in no way related to the operation of the D.C. Cook Nuclear Plant. Therefore, the radioactivity surveillance program has been designed to include reference or "background" stations as well as "indicator" stations. The program is summarized in Table I.

This report contains a compilation of the results of analyses of various types of samples collected during the period January 1981 through December 1981.

SUMMARY

Environmental monitoring results showed that the radiation dose to a member of the general population did not exceed Tehcnical Specifications of 1% of the 10CFR20 limit during during 1981. The activity present above the detection limits in the routinely collected sample media was observed to be of natural and atmospheric fallout origin.

Table 3 summarizes the range and average concentrations for measurements at the indicator and control locations, and the location with the highest annual mean. Complete information is given in the Sample Data Tables (Section 5).

SECTION 2

SAMPLING PROGRAM

All samples are collected by Eberline personnel and shipped to the Eberline laboratory in West Chicago, Illinois. The sample collection procedures remained the same as those detailed in the semi-annual report for the period 01 January through 30 June 1973.

Upon receipt of the samples, the laboratory staff enters the samples in a log book identifying them as to sample type, collection date, and sample code number of location, then verifies the specific analyses to be performed on each sample. The samples are then stored, awaiting analysis, on shelves expressly for this purpose to assure accountability through the laboratory processes.

Table 1 lists the sampling locations and frequencies. Figures I, II, and III show the locations of the various sampling environs.

Table 1 lists the sample analysis program - sample type, frequency, and the type of analysis required.

Table 2 lists the LLD's (Lower Limits of Detection) for the analytical program. These LLD's are based on the Regulatory Guide 4.8. For analyses not listed in Regulatory Guide 4.8, Federal EPA, former requirements for similar programs or other appropriate guides are used. The LLD's are calculated at the 3σ (99% confidence) level.

The Guide specifically states that the LLD's are a priori, not a posteriori (after the fact) limit for a particular measurement. When however, RG 4.8 or other LLD's have not been achieved, a footnote giving a brief explanation has been inserted.

TABLE 1

ENVIRONMENTAL MONITORING PROGRAM

DONALD C. COOK NUCLEAR PLANT

Sample Type	No. Station Ind.	Bkg.	Collection Frequency	Analysis Frequency	Type Analysis	Remarks
Air Particulate	6	4	Weekly	Weekly	Gross Beta	
				Monthly	Gamma Isotopic Composite, 2 Samples	By indicator and background samples.
				Quarterly	Sr-89, Sr-90	
Airborne I-131	6	4	Weekly	Weekly	Gamma Isotopic	
Precipitation	6	4	Monthly	Monthly	Gamma Isotopic Composite, 2 Samples	By indicator and background samples.
				Semi-annual	Sr-89, Sr-90 Composite, 2 Samples	By indicator and background samples.
Lake Water	3	4	Monthly	Monthly	Gamma Isotopic Composite, 2 Samples	By indicator and background samples.
				Quarterly	Tritium Composite, 2 Samples	By indicator and background samples.
Well Water	4	3	Every 18 wks.	Every 18 wks.	Gamma Isotopic Tritium	
Fish	2	2	2 per year	2 per year	Gamma Isotopic Sr-89, Sr-90	Edible portion only.

TABLE 1 (Cont'd)

ENVIRONMENTAL MONITORING PROGRAM

DONALD C. COOK NUCLEAR PLANT

Sample Type	No. Stations Ind.	Bkg.	Collection Frequency	Analysis Frequency	Type Analysis	Remarks
Aquatic Organisms	2	2	2 per year	2 per year	Gamma Isotopic Sr-89, Sr-90	When available
Milk	3	2	Monthly	Monthly	Gamma Isotopic Sr-89, Sr-90 I-131	
Sediment	2	2	2x per year	2x per year	Gamma Isotopic Sr-89, Sr-90	
TLD	9	14	Quarterly	Quarterly	Total Dose	
Food Crops	1	1	Annually	Annually	Gamma Isotopic	

Table 2

LOWER LIMITS OF DETECTION
(LLD's)

Sample Class	Analysis	LLD	Units
Air Particulates	Gross Beta	0.01	pCi/m^3
	Gamma Isotopic	0.01	pCi/m^3
	Sr-89	0.002	pCi/m^3
	Sr-90	0.001	pCi/m^3
Airborne Iodine	I-131	0.01	pCi/m^3
Milk	I-131	0.05	pCi/l
	Gamma Isotopic	10	pCi/l
	Sr-89	5	pCi/l
	Sr-90	1	pCi/l
Well Water	LS Tritium	1000	pCi/l
	Gamma Isotopic	10	pCi/l
Precipitation	Gamma Isotopic	10	pCi/l
	Sr-89	2	pCi/l
	Sr-90	1	pCi/l
Lake Water	Gamma Isotopic	10	pCi/l
	Enriched Tritium	0.2	pCi/ml
Aquatic Organisms	Gamma Isotopic	1	pCi/g wet
	Sr-89	0.05	pCi/g wet
	Sr-90	0.005	pCi/g wet
Sediment	Gamma Isotopic	1	pCi/g dry
	Sr-89	0.05	pCi/g dry
	Sr-90	0.005	pCi/g dry
Fish	Gamma Isotopic	1	pCi/g wet
	Sr-89	0.05	pCi/g wet
	Sr-90	0.005	pCi/g wet
Food Crops	Gamma Isotopic	1	pCi/g wet
Background Radiation (TLD)	Gamma Dose	-	mR/week

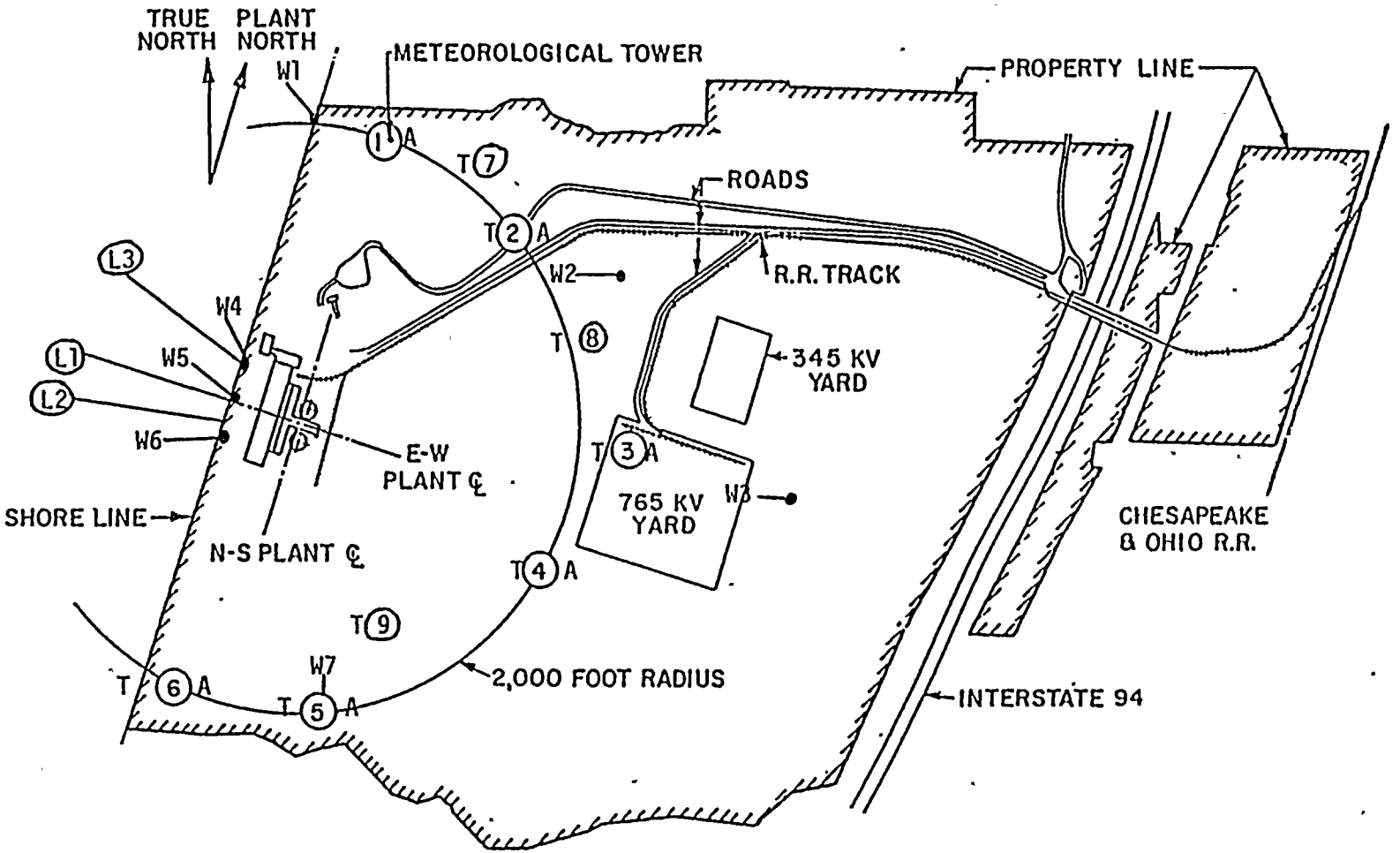


FIGURE I

LOCATIONS
OF INDICATOR AIR SAMPLING STATIONS

A ' Air, Precipitation

T TLD Station

W Well Water

L Lake Water (taken at shoreline)

A - Air, Precipitation, TLD Stations
L - Lake Water Sample Stations
M - Milk Sample Stations

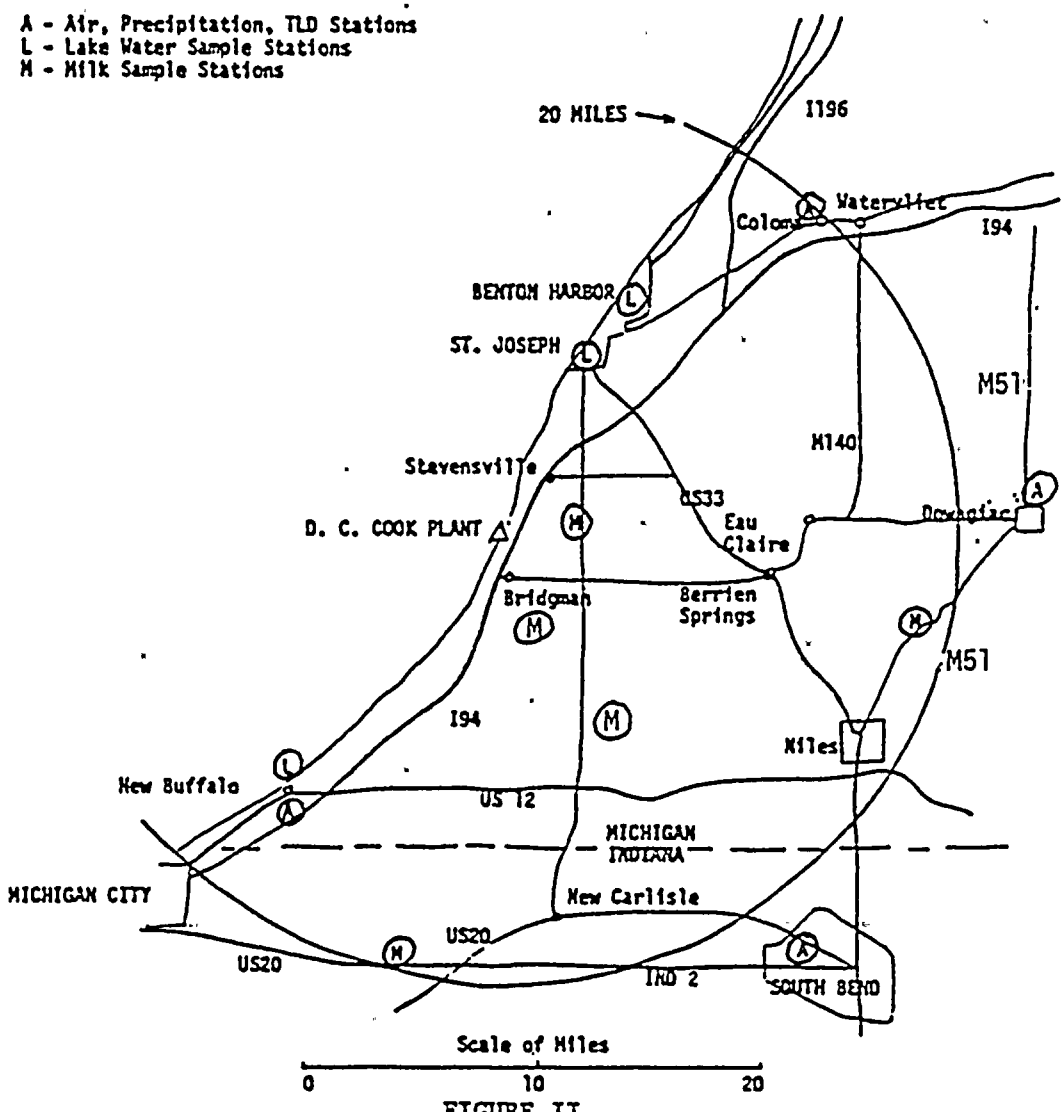
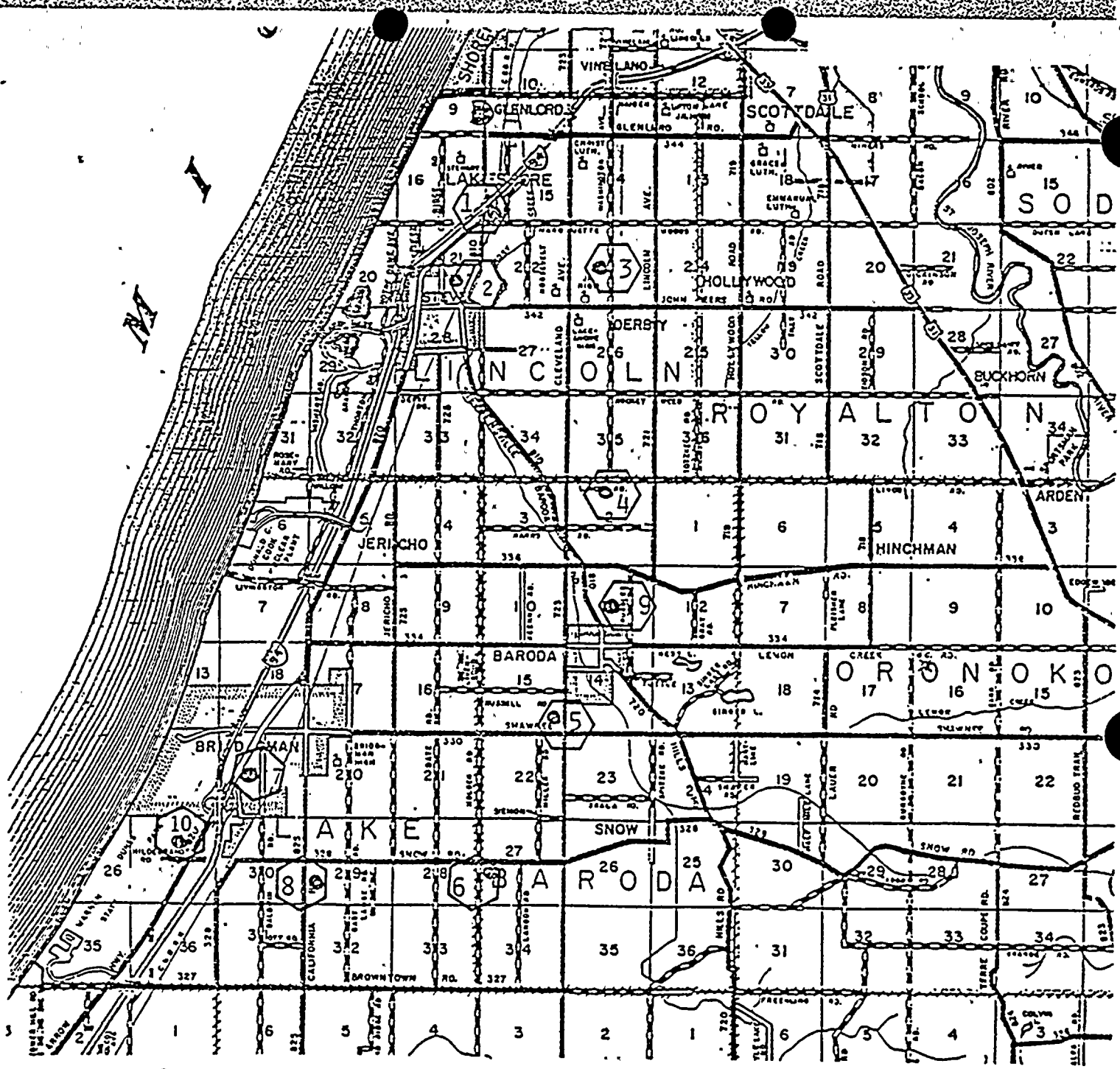


FIGURE II
OFF-SITE
LOCATIONS OF SAMPLING STATIONS



1. Red Arrow Highway and vicinity of I-94 overpass.
2. Stevensville Sub Station.
3. Washington Avenue midway between Brentwood Drive and Kingman Drive.
4. Washington Avenue and Linco Road.
5. Cleveland Avenue and Shawnee Road.
6. Holden Road and Snow Road.
7. Bridgman Sub Station.
8. California Road between Browntown and Snow Roads.
9. Ruggles Road between Hinchman and Lemon Creek Roads.
10. At intersection of Hildebrant Road and Red Arrow Highway.

FIGURE III

TLD MONITOR LOCATIONS LOCATED ON THE FIVE MILE RADIUS FROM THE PLANT

SECTION 3

ANALYSIS PROGRAM

ANALYTICAL PROCEDURES

Samples received at the laboratory are analyzed for the various radioactive components by standard radiochemical methods. These methods are equal to, and in most cases, identical with, those of the U.S.D.O.E.[1] or those of the Federal E.P.A.[2]

Brief descriptions of analytical procedures are available in the Laboratory Procedures Manual available at the Cook Nuclear Plant and the radioanalytical contractor's laboratory.

AIR PARTICULATE FILTERS

Gross Beta - Exposed air particulate filters are counted in low background Geiger or proportional flow beta counters using anti-coincidence background suppression after the short-lived naturally occurring radon and thoron daughters have decayed. Filters are counted long enough to ensure that the required sensitivity (LLD) is met.

Gamma Isotopic - Monthly composites of air particulate filters grouped by indicator and background stations into two samples are counted in high resolution (GeLi) gamma spectrometers for periods of time long enough to ensure that the required program sensitivity (LLD) is met.

Strontium-89 and Strontium-90 - After carrier strontium is added to semiannual composite samples of air particulate filters, the strontium is then separated and purified by either ion exchange chromatography (EPA method) or straight wet chemistry (HASL method). The chemical

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[1]HASL Procedures Manual, edited by John H. Harley, Health and Safety Laboratory, US Atomic Energy Commission, 1972 edition, revised annually.

[2]National Environmental Research Center, Environmental Protection Agency; Handbook of Radiochemical Analytical Methods. Program Element 1HA 325. Office of Research and Development, Las Vegas, Nevada 89114.

yield for strontium is determined by atomic absorbtion spectrometry or gravimetric methods. After a suitable period (usually 14 days) to allow for ingrowth of Y-90, the sample is counted in a low background beta counter (equilibrium or total Sr count). The strontium is next put into solution, carrier yttrium added, and the strontium and yttrium fractions separated. The yttrium is counted and from the Y-90 (Sr-90 daughter) count, the Sr-90 concentration can be determined. The difference between the total strontium concentration as determined by the equilibrium count and the Sr-90 concentration as determined from the Y-90 count is the Sr-89 concentration. Equations are available to permit calculation of Sr-89 and Sr-90 by counting the purified strontium fraction at two points during ingrowth of the Sr-90 daughter Y-90. While either method is acceptable, we find the former method provides more consistent results.

WATER SAMPLES (Includes Lake, Well, Precipitation)

Gamma Isotopic - A measured aliquot of the sample is evaporated to a small controlled volume and counted in a standard geometry in a high resolution (GeLi) gamma spectrometer long enough to ensure meeting the sensitivity requirements of the program. See also the Introduction to Data Tables.

Strontium-89 and Strontium-90 - Stable strontium carrier is added to a measured aliquot of sample. The strontium is then treated from this point on in the same manner as are air particulate samples.

Tritium - Tritium as tritiated water is analyzed by liquid scintillation counting after distillation. If high sensitivity is not required (ie. LLD ~500 pCi/l) the sample is distilled, mixed with the appropriate counting phosphors and counted with no further

treatment. If higher sensitivity is required (ie. <~300 pCi/l) the sample is isotopically enriched in tritium concentration prior to liquid scintillation counting. Isotopic enrichment is done by the classical method of Ostlund which involves alkaline electrolysis of a purified aliquot of sample under controlled conditions of temperature and electrode current density.

MILK SAMPLES

I-131 -- Measured amounts of carrier iodide are added to a known volume of milk and the iodine extracted on anion exchange resin. The iodine is recovered and purified by classical iodine chemistry methods which are similar to those given in former Regulatory Guide 4.3. The yield or recovery of iodine is measured gravimetrically and the precipitated sample is mounted and counted in a low level beta detector for a long enough period to ensure that the required LLD is met.

Gamma Isotopic - A measured aliquot of sample is evaporated and oven-dried to a standard volume and counted in a fixed geometry in a high resolution (GeLi) gamma spectrometer for a long enough period to ensure that the required LLDs are reached (see also Introduction to Data Tables).

Strontium-89 and Strontium-90 - Stable strontium carrier is added to an aliquot of the sample which is then dried and ashed at high temperature (>700°c). The ash is dissolved and the solution treated from this point on in the same manner as are air particulate samples.

ORGANIC SAMPLES (Aquatic Organisms, Food Crops, Fish)

Gamma Isotopic - A measured aliquot of sample is oven-dried or ashed as appropriate, placed in a controlled geometry and counted in a high

resolution (GeLi) gamma spectrometer for a period long enough to ensure that the LLDs of the program will be set (see also Introduction to Data Tables).

Strontium-89 and Strontium-90 - Stable strontium carrier is added to a weighed aliquot of the sample and the sample is ashed at high temperature (>700°c). The ashed sample is then dissolved and processed in the same manner as are air particulate samples.

SEDIMENT SAMPLES

Gamma Isotopic - The sample is oven-dried to facilitate handling and then sieved to remove pieces of stone and/or other large pieces of material. An appropriate sized, weighed aliquot of the sample is then transferred into a standard geometry container and counted for a period long enough to ensure that the LLDs of the program will be met. (See also Introduction to Data Tables.)

Strontium-89 and Strontium-90 - A sample is ashed until free of carbon. The ash, with carriers added, is dissolved in hydrochloric acid, then processed in the same manner as are air particulate samples.

THERMOLUMINISCENT DOSIMETERS

Environmental radiation doses are measured using badges comprizing five chips sealed in plastic protective holders having a density of 50 mg/cm^2. The TLD chips are 1/8" x 1/8" x 1/32 LiF (thallium activated) known commercially as Harshaw-100. The chips are all selected to provide uniform response to within five percent of the mean for the batch.

Prior to installation, the chips are annealed by a standard cycle of 60 minutes at 400°c and immediate cooling to ambient temperature by placing the tray containing the annealed chips on an aluminum block

12" x 12" x 1".

After exposure the chips are read on an Eberline Instrument Corporation Model TLR-6 reader. The system employs a preheat cycle which removes low temperature peaks and integrates and digitizes only the light output in a selected temperature range.

The dose is calculated from the average light output for the five chips and the statistical uncertainty is the standard deviation of the five readings. Control badges are used to detect any unusual exposure to the badge which might occur during shipment.

QUALITY ASSURANCE PROGRAM

A. Design of Plan

Quality of product or service has always been a primary key to increase is sales, customer satisfaction, and profit. The management of Eberline Instrument Corporation recognizes the ever increasing demand for higher quality and reliability for services related to protection of workers and the environment. It is our firm belief that in order to judge the worth of a support service, one must know the philosophy behind it. Eberline will provide only those services for which it is qualified and these will be provided in a manner that is reliable, with a quality assurance program that maintains a high degree of client confidence. This quality assurance program has been prepared consistent with the following specifications, per the Technical and Quality Assurance Requirements for Special Purposes.

ANSI-N45.2, American National Standards Institute

NRC Branch Technical Position of November 1979

NRC Regulatory Guide 4.15, Revision 1 of February 1979.

B. Intercomparison Program

Results of Eberline's Midwestern Facility participation in the USEPA's Crosscheck Program will be included in the monthly reports provided to the client. Other intercomparisons in which we routinely participate include:

Environmental Protection Agency
Environmental Measurement Lab DOE Quality Assessment Program
Battelle Northwest Laboratories
IAEA Analytical Quality Control Service
US National Bureau of Standards
Eberline's Albuquerque Laboratory.

Each of the laboratory managers is responsible for preparing spikes and blanks to be run routinely. Every tenth sample is a spike, a blank, or a split sample.

Regular QC reports are prepared by the laborary manager on a monthly

schedule and forwarded to each client. Each report routinely includes:

results from EIC interlaboratory comparison,
results from EPA Crosscheck program, and
results from other intercomparison programs.

Results are reviewed by the laboratory manager. If a problem is indicated by the data, the nature of the problem is investigated and corrective steps taken immediately. A copy of each report is also provided to the Quality Assurance Manager of the Nuclear Services Division.

C. Quality Assurance Plan

The Quality Assurance Program follows the requirments of Company and Division Manuals. The discussion below outlines Quality Assurance Programs as conducted in the laboratory and as required in our QA Manual.

Procedure Approval

Each procedure goes through a vigorous evaluation and review process before it is incorporated into the EIC Procedures Manual. Established procedures of the Environmental Protection Agency (EPA) or the Environmental Measurements Laboratory of the US Department of Energy (EML) are used unless thorough testing has demonstrated that an alternate procedure is equal to or better than the EPA or EML procedure. Uniform procedures are used at both laboratories to the fullest extent possible, except when deviations are necessary to meet the specific requirements of the client. The manager of each laboratory and the quality assurance manager review and approve significant procedural changes before they are implemented.

Equipment Calibration and Maintenance

Equipment used for qualitative or quantitative measurements is carefully calibrated and maintained with records of each calibration or maintenance action kept in appropriate logbooks. To the extent possible, certified standards are used for all primary calibrations. The following standards are used for the application indicated:

Measurement	Calibration Standard
Gross Beta	Solution of Standard ^{137}Cs certified by NBS or Amersham Searle
Tritium	Solution standard of ^{3}H certified by NBS
Gamma Spectrometry	Solution standards of various gamma emitters certified by NBS or Amersham Searle. Standards are used to calibrate each counting geometry used.
Strontium-89 and 90	Solution standards of ^{90}Sr certified by Amersham Searle or NBS
Gross Alpha	Solution standards of ^{239}Pu certified by NBS or Amersham Searle.
Radiation Dose	^{137}Cs gamma source cross-referenced with NBS using R-meters. ^{226}Ra is used for some special application.

When suitable standards are not available for a specific gamma emitter, quantitative gamma isotopic analysis is based on an energy calibration of the gamma spectrometer and the gamma energy and abundance information provided in Table of Isotopes, Sixth Edition by Lederer, Hollander, and Perlman.

The results of the Quality Control Programs are summarized in Section 6.

SECTION 4

RESULTS AND DISCUSSION

Environmental Radiological Monitoring Program

Name of Facility: Donald C. Cook Nuclear Station Docket Number: 50-315 and 50-316

Location of Facility: Berrien (County) Michigan (State) Reporting Period: January - December 1981

Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analyses Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean[1] (Range)	Location with Highest Mean Name	Location with Highest Mean Mean (Range)	Control Locations Mean[1] (Range)	Number of Non-routine Reported Measurements
Air Particulates (pCi/m^3)	Gross β 509	0.01	0.12 (291/301) 0.01-0.96	On-Site 6	0.16 (52/52) 0.02-0.96	0.11 (205/208) 0.01-0.49	0
	Ce-144 24	0.01	0.06 (9/12) 0.01-0.12	Not Applicable		0.06 (8/12) 0.01-0.11	0
	Zr-95 24	0.01	0.03 (7/12) 0.01-0.06	Not Applicable		0.02 (6/12) 0.01-0.04	0
	Nb-95 24	0.01	0.04 (7/12) 0.01-0.13	Not Applicable		0.03 (8/12) 0.01-0.11	0
	Ce-141 24	0.01	0.02 (4/12) 0.01-0.03	Not Applicable		0.03 (3/12) 0.02-0.04	0
	Ru-103 24	0.01	0.02 (5/12) 0.01-0.02	Not Applicable		0.02 (3/12) 0.01-0.03	0
	Other γ 24	0.01	All LLD	Not Applicable		All LLD	0
	Sr-89 8	0.002	0.002 (1/4) 0.002	Not Applicable		All LLD	0
	Sr-90 8	0.001	All LLD	Not Applicable		All LLD	0
Airborne Iodine (pCi/m^3)	I-131 508	0.01	All LLD	Not Applicable		All LLD	0
Well Water (pCi/l)	Tritium 21	1000	1120 (9/12) 600-1500	On-Site 5	1300 (3/3) 1200-1500	933 (3/9) 800-1200	0
	γ Spec. 21	10	All LLD	Not Applicable		All LLD	0

[1] Mean and range based on detectable measurements only. Fractions indicated in parentheses.

Table 3 (continued)

Facility: Donald C. Cook Nuclear Station

Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analyses Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean[1] (Range)	Location with Highest Mean Name	Location with Highest Mean Mean (Range)	Control Locations Mean[1] (Range)	Number of Non-routine Reported Measurements
Milk (pCi/l)	I-131 57	0.05	All LLD	Not Applicable		All LLD	0
	Sr-89 57	5	All LLD	Not Applicable		All LLD	0
	Sr-90 57	1	3.1 (34/35) 1.0-8.0	Galien	3.3 (11/11) 1.0-7.0	5.2 (22/22) 2.0-14.0	0
	γ Spec. 57	10	All LLD	Not Applicable		All LLD	0
Precipitation (pCi/l)	γ Spec. 24	10	All LLD	Not Applicable		All LLD	0
	Sr-89 4	2	All LLD	Not Apolicable		All LLD	0
	Sr-90 4	1	All LLD	Not Applicable		4 (1/2) 4	0
Lake Water (pCi/l)	γ Spec. 20	10	All LLD	Not Applicable		All LLD	0
	Tritium 8	200	367 (3/4) 200-500	Not Applicable		273 (3/4) 200-320	0
Aquatic Organisms (pCi/g wet)	Ce-144 8	1	1 (1/4) 1	South On-Site	1 (1/2) 1	2 (1/4) 2	0
	Nb-95 8	1	1 (1/4) 1	South On-Site	1 (1/2) 1	2 (1/4) 2	0
	Zr-95 8	1	1 (1/4) 1	South On-Site	1 (1/2) 1	1.5 (2/4) 1.0-2.0	0
	Cr-51 8	1	2 (1/4) 2	South On-Site	2 (1/4) 2	All LLD	0
	Ce-141 8	1	All LLD	Not Applicable		1 (1/4) 1	0
	Other γ 8	1	All LLD	Not Applicable		All LLD	0

[1] Mean and range based on detectable measurements only. Fractions indicated in parentheses.

Table 3 (continued)

Facility: Donald C. Cook Nuclear Station

Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analyses Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean[1] (Range)	Location with Highest Mean Name	Location with Highest Mean Mean (Range)	Control Locations Mean[1] (Range)	Number of Non-routine Reported Measurements
Aquatic Organisms (pCi/g wet)	Sr-89 8	0.05	All LLD	Not Applicable		All LLD	0
	Sr-90 8	0.005	0.023 (2.4) 0.013-0.033	North On-Site	0.033 (1/2) 0.033	0.021 (2/4) 0.017-0.024	0
Sediment (pCi/g dry)	γ Spec. 8	1	All LLD	Not Applicable		All LLD	0
	Sr-89 8	0.05	All LLD	Not Applicable		All LLD	0
	Sr-90 8	0.005	0.013 (1/4) 0.013	South On-Site	0.013 (1/2) 0.013	0.048 (1/4) 0.048	0
Food Crops (pCi/g wet)	γ Spec. 4	1	All LLD	Not Applicable		All LLD	0
Fish (pCi/g wet)	γ Spec 8	1	All LLD	Not Applicable		All LLD	0
	Sr-89 8	0.05	All LLD	Not Applicable		All LLD	0
	Sr-90 8	0.005	0.031 (4/4) 0.018-0.043	North On-Site	0.037 (2/2) 0.031-0.043	0.045 (4/4) 0.030-0.053	0
Background Radiation (TLD) (mR/week)	γ Dose 82	-	1.1 (35/35) 0.7-1.8	On-Site 7	1.2 (4/4) 0.9-1.8	1.1 (47/47) 0.7-1.9	0

[1] Mean and range based on detectable measurements only. Fractions indicated in parentheses.

Results of all the analyses for January through December 1981 are presented in full in Section 5, Data Tables pages 38 through 49.

Table 3 summarizes the range and average concentrations for measurements at the indicator and control locations with the highest annual mean. Environmental monitoring results showed that the radiation dose to a member of the general population did not exceed Technical Specifications of 1 percent of the 10CFR20 limit during 1981.

Specific finding for the various environmental media are discussed below:

AIR PARTICULATE SAMPLES

Atmospheric particulate matter at a field location is accumulated for a one-week on a glass fiber filter using a low-volume air sampler at a collection rate of one cubic foot per minute. This particulate matter contained on the filter is counted for beta activity in a low background counting system after the short-lived naturally-occurring radon and thoron daughters have decayed.

The gross beta particulate data obtained during the first six-month period of 1981 are higher than the data obtained during the latter half. According to P. K. Kuroda et al[1], concentrations of Sr-89 and Sr-90 in rain and snow at Fayetteville, Arkansas, showed a spectacular increase during the spring months of 1981 due to the 25th Chinese nuclear test explosion of October 1980. It is therefore suggested that these higher

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[1]P. K. Kuroda, "Recent Atmospheric Injections of Nuclear Debris: Fallout from the 16 October 1980 Nuclear Explosion", unpublished manuscript, 1981.

levels are attributable to the stratospheric fallout from this test.

The average gross beta concentration for the year for all indicator stations was 0.12 pCi/m^3, and was 0.11 pCi/m^3 for the background stations. Data for analyses of individual filters are given on pages 38 through 41 in Section 5.

The following table summarizes the average gross beta concentrations for both indicator and background stations for each year from 1973 through 1981. The preoperational data were collected in 1973 and 1974; operational data were collected from 1975 through the present.

	Indicator	Background
	$pCi/m^3(\pm 2\sigma)$	
Preoperational		
1973	0.04±0.04	0.04±0.04
1974	0.16±0.24	0.16±0.29
Operational		
1975	0.08±0.18	0.09±0.17
1976	0.09±0.22	0.08±0.19
1977	0.22±0.63	0.22±0.53
1978	0.12±0.40	0.11±0.30
1979	0.04±0.16	0.04±0.16
1980	0.04±0.16	0.04±0.16
1981	0.12±0.40	0.11±0.30

The elevated levels of gross beta activity at both indicator and background locations during preoperational[1] and operational phases from 1974 through 1981 were mainly the result of nuclear test explosions in the atmosphere by the People's Republic of China. Such tests took place on 27 June 1973, 17 June 1974, 23 January 1976, 26 September 1976, 17 November 1976, 17 September 1977, 13 March 1978, 14 December 1978, and

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[1] See Annual Environmental Monitoring Reports for D. C. Cook Plant from previous years for details.

October 1980.

The data indicate that there is significantly no difference between the levels of gross beta activity measured at the indicator and background locations for the operational and preoperational phases of the program. The activity detected are not attributable to the operation of the Cook plant.

Airborne I-131 concentration was less than 0.1 pCi/m^3 for all samples received.

The gamma spectrometry data for monthly composites of air particulate files begins on page 42. Traces of Ce-144, Zr-95, Cs-137, Ru-103, Ru-106, Nb-95, and Ce-141 were detected at both indicator and background stations during the first six-month period of 1981 and are attributable to the stratospheric fallout from the 25th Chinese nuclear test. Be-7, a naturally occurring nuclide formed by the cosmic ray interaction with nuclei in the upper atmosphere, was also detected in the composites. These were generally in the range to be expected from measurement of this nuclide in this medium.

Quarterly composites of air particulate filters were analyzed for Sr-89 and Sr-90. Sr-89 concentrations were at or below the detection limit of 0.002 pCi/m^3, and Sr-90 were also at or below the detection limit of 0.001 pCi/m^3 for both indicator and background locations. These were generally in the range to be expected from measurements of these nuclides in this medium.

MILK SAMPLES

Milk samples were collected monthly and were analyzed for I-131, Sr-89, Sr-90, and gamma emitters.

Sr-89 concentrations measured below the detection limit of 5 pCi/l

in all samples collected during the year. Sr-90 concentrations continued to display considerable variation, which is typical for this type of sample. This nuclide is attributable to worldwide fallout from both recent and older nuclear test programs. Data are given on page 43.

I-131 concentrations were below the detection limits of the program. Date are presented on page 43.

Gamma emitters other than those which occur in nature were not detected in most samples at a measurement sensitivity of 10 pCi/l. Trace Cs-137 was detected in one sample from Dowagiac and was due to worldwide fallout from recent nuclear tests. Data are given on page 44.

PRECIPITATION SAMPLES

Gamma isotopic analyses of monthly precipitation samples from indicator and background locations indicate the presence of no gamma emitters in concentrations exceeding 10 pCi/l (<3000 pCi/m^2). Sr-89 concentrations were less than the detection limit of 2 pCi/l. Traces of Sr-90 were detected in one background sample and are attributable to the recent Chinese bomb test. Data are presented on page 45.

WELL WATER SAMPLES

Well water is collected from seven locations at 18-week intervals during the year and analyzed for tritium and gamma emitters. Low concentrations of tritium were detected in samples from both indicator stations and background stations throughout 1981. It is possible that the tritium found is these samples is a result of plant operations. Gamma emitters were below the detection limit in all samples analyzed. Data are presented on page 46.

LAKE WATER SAMPLES

Samples of water from Lake Michigan are composited by indicator and background locations and analyzed for gamma emitters on a monthly basis. Quarterly composites of the monthly composites are analyzed for tritium.

The gamma emitters in the monthly composites were measured to be less than the detection limit of 10 pCi/l per nuclide for all samples.

The tritium concentrations in the quarterly composites were in the range of 200 to 500 pCi/l for in indicator locations and 200 to 320 pCi/l for the background locations. These concentrations are in the range to be expected from measurements of this nuclide in this medium.

AQUATIC ORGANISM SAMPLES

Aquatic organisms were collected twice during the year from areas north and south of the plant, at on-site and off-site locations. The samples were analyzed for gamma emitters, Sr-89, and Sr-90.

Traces of Ce-144, Nb-95, Ce-141, and Zr-95 were present in several samples. Long and short term worldwide fallout deposits are probably the reason for these activities.

Sr-89 was not detected in any of the samples; the detection limit of 0.05 pCi/g (wet) was achieved. Sr-90 were detected at trace level (0.03 pCi/g wet) in four samples and were attributable to recent fallout. Data are presented on page 47.

SEDIMENT SAMPLES

Sediment samples were collected twice during the year from areas north and south of the plant, at on-site and off-site locations. The samples were analyzed for gamma emitters, Sr-89, and Sr-90.

The gamma emitters were below the detection limit of 1 pCi/g (dry)

in all the samples. Sr-89 was also below the detection limit, 0.05 pCi/g (dry). Trace Sr-90 was evident in two samples and is due to recent stratospheric fallout. Date are given on page 48.

FISH SAMPLES

Fish samples collected from areas north and south of the plant, both on-site and off-site locations, were analyzed for gamma emitters, Sr-89, and Sr-90.

For all samples, gamma emitters were below the detection limit of 1 pCi/g (wet), and Sr-89 was below the detection limit of 0.05 pCi/g (wet). Sr-90 ranged in concentration from 0.018 to 0.053 pCi/g (wet). The concentrations observed were attributable to worldwide fallout and were generally in the range to be expected from measurements of this nuclide in this medium. Data are given on page 48.

FOOD CROP SAMPLES

Grapes and grape leaves were collected during the fall harvest period from on-site and off-site locations and were analyzed for gamma emitters. They were found to be below the detection limit of 1 pCi/g (wet) at both on- and off-site locations. Data are given on page 48.

GAMMA DOSE

Gamma radiation dose was measured with Thermoluminiscent Dosimeters (TLDs) on a quarterly schedule. A total of 20 field locations (9 indicator and 11 background) were monitored during the first, second, and third quarters of the year. Three additional background locations were added in the fourth quarter.

Throughout the year, there was no statistically significant dif-

ference in dose rates between indicator and background locations, nor do they differ significantly from dose rates measured in previous years. Data are presented on page 49.

SECTION 5

DATA TABLES

INTRODUCTION TO THE DATA TABLES

The following information will be helpful in understanding the presentation of the data in the tables in this section.

Wet Weight	a reporting unit used with organic tissue samples such as vegetation and animal samples in which the amount of sample is taken to be the weight as received from the field with no moisture removed.
Dry Weight	a reporting unit used for soil and sediment in which the amount of sample is taken to be the weight of the sample after removal of moisture by drying in an oven at about 110° for about 15 hours.
pCi/m^3	a reporting unit used with air particulate and radioiodine data which refers to the radioactivity content expressed in picocuries of the volume of air expressed in cubic meters passed through the filter and/or the charcoal trap. Note that the volumes are not corrected to standard conditions.
Gamma Emitters or Gamma Isotopic	samples were analyzed by high resolution (GeLi) gamma spectrometry. The resulting spectrum is analyzed by a computer program which scans from about 50 to 2000 kev and lists the energy peak of any nuclides present in concentrations exceeding the sensitivity limits set for that particular experiment.
NA, NS, NR	used in place of a concentration when a sample was not available (NS), or when a sample was not analyzed for some specific measurement (NA), or when an analysis is not required (NR).
Error Terms	figures following "±" are error terms based on counting uncertainties at the 2σ (95% confidence) level. Values preceded by the "<" symbol were below the stated concentration at the 3σ (99% confidence) level.
Exponents	Exponents necessary to prevent data tables from being cumbersome are handled in the conventional manner of including them in the column headings.
Sensitivity	In general, all analyses meet the sensitivity requirements of the program as given in Table 3. For the few samples that do not (because of inadequate sample quantities, analytical interferences, etc.) the sensitivity actually obtained in the analysis is given.
Comment	when all analyses of a particular type during the period resulted in concentrations below the sensitivity limits, a statement is made on the appropriate table rather than presenting a whole page of "<" data. If all but one or two data points are below the sensitivity limits, the previously mentioned convention is followed and the finite data are given as footnotes.

LISTING OF MISSED SAMPLES

1981

Sample Type	Location	Expected Collection Date	Reason
Lake Water	All	January February	Lake frozen at all points.
Air Particulates	ONS 2	01/05-27	Exposed part of filter missing due to apparent vandalism.
Milk	Galien	January	No milk left.
Air Particulates	ONS 4	02/10	Road closed due to snow.
Air Particulates	ONS 4	05/19 06/19-30 07/07	Area flooded.
Milk	SBN	09/12 10/10	No milk available.
Iodine Cartridge	COL	09/26	Lost in processing.
Air Particulates	ONS 2	12/14	No power to unit.

DONALD C. COOK

AIRBORNE IODINE-131* and GROSS BETA in AIR PARTICULATE FILTERS
(Weekly Collections)

Collection Date	Gross Beta 10^{-2} pCi/m^3									
	ON-SITE 1		ON-SITE 2		ON-SITE 3		ON-SITE 4		ON-SITE 5	
	Volume (m^3)	Gross β	Volume (m^3)	Gross β	Volume (m^3)	Gross β	Volume (m^3)	Gross β	Volume (m^3)	Gross β
01/05/81	355	5±1	395	(a)	425	10±1	335	8±1	465	9±1
01/12/81	360	3±1	390	2±1	435	11±1	335	14±1	460	12±1
01/19/81	350	8±1	395	(a)	400	14±1	330	16±2	460	14±1
01/27/81	395	7±1	365	(a)	470	18±2	360	46±5	380	20±2
02/03/81	375	3±1	420	8±1	460	12±1	390	37±3	355	13±1
02/10/81	355	2±1	370	3±1	450	12±1		(a)	330	11±1
02/17/81	345	6±1	365	6±1	450	16±2	710	15±2	335	18±2
02/24/81	355	3±1	355	1±1	435	9±1	375	10±1	365	10±1
03/03/81	355	3±1	190	5±1	410	11±1	380	10±1	275	11±1
03/10/81	355	6±1	280	6±1	400	13±1	380	13±1	330	12±1
03/17/81	360	4±1	95(b)	16±3	415	30±3	385	29±3	325	26±3
03/24/81	350	5±1	190	4±1	410	19±2	385	15±2	325	17±2
03/31/81	320	8±1	405	11±1	410	37±4	395	40±4	315	43±1
04/07/81	345	13±1	335	16±2	395	42±4	355	37±4	110(c)	66±7
04/14/81	335	6±1	330	10±1	405	12±1	340	22±1	60(d)	18±1
04/21/81	330	10±1	355	10±1	395	29±3	355	28±3	320	26±3
04/28/81	290	5±1	350	16±2	60(e)	23±2	380	37±2	320	34±2
05/05/81	350	1±1	360	12±1	245	29±2	375	23±1	355	31±2
05/12/81	485	11±1	350	7±1	285	21±2	510	21±2	345	23±2
05/19/81	295	15±2	345	26±3	350	38±4		(a)	350	41±4
05/26/81	340	12±1	235	22±2	360	37±4	1000	33±3	390	34±3
06/02/81	380	6±1	280	8±1	385	16±2	420	11±1	315	17±2
06/09/81	335	12±1	265	42±4	415	19±2		(a)	295	35±3
06/16/81	355	2±1	270	6±1	390	16±2		(a)	280	18±2
06/23/81	340	3±1	250	8±1	360	19±2		(a)	320	18±2
06/30/81	365	4±1	250	16±2	395	20±2		(a)	315	21±2

* Iodine cartidges are sampled weekly. Concentrations are <0.10 pCi/m^3 unless otherwise noted.

(a) See Listing of Missing Samples page. (b) Low volume due to broken meter. (c) No power.
(d) Low volume due to power offage. (e) Low volume: calculation based on average volume.

DONALD C. COOK

AIRBORNE IODINE-131* and GROSS BETA in AIR PARTICULATE FILTERS
(Weekly Collections)

	Gross Beta 10^{-2} pCi/m³									
	ON-SITE 1		ON-SITE 2		ON-SITE 3		ON-SITE 4		ON-SITE 5	
Collection Date	Volume (m³)	Gross β	Volume (m³)	Gross β	Volume (m³)	Gross β	Volume (m³)	Gross β	Volume (m³)	Gross β
07/07/81	325	5±1	265	4±1	355	17±2	(a)		325	16±2
07/14/81	305	4±1	255	6±1	410	16±2	1740	13±1	315	16±2
07/21/81	360	3±1	300	4±1	430	11±1	305	10±1	320	12±1
07/28/81	335	10±1	320	3±1	465	10±1	210	14±1	340	10±1
08/04/81	265	2±1	290	6±1	365	10±1	265	11±1	305	12±1
08/10/81	330	<1	305	6±1	370	6±1	270	6±1	320	6±1
08/17/81	235	1±1	350	2±1	415	7±1	305	6±1	340	8±1
08/24/81	380	1±1	390	4±1	390	8±1	335	8±1	365	10±1
08/31/81	365	2±1	400	5±1	445	7±1	385	6±1	390	7±1
09/07/81	425	<1	350	1±1	400	4±1	320	3±1	290	3±1
09/14/81	375	1±1	350	3±1	340	7±1	300	6±1	285	7±1
09/21/81	375	<1	340	1±1	340	3±1	295	2±1	350	3±1
09/28/81	375	<1	320	<1	345	4±1	305	3±1	355	4±1
10/05/81	405	1±1	425	3±1	335	3±1	300	6±1	370	3±1
10/12/81	415	<1	430	<1	355	1±1	290	2±1	370	2±1
10/19/81	415	<1	445	2±1	365	5±1	285	4±1	375	6±1
10/26/81	385	1±1	365	1±1	360	3±1	320	3±1	365	3±1
11/02/81	250	1±1	195	2±1	360	8±1	325	7±1	360	8±1
11/09/81	430	1±1	375	1±1	370	5±1	350	5±1	405	2±1
11/16/81	435	1±1	420	2±1	365	6±1	420	5±1	385	7±1
11/23/81	330	1±1	395	1±1	380	5±1	450	<1	400	5±1
11/30/81	350	1±1	390	1±1	380	4±1	410	5±1	430	5±1
12/07/81	340	1±1	330	1±1	395	6±1	430	5±1	360	6±1
12/14/81	215	5±1	(a)		360	3±1	405	4±1	380	7±1
12/21/81	215	1±1	225	1±1	350	5±1	355	4±1	355	6±1
12/28/81	345	1±1	290	<1	350	7±1	360	6±1	365	8±1

* Iodine cartidges are sampled weekly. Concentrations are <0.10 pCi/m³ unless otherwise noted.
(a) See Listing of Missing Samples page.

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AIRBORNE IODINE-131* and GROSS BETA in AIR PARTICULATE FILTERS
(Weekly Collections)

	Gross Beta 10^{-2} pCi/m^3									
	ON-SITE 6		NEW BUFFALO		SOUTH BEND		DOWAGIAC		COLOMA	
Collection Date	Volume (m^3)	Gross Beta	Collection Date	Volume (m^3)	Gross Beta	Volume (m^3)	Gross Beta	Volume (m^3)	Gross Beta	Volume (m^3)	Gross Beta
01/05/81	355	12±1	01/03/81	385	7±1	370	6±1	415	12±1	430	5±1
01/12/81	370	9±1	01/10/81	360	15±1	425	11±1	415	13±1	435	2±1
01/19/81	355	17±2	01/17/81	405	10±1	400	8±1	405	8±1	390	8±1
01/27/81	410	24±2	01/24/81	415	18±2	440	2±1	395	19±2	405	11±1
02/03/81	445	8±1	01/31/81	440	5±1	375	13±1	415	14±1	400	11±1
02/10/81	400	15±2	02/07/81	440	7±1	400	1±1	415	12±1	395	12±1
02/17/81	420	21±2	02/14/81	420	10±1	415	<1	435	10±1	415	4±1
02/24/81	470	6±1	02/21/81	430	18±2	415	13±1	420	13±1	390	18±2
03/03/81	425	12±1	02/28/81	435	1±1	395	8±1	445	5±1	380	7±1
03/10/81	410	25±3	03/07/81	425	14±1	400	5±1	375	14±1	375	4±1
03/17/81	430	28±3	03/14/81	405	18±2	425	30±3	375	19±2	375	18±2
03/24/81	430	17±2	03/21/81	410	19±2	460	5±1	365	18±2	365	17±2
03/31/81	465	42±4	03/28/81	405	17±2	415	20±2	405	23±2	410	9±1
04/07/81	155(a)	96±10	04/04/81	405	45±5	350	42±4	380	49±5	350	22±2
04/14/81	85(b)	22±1	04/11/81	405	24±1	330	28±2	375	25±1	355	14±1
04/21/81	485	28±3	04/18/81	395	27±3	325	27±3	380	24±2	355	9±1
04/28/81	510	39±1	04/25/81	395	22±1	350	7±1	375	7±1	355	14±1
05/05/81	460	33±1	05/02/81	375	30±2	340	8±1	365	35±2	370	9±1
05/12/81	470	25±3	05/09/81	395	23±2	350	11±1	355	26±3	355	6±1
05/19/81	485	43±4	05/16/81	365	32±3	305	11±1	310	33±3	310	21±2
05/26/81	520	33±3	05/23/81	345	33±3	300	7±1	310	40±4	300	33±3
06/02/81	515	13±1	05/30/81	350	24±2	270	8±1	310	23±2	305	17±2
06/09/81	380	19±2	06/06/81	395	12±1	270	29±2	320	14±1	305	6±1
06/16/81	395	16±2	06/13/81	425	24±2	265	8±1	345	14±1	340	12±1
06/23/81	360	17±2	06/20/81	435	10±1	310	7±1	330	14±1	325	12±1
06/30/81	375	19±2	06/27/81	445	15±1	315	9±1	330	12±1	310	12±1

(a) No power. (b) Low volume due to power offage.

* Iodine cartridges are sampled weekly. Concentrations are <0.10 pCi/m^3 unless otherwise noted.

DONALD C. COOK

AIRBORNE IODINE-131* and GROSS BETA in AIR PARTICULATE FILTERS
(Weekly Collections)

	Gross Beta 10^{-2} pCi/m^3										
	ON-SITE 6			NEW BUFFALO		SOUTH BEND		DOWAGIAC		COLOMA	
Collection Date	Volume (m^3)	Gross Beta	Collection Date	Volume (m^3)	Gross Beta	Volume (m^3)	Gross Beta	Volume (m^3)	Gross Beta	Volume (m^3)	Gross Beta
07/07/81	350	15±2	07/04/81	475	17±2	355	8±1	330	21±2	325	19±2
07/14/81	340	16±2	07/11/81	425	15±2	270	4±1	360	11±1	335	11±1
07/21/81	365	11±1	07/18/81	360	13±1	315	3±1	350	11±1	325	5±1
07/28/81	385	11±1	07/25/81	400	13±1	380	8±1	425	12±1	350	13±1
08/04/81	320	12±1	08/01/81	345	7±1	330	5±1	350	7±1	305	4±1
08/10/81	325	6±1	08/08/81	350	7±1	315	2±1	425	7±1	340	7±1
08/17/81	355	7±1	08/15/81	395	8±1	350	6±1	425	8±1	370	1±1
08/24/81	340	10±1	08/22/81	410	8±1	370	1±1	415	6±1	430	6±1
08/31/81	365	7±1	08/29/81	320	7±1	320	5±1	325	7±1	400	7±1
09/07/81	315	4±1	09/05/81	290	5±1	305	2±1	285	5±1	430	4±1
09/14/81	295	7±1	09/12/81	305	6±1	335	1±1	300	4±1	425	4±1
09/21/81	285	4±1	09/19/81	335	3±1	320	<1	295	4±1	390	3±1
09/28/81	290	4±1	09/26/81	315	4±1	370	2±1	280	4±1	320(a)	4±1
10/05/81	300	6±1	10/03/81	335	4±1	375	3±1	395	3±1	275	4±1
10/12/81	295	2±1	10/10/81	325	3±1	345	<1	310	3±1	295	2±1
10/19/81	290	5±1	10/17/81	340	4±1	325	2±1	310	4±1	305	5±1
10/26/81	320	4±1	10/24/81	365	3±1	320	3±1	325	5±1	295	2±1
11/02/81	320	7±1	10/31/81	340	8±1	355	1±1	335	8±1	295	6±1
11/09/81	315	7±1	11/07/81	340	5±1	365	3±1	325	5±1	290	4±1
11/16/81	320	7±1	11/14/81	360	4±1	380	4±1	335	6±1	295	2±1
11/23/81	300	8±1	11/21/81	385	2±1	380	4±1	330	5±1	285	5±1
11/30/81	320	6±1	11/28/81	360	4±1	365	2±1	320	4±1	305	6±1
12/07/81	310	5±1	12/05/81	355	5±1	355	4±1	355	5±1	330	4±1
12/14/81	375	5±1	12/12/81	370	5±1	340	4±1	360	4±1	330	4±1
12/21/81	355	5±1	12/19/81	375	4±1	350	3±1	370	3±1	325	4±1
12/28/81	355	7±1	12/26/81	365	4±1	330	3±1	350	4±1	335	3±1

(a) See Listing of Missed Samples page.
* Iodine cartridges are sampled weekly. Concentrations are <0.10 pCi/m^3 unless otherwise noted.

DONALD C. COOK

GAMMA ISOTOPIC ANALYSIS of MONTHLY AIR PARTICULATE COMPOSITES

	Indicator Stations pCi/m³						
Month	Be-7	Ce-144	Zr-95	Nb-95	Ce-141	Ru-103	Other γ
January	<0.01	0.01±0.01	0.03±0.01	0.01±0.01	0.01±0.01	<0.01	<0.01
February	0.03±0.01	0.01±0.01	0.01±0.01	0.01±0.01	<0.01	<0.01	<0.01
March	0.05±0.02	0.07±0.01	0.03±0.01	0.04±0.01	0.03±0.01	0.02±0.01	<0.01
April	0.04±0.02	0.10±0.01	0.06±0.01	0.06±0.01	0.02±0.01	0.02±0.01	<0.01(a)
May	0.11±0.01	0.12±0.01	0.04±0.01	0.13±0.01	0.03±0.01	0.02±0.01	<0.01
June	0.05±0.01	0.07±0.01	0.01±0.01	0.02±0.01	<0.01	0.01±0.01	<0.01
July	0.10±0.02	0.06±0.01	0.01±0.01	0.02±0.01	<0.01	0.01±0.01	<0.01
August	0.10±0.01	0.05±0.01	<0.01	<0.01	<0.01	<0.01	<0.01
September	0.06±0.01	0.05±0.01	<0.01	<0.01	<0.01	<0.01	<0.01
October	0.07±0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
November	0.06±0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
December	0.09±0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

	Background Stations pCi/m³						
Month	Be-7	Ce-144	Zr-95	Nb-95	Ce-141	Ru-103	Other γ
January	0.06±0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
February	0.02±0.01	0.01±0.01	0.01±0.01	0.01±0.01	<0.01	<0.01	<0.01
March	0.04±0.02	0.02±0.01	0.02±0.01	0.02±0.01	0.04±0.01	0.02±0.01	<0.01
April	0.14±0.02	0.11±0.02	0.04±0.01	0.07±0.01	0.04±0.01	0.02±0.01	<0.01
May	0.12±0.03	0.11±0.02	0.04±0.01	0.11±0.01	0.02±0.01	0.03±0.01	<0.01
June	0.08±0.01	0.05±0.01	0.01±0.01	0.02±0.01	<0.01	<0.01	<0.01 (b)
July	0.08±0.02	0.09±0.01	0.02±0.01	0.01±0.01	<0.01	<0.01	<0.01
August	0.09±0.01	0.02±0.01	<0.01	0.01±0.01	<0.01	<0.01	<0.01
September	0.11±0.02	0.04±0.02	<0.01	0.01±0.01	<0.01	<0.01	<0.01
October	0.08±0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01
November	0.13±0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
December	0.06±0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

STRONTIUM-89/90 ANALYSIS of QUARTERLY AIR PARTICULATE COMPOSITES

Collection Period	Indicator Stations pCi/m³		Background Stations pCi/m³	
	Sr-89	Sr-90	Sr-89	Sr-90
1st quarter	<0.002	<0.001	<0.002	<0.001
2nd quarter	0.002±0.001	0.001±0.001	<0.002	<0.001
3rd quarter	<0.002	<0.001	<0.002	<0.001
4th quarter	<0.002	<0.001	<0.002	<0.001

(a) Cs-137 = 0.01±0.01
(b) Ru-106 = 0.01±0.01

DONALD C. COOK

Sr-89*/90 and I-131 CONCENTRATIONS in MILK SAMPLES
(Monthly Collection)

Collection Site:	Indicator Stations			Background Stations	
	Bridgman K2	Stevensville K1	Galien	Dowagiac K1	South Bend K1
Collection Date	I-131 pCi/l				
01/10/81	<0.5	<0.5	(a)	<0.5	<0.5
02/07/81	<0.5	<0.5	<0.5	<0.5	<0.5
03/07/81	<0.5	<0.5	<0.5	<0.5	<0.5
04/04/81	<0.5	<0.5	<0.5	<0.5	<0.5
05/02/81	<0.5	<0.5	<0.5	<0.5	<0.5
06/06/81	<0.5	<0.5	<0.5	<0.5	<0.5
07/04/81	<0.5	<0.5	<0.5	<0.5	<0.5
08/01/81	<0.5	<0.5	<0.5	<0.5	<0.5
09/12/81	<0.5	<0.5	<0.5	<0.5	(a)
10/10/81	<0.5	<0.5	<0.5	<0.5	(a)
11/07/81	<0.5	<0.5	<0.5	<0.5	<0.5
12/05/81	<0.5	<0.5	<0.5	<0.5	<0.5
	Sr-90 pCi/l				
01/10/81	4±1	2±1	(a)	11±2	8±2
02/07/81	4±2	8±2	4±2	3±1	4±2
03/07/81	3±1	2±2	5±2	4±1	2±1
04/04/81	5±2	4±1	7±2	14±2	7±2
05/02/81	3±2	4±2	3±1	11±3	12±3
06/06/81	4±1	1±1	5±1	4±1	4±1
07/04/81	1±1	<1	2±1	3±1	5±2
08/01/81	2±1	2±1	2±1	4±1	3±1
09/12/81	3±1	1±1	2±1	4±1	(a)
10/10/81	2±1	2±1	2±1	2±1	(a)
11/07/81	1±1	2±1	3±1	3±1	2±1
12/05/81	7±1	1±1	1±1	3±1	2±1

* Sr-89 was determined on each sample and was <5 pCi/l unless otherwise noted.

(a) See Listing of Missing Samples.

DONALD C. COOK

RADIONUCLIDES in MILK SAMPLES
(Monthly Collections)

Collection Site:	Indicator Stations			Background Stations	
	Bridgman K2	Stevensville K1	Galien	Dowagiac K1	South Bend K1
Collection Date	Cs-137 pCi/l				
01/10/81	<10	<10	(a)	<10	<10
02/07/81	<10	<10	<10	<10	<10
03/07/81	<10	<10	<10	<10	<10
04/04/81	<10	<10	<10	<10	<10
05/02/81	<10	<10	<10	<10	<10
06/06/81	<10	<10	<10	<10	<10
07/04/81	<10	<10	<10	<10	<10
08/01/81	<10	<10	<10	<10	<10
09/12/81	<10	<10	<10	<10	(a)
10/10/81	<10	<10	<10	10±3	(a)
11/07/81	<10	<10	<10	<10	<10
12/05/81	<10	<10	<10	<10	<10
	Other Gamma Emitters pCi/l				
	<10	<10	(a)	<10	<10
	<10	<10	<10	<10	<10
	<10	<10	<10	<10	<10
	<10	<10	<10	<10	<10
	<10	<10	<10	<10	<10
	<10	<10	<10	<10	<10
	<10	<10	<10	<10	<10
	<10	<10	<10	<10	<10
	<10	<10	<10	<10	(a)
	<10	<10	<10	<10	(a)
	<10	<10	<10	<10	<10
	<10	<10	<10	<10	<10

(a) See Listing of Missing Samples page.

GAMMA ISOTOPIC ANALYSIS OF PRECIPITATION SAMPLES
(Monthly Collections)

Collection Sites:	Indicator		Background	
Collection Period	pCi/l	nCi/m²	pCi/l	nCi/m²
January	<10	<0.4	<10	<0.4
February	<10	<0.2	<10	<0.2(a)
March	<10	<0.3	<10	<0.3
April	<10	<0.4	<10	<0.3
May	<10	<0.4	<10	<0.3
June	<10	<0.3	<10	<0.2
July	<10	<0.3	<10	<0.2
August	<10	<0.4	<10	<0.3
September	<10	<0.5	<10	<0.3
October	<10	<0.5	<10	<0.3
November	<10	<0.3	<10	<0.5
December	<10	<0.2	<10	<0.2

RADIOSTRONTIUM CONCENTRATIONS IN PRECIPITATION SAMPLES
(Semiannual Analysis on Composites of Monthlys)

	Indicator pCi/l		Background pCi/l	
Collection Period	Sr-89	Sr-90	Sr-89	Sr-90
January-June	<2	<1	<2	4±2
July-December	<2	<1	<2	<1

(a) Ru-103 = 0.4±0.1 nCi/m².

DONALD C. COOK

RADIONUCLIDES IN WELL WATER SAMPLES
(18-week Interval Collections)

Collection Site:	Background Stations			Indicator Stations			
	ONS 1	ONS 2	ONS 3	ONS 4	ONS 5	ONS 6	ONS 7
Collection Date	Tritium pCi/ml						
01/23/81	<1	<1	1.2±0.4	1.1±0.4	1.5±0.4	1.1±0.4	<1
05/06/81	0.8±0.4	<1	<1	1.0±0.4	1.2±0.4	<1	0.9±0.4
09/11/81	0.8±0.4	<1	<1	1.4±0.4	1.2±0.4	1.2±0.4	0.6±0.4
	Gamma Emitters pCi/l						
	<10	<10	<10	<10	<10	<10	<10
	<10	<10	<10	<10	<10	<10	<10
	<10	<10	<10	<10	<10	<10	<10

DONALD C. COOK

GAMMA EMITTERS IN LAKE WATER SAMPLES
(Monthly Composites of Indicator and Background Stations)

Month	Gamma Emitters pCi/l/nuclide	
	Indicator Composite	Background Composite
January	(a)	(a)
February	(a)	(a)
March	<10	<10
April	<10	<10
May	<10	<10
June	<10	<10
July	<10	<10
August	<10	<10
September	<10	<10
October	<10	<10
November	<10	<10
December	<10	<10

TRITIUM IN LAKE WATER SAMPLES
(Quarterly Composites of Monthly Samples)

Quarter	Tritium pCi/l	
	Indicator Stations	Background Stations
1st	200±100	200±100
2nd	400±110	320±200
3rd	<200	<200
4th	500±100	300±200

RADIONUCLIDES IN AQUATIC ORGANISMS
(Semiannual Collections when Available)

Location	Collection Date	pCi/g (wet)			
		Sr-89	Sr-90	Zr-95	Other γ
ONS S	07/23/81	<0.05	0.013±0.005	1±1	<1 (b)
ONS N	07/23/81	<0.05	0.033±0.028	<1	<1
OFS S	07/23/81	<0.05	0.024±0.019	1±1	<1
OFS N	07/23/81	<0.05	0.017±0.013	2±1	<1 (c)
ONS S	09/15/81	<0.05	<0.005	<1	<1
ONS N	09/15/81	<0.05	<0.005	<1	<1
OFS S	09/15/81	<0.05	<0.005	<1	<1
OFS N	09/15/81	<0.05	<0.005	<1	<1

(a) See Listing of Missing Samples page.
(b) Ce-144, Nb-95 = 1±1; Cr-51=2±1.
(c) Ce-144, Nb-95 = 2±1; Ce-141=1±1.

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RADIONUCLIDES IN SEDIMENT SAMPLES
(Semiannual Collections)

Collection Site	Collection Date	pCi/g (dry) Gamma Emitters	Sr-89	Sr-90
ONS N	05/19/81	<1	<0.05	<0.005
ONS S	05/19/81	<1	<0.05	0.013±0.004
OFS N	05/19/81	<1	<0.05	<0.005
OFS S	05/19/81	<1	<0.05	0.048±0.009
ONS N	09/21/81	<1	<0.05	<0.006(a)
ONS S	09/21/81	<1	<0.05	<0.005
OFS N	09/21/81	<1	<0.05	<0.005
OFS S	09/21/81	<1	<0.05	<0.005

RADIONUCLIDES IN FISH SAMPLES
(Semiannual Collections)

Collection Site	Collection Date	pCi/g (wet) Gamma Emitters	Sr-89	Sr-90
ONS N	05/12/81	<1	<0.05	0.031±0.005
ONS S	05/12/81	<1	<0.05	0.032±0.008
OFS N	05/12/81	<1	<0.05	0.053±0.012
OFS S	05/12/81	<1	<0.05	0.045±0.007
ONS N	09/23/81	<1	<0.05	0.043±0.008
ONS S	09/23/81	<1	<0.05	0.018±0.009
OFS N	09/23/81	<1	<0.05	0.030±0.015
OFS S	09/23/81	<1	<0.05	0.051±0.017

RADIONUCLIDES IN FOOD CROPS
(Annual Fall Harvest Collection)

Collection Date	Collection Site: Sample Type	ON Site pCi/g (wet) Gamma Emitters	OFF Site pCi/g (wet) Gamma Emitters
09/30/81	Grapes	<1	<1
09/30/81	Leaves	<1	<1

(a) Lower sensitivity due to low chemical yield.

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GAMMA RADIATION
(Quarterly)

(Measured Using Thermoluminiscent Dosimeters)

	1st Qtr.		2nd Qtr.		3rd Qtr.		4th Qtr.	
Date Annealed:	12/16/80		03/18/81		06/18/81		09/17/81	
Date Read:	04/07/81		07/08/81		10/06/81		12/30/81	
	Main TLD	Backup TLD	Main TLD	Backup TLD	Main TLD	Backup TLD	Main TLD	Backup TLD
Location	Measured mR/week							
Indicator Stations								
On-Site 1	0.9±0.2	0.7±0.1	0.7±0.1	0.9±0.1	1.3±0.2	1.2±0.1	1.5±0.2	1.5±0.6
On-Site 2	missing	missing	0.8±0.1	0.9±0.1	1.4±0.1	1.0±0.1	1.6±0.2	1.7±0.1
On-Site 3	0.8±0.1	0.8±0.2	0.7±0.1	0.8±0.2	1.2±0.1	1.2±0.1	1.5±0.4	1.6±0.3
On-Site 4	0.9±0.1	0.8±0.1	0.9±0.1	0.9±0.1	1.0±0.1	missing	1.4±0.4	1.4±0.4
On-Site 5	0.8±0.2	0.7±0.1	1.0±0.2	0.9±0.1	1.2±0.1	1.3±0.2	1.8±0.5	1.8±0.8
On-Site 6	0.7±0.1	0.7±0.1	missing	1.0±0.1	1.2±0.1	1.2±0.1	1.6±0.1	1.5±0.5
On-Site 7	0.9±0.1	0.7±0.1	0.9±0.1	0.8±0.1	1.3±0.1	1.2±0.2	1.8±0.4	2.1±1.5
On-Site 8	0.8±0.2	0.9±0.1	0.8±0.1	0.7±0.2	1.3±0.1	1.1±0.1	1.5±0.2	1.6±0.4
On-Site 9	0.8±0.1	0.7±0.1	0.8±0.1	1.0±0.1	1.2±0.2	1.1±0.1	1.5±0.2	2.0±0.3
Background Stations								
New	0.9±0.2	0.8±0.1	0.8±0.1	0.9±0.1	1.1±0.1	1.2±0.1	1.5±0.1	1.6±0.1
South Bend	1.0±0.1	0.9±0.2	0.7±0.2	1.0±0.1	1.0±0.1	1.3±0.1	1.7±0.4	1.7±0.3
Dowagiac	0.7±0.1	0.8±0.1	0.8±0.1	0.9±0.2	1.0±0.1	0.9±0.1	1.5±0.3	1.7±0.4
Coloma	0.7±0.1	0.8±0.2	0.7±0.1	0.9±0.1	1.0±0.1	0.9±0.1	1.5±0.2	1.8±0.6
Off-Site-1	0.8±0.1	0.8±0.1	0.9±0.2	0.9±0.1	1.1±0.1	1.0±0.1	1.5±0.2	1.5±0.4
Off-Site-2	0.8±0.1	0.7±0.1	0.8±0.2	0.9±0.1	1.0±0.1	1.0±0.1	1.4±0.1	1.5±0.5
Off-Site-3	0.8±0.1	0.7±0.1	0.7±0.1	0.8±0.1	1.8±0.1	1.1±0.2	1.6±0.5	1.8±0.7
Off-Site-4	0.9±0.2	0.9±0.1	0.8±0.1	0.9±0.1	1.3±0.1	1.0±0.1	1.5±0.2	1.8±0.7
Off-Site-5	0.9±0.1	0.9±0.2	0.9±0.2	0.9±0.1	1.1±0.1	0.9±0.2	1.7±0.4	1.8±0.4
Off-Site-6	0.9±0.1	0.8±0.1	1.0±0.2	0.8±0.1	1.1±0.1	0.9±0.1	1.9±0.3	2.1±1.2
Off-Site-7	0.8±0.1	0.7±0.1	0.9±0.1	0.8±0.1	1.0±0.2	1.0±0.1	1.5±0.4	1.6±0.6
Off-Site-8	Effective 4th Quarter						1.5±0.3	1.5±0.4
Off-Site-9							1.7±0.3	1.7±0.2
Off-Site-10							1.4±0.1	1.5±0.4

SECTION 6

QUALITY ASSURANCE DATA

ENVIRONMENTAL QUALITY CONTROL ANALYSES SUMMARY

1981

The tables below summarize results of samples run for process quality control purposes during the subject month. These listings are in addition to such measurements as detector backgrounds, check source values, radiometric-gravimetric comparisons, system calibrations, etc. Detailed listings of each measurement are maintained at the laboratory and are available for inspection if required.

BLANK SAMPLES

Nuclide Analyzed	Number of Determinations	Number of analyses exceeding the LLD for that analysis
Gross beta	46	1*
Gross alpha	47	0
Strontium-89	95	0
Strontium-90	95	0
Tritium	61	1*
Gamma emitter	64	0
Iodine-131	191	0
Calcium-45	3	0

SPLIT SAMPLES

Nuclide Analyzed	Number of Det'ns	No. agreeing within 2σ	No. agreeing within 3σ	No. differing by > 3σ
Gross beta	142	138	4	0
Gross alpha	39	38	1	0
Gamma emitters	126	122	4	0
Iodine-131	146	146	0	0
Strontium-89	38	38	0	0
Strontium-90	44	42	2	0
Tritium	89	89	0	0
Calcium-45	8	8	0	0
Uranium	71	71	0	0

SPIKED SAMPLES

Nuclide Analyzed	No. of Det'ns	Within 2σ of known	Within 3σ of known	differing from known by > 3σ
Gross beta	55	53	1	1*
Gamma emitters	44	43	1	0
Iodine-131	11	11	0	0
Strontium-89	18	18	0	0
Strontium-90	94	93	1	0
Tritium	45	44	1	0

* Corrective actions were taken to eliminate the problem.

EPA INTERCOMPARISON RESULTS

1981

Month/Year	Sample Type	Analysis	Agency Value	Control Limits (3σ, n=3)	MWF Measured ±2σ error*	Units
December 1980	Water	Iodine-131	22	6	17±2	pCi/liter
December 1980	Water	Tritium	2240	604	2600±300	pCi/liter
December 1980	Air Filter	Gross Alpha	21	9.1	21±2	pCi/filter
December 1980	Air Filter	Gross Beta	19	8.7	28±3	pCi/filter
December 1980	Air Filter	Strontium-90	0	0	LT 1	pCi/filter
December 1980	Air Filter	Cesium-137	19	8.7	19±2	pCi/filter
January 1981	Water	Gross Alpha	9	8.7	10±1	pCi/liter
January 1981	Water	Gross Beta	44	8.7	43±4	pCi/liter
January 1981	Water	Strontium-89	16	8.7	LT 5	pCi/liter
January 1981	Water	Strontium-90	34	2.9	35±4	pCi/liter
January 1981	Milk	Strontium-89	0	0	LT 2	pCi/liter
January 1981	Milk	Strontium-90	20.2	2.6	14±1	pCi/liter
January 1981	Milk	Iodine-131	25.8	10.4	29±3	pCi/liter
January 1981	Milk	Cesium-137	43.5	8.7	47±5	pCi/liter
January 1981	Milk	Barium-140	0	0	LT 25	pCi/liter
January 1981	Milk	Potassium	1551	134	1350±140	pCi/liter
February 1981	Water	Tritium	1760	590	1680±170	pCi/liter
February 1981	Water	Chromium-51	0	0	LT 100	pCi/liter
February 1981	Water	Cobalt-60	25	8.7	29±5	pCi/liter
February 1981	Water	Zinc-65	85	8.7	92±9	pCi/liter
February 1981	Water	Ruthenium-106	0	0	LT 100	pCi/liter
February 1981	Water	Cesium-134	36	8.7	29±5	pCi/liter
February 1981	Water	Cesium-137	4	8.7	9±3	pCi/liter
March 1981	Water	Gross Beta	25	8.7	27±3	pCi/liter
March 1981	Water	Gross Alpha	25	10.4	20±2	pCi/liter
March 1981	Air Filter	Gross Alpha	30	13	30±3	pCi/filter
March 1981	Air Filter	Gross Beta	50	8.7	66±7	pCi/filter
March 1981	Air Filter	Strontium-90	18	2.6	17±4	pCi/filter
March 1981	Air Filter	Cesium-137	14	8.7	15±2	pCi/filter
April 1981	Water	Tritium	2710	615	3000±300	pCi/liter
April 1981	Water	Cesium-134	10	8.7	7±2	pCi/liter
April 1981	Water	Cesium-137	15	8.7	13±1	pCi/liter
April 1981	Water	Strontium-89	38	8.7	35±7	pCi/liter
April 1981	Water	Strontium-90	28	2.6	24±3	pCi/liter
April 1981	Water	Radium-226	15.0	4.0	13.2±1.3	pCi/liter
April 1981	Water	Radium-228	12.0	3.1	10±2	pCi/liter
April 1981	Water	Uranium	12	10	6±2	pCi/liter
May 1981	Water	Strontium-89	36	8.7	29±3	pCi/liter
May 1981	Water	Strontium-90	22	2.6	26±3	pCi/liter
May 1981	Water	Strontium-89				
May 1981	Water	Strontium-90				
May 1981	Water	Iodine-131				
May 1981	Water	Cesium-137				

*When analyses of a particular type result in concentrations below the detection limits, the term "LT" is used to indicate "Less Than" values for that measurement based on 3σ (99.5%) confidence level.

EPA INTERCOMPARISON RESULTS

1981

Month/Year	Sample Type	Analysis	Agency Value	Control Limits (3σ,n=)	MWF Measured ±2σ error	Units
May 1981	Water	Barium-140	0	0	LT 20	pCi/liter
May 1981	Water	Potassium	1559	135	1400±140	mg/liter
June 1981	Water	Chromium-51	0	0	LT 20	pCi/liter
June 1981	Water	Cobalt-60	17	8.7	16±2	pCi/liter
June 1981	Water	Zinc-65	0	0	LT 20	pCi/liter
June 1981	Water	Ruthenium-106	15	8.7	13±4	pCi/liter
June 1981	Water	Cesium-134	21	8.7	13±2	pCi/liter
June 1981	Water	Cesium-137	31	8.7	25±3	pCi/liter
June 1981	Water	Tritium	1950	596	2300±200	pCi/liter
June 1981	Water	Radium-226	6.7	1.7	5.9±0.4	pCi/liter
June 1981	Water	Radium-228	8.0	2.1	10.6±1.6	pCi/liter
June 1981	Air filter	Gross alpha	28	12	31±6	pCi/filter
June 1981	Air filter	Gross beta	54	8.7	74±8	pCi/filter
June 1981	Air filter	Strontium-90	19	2.6	21±5	pCi/filter
June 1981	Air filter	Cesium-137	16	8.7	15±2	pCi/filter
July 1981	Food	Strontium-89	44	8.7	38±4	pCi/kilogram
July 1981	Food	Strontium-90	31	2.8	28±3	pCi/kilogram
July 1981	Food	Iodine-131	82	14	75±8	pCi/kilogram
July 1981	Food	Cesium-137	45	8.7	40±4	pCi/kilogram
July 1981	Food	Barium-140	0	0	<25	pCi/kilogram
July 1981	Food	Potassium	2640	229	2267±227	mg/kilogram
July 1981	Milk	Strontium-89	25	8.7	13±3	pCi/liter
July 1981	Milk	Strontium-90	17	2.6	16±3	pCi/liter
July 1981	Milk	Iodine-131	0	0	<5	pCi/liter
July 1981	Milk	Cesium-137	31	8.7	35±12	pCi/liter
July 1981	Milk	Barium-140	0	0	<16	pCi/liter
July 1981	Milk	Potassium	1600	139	1463±305	mg/liter
August 1981	Water	Iodine-131	73	13	53±11	pCi/liter
August 1981	Water	Tritium	2630	613	2973±878	pCi/liter
August 1981	Water	Uranium	23	10	14±2	pCi/liter
September 1981	Water	Strontium-89	23	8.7	18±5	pCi/liter
September 1981	Water	Strontium-90	11	2.6	14±2	pCi/liter
September 1981	Urine	Tritium	2050	599	2166±624	pCi/liter
September 1981	Water	Radium-226	8.3	2.2	8.4±0.8	pCi/liter
September 1981	Water	Radium-228	11.7	3.0	4.6±3.7	pCi/liter
September 1981	Water	Gross alpha	33	4	32±14	pCi/liter
September 1981	Water	Gross beta	28	8.7	30±6	pCi/liter
September 1981	Air filter	Gross alpha	25	11	25±6	pCi/filter
September 1981	Air filter	Gross beta	52	8.7	71±7	pCi/filter
September 1981	Air filter	Strontium-90	16	2.6	18±2	pCi/filter
September 1981	Air filter	Cesium-137	19	8.7	20±2	pCi/filter

1981

Month/Year	Sample Type	Analysis	Agency Value	Control Limits (3σ,n=)	MWF Measured ±2σ error	Units
October 1981	Water	Gross alpha	80	35	91±26	pCi/liter
October 1981	Water	Gross beta	96	8.7	112±11	pCi/liter
October 1981	Water	Cobalt-60	0	0	LT 5	pCi/liter
October 1981	Water	Strontium-89	21	8.7	13±6	pCi/liter
October 1981	Water	Strontium-90	14.4	2.6	14.6±2.0	pCi/liter
October 1981	Water	Cesium-134	12	2.6	14±2	pCi/liter
October 1981	Water	Cesium-137	15	8.7	20±14	pCi/liter
October 1981	Water	Radium-226	12.7	3.3	11.8±3.5	pCi/liter
October 1981	Water	Radium-228	9.2	2.4	8.3±5.1	pCi/liter
October 1981	Water	Gross Uranium	15	10	9±2	pCi/liter
October 1981	Milk	Strontium-89	23	8.7	24±8	pCi/liter
October 1981	Milk	Strontium-90	18	2.6	14±5	pCi/liter
October 1981	Milk	Iodine-131	52	10	58±11	pCi/liter
October 1981	Milk	Cesium-137	25	8.7	29±9	pCi/liter
October 1981	Milk	Barium-140	0	0	LT 16	pCi/liter
October 1981	Milk	Potassium	1530	133	1700±240	mg/liter
November 1981	Food	Strontium-89	38	8.7	41±6	pCi/kilogram
November 1981	Food	Strontium-90	23	2.6	21±5	pCi/kilogram
November 1981	Food	Cobalt-60	30	8.7	35±8	pCi/kilogram
November 1981	Food	Cesium-137	33	8.7	32±8	pCi/kilogram
November 1981	Food	Barium-140	0	0	LT 31	pCi/kilogram
November 1981	Food	Potassium	2730	236	2700±270	mg/kilogram
December 1981	Water	Tritium	2700	615	2950±127	pCi/liter

1981

EPA INTERCOMPARISON RESULTS

(Lab Performance Evaluation Study-EMSL-LV)

Sample Type	Analysis	Agency Value	Control Limits (3σ,n=1)	MWF Measured ±2σ error	Units
Water	Gross alpha	39	10	39±4	pCi/liter
Water	Gross beta	60	5	70±7	pCi/liter
Water	Cobalt-60	12	5	LT20	pCi/liter
Water	Cesium-134	12	5	11±2	pCi/liter
Water	Cesium-137	20	5	20±2	pCi/liter
Water	Ruthenium-106	0	-	LT100	pCi/liter
Water	Zinc-65	0	-	LT20	pCi/liter
Water	Strontium-89	6	5	5±1	pCi/liter
Water	Strontium-90	0	-	LT 1	pCi/liter
Water	Radium-226	12.8	1.8	12.6±1.3	pCi/liter
Water	Uranium	5	6	4±2	pCi/liter

USDOE QUALITY ASSESSMENT PROGRAM

1981

Sample Type	Nuclide	Known	Measured ±2σ error	Units
Air (81-04)	Be-7	0.244 E+04	0.247±0.015 E+04	pCi/filter
Air (81-04)	Mn-54	0.117 E+03	0.093±0.006 E+03	pCi/filter
Air (81-04)	Sr-89	0.450 E+02	0.515±0.087 E+02	pCi/filter
Air (81-04)	Sr-90	0.630 E+01	<0.100 E+02	pCi/filter
Air (81-04)	Zr-95	0.122 E+03	0.828±0.048 E+02	pCi/filter
Air (81-04)	Sb-125	0.139 E+04	0.133±0.006 E+04	pCi/filter
Air (81-04)	Cs-134	0.190 E+04	0.133±0.007 E+04	pCi/filter
Air (81-04)	U	0.223 E+01	0.750±0.053 E+01	pCi/filter
Soil (81-04)	K-40	0.213 E+02	0.290±0.017 E+02	pCi/g
Soil (81-04)	Cs-137	0.200 E+00	0.250±0.070 E+00	pCi/g
Soil (81-04)	Ra-226	0.770 E+00	0.668±0.057 E+00	pCi/g
Tissue (81-04)	K-40	0.158 E+01	0.433±0.058 E+01	pCi/g
Tissue (81-04)	Sr-90	0.240 E+01	0.188±0.016 E+01	pCi/g
Tissue (81-04)	Ra-226	0.450 E+00	0.433±0.058 E+00	pCi/g
Tissue (81-04)	U	0.290 E-01	0.850±0.333 E-01	pCi/g
Vegetation (81-04)	K-40	0.224 E+03	0.277±0.018 E+03	pCi/g
Vegetation (81-04)	Sr-90	0.560 E+01	0.258±0.016 E+01	pCi/g
Vegetation (81-04)	Cs-137	0.230 E+00	0.200±0.058 E+00	pCi/g
Vegetation (81-04)	U	0.310 E+00	0.133±0.058 E+00	pCi/g
Water (81-04)	H-3	0.246 E+02	0.197±0.012 E+02	pCi/ml
Water (81-04)	Co-57	0.118 E+01	0.243±0.018 E+01	pCi/ml
Water (81-04)	Co-60	0.129 E+01	0.133±0.006 E+01	pCi/ml
Water (81-04)	Sr-90	0.440 E-01	0.405±0.063 E-01	pCi/ml
Water (81-04)	Cs-137	0.137 E+01	0.150±0.012 E+01	pCi/ml
Water (81-04)	Ce-141	0.527 E+01	0.193±0.012 E+01	pCi/ml
Water (81-04)	U	0.145 E-01	0.200±0.026 E-01	µg/ml
Water (81-04)	U	0.102 E-01	0.750±0.140 E-02	pCi/ml

1981

TLD Intercomparison Badges
Irradiated by Battelle Northwest Labs

	Total mR less transportation control							
	1st Qtr		2nd Qtr		3rd Qtr		4th Qtr	
Badge	Known	Measured	Known	Measured	Known	Measured	Known	Measured
A	18.0	18.5±4.1	18.0	17.8±5.0	20.0	25.5±4.8	90.0	86.2±15.5
B	26.0	29.1±2.9	24.0	24.5±5.5	28.0	31.4±2.5	51.0	53.6±5.3
C	35.0	29.1±6.1	38.0	34.1±9.0	16.0	17.9±2.7	100.0	93.4±10.1
D	47.0	46.8±5.4	44.0	43.2±6.0	32.0	36.5±3.5	42.0	41.9±19.7
E	57.0	42.1±6.0	59.0	61.4±6.5	40.0	41.2±4.0	18.0	20.1±3.4
F	69.0	77.6±12.5	69.0	71.2±19.0	53.0	55.4±15.2	29.0	32.0±3.0
G	76.0	65.6±6.6	73.0	74.1±21.6	69.0	75.1±13.2	34.0	32.0±3.0
H	88.0	88.6±12.6	79.0	80.8±17.3	82.0	80.4±10.7	82.0	79.0±8.0
J	100.0	102±10	79.0	79.9±18.2	93.0	86.1±15.5	34.0	38.7±9.3
K	100.0	99±10	99.0	100.2±25.4	100.0	100.4±15.3	74.0	69.2±8.8