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PREOPERATIONAL ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM AT FERMI-2

Annual Report
1979

Prepared for

The Detroit Edison Company

by

Randall C. Smyth

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Northern Environmental Services Division

NUS Corporation
4 Research Place
Rockville, Maryland 20850

Richard W. Englehart

Richard W. Englehart, Ph.D.
Project Manager
Manager, Radiological Programs Department

Raphael S. Daniels

Raphael S. Daniels
Manager,
Land Resources Unit

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I. INTRODUCTION

The preoperational radiological environmental monitoring program for Fermi-2 was initiated on March 15, 1978 and will continue until fuel loading, presently scheduled for 1981. This program is being conducted by NUS Corporation under contract with The Detroit Edison Company (Edison). This is the second Annual Report for the radiological environmental monitoring program being conducted under the contract. This report covers the period December 29, 1978 through January 5, 1980 and summarizes the results of measurements and analyses of data obtained from samples collected during this interval.

A. Site and Station Description

Fermi-2 is a BWR designed to operate at a power level of about 1150 megawatts of electrical output with the main condenser circulating water cooled by two natural draft, wet type, hyperbolic cooling towers. The plant is located on approximately 1120 acres about eight miles east-northeast of Monroe, Michigan; thirty miles southwest of downtown Detroit, Michigan; and, twenty-five miles northeast of downtown Toledo, Ohio. Fermi-2, bounded on the east by Lake Erie, is situated in Frenchtown Township in Monroe County, Michigan.

B. Objectives and Overview of Fermi-2 Monitoring Program

United States Nuclear Regulatory Commission (USNRC) regulations require that nuclear power plants be designed, constructed, and operated to keep levels of radioactive material in effluents to unrestricted areas as low as reasonably achievable (ALARA)(10 CFR 50.34). To assure that these criteria are met, each license authorizing reactor operation includes technical specifications (10 CFR 50.36a) governing the release of radioactive effluents.

In-plant monitoring is utilized to assure that these predetermined release limits are not exceeded. However, as a precaution against unexpected and undefined

processes which might allow undue accumulation of radioactivity in any sector of man's environment, a program for monitoring the plant environs is also included.

The regulations governing the quantities of radioactivity in reactor effluents allow nuclear power plants to contribute, at most, only a few percent increase above normal background radioactivity. Background levels at any one location are not constant but vary with time as they are influenced by external events such as cosmic ray bombardment, weapons test fallout, and seasonal variations. These levels also can vary spatially within relatively short distances reflecting variation in geological composition. Because of these spatial and temporal variations, the radiological surveys of the plant environs are divided into preoperational and operational phases. The preoperational phase of the program of sampling and measuring radioactivity in various media permits a general characterization of the radiation levels and concentrations prevailing prior to plant operation along with an indication of the degree of natural variation to be expected. The operational phase of the program obtains data which, when considered along with the data obtained in the preoperational phase, assist in the evaluation of the radiological impact of plant operation.

Implementation of the preoperational monitoring program fulfills the following objectives:

1. Evaluation of procedures, equipment and techniques

2. Identification of potentially important pathways to be monitored after the plant is in operation

3. Measurement of background levels and their variations along potentially important pathways in the area surrounding the plant.

4. Provision of baseline data for statistical comparison with future operational analytical results.

Sampling locations were selected on the basis of local ecology, meteorology, physical characteristics of the region, and demographic and land use features of the site vicinity. The preoperational program was designed on the basis of the USNRC Branch Technical Position on radiological environmental monitoring as issued by the Radiological Assessment Branch (March, 1978).[1] Edison is presently evaluating the parameters associated with expanding the monitoring program to include new guidelines in the USNRC Branch Technical Position on Regulatory Guide 4.8 (November 1979, Revision 1)[2] and pertinent aspects of USNRC Regulatory Guide 1.97, proposed Revision 2 (December 1979).[3]

In 1979, the radiological monitoring program included the measurement of ambient gamma radiation by thermoluminescent dosimetry; the determination of gamma emitters in shoreline sediments and fish (Perca flavescens); the determination of gross beta and gamma emitters in air particulates; the measurement of gross beta in drinking water; the determination of gamma emitters and tritium in drinking water and surface water; and the determination of gamma emitters in milk at the control location.

II. PROGRAM DESCRIPTION

Fifteen (15) locations within a radius of about 15 miles from the Fermi-2 site were monitored. The number and location of monitoring points were determined by considering the locations where the highest offsite environmental concentrations have been predicted from plant effluent source terms, site hydrology, and site meteorological conditions. Other factors considered were population distribution, ease of access to sampling stations, security and future program integrity.

The preoperational environmental radiological monitoring program for Fermi-2 is summarized in Table 1. Sample collection at Station 15 (drinking water-control) and the indicator milk locations are expected to be implemented in 1980. Gaseous radioiodine monitoring is also scheduled to begin in late 1980. This implementation will be correlated with the finalization of the fuel load date for Fermi-2. Table 2 describes sample locations, associated media, and approximate distance and direction from the site. Figures 1 and 2 designate sampling locations by station number.

TABLE 1

Environmental Radiological Monitoring Program, 1979

Sample Media	Station Number and Location		Sampling Frequency	Analysis Type	Analysis Frequency
Direct Radiation	1	Telephone pole #DE6935 H-6	Continuous sampling TLDs changed quarterly (2 TLDs/ station	Gamma dose	Quarterly
	2	Tree at the termination of Brancho Street			
	3	Tree adjacent to Swan Boat Club			
	4	Site Boundary and Toll Road, Telephone Pole #DE 762 356 C			
	5	Site Boundary and Toll Road, Telephone Pole #DE 56R 776 35 G5			
	6	Site Boundary and Toll Road, Telephone Pole			
	7	Doty Farm, N. Custer Rd. (Control)			
Fish — Yellow Perch (Perca flavescens)	16	Fermi-2 discharge	Semi-annually	Gamma isotopic (edible portion)	Semi-annually (1)
	11	Control in vicinity of Celeron Island			
Shoreline Sediments (2)	8	Pt. Aux Peaux, 110' offshore sighting directly to land-based water tower			
	9	Fermi-2 discharge	Semi-annually	Gamma isotopic	Semi-annually (1)
	10	Estral Beach, 300' offshore sighting directly to land-based windmill			

(1) Samples analyzed in duplicate / replicate.

(2) Lake Erie current patterns in the Fermi-2 area fluctuate in opposite directions along shoreline contours for approximately equal durations during an annual period. As a result, no "control" is established.

TABLE 1 (continued)

Environmental Radiological Monitoring Program, 1979

Sample Media	Station Number and Location	Sample Frequency	Analysis	
			Type	Frequency
Fish Direct Radiation Shoreline Sediments	Same as first year	Same as first year	Same as first year	
Airborne Particulates	1 Telephone Pole #DE6935 H-6 4 Site Boundary and Toll Road, Telephone Pole #DE 762 356 C 5 Site Boundary and Toll Road, Telephone Pole #DE 56R 776 35 G5 7 Doty Farm, N. Custer Rd. (Control)	Continuous sampling, change filters weekly	Gross beta[2]	Weekly[1] - following each filter change
			Gamma Isotopic	Quarterly-Composi by location
Surface Water	12 Unit 1 Raw Lake Water Intake Structure 14 Trenton Power Plant Intake Structure (Screenhouse #2) (Control)	Monthly	Gamma isotopic	Monthly[1]
			Tritium	Quarterly-[1] composite by location
Drinking Water	13 Monroe Water Station	Monthly	Gross beta[2]	Monthly[1]
			Gamma isotopic	Monthly[1]
			Tritium	Quarterly-[1] composite by location

TABLE 1 (continued)

Environmental Radiological Monitoring Program, 1979

Sample Media	Station Number and Location	Sampling Frequency	Analysis	
			Type	Frequency
Milk	Indicator locations(3)	1. Monthly 2. Semi-monthly when animals on pasture	Gamma isotopic Iodine-131	1. Monthly 2. Semi-month when anima on pasture
	7 Doty Farm (Control)			

(1) Samples analyzed in duplicate / replicate.
(2) If gross beta in air or water is greater than 10 times the mean of control samples for any medium, gamma isotopic analysis performed on individual samples.
(3) To be finalized after milch animal census is conducted.

Preoperational Environmental Radiological Monitoring Program, Fermi-2
Sample Locations and Associated Media

Station Number (1)	Direction	Distance from Reactor (Approx.)	Description	Media
1	NE	1.3 mi.	Telphone Pole #DE6935 H-6	Direct Radiation Radioiodine Particulates
2	NNE	1.1 mi.	Tree at the termination of Brancho Steet (private res dence)	Direct Radiation
3	N	1.1 mi.	Tree adjacent to Swan Boat Club	Direct Radiation
4	NNW	0.6 mi.	Site Boundary and Toll Road, Telephone Pole #DE 762 356 C	Direct Radiation Radioiodine Particulates
5	NW	0.6 mi.	Site Boundary and Toll Road, Telephone Pole #DE 56R 776 35 G5	Direct Radiation Radioiodine Particulates
6	WNW	0.6 mi.	Site Boundary and Toll Road, Telephone Pole	Direct Radiation
7	W	15 mi.	Doty Farm, N. Custer Road (Control)	Direct Radiation Radioiodine Particulates Milk
8	S	0.9 mi.	Pt. Aux Peaux, 110 ft. offshore sighting directly to land based water tower	Sediment
9	E	0.2 mi.	Fermi-2 discharge	Sediment
10	NE	1.1 mi.	Estral Beach, 300' offshore sighting directly to land based windmill	Sediment

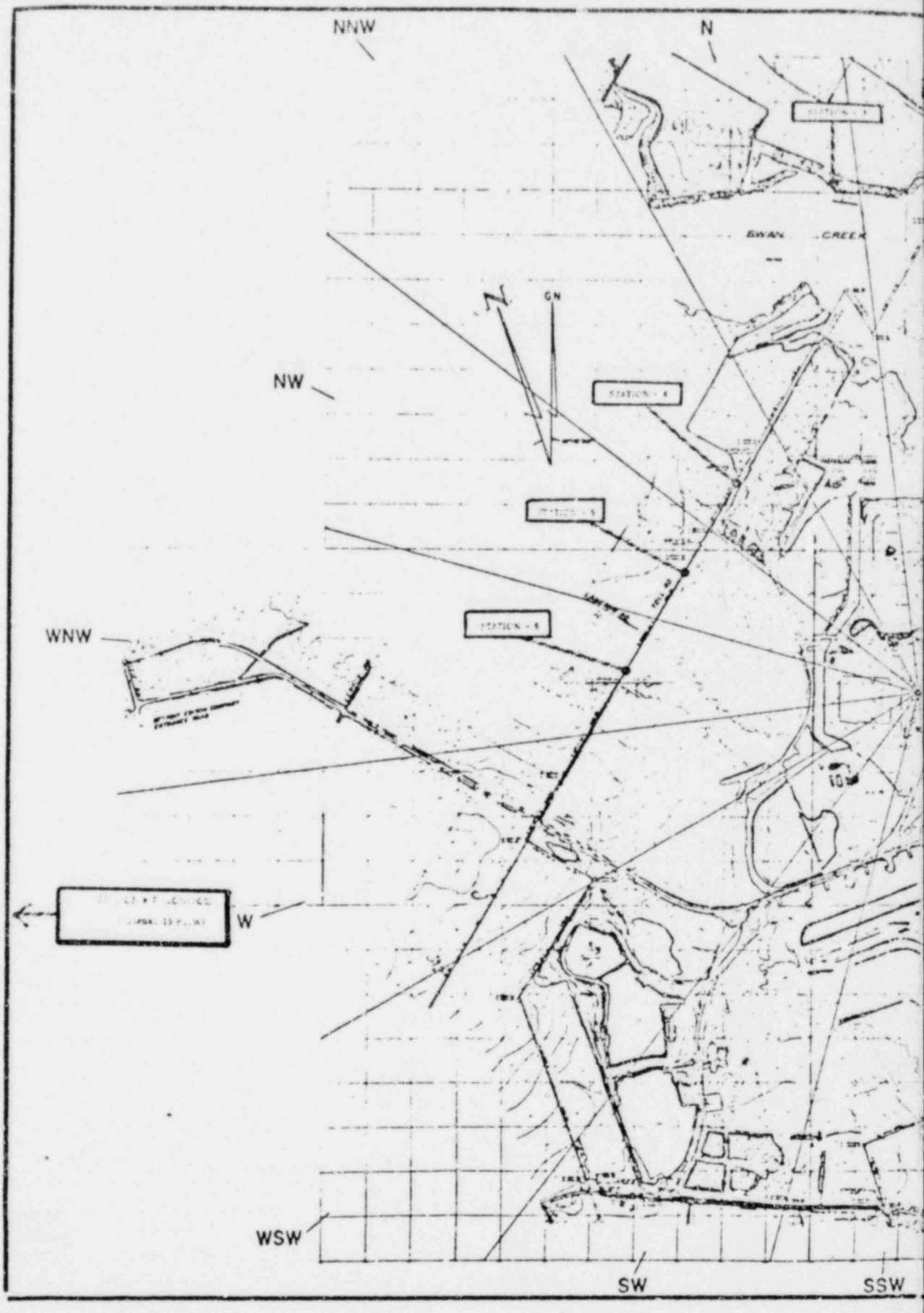
TABLE 2.6 (continued)

Preoperational Environmental Radiological Monitoring Program, Fermi-2
Sample Locations and Associated Media

Station Number[1]	Direction	Distance from Reactor (Approx.)	Description	Media
11	NNE	9.5 mi.	Control in vicinity of Celeron Island	Perca flavescens
12	SSE	0.4 mi.	Unit 1 Raw Lake Water Intake Structure	Surface Water
13	S	1.2 mi.	Monroe Water Station	Drinking Water
14	NE	13 mi.	Trenton Power Plant Intake Structure (Screenhouse #2)	Surface Water
15	NNE	20 mi.	Detroit Water Station[2] (Fighting Island)	Drinking Water
16	E	0.4 mi.	Fermi-2 discharge (1200 ft. offshore)	Perca flavescens

(1) Indicator milk sampling locations will be finalized after milch animal census is conducted.

(2) Access to this location not finalized.


NNW
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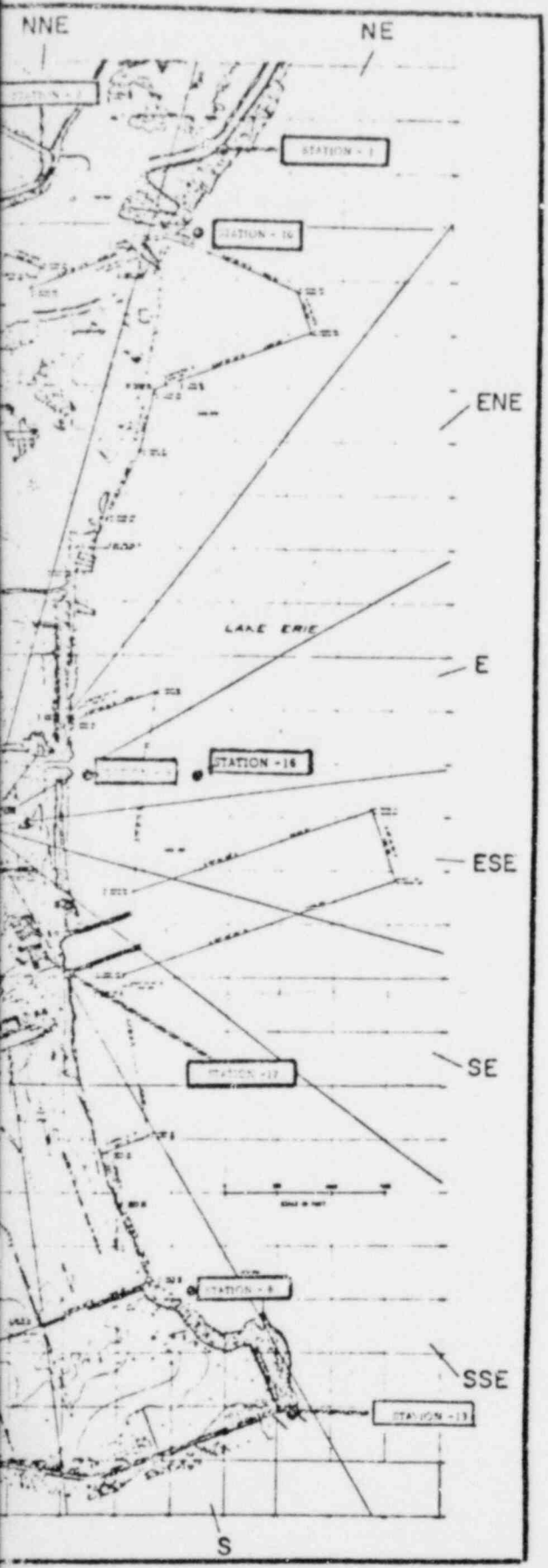
SWAN CREEK
GN

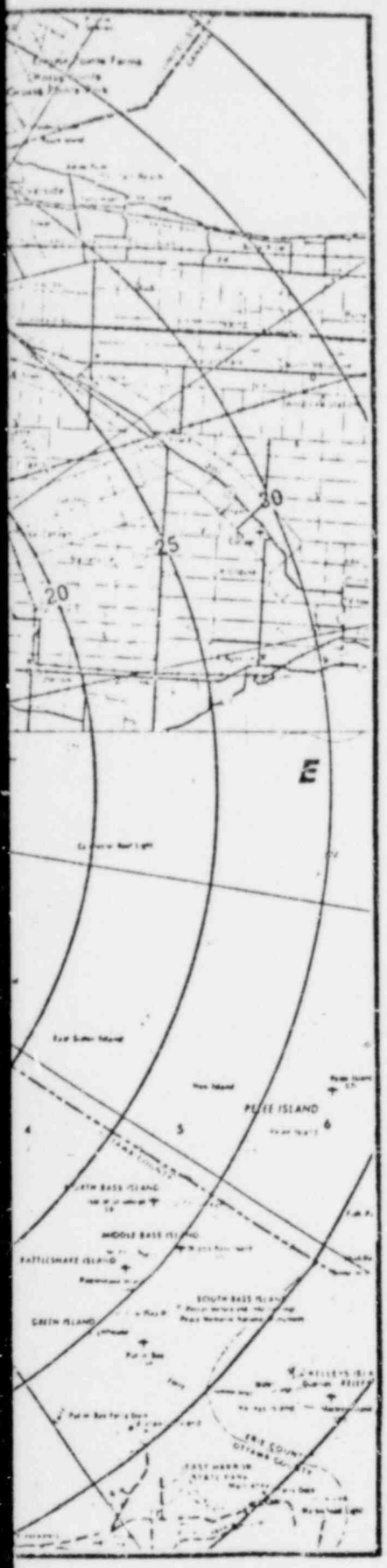


ENRICO FERMI ATOMIC POWER PLANT
UNIT 2

Figure 1

Sampling Locations-By Station Number
(Immediate Vicinity of Fermi-2)


N
DETROIT
DEARBORN
STATION - 15
STATION - 14
STATION - 11
STATION - 7
10
5
W
E
S



ENRICO FERMI ATOMIC POWER PLANT
UNIT 2

Figure 2
Sampling Locations By Station Number
(Greater Than 5 Miles)

III. SAMPLING METHODS AND PROCEDURES

To derive meaningful and useful data from the environmental radiological monitoring program, sampling methods and procedures are required which will provide samples representative of potential pathways of the area. During the preoperational phase of the program, samples are collected and analyzed not only to obtain background radiological levels, but at the same time to acquire experience with the sampling methodology and procedural format dictated by site specific requirements.[4]

A. Direct Radiation

Thermoluminescent dosimeters (TLDs) were used to determine the direct (ambient) radiation levels at seven (7) monitoring points. The locations were selected by ranking the mixed-mode χ/Q values. Stations 1 through 6 are situated in the six calculated highest sectors around the plant site. Station 7, the control, is located approximately 15 miles west of Fermi-2 in the least prevalent wind direction. The selection of the TLD locations follows the guidelines outlined in the USNRC Branch Technical Position on Radiological Environmental Monitoring (March, 1978).[1] Duplicate dosimeters of $CaSO_4$: Dy in teflon, were deployed at each location and exchanged on a quarterly basis by an NUS environmental scientist.

To minimize the in-transit dose contribution, the dosimeters were annealed close to the site within 24 hours prior to field placement. Freshly annealed control dosimeters were sent along with the exposed field dosimeters to determine the exposure received by the dosimeters in transit from the site to readout in Rockville, Maryland. Calibrations of the dosimeters were performed by obtaining accurately known Cs-137 radiation exposures.

B. Fish

Because of its importance to both commercial and recreational fishermen, and the predominance of the species in local waters, yellow perch (Perca flavescens) were

collected for the monitoring program. As described in Table 1, perch were collected from Lake Erie in the vicinity of the Fermi-2 discharge (Station 16). The control location in the vicinity of Celeron Island (Station 11) approximately nine (9) miles NNE of the plant yielded only the fall sample as discussed in Appendix A.

Using a passive collection technique, an experimental gill net (mesh ranging from approximately 0.5 to 3.5 inches to decrease size selectivity) was set at each sampling location by biologists from The Detroit Edison Company. The net was retrieved after approximately 24 hours. Entrapped, surviving species other than yellow perch were released.

C. Shoreline Sediments

Sediments were collected from three (3) locations by biologists from The Detroit Edison Company. Samples were taken with a Ponar dredge from the vicinities of Point Aux Peaux (Station 8), Fermi-2 discharge (Station 9), and Estral Beach (Station 10). The locations are shown in Figure 1.

D. Airborne Particulates

Airborne particulate sampling was initiated on December 30, 1978 after approximately two months of trial operation. Sampling was performed by a RADeCO continuous low volume air sampler (Model HD-28B) by which particulates were collected by drawing air through a 47-millimeter diameter glass fiber filter. The sampling systems are housed in ventilated wooden cabinets bolted to telephone poles.

The air particulate sampling network consists of four (4) stations; one is located at Estral Beach, two are located at the site boundary along Toll Road; a control station is situated at the Doty Farm, approximately 15 miles west of Fermi-2. These locations are identified in Figures 1 and 2 and described in Table 3.

The samplers were run continuously and the filters exchanged weekly. The elapsed time of sampling was recorded on an elapsed time meter. Total air volume was

calculated from the initial and final flow rates recorded by the Site Technician. Calibrations of each air sampler were performed on December 30, 1978, April 1, 1979, July 8, 1979, September 29, 1979, January 5, 1980, and following major repairs.

E. Water

The water sampling network consists of three (3) stations, two (2) surface and (1) drinking, as identified in Figures 1 and 2 and described in Table 2. A Horizon Interval Sampler was used to collect a small volume of water per day. This was automatically composited into a five (5) gallon container. The sample was collected monthly by the Site Technician. The collection of drinking water was scheduled to begin January 1979 at Station 15 (Detroit Water Station, Allen Park, Michigan). The appropriate instrumentation will be installed and sampling initiated by the Site Technician immediately upon notification by Edison that access to Station 15 has been granted by the City of Detroit.

F. Milk

Milk samples were collected monthly from the Doty Farm (Station 7) on North Custer Road. As a preservative, formalin was added to each sample at the time of collection.

On April 22, 1979 and May 13, 1979, milk was collected for I-131 analysis. Iodine carrier and formalin were added to the samples at the time of collection. Sampling and analysis for this isotope was ended after the May sample as a result of the revised fuel load date for Fermi-2.

IV. SUMMARY AND DISCUSSION OF 1979 ANALYTICAL RESULTS

Data from the radiological analyses of environmental media collected during the report period are tabulated and discussed below. The procedures and specifications followed in the laboratory for these analyses are as required in Section 5.0 of the Environmental Systems Group Quality Assurance Manual, Issue B, of NUS Corporation and are detailed in the NUS Radiological Laboratory Manual - "Environmental Monitoring and Radiological Services Procedures/Work Instructions."

Radiological analyses of environmental media characteristically approach and frequently fall below the detection limits of state-of-the-art measurement methods.[4] The use of "LT" in the data tables is the equivalent of the less than symbol (<) and is consistent with the NUS Radiological Laboratory practice of data reporting. The number following the "LT" is a result of the lower limit of detection (LLD) calculation as defined in Appendix D. NUS analytical methods meet the LLD requirements addressed in Table 2 of the USNRC Branch Technical Position (November 1979, Revision 1).[2]

Tables 3 through 12 give the radioanalytical results for individual samples. A statistical summary of the results appears in Table 13. The reported averages are based only on concentrations above the limit of detection. In Table 13, the fraction (f) of the total number of analyses which were detectable follows in parentheses. Also given in parentheses are the minimum and maximum values of detectable activity during the report period.

A. Direct Radiation

Environmental radiation dose rates determined by thermoluminescent dosimeters (TLDs) are given in Table 3. Duplicate TLD badges of four read-out areas each were deployed at each location quarterly. The mean values of four readings (corrected individually for response to a known dose and for in-transit exposure) are reported as "a" and "b".

A statistical summary of the data is included in Table 13. Individual measurements of external radiation levels in the environs of the Fermi-2 site ranged from 0.11 to 0.19 mR/day. Annual levels ranged from 47 to 62 mR/year. Oakley[5] calculates an ionizing radiation dose equivalent of 88.8 mR/year for Michigan, including a terrestrial component of 45.6 mR/year and an ionizing cosmic ray component of 43.2 mR/year. Since Oakley's values represent averages covering wide geographical areas, the measured ambient radiation average of 56 mR/year for the immediate locale of Fermi-2 may not be inconsistent with Oakley's observations. Significant variations occur between geographical areas as a result of geologic composition and altitude differences. Temporal variations result from changes in cosmic ray intensity, local human activities and factors such as ground cover and soil moisture.

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1979

Direct Radiation - Analytical Results
(Results in mR/day ± 2σ (%))[1]

Quarter	Sampling Period		Station Number 1	2	3	4	5	6	7
1	12-29-78	a	0.13 ± 7	0.16 ± 10	0.14 ± 16	0.16 ± 6	0.17 ± 8	0.13 ± 10	0.16 ± 4
	to	b	0.14 ± 10	0.14 ± 10	0.16 ± 6	0.15 ± 10	0.17 ± 9	0.15 ± 10	0.17 ± 8
	4-1-79	mean[2]	0.14 ± 8	0.15 ± 10	0.15 ± 11	0.16 ± 8	0.17 ± 8	0.14 ± 10	0.16 ± 6
2	4-1-79	a	0.12 ± 9	0.14 ± 10	0.15 ± 14	0.16 ± 10	0.18 ± 7	0.15 ± 9	0.18 ± 19
	to	b	0.11 ± 18	0.14 ± 10	0.15 ± 9	0.15 ± 12	0.15 ± 9	0.14 ± 6	0.18 ± 7
	7-8-79	mean	0.12 ± 14	0.14 ± 10	0.15 ± 12	0.16 ± 11	0.16 ± 8	0.14 ± 8	0.18 ± 13
3	7-8-79	a	0.12 ± 14	No data[3]	0.14 ± 24	0.18 ± 13	0.16 ± 17	0.15 ± 11	0.16 ± 9
	to	b	0.13 ± 12		0.15 ± 11	0.16 ± 13	0.15 ± 12	0.13 ± 16	0.17 ± 15
	9-29-79	mean	0.12 ± 13		0.14 ± 18	0.17 ± 13	0.16 ± 14	0.14 ± 14	0.16 ± 12
4	9-29-79	a	0.12 ± 21	0.16 ± 12	0.16 ± 12	0.16 ± 10	0.16 ± 9	0.16 ± 10	0.17 ± 11
	to	b	0.14 ± 11	0.16 ± 11	0.17 ± 10	0.17 ± 10	0.18 ± 9	0.16 ± 11	0.19 ± 20
	1-5-80	mean	0.13 ± 16	0.16 ± 12	0.16 ± 11	0.16 ± 10	0.17 ± 9	0.16 ± 10	0.18 ± 16

(1) 2 x standard deviation of four (4) read-out areas(%)

(2) Simple average (rounded) ± simple average (rounded)

(3) TLDs vandalized

B. Fish

The results of gamma analyses performed on yellow perch (Perca flavescens) collected during 1979 are presented in Table 4. A statistical evaluation is given in Table 13. Naturally occurring K-40 constituted the major detectable nuclide activity in the flesh portion of the fish. The Cs-137 concentrations are attributable to global fallout. The other isotopes identified in the samples are part of the decay chains of naturally occurring uranium and thorium.

Environmental Radiological Monitoring Program, Fermi-2

Preoperational, 1979

Fish-Yellow Perch (Perca flavescens), Edible Portion

Analytical Results

Quarter	Collection Date	Sampling Location		Gamma-Emitting Nuclides pCi/kg, wet ± 2σ													
				K-40	Mn-54	Fe-59	Co-58	Co-60	Zn-65	Cs-134	Cs-137	Pb-214	Pb-212	Bi-214	Tl-208	Ra-226	Others
2	6-15-79	16	a	3600±1100	LT120[2]	LT180	LT110	LT100	LT180	LT70	LT90	ND[3]	ND	ND	ND	ND	ND
			b	4100±400	LT50	LT140	LT70	LT30	LT90	LT30	40±20	50±30	50±20	ND	ND	ND	ND
			mean[1]	3860±800	LT80	LT160	LT90	LT60	LT140	LT50	(1/2)[5]	(1/2)	(1/2)				
		11[4]															
4	10-3-79	16	a	3900±300	LT30	LT90	LT40	LT19	LT60	LT17	27±12	ND	35±16	ND	ND	ND	ND
			b[6]	4300±300	LT30	LT80	LT30	LT19	LT50	LT20	20±11	ND	34±16	ND	ND	270±100	ND
			mean	4100±300	LT30	LT80	LT40	LT19	LT60	LT18	24±12		34±16			(1/2)	
		11[7]	a	3300±200	LT12	LT40	LT14	LT11	LT30	LT10	53±8	ND	22±8	ND	ND	ND	ND
			b	3300±200	LT17	LT50	LT20	LT9	LT30	LT10	60±8	ND	25±8	25±22	30±14	ND	ND
			mean	3300±200	LT14	LT40	LT17	LT10	LT30	LT10	59±8		24±8	(1/2)	(1/2)		

(1) Simple average (rounded) ± simple average (rounded)

(2) LT = Less Than

(3) ND = Not Detected

(4) No sample collected

(5) Fraction in parentheses indicates no. of detectables/no. of analyses

(6) Replicate count

(7) Sample composed of both perch and walleye, edible portion

C. Shoreline Sediments

The processes by which radionuclides and stable elements are concentrated in bottom sediments are complex, involving physicochemical interaction in the environment between the various organic and inorganic materials from the watershed. These interactions can proceed by a myriad of steps in which the elements are adsorbed on or displaced from the surfaces of colloidal particles enriched with chelating organic materials. Biological action of bacteria and other benthic organisms also contribute to the concentration of certain elements and in the acceleration of the sedimentation process.

Results of the gamma isotopic analysis of the sediments sampled from the Fermi-2 environment are given in Table 5. The average, fraction of detectables, and range of radionuclide concentrations are summarized in Table 13. Naturally occurring K-40 was the predominant radionuclide detected in the samples.

Cs-137 was identified in the sample collected from Station 9 in June and October. Due to its presence in global fallout as well as the nonhomogeneity typical of sediment samples, the occasional detection of this isotope is not unusual.

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1979

Shoreline Sediments - Analytical Results

Quarter	Collection Date	Sampling Location		Gamma-Emitting Nuclides, pCi/kg, dry, ± 2σ					
				U daughters	Th daughters	K-40	Cs-134	Cs-137	Others
2	6-12-79	8	a	360 ± 100	180 ± 120	11000 ± 1200	LT 50[2]	LT 100	ND[3]
			b	300 ± 110	220 ± 120	11000 ± 1200	LT 50	LT 90	ND
			mean[1]	330 ± 100	200 ± 120	11000 ± 1200	LT 50	LT 100	
	6-12-79	9	a	780 ± 220	570 ± 220	15000 ± 1800	LT 120	400 ± 90	ND
			b	910 ± 230	640 ± 580	16000 ± 1800	LT 100	250 ± 80	ND
			mean	840 ± 220	600 ± 400	16000 ± 1800	LT 110	320 ± 80	
	6-12-79	10	a	260 ± 120	200 ± 120	14000 ± 1300	LT 50	LT 140	ND
			b	360 ± 180	240 ± 120	14000 ± 1300	LT 50	LT 70	ND
			mean	310 ± 150	220 ± 120	14000 ± 1300	LT 50	LT 100	
4	10-3-79	8	a	410 ± 120	270 ± 70	11000 ± 1000	LT 60	LT 80	ND
			b	370 ± 80	220 ± 70	11000 ± 1000	LT 50	LT 80	ND
			mean	390 ± 100	240 ± 70	11000 ± 1000	LT 60	LT 80	
	10-3-79	9	a	1000 ± 170	670 ± 130	17000 ± 2000	LT 140	1000 ± 130	ND
			b	1000 ± 150	570 ± 110	18000 ± 2000	LT 100	1100 ± 100	ND
			mean	1000 ± 160	620 ± 120	18000 ± 2000	LT 120	1000 ± 120	
	10-3-79	10	a	280 ± 40	140 ± 20	14000 ± 1000	LT 30	LT 30	ND
			b	260 ± 70	190 ± 50	12000 ± 1000	LT 50	LT 60	ND
			mean	270 ± 60	180 ± 40	13000 ± 1000	LT 40	LT 40	

(1) Simple average (rounded) ± simple average (rounded)

(2) LT = Less than

(3) ND = Not detected

D. Airborne Particulates

The weekly gross beta results for airborne particulates are listed in Table 6. The results of gamma analyses performed on quarterly composited filters, by location, are given in Table 7. A statistical summary of the data is provided in Table 13.

In considering tabulated results which include gross activity measurements, it is important to keep in mind the inherent limitations of gross beta counting for mixtures of unknown activities. The counting efficiency of an unknown mixture of activities varies considerably with the particle energy and the amount of absorbing material in the sample. Because of this, the results of gross activity measurements are difficult, if not impossible, to interpret.

As indicated in Table 7, the majority of gamma emitting nuclides identified in the quarterly composite samples were of natural origin. The detection of Ce-144 in the Station 5 composite for Q2 and the occasional identification of Cs-137 are likely to be attributable to global fallout.

Table 5

Environmental Radiological Monitoring Program, Farm-2
Preoperational, 1979

Air Particulates
Analytical Results - Gross Beta

Results in units of 10^{-3} pCi/m^3 ± 2σ

Month	Sampling Period		Station Number 1	4	5	7	Average[1]
January	12/30/78	a	42 ± 4	60 ± 5	39 ± 4	41 ± 4	
	to	b[2]	39 ± 6	49 ± 7	38 ± 6	35 ± 6	
	1/6/79	mean[3]	40 ± 5	54 ± 6	38 ± 5	38 ± 5	42 ± 15
	1/6/79	a	44 ± 7	76 ± 9	53 ± 7	67 ± 8	
	to	b	43 ± 7	70 ± 3	48 ± 7	65 ± 8	
	1/12/79	mean	44 ± 7	73 ± 6	50 ± 7	66 ± 8	58 ± 27
	1/12/79	a	50 ± 6	65 ± 7	78 ± 7	69 ± 3	
	to	b	53 ± 6	77 ± 7	83 ± 7	70 ± 7	
	1/20/79	mean	52 ± 6	71 ± 7	80 ± 7	70 ± 5	68 ± 23
	1/20/79	a	23 ± 5	53 ± 7	63 ± 7	44 ± 6	
	to	b	22 ± 5	60 ± 7	63 ± 7	47 ± 7	
	1/27/79	mean	22 ± 5[4]	56 ± 7	63 ± 7	46 ± 6	55 ± 17
February	1/27/79	a	24 ± 5	31 ± 6	31 ± 5	19 ± 5	
	to	b	26 ± 5	26 ± 6	33 ± 6	28 ± 6	
	2/3/79	mean	25 ± 5	28 ± 6	32 ± 6	24 ± 6	27 ± 7
	2/3/79	a	79 ± 8	110 ± 10	100 ± 9	90 ± 9	
	to	b	61 ± 8	86 ± 9	83 ± 8	70 ± 8	
	2/9/79	mean	70 ± 8	98 ± 10	92 ± 8	80 ± 8	85 ± 25
	2/9/79	a	40 ± 5	56 ± 6	52 ± 6	51 ± 6	
	to	b	44 ± 6	59 ± 6	60 ± 6	52 ± 6	
	2/17/79	mean	42 ± 6	58 ± 6	56 ± 6	52 ± 6	52 ± 14

TABLE C-1 (Continued)

Environmental Radiological Monitoring Program, Fermi 2
Preoperational, 1979

Air Particulates
Analytical Results - Gross Beta

Results in units of 10^{-3} pCi/m^3 ± 2σ

Month	Sampling Period		Station Number 1	4	5	7	Average[1]
February	2/17/79	a	43 ± 6	56 ± 7	63 ± 7	58 ± 7	
(cont.)	to	b	46 ± 6	56 ± 7	65 ± 7	58 ± 7	
	2/24/79	mean	44 ± 6	56 ± 7	64 ± 7	58 ± 7	56 ± 17
March	2/24/79	a	41 ± 6	63 ± 7	64 ± 6	57 ± 7	
	to	b	40 ± 5	61 ± 7	63 ± 6	58 ± 6	
	3/4/79	mean	40 ± 6	62 ± 7	64 ± 6	58 ± 6	56 ± 22
	3/4/79	a	30 ± 6	44 ± 7	43 ± 6	37 ± 7	
	to	b	32 ± 6	41 ± 7	39 ± 6	34 ± 7	
	3/10/79	mean	31 ± 6	42 ± 7	41 ± 6	36 ± 7	38 ± 10
	3/10/79	a	40 ± 6	65 ± 8	64 ± 7	57 ± 7	
	to	b	49 ± 6	62 ± 7	67 ± 7	58 ± 7	
	3/17/79	mean	44 ± 6	64 ± 8	66 ± 7	58 ± 7	58 ± 20
	3/17/79	a	31 ± 6	45 ± 7	23 ± 5	36 ± 7	
	to	b	34 ± 6	43 ± 7	23 ± 5	41 ± 7	
	3/23/79	mean	32 ± 6	44 ± 7	23 ± 5	38 ± 7	34 ± 18
	3/23/79	a	34 ± 5	28 ± 5	46 ± 5	47 ± 6	
	to	b	36 ± 5	33 ± 5	55 ± 6	50 ± 6	
	4/1/79	mean	35 ± 5	30 ± 5	50 ± 6[4]	48 ± 6	41 ± 20

Air Particulates
Analytical Results - Gross Beta

Results in units of 10^{-3} pCi/m^3 ± 2σ

Month	Sampling Period		Station Number 1	4	5	7	Average[1]
April	4/1/79	a	30 ± 6	50 ± 7	34 ± 5	33 ± 4	
	to	b	33 ± 6	46 ± 7	39 ± 6	34 ± 4	
	4/8/79	mean	32 ± 6	48 ± 7	36 ± 6	34 ± 4	38 ± 14
	4/8/79	a	10 ± 5	45 ± 8	23 ± 5	29 ± 4	
	to	b	18 ± 6	50 ± 8	26 ± 5	30 ± 4	
	4/14/79	mean	14 ± 6	48 ± 8	24 ± 5	30 ± 4	29 ± 29
	4/14/79	a	41 ± 5	56 ± 7	22 ± 5	33 ± 9	
	to	b	34 ± 5	55 ± 6	28 ± 5	32 ± 9	
	4/22/79	mean	38 ± 5	56 ± 6	25 ± 5	32 ± 9	38 ± 27
	4/22/79	a	115 ± 48	28 ± 6	46 ± 6	22 ± 10	
	to	b	62 ± 5	20 ± 5	42 ± 6	22 ± 11	
	4/29/79	mean	88 ± 26	24 ± 6	44 ± 6	22 ± 10	44 ± 61
May	4/29/79	a	27 ± 5	51 ± 7	8 ± 4	31 ± 7	
	to	b	28 ± 5	44 ± 6	8 ± 4	37 ± 7	
	5/6/79	mean	28 ± 5	48 ± 6	8 ± 4	34 ± 7	30 ± 33
	5/6/79	a	40 ± 5	40 ± 6	22 ± 4	45 ± 10	
	to	b	36 ± 5	37 ± 6	22 ± 4	41 ± 9	
	5/13/79	mean	38 ± 5	38 ± 6	22 ± 4	43 ± 10	35 ± 18

Environmental Monitoring Program, Point
Preoperational, 1979

Air Particulates
Analytical Results - Gross Beta

Results in units of 10^{-3} pCi/m^3 ± 2σ

Month	Sampling Period		Station Number 1	4	5	7	Average[1]
May (cont.)	5/13/79	a	22 ± 5	68 ± 8	29 ± 5	63 ± 11	
	to	b	27 ± 5	68 ± 8	28 ± 5	46 ± 10	
	5/19/79	mean	24 ± 5	68 ± 8	28 ± 5	54 ± 10	44 ± 42
	5/19/79	a	37 ± 5	55 ± 6	24 ± 5	38 ± 7	
	to	b	33 ± 5	51 ± 6	22 ± 5	37 ± 7	
	5/27/79	mean	35 ± 5	54 ± 6	23 ± 5	38 ± 7	38 ± 26
June	5/27/79	a	37 ± 5	53 ± 7	14 ± 2	NS[5]	
	to	b	30 ± 5	52 ± 7	13 ± 2		
	6/3/79	mean	34 ± 5	52 ± 7	14 ± 2		33 ± 38
	6/3/79	a	51 ± 6	66 ± 7	38 ± 4	NS	
	to	b	44 ± 6	68 ± 7	37 ± 4		
	6/10/79	mean	48 ± 6	67 ± 7	38 ± 4		51 ± 29
	6/10/79	a	49 ± 6	64 ± 7	32 ± 5	35 ± 6	
	to	b	48 ± 7	69 ± 8	30 ± 6	34 ± 6	
	6/17/79	mean	48 ± 6	66 ± 8	31 ± 6	34 ± 6	50 ± 26
	6/17/79	a	32 ± 5	36 ± 6	28 ± 4	26 ± 5	
	to	b	37 ± 5	43 ± 6	30 ± 4	26 ± 5	
	6/24/79	mean	34 ± 5	40 ± 6	29 ± 4[4]	26 ± 5	33 ± 14
	6/25/79	a	38 ± 6	74 ± 8	12 ± 3	28 ± 5	
	to	b	43 ± 6	78 ± 8	14 ± 3	32 ± 5	
	7/1/79	mean	40 ± 6	76 ± 8	13 ± 3	30 ± 5	40 ± 53

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Preoperational, 1979

Air Particulates
Analytical Results - Gross Beta

Results in units of 10^{-3} pCi/m^3 ± 2σ

Month	Sampling Period		Station Number 1	4	5	7	Average[1]
July	7/1/79	a	14 ± 4	68 ± 8	NS	28 ± 5	
	to	b	17 ± 7	70 ± 7		29 ± 5	
	7/8/79	mean	16 ± 6	69 ± 8		28 ± 5	38 ± 56
	7/8/79	a	26 ± 4	30 ± 4	NS	32 ± 5	
	to	b	31 ± 4	33 ± 5		39 ± 5	
	7/15/79	mean	28 ± 4	32 ± 4		36 ± 5	32 ± 8
	7/15/79	a	34 ± 6	29 ± 6	NS	15 ± 5	
	to	b	27 ± 6	32 ± 6		13 ± 5	
	7/22/79	mean	30 ± 6	30 ± 6		14 ± 5	25 ± 18
	7/22/79	a	10 ± 3	24 ± 3	32 ± 3	NS	
	to	b	7 ± 3	24 ± 3	31 ± 3		
	8/5/79	mean	8 ± 3	24 ± 3	32 ± 3		21 ± 24
August	8/5/79	a	NS	NS	20 ± 5	NS	
	to	b			17 ± 5		
	8/12/79	mean			18 ± 5		18 ± 5
	8/12/79	a	NS	NS	31 ± 6	13 ± 5	
	to	b			25 ± 6	12 ± 5	
	8/19/79	mean			28 ± 6	12 ± 5	20 ± 23
	8/19/79	a	NS	NS	41 ± 6	25 ± 6	
	to	b			36 ± 6	18 ± 5	
	8/26/79	mean			38 ± 6	22 ± 6	30 ± 23

Air Particulates
Analytical Results - Gross Beta

Results in units of 10^{-3} pCi/m^3 ± 2σ

Month	Sampling Period		Station Number 1	4	5	7	Average[1]
August	8/26/79	a	NS	NS	39 ± 6	17 ± 6	
(cont.)	to	b			36 ± 7	16 ± 6	
	9/1/79	mean			38 ± 6	16 ± 6	27 ± 31
September	9/1/79	a	NS	NS	30 ± 5	10 ± 5	
	to	b			23 ± 5	10 ± 5	
	9/8/79	mean			26 ± 5	10 ± 5	18 ± 23
	9/8/79	a	NS	NS	28 ± 5	17 ± 5	
	to	b			27 ± 5	17 ± 5	
	9/15/79	mean			28 ± 5	17 ± 5	22 ± 16
	9/15/79	a	NS	NS	40 ± 8	13 ± 5	
	to	b			36 ± 8	8 ± 5	
	9/22/79	mean			38 ± 8	10 ± 5	24 ± 40
	9/22/79	a	NS	NS	33 ± 5	26 ± 5	
	to	b			34 ± 5	17 ± 5	
	9/29/79	mean			34 ± 5	22 ± 5	28 ± 17
October	9/29/79	a	NS	NS	45 ± 5	27 ± 5	
	to	b			42 ± 6	25 ± 6	
	10/7/79	mean			44 ± 6	26 ± 6	35 ± 25

TABLE C (continued)

Environmental Radiological Monitoring Program, Fermi-2
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Air Particulates
Analytical Results - Gross Beta

Results in units of 10^{-3} pCi/m^3 ± 2σ

Month	Sampling Period		Station Number 1	4	5	7	Average[1]
October	10/7/79	a	NS	NS	NS	9 ± 7	
(cont.)	to	b				12 ± 8	
	10/13/79	mean				10 ± 8	10 ± 8
	10/13/79	a	NS	24 ± 5	NS	20 ± 9	
	to	b		29 ± 6		11 ± 9	
	10/20/79	mean		26 ± 6		16 ± 9	21 ± 14
	10/20/79	a	NS	9 ± 4	NS	NS	
	to	b		3 ± 4			
	10/27/79	mean		6 ± 4			6 ± 4
	10/27/79	a	NS	31 ± 5	NS	NS	
	to	b		31 ± 5			
	11/4/79	mean		31 ± 5			31 ± 5
November	11/4/79	a	NS	31 ± 6	NS	NS	
	to	b		29 ± 6			
	11/11/79	mean		30 ± 6			30 ± 6
	11/11/79	a	LT 7[6]	29 ± 6	NS	NS	
	to	b	LT 7	35 ± 6			
	11/17/79	mean	LT 7	32 ± 6			32 ± 6
	11/17/79	a	NS	69 ± 7	NS	NS	
	to	b		71 ± 7			
	11/24/79	mean		70 ± 7			70 ± 7

Air Particulates
Analytical Results - Gross Beta

Results in units of 10^{-3} pCi/m^3 ± 2σ

Month	Sampling Period		Station Number 1	4	5	7	Average(1)
November	11/24/79	a	NS	27 ± 5	NS	NS	
(cont.)	to	b		30 ± 5			
	12/1/79	mean		28 ± 5			28 ± 5
December	12/1/79	a	NS	31 ± 5	NS	NS	
	to	b		29 ± 5			
	12/8/79	mean		30 ± 5			30 ± 5
	12/8/79	a	18 ± 5	28 ± 5	17 ± 5	NS	
	to	b	20 ± 5	24 ± 5	19 ± 5		
	12/15/79	mean	19 ± 5	26 ± 5	18 ± 5		21 ± 9
	12/15/79	a	29 ± 5	35 ± 6	58 ± 7	NS	
	to	b	35 ± 6	39 ± 6	60 ± 7		
	12/22/79	mean	32 ± 6	37 ± 6	59 ± 7		43 ± 29
	12/22/79	a	8 ± 4	9 ± 4	31 ± 5	NS	
	to	b	12 ± 4	14 ± 5	30 ± 5		
	12/29/79	mean	10 ± 4	12 ± 5	30 ± 5		17 ± 22
		Average(1)	36 ± 32	46 ± 39	38 ± 38	35 ± 36	

(1) Simple average of means ± 2 x standard deviation of the mean values (rounded)
(2) Replicate count
(3) Simple average (rounded) ± simple average (rounded)
(4) Foreign material entrapped on air filter - not included in average determinations
(5) NS - No Sample
(6) LT - Less Than

Exhibit

Environmental Radiological Monitoring Program, Period 2
Preoperational, 1979

Air Particulates

Analytical Results - Gamma Emitting Nuclides

Quarterly Composite, By Location

Quarter	Sampling Location		Cs-134	Cs-137	Be-7	Ce-144	Pb-212	Others
					pCi/m^3 ± 2σ			
1	1	a[1]	LT 1.2E-03[3]	1.4E-03 ± 7E-04	8.1E-02 ± 1.7E-02	ND[4]	ND	ND
		b[1]	LT 3E-03	LT 3E-03	7.8E-02 ± 1.6E-02	ND	ND	ND
		mean[2]	LT 2.1E-03	(1/2)[5]	8.0E-02 ± 1.4E-02			
	4	a	LT 3E-03	LT 4E-03	9.7E-02 ± 1.9E-02	ND	ND	ND
		b	LT 3E-03	LT 4E-03	7.4E-02 ± 1.8E-02	ND	ND	ND
		mean	LT 3E-03	LT 4E-03	8.6E-02 ± 1.8E-02			
	5	a	LT 1.0E-03	1.4E-03 ± 8E-04	9.3E-02 ± 1.8E-02	ND	ND	ND
		b	LT 1.3E-03	2.0E-03 ± 9E-04	1.0E-01 ± 1.8E-02	ND	ND	ND
		mean	LT 1.2E-03	1.7E-03 ± 8E-04	9.6E-02 ± 1.8E-02			
	7	a	LT 1.1E-03	LT 3E-03	9.1E-02 ± 1.9E-02	ND	ND	ND
		b	LT 2E-03	LT 5E-03	8.4E-02 ± 1.8E-02	ND	ND	ND
		mean	LT 1.6E-03	LT 4E-03	8.8E-02 ± 1.8E-02			
2	1	a	LT 9E-04	LT 9E-04	9.2E-02 ± 1.8E-02	ND	ND	ND
		b	LT 9E-04	LT 1.1E-03	8.6E-02 ± 1.8E-02	ND	ND	ND
		mean	LT 9E-04	LT 1.0E-03	8.9E-02 ± 1.8E-02			
	4	a	LT 1.4E-03	2.1E-03 ± 1.1E-03	1.2E-01 ± 2E-02	ND	ND	ND
		b	LT 1.4E-03	2.4E-03 ± 1.2E-03	1.1E-01 ± 2E-02	ND	ND	ND
		mean	LT 1.4E-03	2.2E-03 ± 1.2E-03	1.2E-01 ± 2E-02			
	5	a	LT 1.3E-03	1.2E-03 ± 7E-04	4.8E-02 ± 1.3E-02	4.6E-03 ± 3E-03	ND	ND
		b	LT 1.0E-03	1.3E-03 ± 8E-04	7.5E-02 ± 1.4E-02	7.0E-03 ± 3E-03	ND	ND
		mean	LT 1.2E-03	1.2E-03 ± 8E-04	6.2E-02 ± 1.4E-02	5.8E-03 ± 3E-03		
	7	a	LT 2E-03	LT2E-03	6.6E-02 ± 1.8E-02	ND	2.2E-03 ± 1.1E-03	ND
		b	LT 1.5E-03	1.9E-03 ± 8E-04	7.3E-02 ± 1.5E-02	ND	ND	ND
		mean	LT 1.8E-03	(1/2)	7.0E-02 ± 1.6E-02		(1/2)	

TABLE 7 (Continued)

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1979

Air Particulates

Analytical Results - Gamma Emitting Nuclides

Quarterly Composite, By Location

Quarter	Sampling Location		Cs-134	Cs-137	Be-7	Ce-144	Pb-212	Others
					pCi/m^3 ± 2σ			
3	1	a	LT 5E-03	LT 7E-03	5.4E-02 ± 3E-02	ND	ND	ND
		b	LT 3E-03	LT 2E-03	7.0E-02 ± 3E-02	ND	ND	ND
		mean	LT 4E-03	LT 4E-03	6.2E-02 ± 3E-02			
	4	a	LT 6E-03	LT 9E-03	9.4E-02 ± 3E-02	ND	ND	ND
		b	LT 6E-03	LT 7E-03	9.4E-02 ± 4E-02	ND	ND	ND
		mean	LT 6E-03	LT 8E-03	9.4E-02 ± 4E-02			
	5	a	LT 3E-03	LT 4E-03	1.1E-01 ± 2E-02	ND	ND	ND
		b	LT 1.4E-03	1.5E-03 ± 7E-04	1.0E-01 ± 2E-02	ND	ND	ND
		mean	LT 2E-03	(1/2)	1.0E-01 ± 2E-02			
	7	a	LT 8E-04	LT 1.2E-03	4.2E-02 ± 1.3E-03	ND	ND	ND
		b	LT 9E-04	LT 1.5E-03	7.4E-02 ± 1.4E-03	ND	ND	ND
		mean	LT 8E-04	LT 1.4E-03	5.8E-02 ± 1.4E-03			
4	1	a	LT 3E-03	LT 3E-03	6.9E-02 ± 1.5E-02	ND	ND	ND
		b	LT 3E-03	LT 5E-03	7.1E-02 ± 1.6E-02	ND	ND	ND
		mean	LT 4E-03	LT 4E-03	7.0E-02 ± 1.6E-02			
	4	a	LT 2E-03	LT 2E-03	5.6E-02 ± 9E-03	ND	ND	ND
		b	LT 2E-03	LT 2E-03	6.0E-02 ± 9E-03	ND	ND	ND
		mean	LT 2E-03	LT 2E-03	5.8E-02 ± 9E-03			
	5	a	LT 2E-03	LT 3E-03	9.4E-02 ± 1.7E-02	ND	ND	ND
		b	LT 3E-03	LT 4E-03	1.0E-01 ± 2E-02	ND	ND	ND
		mean	LT 2E-03	LT 4E-03	9.7E-02 ± 1.8E-02			
	7	a	LT 3E-03	LT 3E-03	LT 3E-02	ND	ND	ND
		b	LT 5E-03	LT 6E-03	2.6E-02 ± 1.4E-02	ND	ND	ND
		mean	LT 33	LT 4E-03	(1/2)			

(1) Replicate count

(2) Simple average (rounded) ± simple average (rounded)

(3) LT = Less Than

(4) ND = Not Detected

(5) Fraction in parentheses indicates no. of detectables/no. of analyses

E. Water

Gamma emitting nuclides and tritium for all water samples are reported in Tables 8 and 9, respectively. The gross beta results for the drinking water samples are presented in Table 10. Table 13 gives a statistical summary of the water analytical results.

The only detectable gamma activity during the reporting period was naturally occurring Ra-226 and K-40.

Detectable tritium concentrations ranged from 190 to 520 pCi/l for all monitoring stations. These measurements are not inconsistent with typical environmental levels identified at other facilities.

The gross beta activity for drinking water at Station 13 was consistent during the reporting period with an overall mean of 2.1 pCi/l. This number was calculated from detectable measurements only.

TABLE

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1979

Water
Analytical Results - Gamma Emitting Nuclides

Compositing Month	Sampling Location		Mn-54	Fe-59	Co-58	Co-60	Zn-65	Zr-Nb-95	Cs-134	Cs-137	Ba-La-140	K-40	Ra-226	Others
			pCi/l ± 2σ											
January	12[1]	a	LT 8[5]	LT 17	LT 10	LT 5	LT 14	LT 7	LT 9	LT 9	LT 4	ND[6]	ND	ND
		b	LT 7	LT 15	LT 9	LT 7	LT 12	LT 10	LT 9	LT 10	LT 4	ND	ND	ND
		mean[3]	LT 8	LT 16	LT 10	LT 6	LT 13	LT 8	LT 9	LT 10	LT 4			
	14[1]	No data[4]												
	13[2]	a	LT 10	LT 19	LT 7	LT 6	LT 14	LT 8	LT 6	LT 8	LT 4	ND	130±60	ND
		b	LT 9	LT 17	LT 10	LT 6	LT 16	LT 8	LT 6	LT 7	LT 4	ND	ND (1/2)[7]	ND
		mean	LT 10	LT 18	LT 8	LT 6	LT 15	LT 8	LT 6	LT 8	LT 4			
February	12	a	LT 18	LT 40	LT 20	LT 16	LT 30	LT 10	LT 17	LT 16	LT 40	ND	ND	ND
		b	LT 17	LT 30	LT 16	LT 16	LT 30	LT 8	LT 17	LT 16	LT 15	ND	ND	ND
		mean	LT 18	LT 40	LT 18	LT 16	LT 30	LT 9	LT 17	LT 16	LT 30			
	14	No data[4]												
	13	a	LT 17	LT 30	LT 17	LT 16	LT 30	LT 8	LT 17	LT 16	LT 18	ND	ND	ND
		b	LT 17	LT 30	LT 17	LT 16	LT 30	LT 8	LT 17	LT 16	LT 18	ND	ND	ND
		mean	LT 17	LT 30	LT 17	LT 16	LT 30	LT 8	LT 17	LT 16	LT 18			
March	12	a	LT 17	LT 30	LT 15	LT 16	LT 30	LT 8	LT 17	LT 16	LT 11	ND	ND	ND
		b	LT 17	LT 30	LT 16	LT 16	LT 30	LT 8	LT 17	LT 16	LT 12	ND	ND	ND
		mean	LT 17	LT 30	LT 16	LT 16	LT 30	LT 8	LT 17	LT 16	LT 12			
	14	No data[4]												
	13	a	LT 17	LT 30	LT 16	LT 16	LT 30	LT 8	LT 17	LT 16	LT 13	ND	ND	ND
		b	LT 17	LT 30	LT 16	LT 16	LT 30	LT 8	LT 17	LT 16	LT 13	ND	ND	ND
		mean	LT 17	LT 30	LT 16	LT 16	LT 30	LT 8	LT 17	LT 16	LT 13			

TABLE B (Cor)

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1979

Water
Analytical Results - Gamma Emitting Nuclides

pCi/l ± 2σ

Compositing Month	Sampling Location		Mn-54	Fe-59	Co-58	Co-60	Zn-65	Zr-Nb-95	Cs-134	Cs-137	Ba-La-140	K-40	Ra-226	Others
April	12	a	LT 10	LT 16	LT 13	LT 7	LT 17	LT 7	LT 15	LT 15	LT 11	ND	ND	ND
		b	LT 14	LT 16	LT 13	LT 9	LT 25	LT 8	LT 14	LT 8	LT 11	ND	ND	ND
		mean	LT 12	LT 16	LT 13	LT 9	LT 21	LT 8	LT 14	LT 12	LT 11			
	14	No data(4)												
	13	a	LT 4	LT 10	LT 5	LT 4	LT 7	LT 5	LT 5	LT 7	LT 10	ND	ND	ND
		b	LT 4	LT 11	LT 5	LT 4	LT 9	LT 5	LT 4	LT 5	LT 11	ND	ND	ND
		mean	LT 4	LT 11	LT 5	LT 4	LT 8	LT 5	LT 4	LT 6	LT 10			
May	12	a	LT 14	LT 20	LT 14	LT 9	LT 16	LT 7	LT 12	LT 8	LT 8	ND	ND	ND
		b	LT 13	LT 20	LT 13	LT 9	LT 19	LT 8	LT 13	LT 8	LT 8	ND	ND	ND
		mean	LT 14	LT 20	LT 14	LT 9	LT 18	LT 8	LT 12	LT 8	LT 8			
	14	No data(4)												
	13	a	LT 10	LT 21	LT 9	LT 9	LT 21	LT 8	LT 15	LT 15	LT 15	ND	ND	ND
		b	LT 7	LT 22	LT 9	LT 9	LT 18	LT 9	LT 10	LT 9	LT 8	ND	ND	
		mean	LT 8	LT 22	LT 9	LT 9	LT 20	LT 8	LT 12	LT 12	LT 12			
June	12	a	LT 9	LT 20	LT 14	LT 9	LT 18	LT 7	LT 12	LT 15	LT 15	ND	ND	ND
		b	LT 8	LT 19	LT 10	LT 9	LT 20	LT 8	LT 9	LT 10	LT 15	ND	ND	ND
		mean	LT 8	LT 20	LT 12	LT 9	LT 19	LT 8	LT 10	LT 12	LT 15			
	14	No data(4)												
	13	a	LT 14	LT 18	LT 14	LT 9	LT 20	LT 7	LT 9	LT 7	LT 15	ND	ND	ND
		b	LT 4	LT 13	LT 6	LT 3	LT 8	LT 6	LT 4	LT 5	LT 35	ND	ND	ND
		mean	LT 9	LT 16	LT 10	LT 6	LT 14	LT 6	LT 6	LT 6	LT 25			

TABLE 8 (Continued)

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1979

Water
Analytical Results - Gamma Emitting Nuclides

pCi/l ± 2σ

Compositing Month	Sampling Location		Mn-54	Fe-59	Co-58	Co-60	Zn-65	Zr-Nb-95	Cs-134	Cs-137	Ba-La-140	K-40	Ra-226	Others
July	12	a	LT 5	LT 10	LT 6	LT 4	LT 9	LT 8	LT 5	LT 8	LT 12	ND	ND	ND
		b	LT 13	LT 23	LT 10	LT 10	LT 21	LT 11	LT 15	LT 15	LT 60	ND	ND	ND
		mean	LT 9	LT 16	LT 8	LT 7	LT 15	LT 10	LT 10	LT 12	LT 36			
	14	No data(4)												
	13	a	LT 9	LT 23	LT 10	LT 9	LT 23	LT 9	LT 9	LT 10	LT 32	ND	ND	ND
		b	LT 13	LT 29	LT 9	LT 9	LT 19	LT 9	LT 6	LT 7	LT 33	ND	ND	ND
		mean	LT 11	LT 26	LT 10	LT 9	LT 21	LT 9	LT 8	LT 8	LT 32			
August	12	a	LT 12	LT 23	LT 15	LT 9	LT 23	LT 8	LT 7	LT 7	LT 19	ND	ND	ND
		b	LT 7	LT 21	LT 7	LT 8	LT 15	LT 9	LT 9	LT 10	LT 33	ND	ND	ND
		mean	LT 10	LT 22	LT 11	LT 8	LT 19	LT 8	LT 8	LT 8	LT 26			
	14	a	LT 5	LT 10	LT 7	LT 4	LT 10	LT 7	LT 6	LT 8	LT 8	ND	ND	ND
		b	LT 5	LT 9	LT 6	LT 4	LT 8	LT 8	LT 7	LT 7	LT 7	ND	ND	ND
		mean	LT 5	LT 10	LT 6	LT 4	LT 9	LT 8	LT 6	LT 7	LT 8			
	13	a	LT 10	LT 20	LT 10	LT 9	LT 18	LT 10	LT 11	LT 14	LT 16	ND	ND	ND
		b	LT 5	LT 10	LT 5	LT 4	LT 9	LT 7	LT 7	LT 6	LT 8	ND	ND	ND
		mean	LT 8	LT 15	LT 8	LT 11	LT 14	LT 8	LT 9	LT 10	LT 12			
September	12	a	LT 11	LT 19	LT 10	LT 9	LT 20	LT 13	LT 15	LT 15	LT 16	ND	ND	ND
		b	LT 7	LT 19	LT 7	LT 9	LT 18	LT 9	LT 8	LT 10	LT 16	ND	ND	ND
		mean	LT 9	LT 19	LT 8	LT 9	LT 19	LT 12	LT 12	LT 12	LT 16			
	14	a	LT 9	LT 12	LT 8	LT 6	LT 13	LT 9	LT 11	LT 12	LT 11	ND	ND	ND
		b	LT 9	LT 15	LT 11	LT 10	LT 17	LT 10	LT 12	LT 12	LT 16	ND	ND	ND
		mean	LT 9	LT 14	LT 10	LT 8	LT 15	LT 10	LT 12	LT 12	LT 14			
	13	a	LT 9	LT 19	LT 12	LT 9	LT 18	LT 11	LT 11	LT 15	LT 15	ND	ND	ND
		b	LT 6	LT 11	LT 9	LT 5	LT 11	LT 7	LT 8	LT 8	LT 9	ND	ND	ND
		mean	LT 8	LT 15	LT 10	LT 7	LT 14	LT 9	LT 10	LT 12	LT 12			

Environmental Radiological M[illegible] Program, Permit-2
Preoperation [illegible]9

Water
Analytical Results - Gamma Emitting Nuclides

Compositing Month	Sampling Location		Mn-54	Fe-59	Co-58	Co-60	Zn-65	Zr-Nb-95	pCi/l ± 2σ Cs-134	Cs-137	Ba-La-140	K-40	Ra-226	Others
October	12	a	LT 12	LT 19	LT 13	LT 9	LT 20	LT 16	LT 12	LT 17	LT 18	120±90	ND	ND
		b	LT 4	LT 8	LT 6	LT 4	LT 9	LT 6	LT 6	LT 6	LT 7	ND	ND	ND
		mean	LT 8	LT 14	LT 10	LT 6	LT 14	LT 11	LT 9	LT 12	LT 12	(1/2)		
	14	No data(8)												
	13	a	LT 5	LT 9	LT 6	LT 4	LT 9	LT 6	LT 5	LT 6	LT 7	ND	ND	ND
		b	LT 4	LT 12	LT 6	LT 4	LT 8	LT 7	LT 4	LT 6	LT 26	110±30	90±40	ND
		mean	LT 4	LT 10	LT 6	LT 4	LT 8	LT 6	LT 4	LT 6	LT 16	(1/2)	(1/2)	
November	12	a	LT 10	LT 15	LT 8	LT 7	LT 16	LT 11	LT 11	LT 13	LT 11	ND	ND	ND
		b	LT 5	LT 7	LT 6	LT 3	LT 8	LT 4	LT 4	LT 4	LT 7	130±30	90±40	ND
		mean	LT 8	LT 11	LT 7	LT 5	LT 12	LT 8	LT 8	LT 8	LT 9	(1/2)	(1/2)	
	14	a	LT 11	LT 20	LT 15	LT 9	LT 17	LT 14	LT 17	LT 18	LT 12	100±60	ND	ND
		b	LT 4	LT 10	LT 4	LT 4	LT 12	LT 6	LT 6	LT 6	LT 6	93±33	ND	ND
		mean	LT 8	LT 15	LT 10	LT 6	LT 14	LT 10	LT 12	LT 12	LT 9	97±46		
	13	a	LT 13	LT 18	LT 11	LT 9	LT 17	LT 15	LT 15	LT 15	LT 12	120±60	ND	ND
		b	LT 12	LT 17	LT 13	LT 9	LT 20	LT 16	LT 15	LT 16	LT 13	150±60	ND	ND
		mean	LT 12	LT 18	LT 12	LT 9	LT 18	LT 16	LT 15	LT 16	LT 12	140±60		
December	12	a	LT 12	LT 21	LT 15	LT 9	LT 22	LT 16	LT 13	LT 17	LT 17	120±60	ND	ND
		b	LT 12	LT 21	LT 13	LT 8	LT 19	LT 15	LT 11	LT 19	LT 18	140±80	ND	ND
		mean	LT 12	LT 21	LT 14	LT 8	LT 20	LT 16	LT 12	LT 18	LT 18	130±70		
	14	a	LT 10	LT 20	LT 11	LT 9	LT 17	LT 15	LT 12	LT 13	LT 18	180±70	ND	ND
		b	LT 15	LT 24	LT 13	LT 9	LT 20	LT 17	LT 16	LT 14	LT 21	140±70	ND	ND
		mean	LT 12	LT 22	LT 12	LT 9	LT 18	LT 16	LT 14	LT 14	LT 20	170±70		
	13	a	LT 11	LT 15	LT 12	LT 7	LT 24	LT 11	LT 12	LT 14	LT 14	ND	ND	ND
		b	LT 11	LT 27	LT 15	LT 9	LT 21	LT 15	LT 17	LT 15	LT 18	160±80	ND	ND
		mean	LT 11	LT 21	LT 14	LT 8	LT 22	LT 13	LT 14	LT 14	LT 16	(1/2)		

(1) Surface Water
(2) Drinking Water
(3) Simple average (rounded) ± simple average (rounded)
(4) Insufficient sample for analysis
(5) LT = Less Than
(6) ND = Not Detected
(7) Fraction in parentheses indicates number of detectables over number of analyses
(8) Vandalism (Sampler turned off during collection period)

TABLE 9

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1979

Water
Analtyical Results - Tritium
Quarterly Composite, By Location

Quarter	Sampling Location		pCi/l ± 2σ
1	12(1)	a	220 ± 170
		b	190 ± 170
		mean(3)	200 ± 170
	14(1)	a	LT 300(4)
		b	390 ± 180 (5)
		mean	(1/2)
	13(2)	a	190 ± 170
		b	270 ± 170
		mean	230 ± 170
2	12	a	LT 300
		b	LT 300
		mean	LT 300
	14	a	LT 300
		b	LT 300
		mean	LT 300
	13	a	LT 300
		b	LT 300
		mean	LT 300
3	12	a	270 ± 180
		b	220 ± 180
		mean	240 ± 180
	14	a	330 ± 180
		b	520 ± 190
		mean	420 ± 18.
	13	a	350 ± 180
		b	220 ± 180
		mean	280 ± 180
4	12	a	LT 300
		b	LT 300
		mean	LT 300
	14	a	LT 300
		b	LT 300
		mean	LT 300
	13	a	LT 300
		b	LT 300
		mean	LT 300

(1) Surface water
(2) Drinking water
(3) Simple average (rounded) ± simple average (rounded)
(4) LT = Less than
(5) Fraction in parentheses indicates no. of detectables/no. of analyses

TABLE 10

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1979

Drinking Water - Analytical Results - Gross Beta

Compositing Month	Sampling Location		pCi/l ± 2σ
January	13	a	2.8 ± 0.8
		b	2.1 ± 0.7
		mean (1)	2.4 ± 0.8
February	13	a	2.8 ± 0.6
		b	3.6 ± 0.7
		mean	3.2 ± 0.6
March	13	a	2.4 ± 0.6
		b	2.0 ± 0.7
		mean	2.2 ± 0.6
April	13	a	2.1 ± 0.6
		b	2.5 ± 0.7
		mean	2.3 ± 0.6
May	13	a	2.2 ± 0.6
		b	1.7 ± 0.6
		mean	2.0 ± 0.6
June	13	a	2.6 ± 0.6
		b	2.3 ± 0.6
		mean	2.4 ± 0.6
July	13	a	1.9 ± 0.6
		b	1.5 ± 0.6
		mean	1.7 ± 0.6

TABLE 10 (Continued)

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1979

Drinking Water - Analytical Results - Gross Beta

Compositing Month	Sampling Location		pCi/l ± 2σ
August	13	a	1.6 ± 0.6
		b	1.5 ± 0.5
		mean	1.6 ± 0.6
September	13	a	1.0 ± 0.5
		b	1.4 ± 0.5
		mean	1.2 ± 0.5
October	13	a	LT 3 (2)
		b	LT 4
		mean	LT 4
November	13	a	LT 2.0
		b	2.2 ± 1.1
		mean	(1/2) (3)
December	13	a	LT 4
		b	LT 2
		mean	LT 3

(1) Simple average (rou[illegible]) ± simple avarage (rounded)

(2) LT = Less Than

(3) Number in parentheses indicates number of detectables/number of analyses

F. Milk

The analytical results of gamma emitting nuclides in milk are reported in Table 11. The only nuclides identified during the reporting period were naturally occurring K-40 and Pb-212.

The results of the I-131 analyses performed by radiochemical separation are shown in Table 12. The activity on all samples was less than the limit of detection.

A statistical summary of the analytical data is provided in Table 13.

Environmental Radiological [illegible]ring Program, Fermi-2
Preoperational, 1979

Milk

Analytical Results - Gamma Emitting Nuclides

Month	Sampling Location		pCi/l ± 2σ Cs-134	Cs-137	Ba-La-140	K-40	Pb-214
January	7	a	LT 15[2]	LT 10	LT 15	1200 ± 200	ND[3]
		b	LT 14	LT 14	LT 15	1200 ± 200	ND
		mean[1]	LT 14	LT 12	LT 15	1200 ± 200	
February	7		LT 16	LT 16	LT 40	1300 ± 30	ND
March	7		LT 16	LT 16	LT 10	1300 ± 30	ND
April	7		LT 8	LT 8	LT 900[4]	1400 ± 80	ND
May	7		LT 9	LT 9	LT 14	1400 ± 190	ND
June	7		LT 9	LT 11	LT 14	1500 ± 190	ND
July	7		LT 8	LT 9	LT 27	1400 ± 180	ND
August	7		LT 8	LT 9	LT 27	1300 ± 180	ND
September	7		LT 10	LT 12	LT 14	1400 ± 190	ND
October	7		LT 15	LT 20	LT 15	1400 ± 200	ND
November	7		LT 18	LT 20	LT 12	1300 ± 200	ND
December	7		LT 17	LT 20	LT 16	1400 ± 200	24 ± 13

(1) Simple average (rounded)
(2) LT = Less Than
(3) ND = Not Detected
(4) Detection limit could not be achieved due to delay in counting

TABLE 12

Environmental Radiological Monitoring Program, Fermi-2

Preoperational, 1979

Milk

Analytical Results - Iodine-131

Collection Date	Sampling Location	pCi/l
4-22-79	Station 7	LT 0.1[1]
5-13-79	Station 7	LT 0.3

(1) LT = less than

TABLE 13

INDICATOR LOCATION STATISTICAL EVALUATION

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SEMI-ANNUAL REPORT

NAME OF FACILITY: ENRICO FERMI UNIT 2 DOCKET NO. 50-341

LOCATION OF FACILITY: 10 MILES SOUTHWEST OF DETROIT, MICHIGAN (FRENCHTOWN TOWNSHIP)

REPORTING PERIOD: SEPTEMBER 29, 1978, THROUGH JANUARY 5, 1980

Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analyses Performed	Lower Limit of Detection (LLD) (1)	All Indicator Locations Mean (f) Range (2)	Location With Highest Mean Name Distance	Mean (f) Range (2)	Control Locations Mean (f) Range (2)	Number of Nonroutine Reported Measurements
TLD - Direct Radiation (mR/day)	Gamma Dose 54		0.15 (46/46) (0.11-0.18)	Station 5 0.6 mi. NW	0.17 (8/8) (0.15-0.18)	0.17 (8/8) (0.15-0.19)	0
Fish (Perca flavescens) (pCi/kg, wet weight)	Gamma Spec 6			One (1) indicator location sampled during reporting period.			0
	K - 40		4000 (4/4) (3600-4300)			3300 (2/2) (3300-3300)	0
	Mn - 54	130	<LLD			< LLD	0
	Fe - 59	260	<LLD			< LLD	0
	Co - 58	130	<LLD			< LLD	0
	Co - 60	130	<LLD			< LLD	0
	Zn - 65	260	<LLD			< LLD	0
	Cs -134	130	<LLD			< LLD	0
	Cs -137	130	29 (3/4) (20-40)			59 (2/2) (58-60)	0
	Pb -214		50 (1/4) (50 - 50)			< LLD	0
	Pb -212		40 (3/4) (34-50)			24 (2/2) (22-25)	0
	Bi - 214		< LLD			25 (1/2) (25-25)	0
	Tl - 208		< LLD			30 (1/2) (30-30)	0
	Ra - 226		270 (1/4) (270-270)				0

TABLE 13 (CONT.)

INDICATOR LOCATION STATISTICAL EVALUATION

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SEMI-ANNUAL REPORT

NAME OF FACILITY: ENRICO FERMI UNIT 2 DOCKET NO. 50-341

LOCATION OF FACILITY: 30 MILES SOUTHWEST OF DETROIT, MICHIGAN (FRENCHTOWN TOWNSHIP)

REPORTING PERIOD: DECEMBER 29, 1978, THROUGH JANUARY 5, 1980

Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analyses Performed	Lower Limit of Detection (LLD) (1)	All Indicator Locations Mean (f) (2) Range	Location With Highest Mean Name / Distance	Mean (f) (2) Range	Control Locations Mean (f) (2) Ranges	Number of Nonroutine Reported Measurements
Shoreline Sediments (pCi/kg, dry weight)	Gamma Spec. 12					See note 3	
	U Daughters		520 (12/12) (260-1000)	Station 9 0.2 mi. E	920 (2/4) (780-1000)		0
	Th Daughters		37 (12/12) (160-670)	Station 9 0.2mi. E	610 (2/4) (570-670)		0
	K - 40		14000 (12/12) (11000-18000)	Station 9 0.2 mi. E	17000 (2/4) (15000-18000)		0
	Cs -134	150	<LLD				
	Cs -137	150	660 (4/12) (250-1000)	Station 9 0.2 mi E	660 (2/4) (250-1100)		0
Water, Surface and Drinking (pCi/liter)	Gamma Spec 56					To date, sampling has not been initiated at the control drinking water station.	
	Mn - 54	15	<LLD				0
	Fe - 59	30	<LLD				0
	Ce - 58	15	<LLD				0
	Co - 60	15	<LLD				0
	Zn - 65	30	<LLD				0
	Zr - Nb - 95	10	<LLD				0
	K - 40		130 (8/48) (110-160)	Station 13 1.2 mi. S	140 (4/24) (110-160)	130 (4/8) (93-180)	0

TABLE 13 (CONT.)

INDICATOR LOCATION STATISTICAL EVALUATION

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SEMI-ANNUAL REPORT

NAME OF FACILITY: ENRICO FERMI UNIT 2 DOCKET NO. 50-341

LOCATION OF FACILITY: 30 MILES SOUTHWEST OF DETROIT, MICHIGAN (FRENCHTOWN TOWNSHIP)

REPORTING PERIOD: DECEMBER 29, 1978, THROUGH JANUARY 5, 1980

Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analyses Performed	Lower Limit of Detection (1) (LLD)	All Indicator Locations Mean (f) (2) Range	Location With Highest Mean Name / Distance	Mean (f) (2) Range	Control Locations Mean (f) (2) Range	Number of Nonroutine Reported Measurements
Water, Surface and Drinking (Con't) (pCi/liter)	Cs - 134	15	<LLD				0
	Cs - 137	15	<LLD				0
	Ba - La - 140	15	<LLD				0
	Ra - 226		100 (3/48) (90-130)	Station 13 1.2 mi. S	100 (3/48) (90-130)	<LLD	0
	Tritium 24	330	240 (4/6) (190-350)	Station 13 1.2 mi. S	260 (4/8) (190-350)	410 (3/8) (330-520)	0
Intaking Water pCi/liter	Gross Beta 24	2	2.1 (19/24) (1.2-3.6)	One (1) indicator location sampled during reporting period		To date, sampling has not been initiated at control location.	0
Airborne Particulates (1E-03 pCi/ m^3)	Gross Beta 296	10	40 (238/222) (3-115)	Station 4 0.6 mi. NNW	46 (82/82) (3-110)	35 (74/74) (8-90)	0
Airborne Particulates (1E-03 pCi/ m^3)	Gamma Spec 32						
	Cs - 134	0.01	<LLD				
	Cs - 137	0.01	0.17 (3/24) (0.12-0.24)	Station 4 0.6 mi. NNW	2.2 (2/8) (2.0-2.4)	0.19 (1/8) (0.19-0.19)	0
	Be - 7		8.5 (24/24) (4.2-12)	Station 4 0.6 mi. NNW	9.0 (8/8) (5.6-12)	6.6 (7/8) (2.6-9.1)	0
	Ce-144		0.58 (2/8) (0.46-0.70)	Station 5 0.6 mi. NW	0.58 (2/8) (0.46-0.70)	<LLD	0
	Pb-212		<LLD			0.22 (1/8) (0.22-0.22)	0

TABLE II, (CONT.)

INDICATOR LOCATION STATISTICAL EVALUATION

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SEMI-ANNUAL REPORT

NAME OF FACILITY: ENRICO FERMI UNIT 2 DOCKET NO. 50-341

LOCATION OF FACILITY: 30 MILES SOUTHWEST OF DETROIT, MICHIGAN (FRENCHTOWN TOWNSHIP)

REPORTING PERIOD: DECEMBER 29, 1978, THROUGH JANUARY 5, 1980

Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analyses Performed	Lower Limit of Detection (1) (LLD)	All Indicator Locations Mean (f) (2) Range	Location With Highest Mean Name / Distance	Mean (f) (2) Range	Control Locations Mean (f) (2) Range	Number of Nonroutine Reported Measurements
Milk (pCi/liter)	Gamma Spec 13		To date, indicator locations not finalized.				0
	Cs - 134	15				<LLD	0
	Cs - 137	15				<LLD	0
	Ba - La - 140	15				<LLD	0
	K - 40					1300 (13/13) (1200-1500)	0
	Pb - 214					24 (1/13) (24-24)	0
	I - 131	0.5				<LLD	0

(1) LLD = Lower Limit of Detection as defined in the USNRC Branch Technical Position on radiological environmental monitoring, Table 3, (November 1979, Revision 1).

(2) Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (f).

(3) Lake Erie current patterns in the Fermi-2 area fluctuate in opposite directions along shoreline contours for approximately equal durations during an annual period. As a result, no "control" location is established.

V. REFERENCES

1. U.S. Nuclear Regulatory Commission, "An Acceptable Radiological Environmental Monitoring Program", Radiological Assessment Branch Technical Position, March 1978.

2. U.S. Nuclear Regulatory Commission, "An Acceptable Radiological Environmental Monitoring Program," Radiological Assessment Branch Technical Position, November 1979, Revision 1.

3. U.S. Nuclear Regulatory Commission, "Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following An Accident," Office of Standards Development, Proposed Revision 2 to Regulatory Guide 1.97, December 1979.

4. National Council on Radiation Protection and Measurements, "Environmental Radiation Measurements", NCRP Report No. 50, Washington, D.C., December 27, 1976.

5. Oakley, D.C., "Natural Radiation Exposure in the United States", ORP/SID 72-1 Office of Radiation Programs, U.S. Environmental Protection Agency, Washington, D.C., June 1972.

APPENDIX A

Deviations in the Sampling and Analytical Regime

The following deviations in the Fermi-2 monitoring program have been documented by NUS Corporation and transmitted to The Detroit Edison Company during 1979.

A. Direct Radiation

The duplicate TLDs deployed at Station 2 for 1979-Q3 were missing at the time of collection, September 29, 1979. It is assumed that vandalism was responsible for the loss. The TLDs for 1979-Q4 were placed at this location as scheduled.

B. Fish

No sample of yellow perch (Perca flavescens) at Station 11 (Control) was collected by biologists from The Detroit Edison Company. Repeated attempts at sampling by the staff were unsuccessful. Two causes contributed to the lack of sample: (1) vandalism of the gill nets (2) the low density of perch due to a walleye "run" occurring during this period. Responsible staff of The Detroit Edison Company will be evaluating techniques and alternate locations in preparation for subsequent collection efforts.

Biologists from Edison collected yellow perch from Station 11 (Celeron Island) in October. Due to the small volume of sample, samples of walleye collected at the same time were also sent to the Radiological Laboratory for analysis. During sample preparation, the technician accidently mixed both species of fish together. The gamma isotopic analysis was performed on the combined sample.

C. Airborne Particulates

During 1979, data recovery from the air sampling network ranged from 79% (Station 4) to 65% (Station 1). In November and December of 1978 (the instrument

trial period) and the first half of 1979, data recovery was excellent. The majority of downtime occurred in the second half of 1979. Edison owns five air samplers, four deployed at "active" monitoring locations and one spare unit. From June through October, all five units experienced pump freezing which resulted from a breakdown of the lubricating oil. The site technician attempted field repairs but due to the nature of the problem, the instruments were ultimately shipped to the vendor in California for repairs. As repairs were completed, each unit was shipped first to NUS for calibration, and then to the site technician for field deployment. As can be expected, each shipment of an instrument entailed approximately one week for delivery, plus the requisite time for repairs. As repaired instruments were received and calibrated, they were cycled to field status on an "as available" basis. Based upon vendor recommendations, a new type of oil is now being used to help eliminate future problems of this nature.

Other difficultes encountered during the year included thermal overloads from cooling fan malfunctions, broken venturi tubes creating loss of vacuum, and, most recently, vane deterioration.

Edison is evaluating a program to improve field data recovery based on the identified common failure modes of the instruments. The program includes:

- purchase of one additional instrument
- purchase of two (2) each of complete subassemblies of those components which experience has shown are particularly subject to failure
- stocking an increased inventory of miscellaneous spare parts and increased frequency of preventive maintenance (such as periodic replacement of pump vanes etc.).

The intent of these steps is to allow immediate field replacement of malfunctioning units, and field repair of them with complete subassemblies if necessary. Increased frequency of replacement of wearing parts should also avoid some field failures.

D. Water

An insufficient sample for gamma analysis was collected at Station 14 (Trenton Channel) for the first half of 1979. Numerous attempts at repairs proved unsuccessful, although immediately following repairs, and for up to one week after repairs, the instrument had been observed to be performing satisfactorily. Ice formation, clogged sampling lines, and the ten foot vertical pull to the sampling head contributed to the lack of sample. A larger pump head and sampling line were installed in August with acceptable results. Installation of a new sample head and increased diameter tubing was delayed from the expected installation date by vendor back order.

No water sample was collected from Station 14 (Trenton Channel) for the month of October. During the scheduled sample collection, the site technician discovered that the interval sampler had been turned off. It is assumed that an Edison employee inadvertently shut the sample off since that instrument is located in an area where access to the property is controlled by Edison.

E. Milk

As a result of a personnel error in the execution of a computer command, the acquired gamma spectrum for the April milk sample from Station 7 was lost. The sample was recounted at a later date; but because of the delay, the detection limit for Ba-La-140 could not be achieved.

APPENDIX B

Laboratory Quality Assurance

I. Introduction

The quality assurance program of the Radiological Laboratory of NUS is briefly described in this appendix.

Information on each incoming sample is entered in a permanent log book. A sample number is assigned to each sample at the time of receipt. This sample number uniquely identifies each sample.

Separate laboratory notebooks are used for each major environmental monitoring program.

Laboratory counting instruments are calibrated, using radionuclide standards obtained from the National Bureau of Standards, the EPA, and reliable commercial suppliers, such as Amersham-Searle. Calibration of counting instruments is maintained by regular counting of radioactive reference sources. Background counting rates are measured regularly on all counting instruments. Additional performance checks for the gamma-ray scintillation spectrometer include regular checks and adjustment, when necessary, of energy calibration.

Blank samples are processed, with each group of samples analyzed for specific radionuclides, using radiochemical separation procedures. Blank, spiked (known quantities of radioactivity added), and replicate samples are processed periodically to determine analytical precision and accuracy.

II. Laboratory Analyses for Quality Assurance

The quality assurance procedures employed in the conduct of radiological monitoring programs by the Northern Environmental Services Division Radiological

Laboratory are as required in Section 5.0 of the Environmental Systems Group Quality Assurance Manual and detailed in the NUS Radiological Laboratory Manual. These procedures include the requirement for (1) laboratory analysis of samples distributed by appropriate government or other standards-maintaining agencies in a laboratory intercomparison program, (2) analysis of some of the client's environmental samples split with other independent laboratories, and (3) analysis in duplicate of a specified fraction of the client's environmental samples.

A. Samples Split with Independent Laboratories

Aliquots of shoreline sediments collected in October from Stations 9 and 10 were sent to an independent laboratory for gamma analyses. The results are listed in Table B-1. Considering the low levels of radionuclides present in the samples and the difficulty included in processing sediment so that replicate, homogeneous portions may be obtained, the agreement between the results is considered good.

Samples of water collected in December from Stations 12 and 14 were sent to an independent laboratory for gamma analysis. Composites of water for Q-4 collected from the same locations were also split for tritium analysis. The results of these analyses are shown in Table B-2.

After analysis at NUS, the December milk sample from Station 7 was sent to an independent laboratory for gamma isotopic analysis. The results appear in Table B-3.

B. United States Environmental Protection Agency Intercomparison Program

The NUS Radiological Laboratory participates in the U. S. Environmental Radioactivity Laboratory Intercomparison Studies (Cross-check) Program. The NUS results of analyses performed on samples pertinent to the Fermi-2 program during 1979, and the known values are listed in Tables B-4 through B-7.

C. Thermoluminescent Dosimeter Intercomparison

The Laboratory also participated in the Fourth International Intercomparison of Environmental Dosimeters in 1979, the NUS results, calculated exposures, and means of all participants are listed in Table B-9.

D. In-House Duplicate Analyses

The majority of analytical work for the Fermi-2 program during 1979 was performed in duplicate/replicate and has been addressed in Tables 3 through 12.

TABLE B-1

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1979

Shoreline Sediments - Independent Laboratory Results

			Gamma Emitting Nuclides, pCi/kg, dry, ±2σ						
Quarter	Collection Date	Sampling Location	U Daughters	Th Daughters	K-40	Cs-134	Cs-137	Co-60	Others
4	10-3-79	9	NR(1)	1100 ± 100	15000 ± 2000	LT 40(2)	1000 ± 100	190 ± 50	ND(3)
	10-3-79	10	NR	230 ± 20	11000 ± 1000	LT 20	LT 20	LT 20	ND

(1) NR = Not Reported
(2) LT = Less Than
(3) ND = Not Detected

TABLE B-2

Environmental Radiological Monitoring Program
Preoperational, 1979

Surface Water - Independent Laboratory Results

Quarter	Collection Date	Sampling Location	Gamma Emitting Nuclides pCi/l ± 2σ Cs-137	Gamma Emitting Nuclides pCi/l ± 2σ Others	pCi/l ± 2σ H-3[1]
4	12-29-79	12	LT 38[2]	ND[3]	0 ± 100
	12-29-79	18	LT 35	ND	0 ± 100

(1) Quarterly composite
(2) LT = Less Than
(3) ND = Not Detected

TABLE B-3

Environmental Radiological Monitoring Program
Preoperational, 1979

Milk - Independent Laboratory Results

Quarter	Collection Date	Sampling Location	Gamma Emitting Nuclides, pCi/l ± 2σ		
			Cs-137	K-40	Others
4	12-29-79	7	LT 56[1]	2400 ± 1300	ND[2]

(1) LT = Less Than
(2) ND = Not Detected

TABLE B-4

United States Environmental Protection Agency Intercomparison Program - 1979

Analytical Results - Gross Beta in Water

Month	Known Value pCi/l ± 3σ	NUS Value pCi/l (1)
January	16 ± 15	15
March	16 ± 15	16
May	22 ± 15	22
September	40 ± 15	9 (2)
November	Sample destroyed in shipment to NUS	

(1) Mean of three reported values

(2) Investigation of NUS reported result revealed that a probable technician error was responsible for the NUS value being low by a factor of five. Technician used 200 mls of sample for the analysis but calculated the results based on one liter, the volume normally used.

TABLE B-5

United States Environmental Protection Agency
Intercomparison Program - 1979

Analytical Results - Gamma in Milk

Month	Known Value (pCi/l ± 3σ)				NUS Value[1] (pCi/l)			
	I-131	Cs-137	Ba-140	K(mg/l ± 3)	I-131	Cs-137	Ba-140	K (mg/l)
January	105 ± 15	49 ± 15	0	1560 ± 234	94	48	LT 11[2]	1350
April	96 ± 15	134 ± 24	0	1560 ± 234	GE(Li) at vendor for repairs - no data reported			
November	637 ± 96	49 ± 15	0	1470 ± 219	673	50	LT 19	1684

(1) Mean of reported values

(2) LT = Less Than

TABLE B-6

United States Environmental Protection Agency
Intercomparison Program - 1979

Analytical Results - Tritium

Month	Known Value (pCi/l ± 3σ)	NUS Value (pCi/l) (1)
February	1280 ± 993	1400
April	2270 ± 1047	1930
June	1540 ± 1010	1410
October	1560 ± 1111	1370

(1) Mean of reported values

TABLE B-7

United States Environmental Protection Agency Intercomparison Program - 1979

Analytical Results - Gamma in Water

Month	Known Value (pCi/l ± 3σ)						NUS Value (pCi/l)[1]					
	Cr-51	Co-60	Zn-65	Ru-106	Cs-134	Cs-137	Cr-51	Co-60	Zn-65	Ru-106	Cs-134	Cs-137
February	0	9 ± 15	21 ± 15	0	6 ± 15	12 ± 15	LT 137[2]	LT 15	13	LT 90	LT 10	LT 12
June	0	47 ± 15	0	0	71 ± 15	0	LT 170	49	LT 20	LT 100	69	LT 10
October[3]	113 ± 18	6 ± 15	0	0	7 ± 15	11 ± 15	LT 226	LT 9	LT 14	LT 84	LT 15	LT 13

(1) Mean of reported values

(2) LT = Less Than

(3) NUS delayed counting due to client backlog

TABLE B-8

United States Environmental Protection Agency
Intercomparison Program - 1979

Analytical Results - Cs-137 and Gross Beta - Air Filters

	Known Value (pCi ± 3σ)		NUS Value (pCi)[1]	
Month	Cs-137	Gross Beta	Cs-137	Gross Beta
January	6 ± 15	18 ± 15	9	22
March	21 ± 15	63 ± 15	NR[2]	76
October	12 ± 15,	31 ± 15	17	37

(1) Mean of reported values

(2) NR = Not Reported (GE(Li) at vendor for repairs)

TABLE B-9

Fourth International Intercomparison of Environmental Dosimeters - 1979

Analytical Results - Mean mR ± 2σ

	NUS Value	Calculated Exposure	All Dosimeters
Laboratory "Low"	9.9 ± 1.4	12.2 ± 2.4	12.0 ± 7.6
Laboratory "High"	37.8 ± 3.5	45.8 ± 9.2	43.9 ± 15.2
Field	13.2 ± 1.5	14.1 ± 1.4(1)	16.0 ± 9.0

(1) Value determined from a continuously operated recording pressurized ion chamber.

APPENDIX C

Analytical Procedures

Environmental samples for the Fermi-2 environmental radiological monitoring program were collected and analyzed in accordance with procedures described in detail in the NUS Laboratory Manual - "Environmental Monitoring and Radiological Services Procedures/Work Instructions." These analytical procedures have been adapted from the published analytical methods of the Environmental Measurements Laboratory (EML - formerly HASL), the laboratories of the Environmental Protection Agency, and pertinent ASTM procedures.

APPENDIX D

Reporting of Analytical Results

In the tables presenting analytical measurements, the calculated value is reported with the two sigma counting error (2σ) derived from a statistical analysis of both the sample and background count rates. The precision of the results is influenced by the size of the sample, the background count rate, and the method used to round off the value obtained to reflect the degree of significance of the results. For analytical results obtained from gamma spectral analysis, the precision is also influenced by the composition and concentrations of the radionuclides in the sample, the size of the sample, and the assumptions used in selecting the radionuclides to be quantitatively determined. The two sigma error for the net counting rate is:

$$2\sigma = 2\sqrt{\frac{R_s}{t_s} + \frac{R_b}{t_b}}$$

where

R_s = sample counting rate

R_b = background counting rate

t_s = sample counting time

t_b = background counting time

If the measurements on the samples are not statistically significant (i.e., the two sigma counting error is equal to or greater than the net measured value), then the radioactivity concentrations in the sample are considered not detected.

Results reported as less than - "LT" - are below the lower limit of detection (LLD). The LLD is defined as the smallest concentration of radioactive material in a sample that will yield a net count (above system background) that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{4.66\, s_b}{E \times V \times 2.22 \times Y \times \exp(-\lambda \Delta t)}$$

where

LLD is the lower limit of detection as defined above (as pCi per unit mass or volume)

s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute)

E is the counting efficiency (as counts per disintegration)

V is the sample size (in units of mass or volume)

2.22 is the number of disintegrations per minute per picocurie

Y is the fractional radiochemical yield (when applicable)

λ is the radioactive decay constant for the particular radionuclide

Δt is the elapsed time between sample collection and counting

The following are definitions or descriptions of statistical terms used in the reporting and analysis of environmental monitoring results.

Precision relates to the reproducibility of measurements within a set, that is, to the scatter or dispersion of a set about its central value.

Measures of the Central Value of a Set. Mean (or Average or Arithmetic Mean) is the sum $\sum_{i=1}^{n} X_i$ of the values of individual results divided by the number of results in the set. The mean is given by

$$\overline{X} = (X_1 + X_2 + \ldots X_n)/n = \sum_{i=1}^{n} X_i/n$$

Measures of Precision with a Set. Standard Deviation is the square root of the quantity (sum of squares of deviations of individual results from the mean, divided by one less than the number of results in the set). The standard deviation, s, is given by:

$$s = \sqrt{\sum_{i=1}^{n} (X_1 - \overline{X})^2 / (n - 1)}$$

Standard deviation has the same units as the measurement. It becomes a more reliable expression of precision as n becomes larger. When the measurements are independent and normally distributed, the most useful statistics are the mean for the central value and the standard deviation for the dispersion.

Relative Standard Deviation is the standard deviation expressed as a fraction of the mean, $s/\overline{X}$. It is sometimes multiplied by 100 and expressed as a percentage.

Range is the difference in magnitude between the largest and smallest results in a set. Instead of a single value, the actual limits are sometimes expressed (minimum value - maximum value).