NUS-3752

PREOPERATIONAL ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM

AT

FERMI-2

Annual Report
1980

Prepared for

The Detroit Edison Company

by

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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 1982. This program is being conducted by NUS Corporation under contract with The Detroit Edison Company (Edison). This is the third Annual Report for the radiological environmental monitoring program being conducted under the contract. This report covers the period December 29, 1979 through January 6, 1981 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 1130 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 will be used 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 originally designed on the basis of

the USNRC Branch Technical Position on radiological environmental monitoring issued by the Radiological Assessment Branch (March 1978).[1]

In 1980 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.

In response to guidelines established in the USNRC Branch Technical Position on the radiological portion of Regulatory Guide 4.8 (November 1979, Revision 1),[2] Edison expanded the TLD program at Fermi-2 to thirty-seven locations beginning the third quarter of 1980.

II. PROGRAM DESCRIPTION

Forty-five (45) 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 off-site environmental concentrations have been predicted from plant effluent source terms, site hydrology, and site meteorological conditions. Other factors considered were applicable regulations, 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), indicator milk locations, and gaseous radioiodine monitoring are expected to be implemented in 1981 or 1982. 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 through 3 designate sampling locations by station number.

TABLE 1

Preoperational Environmental Radiological Monitoring Program at Fermi-2, 1980

Sample Media	Station Number	Location	Sampling Frequency	Analysis Type	Analysis Frequency
Direct Radiation	1	Telephone pole #DE6935H6	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 #DF762356C			
	5	Site Boundary and Toll Road, Telephone pole #DE56R77635G5			
	6	Site Boundary and Toll Road telephone pole			
	7	Doty Farm, N Custer Road (control)			
	S-1	Pole NE corner Dixie Highway and Post Road			
	S-2	Pole NW corner Dixie Highway and Swan Creek			
	S-3	Pole #DE5240G5 on Masserant - South on SE corner of driveway to abandoned barn			
	S-4	Pointe Mouillee - W Jefferson and Campau Road, Pole #DE7045GC3 on SE corner of Bridge			
	S-5	Pointe Mouillee Game Area - Field Office, pole near tree north area of parking lot			
	S-6	Labo and Dixie Highway - Pole #175W3909 on SW corner with light			
	S-7	Labo and Brandon - Pole #DE6150G4 on SE corner near RR			
	S-8	Pole #R56DE27305 behind post office in Newport			
	S-9	Pole #R45DE40230 on SE corner War and Post Roads			
	S-10	Pole #MG78SPG735 on NE corner Nedau and Lapard - near mobile home park			
	S-11	Pole #DECO37406 on NW corner Mentel and Hurd			
	S-12	Pole #DE71440H in parking lot of Department Natural Resources Office Building - Stearling State Park			

TABLE 1 (Continued)

Preoperational Environmental Radiological Monitoring Program at Fermi-2, 1980

Sample Media	Station Number	Location	Sampling Frequency	Analysis Type	Analysis Frequency
Direct Radiation (Continued)	S-13	Pole #DE74540GC on Williams Road - school complex approximately 200 yards S of Jefferson High (special area)	Continuous sampling TLDs changed quarterly (2 TLDs/station)	Gamma dose	Quarterly
	S-14	Pole #DE4535G6R60, N side of Pearl - Woodland Beach (populated area)			
	S-15	Pole #DE7640H5, S side of Long and Point Aux Peaux (site boundary)			
	S-16	Pole #DE5840G5RG69, S side of Point Aux Peaux - next to vent pipe (site boundary)			
	S-17	Fermi gate along Point Aux Peaux Road - on fence post W of gate (site boundary)			
	S-18	Pole #DECO3435 on S corner of Toll Road S of main gate (site boundary)			
	S-19	Pole #DE7440H5 on Toll Road, first residence from Enrico Fermi Drive			
	S-20	Pole #DE7785BB1 at end of Front Street - in front of Detroit Edison Generation Plant			
	S-21	Pole #878150, junction of Mortar and Laplaisance			
	S-22	Junction of Dixie Highway and Laplaisance/Albain			
	S-23	Pole #DE4940B4, Custer(St. Mary's) Park, corner of N Custer and Dixie(Monroe St.)(N side, next to river) (special area)			
	S-24	Pole #DECO3160A, Milton "Pat" Munson Recreational Reserve - N Custer Road (control)			
	S-25	Pole #MTBC2, corner Stony Creek and Finzel Roads			
	S-26	Pole #DECO5028, N corner Grafton and Ash Roads			
	S-27	Pole #DECO35640, junction of Port Creek and Will-Carlton Roads			
	S-28	Pole #064Y7224, SE side of I-75, corner Pace and S Huron River Drive (special area)			
	S-29	Pole #DECO45440, N side of Cahill and Gibraltar Roads			
	S-30	Pole #DE5540G4, S corner of Adams and Gibraltar (across from Humbug Marina)			

TABLE 1 (Continued)

Preoperational Environmental Radiological Monitoring Program at Fermi-2, 1980

Sample Media	Station Number	Location	Sampling Frequency	Analysis Type	Analysis Frequency
Fish	16	Fermi-2 discharge	Semi-annually	Gamma isotopic (edible portion)	Semi-annually (1)
Yellow Perch (Perca flavescens)	11	Control in vicinity of Celeron Island			
Shoreline Sediments (2)	8	Point Aux Peaux, 100 ft offshore sighting directly to land-based water tower			
	9	Fermi-2 discharge	Semi-annually	Gamma isotopic	Semi-annually (1)
	10	Estral Beach, 300 feet offshore sighting directly to land-based windmill			
Airborne Particulates	1	Telphone pole #DE6933H6	Continuous sampling, change filters weekly	Gross beta (3)	Weekly (1) following each filter change
	4	Site Boundary and Toll Road, Telephone pole #DE762336C			
	5	Site Boundary and Toll Road, Telephone pole #DE56R77635G5		Gamma isotopic	Quarterly-composite by location (1)
	7	Doty Farm, N Custer Road (control)			
Surface Water	12	Unit 1 Raw Lake Water Intake Structure	Monthly	Gamma isotopic	Monthly (1)
	14	Trenton Power Plant Intake Structure (Screenhouse #2)(control)		Tritium	Quarterly-composite by location (1)
Drinking Water	13	Monroe Water Station	Monthly	Gross beta (3) Gamma isotopic Tritium	Monthly (1) Monthly (1) Quarterly-composite by location (1)
Milk	7	Doty Farm (control)	Monthly	Gamma isotopic	Monthly

(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.

(3) 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

(4) To be finalized after milch animal census

TABLE 2

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.	Telephone Pole #DE6935H6	Direct Radiation Radioiodine* Particulates
2	NNE	1.1 mi.	Tree at the termination of Brancho Street (private residence)	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 #DE762356C	Direct Radiation Radioiodine* Particulates
5	NW	0.6 mi.	Site Boundary and Toll Road, Telephone Pole #DE56R77635G5	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
S-1	NW	2.4 mi.	Pole NE corner Dixie Highway and Post Road	Direct Radiation
S-2	NNW	2.4 mi.	Pole NW corner Dixie Highway and Swan Creek	Direct Radiation
S-3	N	2.6 mi.	Pole #DE5240G5, on Masserant - South on SE corner of driveway to abandoned barn	Direct Radiation
S-4	NNE	6.3 mi.	Pointe Mouillee - W Jefferson and Campau Road, Pole #DE2045GC3 on SE corner of Bridge	Direct Radiation
S-5	NE	5.1 mi.	Pointe Mouillee Game Area - Field Office, pole near tree north area of parking lot	Direct Radiation
S-6	N	4.5 mi.	Labo and Dixie Highway - Pole #175W3909 on SW corner with light	Direct Radiation
S-7	NNW	5.0 mi.	Labo and Brandon - Pole #DE6150G4 on SE corner near RR	Direct Radiation

TABLE 2 (Continued)

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

Station Number (1)	Direction	Distance from Reactor (Approx.)	Description	Media
S-8	NW	4.0 mi.	Pole #R36DE27305 behind post office in Newport	Direct Radiation
S-9	WNW	4.9 mi.	Pole #R45DE40230 on SE corner of War and Post Roads	Direct Radiation
S-10	W	5.5 mi.	Pole #MO78SPG735 on NE corner Nedau and Lapard near mobile home park	Direct Radiation
S-11	SW	4.5 mi.	Pole #DECO37406 on NW corner Mentel and Hurd	Direct Radiation
S-12	SW	4.9 mi.	Pole #DE71440H in parking lot of Department Natural Resources Office Building - Stearling State Park	Direct Radiation
S-13	W	2.8 mi.	Pole #DE74540GC on Williams Road - school complex approximately 200 yards S of Jefferson High (special area)	Direct Radiation
S-14	WSW	2.8 mi.	Pole #DE4535G6R60 N side of Pearl - Woodland Beach (populated area)	Direct Radiation
S-15	S	0.9 mi.	Pole #DE7640H5 S side of Long and Point Aux Peaux (site boundary)	Direct Radiation
S-16	SSW	1.0 mi.	Pole #DE5840G5RG69 S side of Point Aux Peaux - next to vent pipe (site boundary)	Direct Radiation
S-17	SW	0.9 mi.	Fermi gate along Point Aux Peaux Road - on fence post W of gate (site boundary)	Direct Radiation
S-18	WSW	1.2 mi.	Pole #DECO3435 on S corner of Toll Road S of main gate (site boundary)	Direct Radiation
S-19	W	1.0 mi.	Pole #DE7440H5 on Toll Road, first residence from Enrico Fermi Drive	Direct Radiation
S-20	SSW	6.2 mi.	Pole #DE7785BB1 at end of Front Street - in front of Detroit Edison Generation Plant	Direct Radiation
S-21	SW	10.1 mi.	Pole #878130 junction of Mortar and Laplaisance	Direct Radiation
S-22	WSW	9.9 mi.	Junction of Dixie Highway and Laplaisance/Albain	Direct Radiation

TABLE 2 (Continued)

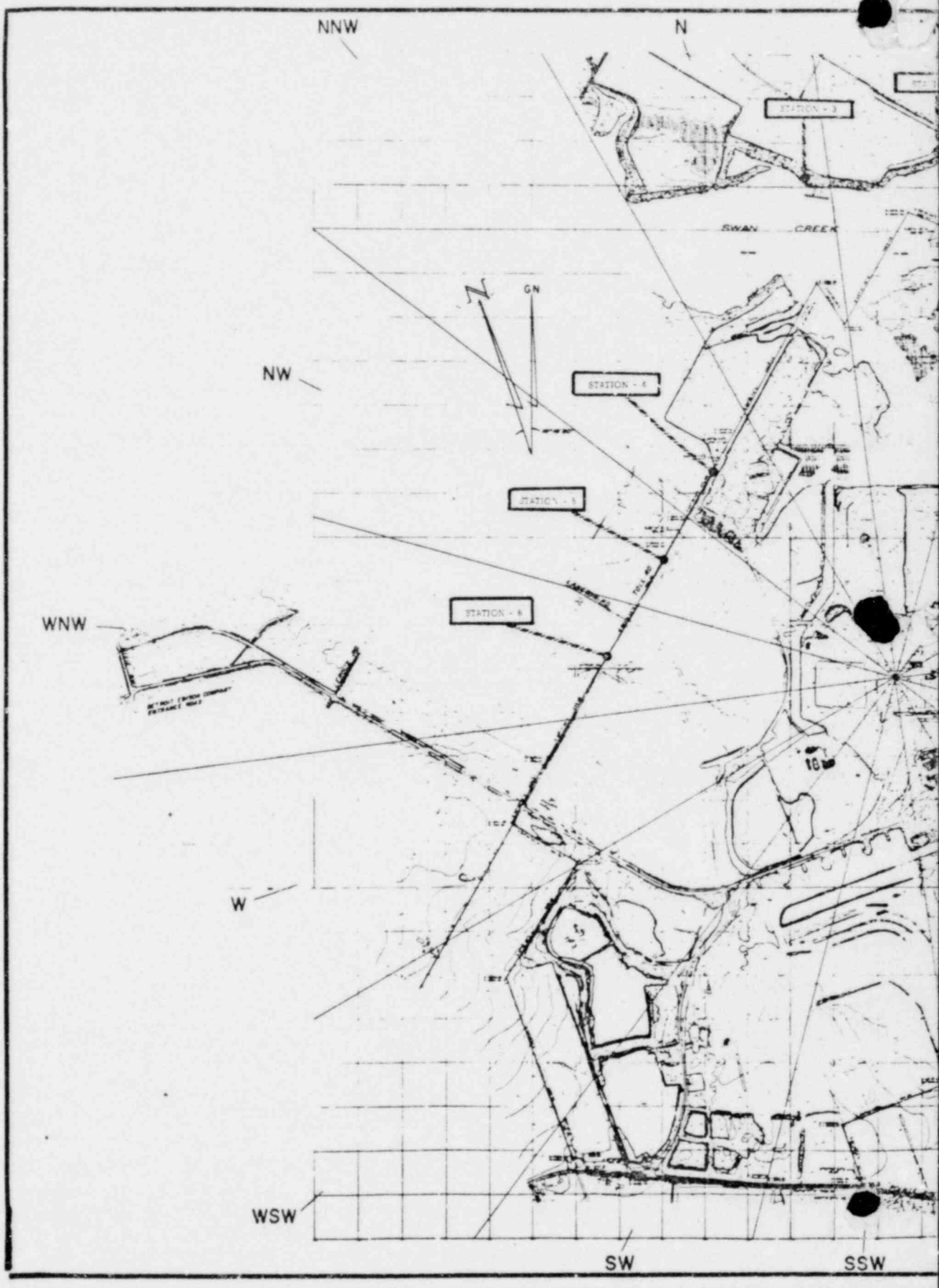
Preoperational Environmental Radiological Monitoring Program, Fermi-2
Sample Locations and Associated Media

Station Number (1)	Direction	Distance from Reactor (Approx.)	Description	Media
S-23	WSW	8.0 mi.	Pole DE4940B4, Custer (St. Mary's) Park corner of N Custer and Dixie (Monroe St.) (N side, next to river)(special area)	Direct Radiation
S-24	WSW	9.2 mi.	Pole #DECO3160A, Milton "Pat" Munson Recreational Reserve - N Custer Road (control)	Direct Radiation
S-25	WNW	10.1 mi.	Pole #MTBC2, corner Stony Creek and Finzel Roads	Direct Radiation
S-26	NW	8.7 mi.	Pole #DECO5028, N corner Grafton and Ash Roads	Direct Radiation
S-27	NNW	9.9 mi.	Pole #DECO35640, junction of Port Creek and Will-Carlton Roads	Direct Radiation
S-28	N	6.9 mi.	Pole #064Y7224, SE side of I-75, corner Pace and S Huron River Drive (special area)	Direct Radiation
S-29	N	9.5 mi.	Pole #DECO45440, N side corner of Cahill and Gibraltar Roads	Direct Radiation
S-30	NNE	9.9 mi.	Pole #DE5540G4, S corner of Adams and Gibraltar (across from Humbug Marina)	Direct Radiation
8	S	0.9 mi.	Point 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 ft offshore sighting directly to land based windmill	Sediment
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)	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

* Sample collections for these media not performed during 1980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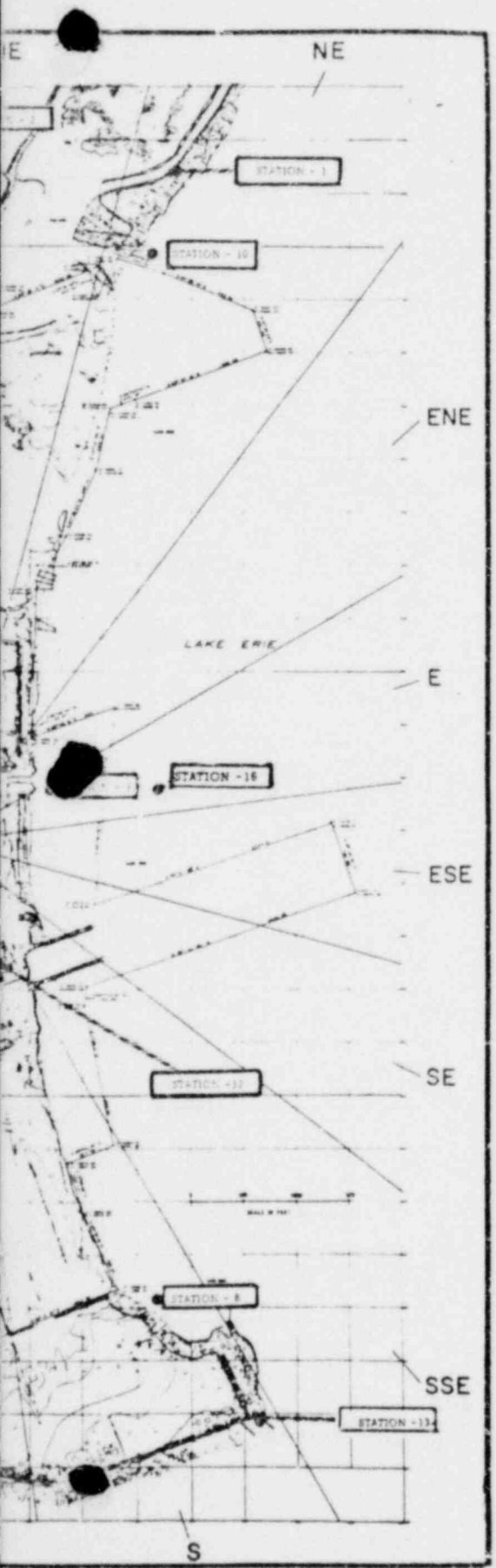
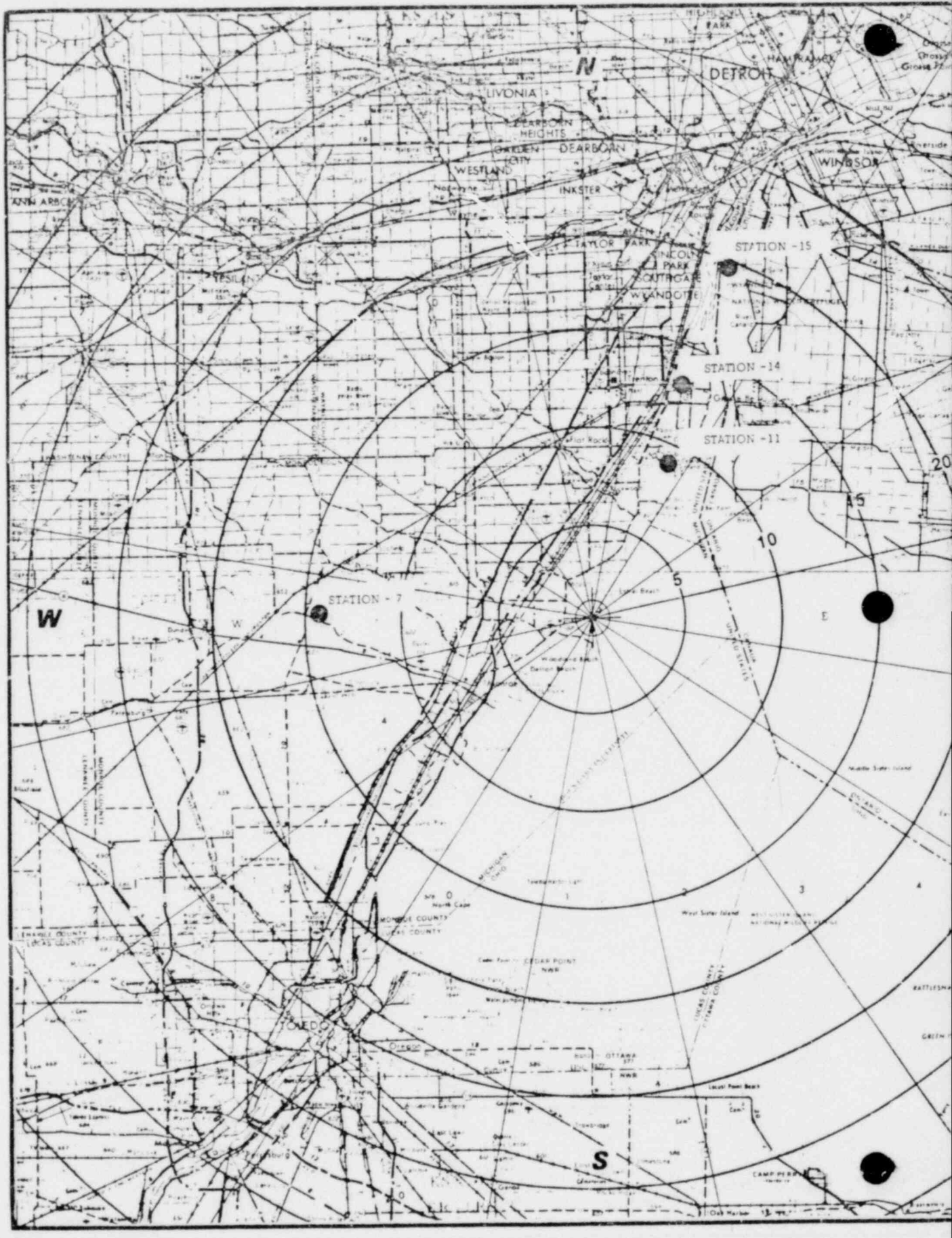
NW
WNW
W
WSW
SW
SSW
SWAN CREEK
STATION - 4
STATION - 5
STATION - 6
GN



ENRICO FERMI ATOMIC POWER PLANT
UNIT 2

Figure 1

Sampling Locations-By Station Number
(Immediate Vicinity of Fermi-2)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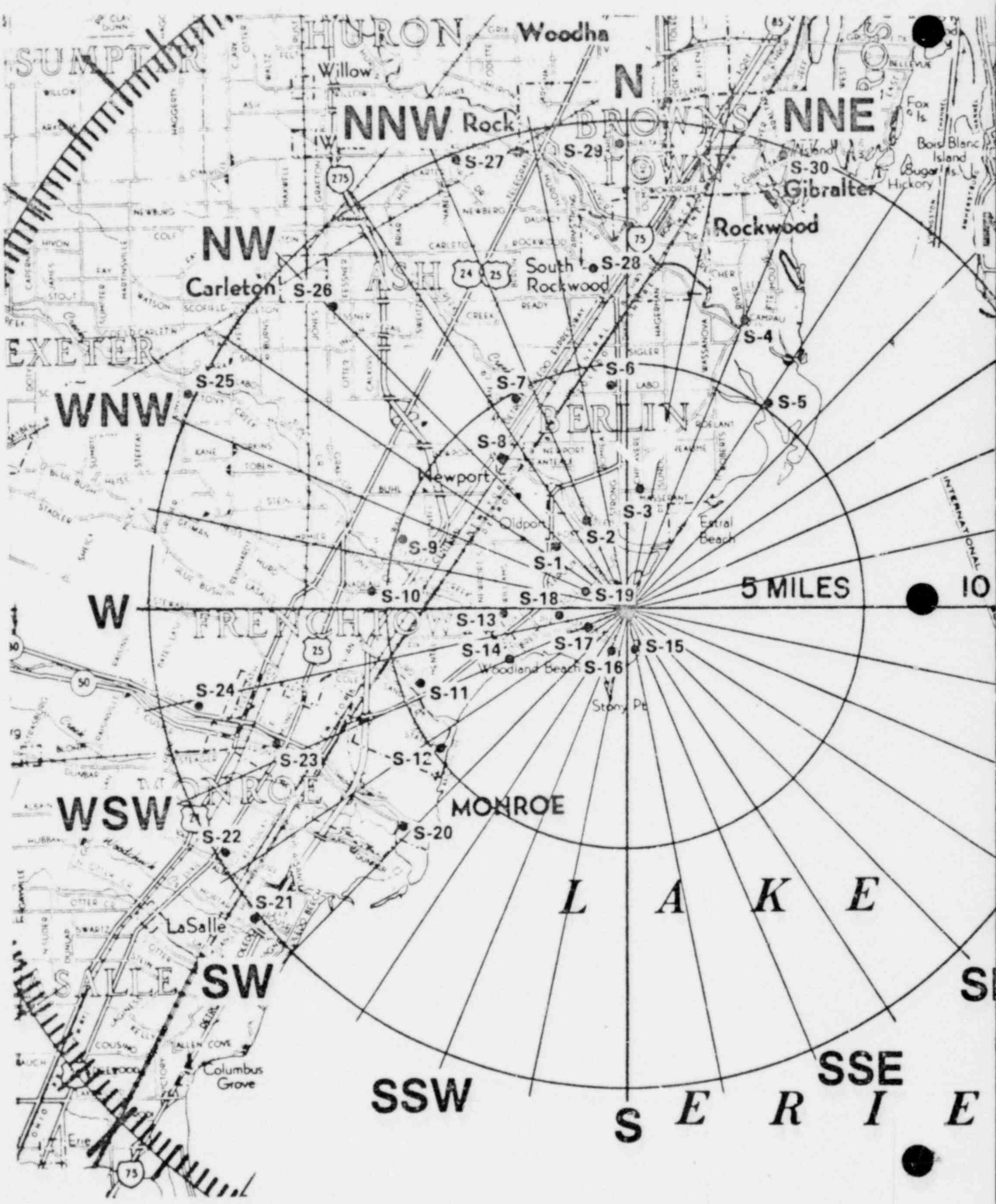
LIVONIA
DEARBORN HEIGHTS
DEARBORN
WESTLAND
INKSTER
WINDSOR
TAYLOR
LINCOLN PARK
SOUTHGATE
WYANDOTTE
STATION - 15
STATION - 14
STATION - 11
STATION - 7
5
10
15
20
TOLEDO

ENRICO FERMI ATOMIC POWER PLANT
UNIT 2

Figure 2
Sampling Locations By Station Number
(Greater Than 5 Miles)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NNW
NW
WNW
W
WSW
SW
SSW
S
SSE
5 MILES
10
LAKE ERIE
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BROWNSTOWN
ASH
EXETER
BERLIN
FRENCHTOWN
MONROE
LASALLE
Willow
Rock
Carleton
South Rockwood
Rockwood
Gibralter
Newport
Oldport
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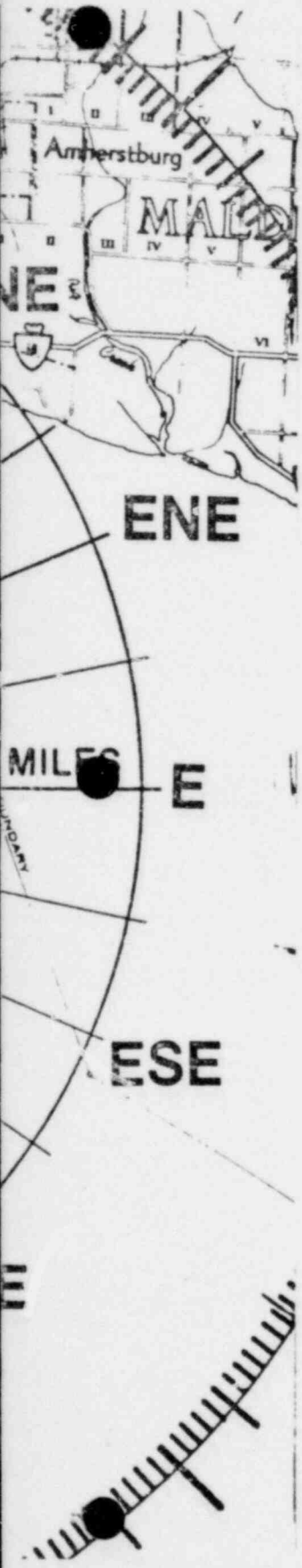
Woodland Beach
Stony Pt
MONROE
LaSalle
Columbus Grove
Erie
Fox Is
Bois Blanc Island
Sugar Is
Hickory



ENRICO FERMI ATOMIC POWER PLANT
UNIT 2

FIGURE 3

SUPPLEMENTARY TLD LOCATIONS –
BY STATION NUMBER

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.[3]

A. Direct Radiation

Thermoluminescent dosimeters (TLDs) were used to determine the direct (ambient) radiation levels at thirty-seven (37) monitoring points as described in Tables 1 and 2. Stations 1 through 6 are situated in the six sectors around the plant having the highest calculated mixed-mode X/Q values. In July, the TLD network was expanded by thirty locations. These points were selected in accordance with the RATS (ring-around-the-station) philosophy outlined in the USNRC Branch Technical Position on Radiological Monitoring (Revision 1, November 1979).[2] The RATS locations are situated at the site boundary and at distances of approximately 2, 5, and 10 miles from Fermi-2. Stations 7 and S-24, the control locations, are located approximately 15 and 9 miles west of Fermi-2, respectively, in the least prevalent wind direction.

Duplicate dosimeters of $CaSO_4$:Dy in teflon, were deployed at each location and exchanged on a quarterly basis. To minimize the in-transit dose contribution, the dosimeters were annealed close to the site 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) and from the control location in the vicinity of Celeron Island (Station 11) approximately nine (9) miles NNE of the plant. Only the fall samples were collected in 1980 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 in November 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. The scheduled spring samples were not collected in 1980 and are addressed in Appendix A.

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 Tables 1 and 2.

The samples were run continuously and the filter 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 January 5, 1980, April 4, 1980, December 13, 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 Tables 1 and 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 is scheduled to begin at Station 15 (Detroit Water Station, Allen Park, Michigan) when Edison is notified that access to Station 15 has been granted by the City of Detroit. Sampling at this location will be correlated with the finalization of the fuel load data for Fermi-2.

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.

Indicator locations will be finalized following a milch animal survey in 1981 or 1982. The survey and subsequent sample collections will be correlated with the Fermi-2 fuel load date.

IV. SUMMARY AND DISCUSSION OF 1980 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 Serivces Procedure/Work Instructions."

Radiological analyses of environmental media characteristically approach and frequently fall below the detection limits of state-of-the-art measurement methods.[3] 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. "ND" (Not Detected) is used periodically in the tables presenting gamma analysis results for various media. It primarily appears under the "Others" column, and indicates that no other detectable gamma emitting nuclides were identified. NUS analytical methods meet the LLD requirements addressed in Table 2 of the USNRC Branch Technical Position on Radiological Monitoring (November 1979, Revision 1).[2]

Tables 3 through 11 give the radioanalytical results for individual samples. A statistical summary of the results appears in Table 12. The reported averages are based only on concentrations above the limit of detection. In Table 12, 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 Tables 3 and 3A. Duplicate TLD badges of four readout 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 1980 data is included in Table 12. Individual measurements of external radiation levels in the environs of the Fermi-2 site ranged from 0.09 to 0.24 mrem/day (0.10 to 0.27 mR/day). Annual levels ranged from 32 to 87 mrem/year (36 to 99 mR/year). Oakley[4] calculates an ionizing radiation dose equivalent of 82.2 mrem/year for Michigan, including a terrestrial component of 45.6 mrem/year and an ionizing cosmic ray component of 36.6 mrem/year (excludes neutron component). Since Oakley's values represent averages covering wide geographical areas, the measured ambient radiation average of 60 mrem/year for the immediate locale of Fermi-2 may not be inconsistent with Oakely's observations. Significant variations occur between geographical areas as a result of geological 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.

TABLE 3

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1980 - Q1 and Q2

Direct Radiation - Analytical Results

Results in Units of mR/day ± 2σ (1)

Quarter		Station Number 1	2	3	4	5	6	7
1	a	0.13±0.02	0.18±0.01	0.17±0.03	0.17±0.02	0.15±0.01	0.13±0.02	0.17±0.03
	b	0.12±0.02	0.15±0.02	0.15±0.02	0.15±0.02	0.16±0.03	0.15±0.01	0.16±0.02
	mean(2)	0.12±0.02	0.16±0.02	0.14±0.02	0.16±0.02	0.16±0.02	0.14±0.02	0.16±0.02
2	a	0.10±0.02	0.14±0.02	0.15±0.02	0.14±0.02	0.16±0.02	0.12±0.02	0.15±0.03
	b	0.11±0.01	0.14±0.02	0.14±0.02	0.14±0.02	0.13±0.02	0.12±0.01	0.14±0.02
	mean	0.10±0.02	0.14±0.02	0.14±0.02	0.14±0.02	0.14±0.02	0.12±0.02	0.14±0.02

(1) 2 x standard deviation of four(4) readout areas

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

TABLE 3A

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1980-Q3 and Q4

Direct Radiation - Analytical Results

Results in Units of mR/day ± 2σ (1)

Station Number	Q3			Q4		
	a	b	mean (2)	a	b	mean (2)
1	0.10±0.04	0.18±0.04	0.14±0.04	0.11±0.02	0.17±0.03	0.14±0.02
2	0.20±0.02	0.18±0.03	0.19±0.02	0.16±0.03	0.20±0.03	0.18±0.03
3	NS (3)	NS		NS	NS	
4	0.18±0.01	0.23±0.04	0.20±0.02	0.17±0.02	0.15±0.02	0.16±0.02
5	0.20±0.02	0.21±0.03	0.20±0.02	0.18±0.02	0.18±0.05	0.18±0.04
6	0.15±0.01	0.18±0.08	0.16±0.04	0.15±0.03	0.16±0.02	0.16±0.02
7	0.19±0.06	0.21±0.02	0.20±0.04	0.13±0.03	0.13±0.02	0.13±0.02
S-1	0.21±0.04	0.22±0.02	0.22±0.03	0.24±0.04	0.17±0.02	0.20±0.03
S-2	NS	NS		NS	NS	
S-3	0.22±0.02	0.20±0.03	0.21±0.02	0.19±0.04	0.18±0.03	0.18±0.04
S-4	0.18±0.02	0.15±0.03	0.16±0.02	0.13±0.03	0.15±0.02	0.14±0.02
S-5	0.18±0.02	0.17±0.02	0.18±0.02	0.12±0.02	0.12±0.02	0.12±0.02
S-6	0.22±0.02	0.21±0.03	0.22±0.02	0.18±0.03	0.17±0.04	0.18±0.04
S-7	NS	NS		0.17±0.03	NS	0.17±0.03
S-8	0.23±0.05	0.21±0.02	0.22±0.04	NS	NS	
S-9	0.21±0.03	0.24±0.05	0.22±0.04	0.17±0.03	0.15±0.02	0.16±0.02
S-10	0.19±0.01	0.20±0.03	0.20±0.02	NS	NS	
S-11	0.18±0.02	0.20±0.03	0.19±0.02	0.16±0.02	0.18±0.08	0.17±0.05
S-12	0.25±0.09	0.24±0.03	0.24±0.06	0.14±0.03	0.20±0.03	0.17±0.03
S-13	0.19±0.02	0.24±0.02	0.22±0.02	0.18±0.02	0.19±0.03	0.18±0.02
S-14	0.22±0.0	0.18±0.02	0.20±0.02	0.12±0.03	0.16±0.02	0.14±0.02
S-15	NS	NS		0.13±0.02	0.11±0.02	0.12±0.02
S-16	0.21±0.02	0.20±0.03	0.20±0.02	0.18±0.02	0.18±0.02	0.18±0.02
S-17	NS	NS		0.18±0.03	0.16±0.02	0.17±0.02
S-18	0.23±0.03	0.26±0.02	0.24±0.02	0.18±0.03	0.25±0.05	0.22±0.04
S-19	0.22±0.03	0.27±0.03	0.24±0.03	0.25±0.04	0.21±0.03	0.23±0.04
S-20	0.17±0.03	0.17±0.03	0.17±0.03	0.12±0.02	0.11±0.02	0.12±0.02
S-21	0.21±0.04	0.21±0.03	0.21±0.04	0.16±0.03	0.14±0.02	0.15±0.02
S-22	0.18±0.03	0.15±0.02	0.16±0.02	0.18±0.02	0.13±0.02	0.16±0.02
S-23	0.18±0.01	0.17±0.05	0.18±0.03	0.10±0.02	0.12±0.04	0.11±0.03
S-24	0.18±0.06	0.22±0.01	0.20±0.08	0.13±0.03	0.17±0.03	0.15±0.03
S-25	0.20±0.02	0.19±0.03	0.20±0.02	0.23±0.03	0.18±0.03	0.20±0.03
S-26	0.20±0.02	0.20±0.02	0.20±0.02	0.13±0.02	0.14±0.03	0.14±0.02
S-27	0.16±0.03	0.19±0.05	0.18±0.04	0.15±0.05	0.15±0.03	0.15±0.04
S-28	0.19±0.02	0.16±0.02	0.18±0.02	0.13±0.02	0.15±0.02	0.14±0.02
S-29	NS	NS		NS	NS	
S-30	NS	NS		NS	NS	

(1) 2 x standard deviation of four(4) readout areas

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

(3) NS = No Sample (TLD vandalized)

B. Fish

The results of gamma analyses performed on yellow perch (Perca flavescens) collected during 1980 are presented in Table 4. Although only one sample collection from each location was performed in 1980, the results have been included in Table 12 for completeness.

Naturally occurring K-40 constituted the major detectable nuclide activity in the flesh portions of the fish. Cs-137 was detected in the sample collected from Station 11. This isotope has been identified in fish samples collected from this location in previous years. Since it is present in global fallout, the occasional detection of Cs-137 in environmental media is not unusual.

TABLE 4

Environmental Radiological Monitoring Program, Fermi-2

Preoperational, 1980

Fish - Yellow Perch (Perca flavescens), Analytical Results (Edible Portion)

Gamma Emitting Nuclides

Quarter	Collection Date	Sampling Location		Results in Units of pCi/kg, wet ± 2σ								
				K-40	Mn-54	Fe-59	Co-58	Co-60	Zn-65	Cs-134	Cs-137	Others
4	11-12-80	16	a	3500±400	LT 40[2]	LT 110	LT 60	LT 30	LT 80	LT 30	LT 50	ND[3]
			b	3100±400	LT 50	LT 140	LT 70	LT 30	LT 90	LT 18	LT 70	ND
			mean[1]	3300±400	LT 40	LT 120	LT 60	LT 30	LT 80	LT 20	LT 60	
		11	a	3100±400	LT 20	LT 60	LT 30	LT 20	LT 40	LT 14	27±10	ND
			b[4]	2400±200	LT 19	LT 90	LT 30	LT 17	LT 50	LT 14	17±6	ND
			mean	2800±300	LT 20	LT 80	LT 30	LT 18	LT 40	LT 14	22±8	

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

(2) LT = Less Than

(3) ND = Not Detected

(4) Replicate Count

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 collodial 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 analyses 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 12. Samples were collected only in November (see Appendix A).

In 1980, Cs-137 was detected in the sample collected from Station 9. A review of historical data shows that this isotope has routinely been identified in sediment samples from this location. The mean Cs-137 concentration of 380 pCi/kg (dry) is consistent with previous results.

TABLE 5

Environmental Radiological Monitoring Program, Fermi-2

Preoperational, 1980

Shoreline Sediments Analytical Results - Gamma Emitting Nuclides

Quarter	Collection Date	Sampling Location		Results in Units of pCi/kg, dry, ± 2σ										
				Bi-214	Pb-214	Ra-226	Bi-212	Pb-212	Tl-208	Ac-228	K-40	Cs-134	Cs-137	Others
4	11-12-80	8	a	500±120	560± 70	730±350	LT1200[2]	180± 60	290±120	420±140	12000±1000	LT 70	LT 100	ND[3]
			b	330± 80	520± 70	330±190	540±320	240± 50	320±100	390± 90	11000±1000	LT 60	LT 70	ND
			mean[1]	520±100	540± 70	530±270	(1/2)[4]	210± 60	300±110	400±120	12000±1000	LT 60	LT 80	
	11-12-80	9	a	740±100	710±120	840±280	LT1300	440± 80	670±140	540±170	13000±1000	LT 80	240± 60	ND
			b	890±130	920±120	900±540	1300±600	460±110	530±200	690±160	13000±2000	LT 120	430± 70	ND
			mean	820±120	820±120	870±410	(1/2)	450±100	600±170	620±160	13000±2000	LT 100	380± 60	
	11-12-80	10	a	380±110	320± 50	LT 700	LT 900	160± 50	300±210	310±110	13000±1000	LT 50	LT 70	ND
			b	260± 80	340± 70	340±180	LT1000	130± 50	330±200	210±100	14000±1000	LT 70	LT 80	ND
			mean	320±100	330± 60	(1/2)	LT1000	140± 50	320±200	260±100	14000±1000	LT 60	LT 80	

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

(2) LT = Less Than

(3) ND = Not Detected

(4) Fraction in parentheses indicates number of detectables/number of analyses

D. Airborne Particulates

The weekly gross beta results for airborne particulates are listed in Table 6. The results of gamma analyses performed on composited filters quarterly, by location, are given in Tables 7 and 7A. A statistical summary of the data is provided in Table 12.

On October 16, 1980, the Peoples Republic of China conducted an above ground nuclear weapons test. U. S. Environmental Protection Agency (USEPA) monitoring data indicate that high altitude debris from the test passed over the west coast of the United States early on October 19, 1980. Debris did not reach the east coast until late on October 20. Initial USEPA test results showed only traces of ground level activity directly attributable to the weapons test. Milk samples contained no activity above normal background. Subsequent but less intensive USEPA monitoring of air particulate samples indicate a slow buildup of gross beta activity. This trend is considered somewhat unusual based on the absence of "peak" periods normally associated with the cyclic passage of radionuclides from atmospheric nuclear tests.(5)

In considering the results of gross activity measurements, it is important to keep in mind the inherent limitations of gross beta counting for mixtures of unknown composition. The counting efficiency for an unknown mixture of activities varies considerably with the energy of decay and the amount of absorbing material in the sample. Because of this, the results of gross activity measurements are difficult to interpret.

USEPA observations are supported by the gross beta results of air particulate samples collected after October 16, 1980 from the Fermi-2 area. As indicated in Table 6, average gross beta activities increased beginning with the sampling period October 14, 1980 to October 21, 1980. This trend continued for the remainder of the reporting period.

Gamma analyses of the fourth quarter composites identified various fission products attributable to the Chinese test. The occasional detection of Cs-137 in previous quarterly composites is likely associated with long term global fallout.

TABLE 6

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1980

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
January	1-5-80	a(1)	24 ± 5	33 ± 6	79 ± 8	NS(3)
	to	b	27 ± 5	32 ± 6	70 ± 7	
	1-12-80	mean(2)	26 ± 5	32 ± 6	74 ± 8	
	1-12-80	a	28 ± 6	32 ± 6	66 ± 7	NS
	to	b	32 ± 6	38 ± 6	72 ± 7	
	1-19-80	mean	30 ± 6	35 ± 6	69 ± 7	
	1-19-80	a	17 ± 5	23 ± 6	15 ± 5	NS
	to	b	20 ± 5	18 ± 5	15 ± 5	
	1-25-80	mean	18 ± 5	20 ± 6	15 ± 5	
	1-25-80	a	13 ± 5	16 ± 5	39 ± 6	NS
	to	b	12 ± 5	17 ± 5	36 ± 6	
	2-2-80	mean	12 ± 5	16 ± 5	38 ± 6	

TABLE 6 (Continued)

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1980

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
February	2-2-80	a	NS	14 ± 5	35 ± 6	NS
	to	b		11 ± 5	28 ± 6	
	2-9-80	mean		12 ± 5	32 ± 6	
	2-9-80	a	16 ± 4	41 ± 6	80 ± 7	NS
	to	b	14 ± 5	35 ± 6	69 ± 7	
	2-16-80	mean	15 ± 4	38 ± 6	74 ± 7	
	2-16-80	a	21 ± 5	29 ± 5	60 ± 7	NS
	to	b	21 ± 5	22 ± 5	48 ± 6	
	2-23-80	mean	21 ± 5	26 ± 5	54 ± 6	
	2-23-80	a	37 ± 11	30 ± 5	68 ± 7	23 ± 5
	to	b	25 ± 12	27 ± 6	60 ± 7	16 ± 5
	3-1-80	mean	31 ± 12	28 ± 6	64 ± 7	20 ± 5

TABLE 6 (Continued)

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1980

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
March	3-1-80	a	37 ± 13	18 ± 5	41 ± 6	8 ± 4
	to	b	55 ± 15	17 ± 5	35 ± 6	5 ± 4
	3-8-80	mean	46 ± 14	18 ± 5	38 ± 6	6 ± 4
	3-8-80	a	12 ± 3	23 ± 5	54 ± 6	13 ± 5
	to	b	9 ± 4	19 ± 5	45 ± 6	15 ± 5
	3-15-80	mean	10 ± 4	21 ± 5	50 ± 6	14 ± 5
	3-15-80	a	9 ± 4	17 ± 5	45 ± 6	9 ± 6
	to	b	8 ± 4	15 ± 5	44 ± 6	7 ± 6
	3-23-80	mean	8 ± 4	16 ± 5	44 ± 6	8 ± 6
	3-23-80	a	9 ± 3	13 ± 3	16 ± 3	4 ± 4
	to	b	14 ± 2	17 ± 3	21 ± 3	6 ± 3
	4-5-80	mean	12 ± 2	15 ± 3	18 ± 3	5 ± 4

TABLE 6 (Continued)

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1980

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
April	4-5-80	a	12 ± 4	13 ± 4	39 ± 5	4 ± 3
	to	b	7 ± 4	6 ± 4	34 ± 6	10 ± 4
	4-12-80	mean	10 ± 4	10 ± 4	36 ± 6	7 ± 4
	4-12-80	a	12 ± 4	18 ± 5	36 ± 6	11 ± 4
	to	b	10 ± 4	14 ± 4	29 ± 5	8 ± 4
	4-19-80	mean	11 ± 4	16 ± 4	32 ± 6	10 ± 4
	4-19-80	a	16 ± 4	22 ± 5	34 ± 5	5 ± 4
	to	b	15 ± 4	17 ± 5	36 ± 6	10 ± 4
	4-26-80	mean	16 ± 4	20 ± 5	35 ± 6	8 ± 4
	4-26-80	a	10 ± 4	12 ± 4	19 ± 5	LT 6 (4)
	to	b	8 ± 4	10 ± 4	18 ± 5	LT 6
	5-3-80	mean	9 ± 4	11 ± 4	18 ± 5	LT 6

TABLE 6 (Continued)

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1980

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
May	5-3-80	a	18 ± 5	23 ± 5	32 ± 4	12 ± 4
	to	b	17 ± 5	20 ± 5	26 ± 4	10 ± 4
	5-10-80	mean	18 ± 5	22 ± 5	29 ± 4	11 ± 4
	5-10-80	a	16 ± 4	18 ± 4	49 ± 7	7 ± 4
	to	b	14 ± 4	15 ± 4	42 ± 7	10 ± 4
	5-18-80	mean	15 ± 4	16 ± 4	46 ± 7	8 ± 4
	5-18-80	a	12 ± 4	26 ± 5	NS	20 ± 4
	to	b	17 ± 5	24 ± 5		14 ± 4
	5-25-80	mean	10 ± 4	25 ± 5		17 ± 4
	5-25-80	a	26 ± 6	37 ± 6	NS	19 ± 5
	to	b	30 ± 6	29 ± 6		24 ± 6
	5-31-80	mean	28 ± 6	33 ± 6		22 ± 6

TABLE 6 (Continued)

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1980

Air Particulates
Analytical Results - Gross Beta

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

Month	Sampling Period		Station Number 1	4	5	7
June	5-31-80	a	14 ± 4	22 ± 5	NS	13 ± 4
	to	b	16 ± 4	21 ± 5		8 ± 4
	6-7-80	mean	15 ± 4	22 ± 5		10 ± 4
	6-7-80	a	18 ± 4	26 ± 4	LT 10	13 ± 4
	to	b	14 ± 4	21 ± 4	LT 10	14 ± 4
	6-15-80	mean	16 ± 4	24 ± 4	LT 10	14 ± 4
	6-15-80	a	16 ± 5	15 ± 5	NS	11 ± 5
	to	b	16 ± 5	15 ± 5		13 ± 5
	6-21-80	mean	16 ± 5	15 ± 5		12 ± 5
	6-21-80	a	22 ± 4	26 ± 5	NS	19 ± 4
	to	b	25 ± 4	30 ± 6		20 ± 4
	6-30-80	mean	24 ± 4	28 ± 6		20 ± 4

TABLE 6 (Continued)

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1980

Air Particulates
Analytical Results - Gross Beta

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

Month	Sampling Period		Station Number 1	4	5	7
July	6-30-80	a	11 ± 5	NS	NS	13 ± 5
	to	b	11 ± 5			11 ± 5
	7-6-80	mean	11 ± 5			12 ± 5
	7-6-80	a	24 ± 5	32 ± 7	27 ± 11	36 ± 10
	to	b	22 ± 5	36 ± 8	23 ± 11	32 ± 10
	7-13-80	mean	23 ± 5	34 ± 8	25 ± 11	34 ± 10
	7-13-80	a	14 ± 5	13 ± 7	NS	13 ± 3
	to	b	14 ± 5	15 ± 7		13 ± 3
	7-19-80	mean	14 ± 5	14 ± 7		13 ± 3
	7-19-80	a	20 ± 5	LT 7	NS	19 ± 4
	to	b	14 ± 10	LT 7		16 ± 4
	7-27-80	mean	17 ± 8	LT 7		18 ± 4

TABLE 6 (Continued)

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1980

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
August	7-27-80	a	25 ± 6	NS	NS	24 ± 6
	to	b	22 ± 6			19 ± 6
	8-2-80	mean	24 ± 6			22 ± 6
	8-2-80	a	16 ± 5	NS	NS	14 ± 5
	to	b	17 ± 5			18 ± 5
	8-9-80	mean	16 ± 5			16 ± 5
	8-9-80	a	9 ± 4	NS	NS	6 ± 4
	to	b	9 ± 4			11 ± 5
	8-16-80	mean	9 ± 4			8 ± 4
	8-16-80	a	6 ± 4	NS	NS	12 ± 5
	to	b	LT 6 (5)			9 ± 4
	8-23-80	mean	(1/2)			10 ± 4
	8-23-80	a	21 ± 5	NS	NS	23 ± 5
	to	b	20 ± 5			25 ± 5
	8-30-80	mean	20 ± 5			24 ± 5

TABLE 6 (Continued)

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1980

Air Particulates
Analytical Results - Gross Beta

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

Month	Sampling Period		Station Number 1	4	5	7
September	8-30-80	a	NS	NS	NS	11 ± 5
	to	b				15 ± 5
	9-7-80	mean				13 ± 5
	9-7-80	a	NS	NS	NS	19 ± 5
	to	b				15 ± 5
	9-14-80	mean				17 ± 5
	9-14-80	a	35 ± 7	NS	24 ± 6	15 ± 5
	to	b	39 ± 7		21 ± 6	12 ± 5
	9-20-80	mean	37 ± 7		22 ± 6	14 ± 5
	9-20-80	a	25 ± 5	20 ± 7	20 ± 5	13 ± 4
	to	b	27 ± 5	19 ± 7	25 ± 5	8 ± 4
	9-28-80	mean	26 ± 5	20 ± 7	22 ± 5	10 ± 4

TABLE 6 (Continued)

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1980

Air Particulates
Analytical Results - Gross Beta

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

Month	Sampling Period		Station Number 1	4	5	7
October	9-28-80	a	NS	NS	30 ± 5	18 ± 4
	to	b			32 ± 4	19 ± 4
	10-7-80	mean			31 ± 4	18 ± 4
	10-7-80	a	10 ± 5	12 ± 5	12 ± 5	LT 7
	to	b	9 ± 5	15 ± 5	9 ± 5	9 ± 4
	10-14-80	mean	10 ± 5	14 ± 5	10 ± 5	(1/2)
	10-14-80	a	38 ± 6	41 ± 6	33 ± 6	37 ± 6
	to	b	33 ± 6	30 ± 6	27 ± 6	35 ± 6
	10-21-80	mean	36 ± 6	36 ± 6	30 ± 6	36 ± 6
	10-21-80	a	35 ± 6	36 ± 6	34 ± 6	59 ± 6
	to	b	26 ± 6	29 ± 6	29 ± 6	47 ± 6
	10-28-80	mean	30 ± 6	32 ± 6	32 ± 6	53 ± 6

TABLE 6 (Continued)

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1980

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
November	10-28-80	a	37 ± 6	33 ± 6	23 ± 5	34 ± 6
	to	b	34 ± 6	31 ± 6	18 ± 5	33 ± 6
	11-5-80	mean	36 ± 6	32 ± 6	20 ± 5	34 ± 6
	11-5-80	a	26 ± 5	23 ± 5	12 ± 5	20 ± 5
	to	b	27 ± 6	17 ± 5	9 ± 5	22 ± 5
	11-11-80	mean	26 ± 6	20 ± 5	10 ± 5	21 ± 5
	11-11-80	a	17 ± 5	46 ± 6	35 ± 6	51 ± 6
	to	b	15 ± 5	43 ± 6	25 ± 6	43 ± 6
	11-18-80	mean	16 ± 5	44 ± 6	30 ± 6	47 ± 6
	11-18-80	a	41 ± 5	61 ± 6	43 ± 5	41 ± 5
	to	b	42 ± 5	64 ± 6	47 ± 5	44 ± 5
	11-26-80	mean	42 ± 5	62 ± 6	45 ± 5	42 ± 5

TABLE 6 (Continued)

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1980

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
December	11-26-80	a	48 ± 6	NS	71 ± 7	50 ± 6
	to	b	48 ± 6		61 ± 6	54 ± 6
	12-4-80	mean	48 ± 6		66 ± 6	52 ± 6
	12-4-80	a	79 ± 6	NS	83 ± 6	66 ± 6
	to	b	89 ± 7		80 ± 6	66 ± 6
	12-13-80	mean	84 ± 6		82 ± 6	66 ± 6
	12-13-80	a	48 ± 5	NS	NS	51 ± 5
	to	b	53 ± 5			51 ± 5
	12-22-80	mean	51 ± 5			51 ± 5
	12-22-80	a	70 ± 8	110 ± 9	NS	76 ± 8
	to	b	76 ± 8	110 ± 9		85 ± 8
	12-28-80	mean	73 ± 8	110 ± 9		80 ± 8

(1) Replicate count
(2) Simple average (rounded) ± simple average (rounded)
(3) NS = No Sample
(4) LT = Less Than
(5) Fraction in parentheses indicates number of detectables/number of analyses

TABLE 7

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1980

Air Particulates

Analytical Results - Gamma Emitting Nuclides
Quarterly Composite, By Location (1980-Q1,Q2,Q3)

Results in Units of $pCi/m^3 \pm 2\sigma$

Quarter	Sampling Location		Cs-134	Cs-137	Be-7	Ce-141	Ce-144	Ru-103	Zr-95	Nb-95	Bi-214	Others
1	1	a	LT 1.1E-03[3]	LT 1.0E-03	4.2E-03±1.0E-03	ND[4]	ND	ND	ND	ND	ND	ND
		b	LT 2E-03	LT 3E-03	5.0E-03±1.1E-03	ND	ND	ND	ND	ND	ND	ND
		mean	LT 1.6E-03	LT 2E-03	4.6E-03±1.0E-03							
	4	a	LT 8E-04	LT 9E-04	6.8E-03±9E-04	ND	ND	ND	ND	ND	ND	ND
		b	LT 1.1E-03	LT 1.2E-03	6.5E-03±9E-04	ND	ND	ND	ND	ND	ND	ND
		mean	LT 1.0E-03	LT 1.0E-03	6.6E-03±9E-04							
	5	a	LT 1.1E-03	LT 1.5E-03	1.1E-02±1.3E-03	ND	ND	ND	ND	ND	ND	ND
		b	LT 1.8E-03	LT 3E-03	1.1E-02±1.4E-03	ND	ND	ND	ND	ND	ND	ND
		mean	LT 1.4E-03	LT 2E-03	1.1E-02±1.4E-03							
	7	a	LT 1.5E-03	LT 1.6E-03	7.6E-03±2.0E-03	ND	ND	ND	ND	ND	ND	ND
		b	LT 1.3E-03	LT 2E-03	6.6E-03±1.9E-03	ND	ND	ND	ND	ND	ND	ND
		mean	LT 1.4E-03	LT 1.8E-03	7.1E-03±2.0E-03							
2	1	a	LT 1.6E-03	1.1E-03±5.7E-04	7.4E-03±1.2E-03	ND	ND	ND	ND	ND	ND	ND
		b	LT 1.1E-03	LT 2E-03 (1/2)[5]	7.9E-03±1.1E-03	ND	ND	ND	ND	ND	ND	ND
		mean	LT 1.3E-03		7.6E-03±2.0E-03							
	4	a	LT 1.6E-03	LT 3E-03	7.9E-03±1.1E-03	ND	ND	ND	ND	ND	ND	ND
		b	LT 6E-04	LT 9E-04	9.0E-03±1.0E-03	ND	ND	ND	ND	ND	ND	ND
		mean	LT 1.1E-03	LT 2E-03	8.4E-03±1.0E-03							
	5	a	LT 4E-03	LT 4E-03	1.2E-02±2E-03	ND	ND	ND	ND	ND	ND	ND
		b	LT 5E-03	LT 5E-03	1.3E-02±2E-03	ND	ND	ND	ND	ND	ND	ND
		mean	LT 4E-03	LT 4E-03	1.2E-02±2E-03							
	7	a	LT 7E-04	LT 9E-04	6.0E-03±8E-04	ND	ND	ND	ND	ND	ND	ND
		b	LT 1.1E-03	LT 1.7E-03	5.8E-03±9E-04	ND	ND	ND	ND	ND	ND	ND
		mean	LT 9E-04	LT 1.3E-03	5.9E-03±8E-04							

TABLE 7 (Continued)

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1980

Air Particulates

Analytical Results - Gamma Emitting Nuclides
Quarterly Composite, By Location (1980-Q1,Q2,Q3)

Results in Units of $pCi/m^3 \pm 2\sigma$

Quarter	Sampling Location		Cs-134	Cs-137	Be-7	Ce-141	Ce-144	Ru-103	Zr-95	Nb-95	Bi-214	Others
3	1	a	LT 1.2E-03	LT 2E-03	5.2E-03±0.9E-03	ND	ND	ND	ND	ND	ND	ND
		b	LT 2E-03	LT 2E-03	4.6E-03±0.9E-03	ND	ND	ND	ND	ND	ND	ND
		mean	LT 1.6E-03	LT 2E-03	4.9E-03±0.9E-03							
	4	a	LT 5E-03	LT 1.3E-02	9.0E-03±3.6E-03	ND	ND	ND	ND	ND	ND	ND
		b	LT 5E-03	LT 1.2E-02	LT 9E-03	ND	ND	ND	ND	ND	ND	ND
		mean	LT 5E-03	LT 1.2E-02	(1/2)							
	5	a	LT 3E-03	LT 2E-02	7.1E-03±2.7E-03	ND	ND	ND	ND	ND	ND	ND
		b	LT 3E-03	LT 8E-03	1.2E-02±0.3E-02	ND	ND	ND	ND	ND	ND	ND
		mean	LT 3E-03	LT 1.4E-02	1.0E-02±2.8E-03							
	7	a	LT 8E-04	LT 2E-03	3.6E-03±0.8E-03	ND	ND	ND	ND	ND	ND	ND
		b	LT 2E-03	LT 2E-03	3.6E-03±0.8E-03	ND	ND	ND	ND	ND	ND	ND
		mean	LT 1.4E-03	LT 2E-03	3.6E-03±0.8E-03							

(1) Replicate count
(2) Simple average (rounded) ± simple average (rounded)
(3) LT = Less Than
(4) ND = Not Detected
(5) Fraction in parentheses indicates number of detectables/number of analyses

TABLE 7A

Environmental Monitoring Program, Fermi-2
Preoperational, 1980

Air Particulates

Analytical Results - Gamma Emitting Nuclides
Quarterly Composite, By Location (1980-Q4)

Results in Units of $pCi/m^3 \pm 2\sigma$

Quarter	Sampling Location		Cs-134	Cs-137	Be-7	Ce-141	Ce-144
4	1	a(1)	LT 1.2E-03(3)	LT 1.2E-03	5.9E-03±8E-04	2.5E-03±6E-04	2.5E-03±1.4E-03
		b	LT 1.0E-03	LT 1.0E-03	6.1E-03±8E-04	2.7E-03±6E-04	LT 5E-03
		mean(2)	LT 1.1E-03	LT 1.1E-03	6.0E-03±8E-04	2.6E-03±6E-04	(1/2)(4)
	4	a	LT 1.5E-03	LT 2E-03	8.6E-03±1.3E-03	3.4E-03±1.3E-03	LT 1.0E 02
		b	LT 1.5E-03	LT 2E-03	8.9E-03±1.3E-03	LT 6E-03	LT 2E-03
		mean	LT 1.5E-03	LT 2E-03	8.8E-03±1.3E-03	(1/2)	LT 2E-03
	5	a	LT 1.6E-03	LT 1.4E-03	7.2E-03±1.2E-03	2.5E-03±1.3E-03	LT 7E-03
		b	LT 1.3E-03	LT 1.4E-03	6.2E-03±1.2E-03	3.6E-03±1.3E-03	LT 7E-03
		mean	LT 1.4E-03	LT 1.4E-03	6.7E-03±1.2E-03	3.0E-03±1.3E-03	LT 7E-03
	7	a	LT 6E-04	LT 7E-04	4.9E-03±7E-04	2.0E-03±5E-04	2.2E-03±1.3E-03
		b	LT 8E-04	LT 7E-04	5.9E-03±7E-04	2.3E-03±5E-04	LT 4E-03
		mean	LT 7E-04	LT 7E-04	5.4E-03±7E-04	2.2E-03±5E-04	(1/2)

TABLE 7A (Continued)

Environmental Monitoring Program, Fermi-2
Preoperational, 1980

Air Particulates

Analytical Results - Gamma Emitting Nuclides
Quarterly Composite, By Location (1980-Q4)

Results in Units of $pCi/m^3 \pm 2\sigma$

Quarter	Sampling Location		Ru-103	Zr-95	Nb-95	Bi-214	Others
4	1	a	4.0E-03±7E-04	2.0E-03±1.1E-03	2.6E-03±7E-04	ND(5)	ND
		b	3.8E-03±7E-04	2.5E-03±8E-04	3.0E-03±7E-04	ND	ND
		mean	3.9E-03±7E-04	2.2E-03±1.0E-03	2.8E-03±7E-04		
	4	a	2.8E-03±1.1E-03	LT 4E-03	2.7E-03±1.1E-03	4.2E-03±1.9E-03	ND
		b	3.7E-03±1.2E-03	LT 5E-03	3.8E-03±1.2E-03	3.5E-03±1.6E-03	ND
		mean	3.2E-03±1.2E-03	LT 4E-03	3.2E-03±1.2E-03	3.8E-03±1.8E-03	
	5	a	3.1E-03±1.0E-03	2.4E-03±1.4E-03	1.8E-03±1.1E-03	ND	ND
		b	2.5E-03±1.1E-03	LT 4E-03	3.2E-03±1.1E-03	ND	ND
		mean	2.8E-03±1.0E-03	(1/2)	2.5E-03±1.1E-03		
	7	a	2.9E-03±6E-04	2.5E-03±9E-04	2.5E-03±7E-04	ND	ND
		b	3.1E-03±7E-04	2.5E-03±1.1E-03	2.8E-03±6E-04	ND	ND
		mean	3.0E-03±6E-04	2.5E-03±1.0E-03	2.6E-03±6E-04		

(1) Replicate count
(2) Simple average (rounded) ± simple average (rounded)
(3) LT = Less Than
(4) Fraction in parentheses indicates number of detectables/number of analyses
(5) ND = Not Detected

E. Water

Analytical results of gamma emitting nuclides and tritium for all water samples are presented in Tables 8 and 9, respectively. Gross beta results of the drinking water samples are reported in Table 10. A statistical evaluation of the analytical results is given in Table 12.

Mn-54 and Cs-137 were detected in the May samples collected from Station 13 (Monroe Water Station). These isotopes were not detected in their respective duplicate samples. The occasional detection of Cs-137 is probably a result of long term global fallout. The identification of Mn-54, a corrosion product, is likely attributable to counting statistics. No other gamma emitting isotopes were detected in any water samples collected during the reporting period.

Detectable tritium concentrations ranged from 200 to 310 pCi/l for all monitoring stations. These measurements are not inconsistent with historical tritium concentrations identified in the environs of Fermi-2.

The gross beta activity for drinking water at Station 13 was consistent during the reporting period with an overall mean of 4.3 pCi/l. This number was calculated from detectable measurements only.

TABLE 8

Environmental Radiological Monitoring Program - Fermi 2
Preoperational, 1980

Water
Analytical Results - Gamma Emitting Nuclides

Results in Units of 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	Others
January	12[1]	a	LT 11[4]	LT 19	LT 15	LT 9	LT 18	LT 13	LT 14	LT 8	LT 18	ND[5]
		b	LT 4	LT 8	LT 7	LT 4	LT 11	LT 5	LT 6	LT 7	LT 7	ND
		mean[3]	LT 8	LT 14	LT 11	LT 6	LT 14	LT 9	LT 10	LT 18	LT 12	
	14[1]	a	LT 13	LT 22	LT 14	LT 9	LT 20	LT 11	LT 15	LT 8	LT 19	ND
		b	LT 10	LT 15	LT 11	LT 9	LT 19	LT 10	LT 8	LT 9	LT 17	ND
		mean	LT 12	LT 18	LT 12	LT 9	LT 20	LT 10	LT 12	LT 8	LT 18	
	13[2]	a	LT 10	LT 21	LT 15	LT 9	LT 21	LT 14	LT 15	LT 8	LT 17	ND
		b	LT 10	LT 19	LT 10	LT 9	LT 23	LT 9	LT 13	LT 14	LT 18	ND
		mean	LT 10	LT 20	LT 12	LT 9	LT 22	LT 12	LT 14	LT 11	LT 18	
February	12	a	LT 6	LT 9	LT 6	LT 4	LT 9	LT 7	LT 7	LT 8	LT 8	ND
		b	LT 5	LT 7	LT 4	LT 4	LT 8	LT 6	LT 6	LT 7	LT 8	ND
		mean	LT 6	LT 8	LT 5	LT 4	LT 8	LT 6	LT 6	LT 8	LT 8	
	14	a	LT 15	LT 20	LT 14	LT 9	LT 24	LT 14	LT 11	LT 15	LT 14	ND
		b	LT 14	LT 20	LT 15	LT 8	LT 21	LT 13	LT 14	LT 19	LT 15	ND
		mean	LT 14	LT 20	LT 14	LT 8	LT 22	LT 14	LT 12	LT 17	LT 14	
	13	a	LT 9	LT 13	LT 10	LT 6	LT 16	LT 12	LT 12	LT 13	LT 12	ND
		b	LT 4	LT 8	LT 5	LT 3	LT 7	LT 6	LT 13	LT 6	LT 10	ND
		mean	LT 6	LT 10	LT 8	LT 4	LT 12	LT 9	LT 9	LT 10	LT 11	
March	12	a	LT 8	LT 19	LT 8	LT 9	LT 21	LT 10	LT 10	LT 9	LT 19	ND
		b	LT 6	LT 18	LT 8	LT 8	LT 15	LT 8	LT 8	LT 9	LT 18	ND
		mean	LT 7	LT 18	LT 8	LT 8	LT 18	LT 9	LT 9	LT 9	LT 18	
	14	a	LT 7	LT 14	LT 8	LT 8	LT 17	LT 9	LT 7	LT 9	LT 19	ND
		b	LT 7	LT 14	LT 9	LT 8	LT 12	LT 8	LT 8	LT 8	LT 19	ND
		mean	LT 7	LT 14	LT 8	LT 8	LT 14	LT 8	LT 8	LT 8	LT 19	
	13	a	LT 8	LT 15	LT 6	LT 7	LT 13	LT 9	LT 8	LT 9	LT 17	ND
		b	LT 6	LT 14	LT 7	LT 7	LT 15	LT 9	LT 7	LT 7	LT 20	ND
		mean	LT 7	LT 14	LT 6	LT 7	LT 14	LT 9	LT 8	LT 8	LT 18	

TABLE 8 (Continued)

Environmental Radiological Monitoring Program - Fermi 2
Preoperational, 1980

Water
Analytical Results - Gamma Emitting Nuclides

Results in Units of pCi/l ± 2σ

Compositing Month	Sampling Location		Mn-54	Fe-59	Co-58	Co-60	Zr-95	Zr-Nb-95	Cs-134	Cs-137	Ba-La-140	Others
April	12	a	LT 7	LT 13	LT 9	LT 6	LT 14	LT 11	LT 11	LT 12	LT 10	ND
		b	LT 6	LT 11	LT 6	LT 4	LT 9	LT 8	LT 4	LT 7	LT 9	ND
		mean	LT 6	LT 12	LT 8	LT 5	LT 12	LT 10	LT 8	LT 10	LT 10	
	14	a	LT 4	LT 8	LT 4	LT 3	LT 7	LT 4	LT 4	LT 4	LT 10	ND
		b	LT 7	LT 14	LT 9	LT 6	LT 14	LT 11	LT 11	LT 12	LT 10	ND
		mean	LT 6	LT 11	LT 6	LT 4	LT 10	LT 8	LT 8	LT 8	LT 10	
	13	a	LT 2	LT 8	LT 3	LT 3	LT 7	LT 3	LT 3	LT 4	LT 9	ND
		b	LT 7	LT 13	LT 9	LT 4	LT 11	LT 9	LT 4	LT 10	LT 13	ND
		mean	LT 4	LT 10	LT 5	LT 4	LT 9	LT 6	LT 4	LT 7	LT 11	
May	12	a	LT 5	LT 11	LT 7	LT 3	LT 7	LT 7	LT 5	LT 6	LT 30	ND
		b	LT 4	LT 9	LT 5	LT 2	LT 6	LT 6	LT 4	LT 5	LT 30	ND
		mean	LT 4	LT 10	LT 6	LT 2	LT 6	LT 6	LT 4	LT 6	LT 30	
	14	a	LT 4	LT 10	LT 5	LT 3	LT 9	LT 5	LT 4	LT 6	LT 8	ND
		b	LT 4	LT 8	LT 5	LT 3	LT 8	LT 5	LT 5	LT 6	LT 5	ND
		mean	LT 4	LT 9	LT 5	LT 3	LT 8	LT 5	LT 4	LT 6	LT 6	
	13	a	LT 4	LT 10	LT 4	LT 4	LT 7	LT 6	LT 5	5.4±2.6	LT 7	ND
		b	5.6±3.1 (6)	LT 20	LT 10	LT 10	LT 25	LT 13	LT 11	LT 12	LT 16	ND
		mean	(1/2)	LT 15	LT 7	LT 7	LT 16	LT 10	LT 8	(1/2)	LT 12	
June	12	a	LT 14	LT 23	LT 9	LT 11	LT 25	LT 14	LT 9	LT 8	LT 19	ND
		b	LT 4	LT 7	LT 5	LT 3	LT 8	LT 5	LT 5	LT 5	LT 7	ND
		mean	LT 9	LT 15	LT 7	LT 7	LT 16	LT 10	LT 7	LT 6	LT 13	
	14	a	LT 12	LT 20	LT 13	LT 10	LT 20	LT 14	LT 12	LT 17	LT 20	ND
		b	LT 3	LT 7	LT 5	LT 3	LT 7	LT 5	LT 4	LT 5	LT 7	ND
		mean	LT 8	LT 14	LT 9	LT 6	LT 14	LT 10	LT 8	LT 11	LT 14	
	13	a	LT 5	LT 7	LT 4	LT 3	LT 8	LT 4	LT 5	LT 5	LT 5	ND
		b	LT 15	LT 27	LT 11	LT 12	LT 24	LT 12	LT 12	LT 14	LT 20	ND
		mean	LT 10	LT 17	LT 8	LT 8	LT 16	LT 8	LT 8	LT 10	LT 12	

TABLE 8 (Continued)

Environmental Radiological Monitoring Program - Fermi 2
Preoperational, 1980

Water
Analytical Results - Gamma Emitting Nuclides

Results in Units of 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	Others
July	12	a	LT 5	LT 13	LT 6	LT 5	LT 10	LT 7	LT 4	LT 6	LT 1[illegible]	ND
		b	LT 4	LT 11	LT 4	LT 3	LT 9	LT 5	LT 4	LT 5	LT 17	ND
		mean	LT 4	LT 12	LT 5	LT 4	LT 10	LT 6	LT 4	LT 6	LT 16	
	14	a	LT 9	LT 30	LT 10	LT 11	LT 20	LT 11	LT 11	LT 9	LT 30	ND
		b	LT 9	LT 30	LT 12	LT 5	LT 13	LT 14	LT 5	LT 11	LT 90	ND
		mean	LT 9	LT 30	LT 11	LT 8	LT 16	LT 12	LT 8	LT 10	LT 60	
	13	a	No Sample									
		b										
		mean										
August	12	a	LT 2	LT 4	LT 2	LT 1.2	LT 3	LT 3	LT 2	LT 2	LT 5	ND
		b	LT 6	LT 13	LT 7	LT 4	LT 10	LT 8	LT 7	LT 8	LT 15	ND
		mean	LT 4	LT 8	LT 4	LT 3	LT 6	LT 6	LT 4	LT 5	LT 10	
	14	a	LT 3	LT 6	LT 4	LT 2	LT 5	LT 4	LT 2	LT 4	LT 6	ND
		b	LT 8	LT 16	LT 10	LT 5	LT 13	LT 11	LT 10	LT 11	LT 30	ND
		mean	LT 6	LT 11	LT 7	LT 4	LT 9	LT 8	LT 6	LT 8	LT 18	
	13	a	LT 2	LT 4	LT 2	LT 1.4	LT 3	LT 2	LT 2	LT 2	LT 4	ND
		b	LT 5	LT 10	LT 4	LT 4	LT 8	LT 5	LT 4	LT 5	LT 12	ND
		mean	LT 3	LT 7	LT 3	LT 3	LT 6	LT 4	LT 3	LT 4	LT 8	
September	12	a	LT 13	LT 20	LT 12	LT 9	LT 18	LT 8	LT 15	LT 8	LT 14	ND
		b	LT 4	LT 6	LT 5	LT 3	LT 6	LT 4	LT 5	LT 6	LT 6	ND
		mean	LT 8	LT 13	LT 8	LT 6	LT 12	LT 6	LT 10	LT 7	LT 10	
	14	a	LT 7	LT 15	LT 8	LT 5	LT 13	LT 9	LT 8	LT 9	LT 10	ND
		b	LT 15	LT 20	LT 15	LT 9	LT 30	LT 9	LT 9	LT 8	LT 16	ND
		mean	LT 11	LT 18	LT 12	LT 7	LT 22	LT 9	LT 8	LT 8	LT 13	
	13	a	LT 15	LT 20	LT 10	LT 11	LT 30	LT 11	LT 9	LT 18	LT 15	ND
		b	LT 4	LT 8	LT 5	LT 3	LT 6	LT 5	LT 5	LT 6	LT 5	ND
		mean	LT 10	LT 14	LT 8	LT 7	LT 18	LT 8	LT 7	LT 12	LT 10	

TABLE 8 (Continued)

Environmental Radiological Monitoring Program - Fermi 2
Preoperational, 1980

Water
Analytical Results - Gamma Emitting Nuclides

Results in Units of 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	Others
October	12	a	LT 11	LT 20	LT 12	LT 11	LT 20	LT 12	LT 12	LT 14	LT 15	ND
		b	LT 7	LT 12	LT 8	LT 5	LT 10	LT 8	LT 8	LT 10	LT 8	ND
		mean	LT 9	LT 16	LT 10	LT 8	LT 15	LT 10	LT 10	LT 12	LT 12	
	14	a	LT 10	LT 19	LT 12	LT 10	LT 20	LT 12	LT 8	LT 14	LT 15	ND
		b	LT 5	LT 7	LT 4	LT 3	LT 8	LT 4	LT 5	LT 6	LT 5	ND
		mean	LT 8	LT 13	LT 8	LT 6	LT 14	LT 8	LT 6	LT 10	LT 10	
	13	a	LT 14	LT 30	LT 9	LT 11	LT 30	LT 11	LT 11	LT 9	LT 16	ND
		b	LT 6	LT 12	LT 6	LT 4	LT 11	LT 8	LT 6	LT 9	LT 8	ND
		mean	LT 10	LT 21	LT 7	LT 7	LT 20	LT 10	LT 8	LT 9	LT 12	
November	12	a	LT 10	LT 20	LT 10	LT 11	LT 20	LT 12	LT 11	LT 9	LT 15	ND
		b	LT 4	LT 7	LT 4	LT 3	LT 7	LT 4	LT 4	LT 6	LT 6	ND
		mean	LT 7	LT 14	LT 7	LT 7	LT 14	LT 8	LT 8	LT 8	LT 10	
	14	a	LT 9	LT 18	LT 10	LT 8	LT 19	LT 9	LT 11	LT 9	LT 15	ND
		b	LT 3	LT 6	LT 3	LT 3	LT 6	LT 4	LT 4	LT 4	LT 6	ND
		mean	LT 6	LT 12	LT 6	LT 6	LT 12	LT 6	LT 8	LT 6	LT 10	
	13	a	LT 7	LT 14	LT 8	LT 8	LT 17	LT 8	LT 8	LT 7	LT 15	ND
		b	LT 5	LT 11	LT 6	LT 5	LT 11	LT 7	LT 5	LT 8	LT 10	ND
		mean	LT 6	LT 12	LT 7	LT 6	LT 14	LT 8	LT 6	LT 8	LT 12	
December	12	a	LT 6	LT 11	LT 7	LT 4	LT 8	LT 5	LT 5	LT 7	LT 8	ND
		b	LT 14	LT 20	LT 8	LT 9	LT 30	LT 8	LT 9	LT 8	LT 15	ND
		mean	LT 10	LT 16	LT 8	LT 6	LT 19	LT 6	LT 7	LT 8	LT 12	
	14	a	LT 10	LT 15	LT 11	LT 7	LT 18	LT 12	LT 11	LT 13	LT 14	ND
		b	LT 14	LT 20	LT 15	LT 9	LT 20	LT 9	LT 8	LT 8	LT 15	ND
		mean	LT 12	LT 18	LT 13	LT 8	LT 19	LT 10	LT 10	LT 10	LT 14	
	13	a	LT 5	LT 6	LT 4	LT 3	LT 7	LT 5	LT 5	LT 6	LT 6	ND
		b	LT 15	LT 20	LT 14	LT 10	LT 20	LT 9	LT 9	LT 9	LT 15	ND
		mean	LT 10	LT 13	LT 9	LT 6	LT 14	LT 7	LT 7	LT 8	LT 10	

(1) Surface Water
(2) Drinking Water
(3) Simple average rounded ± simple average (rounded)
(4) LT = Less Than
(5) ND = Not Detected
(6) Fraction in parentheses indicates number of detectables/number of analyses

TABLE 9

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1980

Water
Analytical Results - Tritium
Quarterly Composite, By Location

Quarter	Sampling Location		Results in Units of pCi/l ± 2σ
1	12[1]	a	LT 300[4]
		b	LT 300
		mean[3]	LT 300
	14[1]	a	LT 300
		b	LT 300
		mean	LT 300
	13[2]	a	LT 300
		b	LT 300
		mean	LT 300
2	12	a	230 ± 200
		b	LT 300
		mean	(1/2)[5]
	14	a	LT 300
		b	LT 300
		mean	LT 300
	13	a	310 ± 200
		b	LT 300
		mean	(1/2)

TABLE 9 (Continued)

Environmental Radiological Monitoring Program, Fermi-2

Preoperational, 1980

Water
Analytical Results - Tritium
Quarterly Composite, By Location

Quarter	Sampling Location		Results in Units of pCi/l ± 2σ
3	12	a	LT 300
		b	LT 300
		mean	LT 300
	14	a	200 ± 180
		b	240 ± 180
		mean	220 ± 180
	13	a	LT 300
		b	240 ± 180
		mean	(1/2)
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 number of detectables/number of analyses

TABLE 10

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1980

Drinking Water , Analytical Results - Gross Beta

Compositing Month	Sampling Location		Results in Units of pCi/l $\pm 2\sigma$
January	13	a	5.9 ± 1.8
		b	5.1 ± 1.6
		mean[1]	5.5 ± 1.7
February	13	a	3.6 ± 1.6
		b	4.8 ± 1.5
		mean	4.2 ± 1.6
March	13	a	3.0 ± 1.3
		b	3.5 ± 1.2
		mean	3.2 ± 1.2
April	13	a	5.8 ± 2.0
		b	8.4 ± 2.1
		mean	7.1 ± 2.0
May	13	a	4.5 ± 1.4
		b	2.0 ± 1.3
		mean	3.2 ± 1.4
June	13	a	5.0 ± 1.5
		b	3.6 ± 1.4
		mean	4.3 ± 1.4

TABLE 10 (Continued)

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1980

Drinking Water, Analytical Results - Gross Beta

Compositing Month	Sampling Location		Results in Units of pCi/l $\pm 2\sigma$
July	13	a	No Sample
		b	
		mean	
August	13	a	LT 2 (2)
		b	LT 2
		mean	LT 2
September	13	a	LT 5
		b	3.8 $\pm$ 3.2
		mean	(1/2) (3)
October	13	a	2.6 $\pm$ 1.4
		b	2.8 $\pm$ 1.7
		mean	2.7 $\pm$ 1.6
November	13	a	7.1 $\pm$ 1.5
		b	4.3 $\pm$ 1.4
		mean	5.7 $\pm$ 1.4
December	13	a	LT 3
		b	3.6 $\pm$ 1.8
		mean	(1/2)

(1) Simple average (rounded) $\pm$ simple average (rounded)
(2) LT = Less Than
(3) Fraction in parentheses indicated number of detectables/number of analyses

F. Milk

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

A statistical summary of the analytical data is provided in Table 12.

TABLE 11

Environmental Radiological Monitoring Program, Fermi-2
Preoperational, 1980

Milk

Analytical Results - Gamma Emitting Nuclides

		Results in Units of pCi/l $\pm$ 2σ				
Collection Month	Station Number	Cs-134	Cs-137	Ba-La-140	K-40	Others
January	7	LT 8[1]	LT 13	LT 11	1300 $\pm$ 100	ND[2]
February	7	LT 4	LT 8	LT 5	1300 $\pm$ 100	ND
March	7	LT 6	LT 7	LT 8	1200 $\pm$ 100	ND
April	7	LT 8	LT 9	LT 13	1300 $\pm$ 100	ND
May	7	LT 3	LT 5	LT 5	1200 $\pm$ 100	ND
June	7	LT 4	LT 10	LT 7	1200 $\pm$ 100	ND
July	7	LT 7	LT 8	LT 9	1500 $\pm$ 100	ND
August	7	LT 5	LT 6	LT 11	1300 $\pm$ 100	ND
September	7	LT 8	LT 9	LT 13	1400 $\pm$ 200	ND
October	7	LT 14	LT 11	LT 17	1200 $\pm$ 200	ND
November	7	LT 6	LT 6	LT 15	1400 $\pm$ 200	ND
December	7	LT 10	LT 11	LT 14	1200 $\pm$ 200	ND

(1) LT = Less Than

(2) ND = Not Detected

TABLE 12

Environmental Radiological Monitoring Program 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, 1979 through January 6, 1981

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 Annual Mean: Name / Distance & Direction	Mean (f) (2) Range	Control Locations Mean (f) (2) Range	Number of Nonroutine Reported Measurements
TLD's - Direct Radiation (mR/day)	Gamma Dose 149		0.18 (137/137) (0.10 - 0.27)	Station S-19 Site Boundary W	0.24 (4/4) (0.21-0.27)	0.17 (12/12) (0.13-0.22)	0
Fish (pCi/kg (wet weight))	Gamma Spec 4			One (1) indicator location sampled during reporting period.			0
	K-40		3300 (2/2) (3100-3500)			2800 (2/2) (2400-3100)	
	Mn-54	130	LLD			LLD	0
	Fe-59	260	LLD			LLD	0
	Co-58, 60	130	LLD			LLD	0
	Zn-65	260	LLD			LLD	0
	Cs-134	130	LLD			LLD	0
	Cs-137	150	LLD			22 (2/2) (17-27)	0
Shoreline Sediments (3) (pCi/kg (dry weight))	Gamma Spec 6					See note 3	
	Bi-214		550 (6/6) (260-890)	Station 9 0.2 mi. E	820 (2/2) (740-890)		0
	Pb-214		560 (6/6) (320-920)	Station 9 0.2 mi. E	820 (2/2) (710-920)		0
	Ra-225		350 (5/6) (330-900)	Station 9 0.2 mi. E	870 (2/2) (840-900)		0
	Bi-212		920 (2/6) (540-1300)	Station 9 0.2 mi. E	1300 (1/1) (1300-1300)		0
	Pb-212		270 (6/6) (130-460)	Station 9 0.2 mi. E	450 (2/2) (440-460)		0
	Tl-208		410 (6/6) (300-670)	Station 9 0.2 mi. E	600 (2/2) (530 -670)		0

TABLE 12 (Continued)

Environmental Radiological Monitoring Program 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, 1979 through January 6, 1981

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 Annual Mean Name Distance & Direction	Mean(f) (2) Range	Control Locations Mean(f) (2) Range	Number of Nonroutine Reported Measurements
Shoreline Sediments (3) (Continued) (pCi/kg (dry weight))	Gamma Spec (Continued)	6						
	Ac-228			430 (6/6) (210-690)	Station 9 0.2 mi. E	620 (2/2) (540-690)		0
	K-40			13000 (6/6) (11000-14000)	Station 10 1.1 mi. NE	14000 (2/2) (13000-14000)		0
	Cs-134		150	LLD				0
	Cs-137		180	380 (2/6) (340-430)	Station 9 0.2 mi. E	380 (2/6) (340-430)		0
Airborne Particulates (1 E-03 pCi/m^3)	Gross Beta	310	10	29 (221/226) (6-110)	Station 4 0.6 mi. NNW	37 (78/72) (6-110)	22 (83/84) (4-85)	0
Airborne Particulates (1 E-02 pCi/m^3)	Gamma Spec	32						
	Cs-134		0.05	LLD				0
	Cs-137		0.06	LLD				0
	Be-7			0.80 (23/24) (0.42-1.3)	Station 5 0.6 mi. NW	0.99 (8/8) (0.62-1.3)	0.55 (8/8) (0.36-0.76)	0
	Ce-141			0.30 (5/24) (0.25-0.36)	Station 5 0.6 mi. NW	0.30 (2/8) (0.25-0.36)	0.22 (2/8) (0.20-0.23)	0
	Ce-144			0.25 (1/24) (0.25-0.25)	Station 1 1.3 mi. NE	0.25 (1/8) (0.25-0.25)	0.22 (1/8) (0.22-0.22)	0
	Ru-103			0.33 (6/24) (0.25-0.40)	Station 1 1.3 mi. NE	0.39 (2/8) (0.38-0.40)	0.30 (2/8) (0.29-0.31)	0
	Zr-95			0.23 (3/24) (0.20-0.25)	Station 5 0.6 mi. NW	0.24 (1/8) (0.24-0.24)	0.25 (2/8) (0.25-0.25)	0
	Nb-95			0.28 (6/24) (0.18-0.38)	Station 4 0.6 mi. NNW	0.32 (2/8) (0.27-0.38)	0.26 (2/8) (0.25-0.28)	0
	Bi-214			0.38 (2/24) (0.35-0.42)	Station 4 0.6 mi. NNW	0.38 (2/24) (0.35-0.42)	LLD	0

TABLE 12 (Continued)

Environmental Radiological Monitoring Program 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, 1979 through January 6, 1981

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 Annual Mean Name Distance & Direction	Mean(f)[2] Range	Control Locations Mean(f)[2] Range	Number of Nonroutine Reported Measurements
Water, Surface/ Drinking (pCi/liter)	Gamma Spec	70						
(To date, sampling has not been initiated at the drinking water control location)	Mn-54		15	5.6 (1/46) (5.6-5.6)	Station 13 1.2 mi. S	5.6 (1/22) (5.6-5.6)	LLD	0
	Fe-59		30	LLD			LLD	0
	Co-58/60		15	LLD			LLD	0
	Zn-65		30	LLD			LLD	0
	Zr/Nb-95		30/15	LLD			LLD	0
	Cs-134		15	LLD			LLD	0
	Cs-137		18	5.4 (1/46) (5.4-5.4)	Station 13 1.2 mi. S	5.4 (1/22) (5.4-5.4)	LLD	0
	Ba/La-140		60/15	LLD				0
	Tritium	24	2000	260 (3/16) (230-310)	Station 13 1.2 mi. S	280 (2/8) (240-310)	220 (2/8) (200-240)	0
Drinking Water (pCi/liter)	Gross Beta	22	4	4.3 (18/22) (0.2-8.4)	One (1) indicator location sampled during reporting period		To date, sampling has not been initiated at control location.	-
Milk	Gamma Spec	12		To date, indicator locations not finalized.				
	Cs-134		15				LLD	0
	Cs-137		18				LLD	0
	Ba/La-140		60/15				LLD	0
	K-40						1300 (12/12) (1200-1500)	0

(1) LLD = Lower Limit of Detection as defined in the USNRC Branch Technical Position on radiological environmental monitoring, Table 2, (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. National Council on Radiation Protection and Measurements, "Environmental Radiation Measurements," NCRP Report No. 50, Washington, D.C., December 27, 1976.

4. 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.

5. Personal Communication, U. S. Environmental Protection Agency, February 1981.

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 1980.

A. Direct Radiation

The TLDs deployed at Stations 3, S-2, S-7, S-14, S-17, S-29, and S-30 for 1980-Q3 and Stations 3, S-2, S-7 (1 TLD), S-8, S-29 and S-30 for 1980-Q4 were missing at the time of collection. Vandalism, inherent to a field program of this type, is assumed to be responsible.

1980-Q4 was the second consecutive quarter in which TLDs deployed at Stations S-2, S-7, S-29 and S-30 were vandalized. Since the locations have only been included in the program since mid-1980, no data has been obtained to date. If this pattern continues, these stations may be relocated to less visible areas.

B. Fish/Sediment

No spring fish or sediment samples were collected by Edison biologists as scheduled. Edison personnel changes apparently resulted in a communication breakdown relative to sampling schedule requirements.

C. Air Particulates

No air particulate sample was collected at Station 1 for the period February 2, 1980 to February 9, 1980. A blown fuse on the instrument was discovered by the Site Technician. The cause was most likely attributable to short circuit caused by heavy rains. The fuse was replaced and routine sample collection initiated.

No air particulate samples were collected from Station 7 for the period January 5, 1980 to February 23, 1980. The instrument normally installed at this location and also the spare sampler were still at the vendor for repairs. Following repairs and calibration, the instruments were shipped to the Site Technician for installation in late February.

Data recovery from Stations 4 and 5 was very limited during the middle of 1980 as evidenced in Table 6. Although the Site Technician was performing preventive maintenance on all instruments, malfunctions still occurred. Some samples were declared invalid upon receipt at the NUS Laboratory. This was a result of an instrument(s) not operating when the Site Technician made his scheduled weekly collections and could not determine a final flow rate. There was evidence, however, to support instrument performance during the week. The instrument timers indicated some collection had occurred and the filters were "loaded." Other problems such as broken oil lines, oil reservoir leakage, split vanes, and electrical difficulties impacted data recovery.

Pending contractual agreements (Edison/NUS), instrument vendor misplacement of records and back-orders delayed the purchase of spare equipment. Edison now has two complete spare sampling instruments and an inventory of spare components which experience has shown are particularly subject to failure.

Air particulate samples not collected or voided during the fourth quarter are addressed in the following table:

Collection Period	Station Number(s)	Rationale
9/28 - 10/7	1,4	Station 1 - instrument not functional at time of collection. Could not determine final flow rate - sample voided (spare installed). Station 4 - flow indicator erratic - sample voided.
11/26 - 12/4	4	Recurrence of 9/28 - 10/7 problem Sample voided.
12/4 - 12/13	4	Continuation of 11/26 - 12/4. Problem identified during audit. Site Technician instructed to repair within 24 hours. Loose hose-breach of vaccum. Sample voided.
12/13 - 12/22	4,5	Air particulate samples from both locations placed into same envelope by site Technician. Impossible to differentiate samples - both voided.
12/22 - 12/28	5	Instrument not functional at time of collection. Could not determine final flow rate - sample voided.

D. Water

No drinking water sample was collected in July from Station 13. The City of Monroe changed locks on the doors to their pumping station where the sample is collected sometime during the month. The Site Technician was not able to gain access to this location until approximately one week after the scheduled collection. Because the schedule date had passed, the technician erroneously disposed of the July composite in order to begin collection of the August sample.

The tritium samples collected in June and July were inadvertently discarded with the packing material upon receipt in the laboratory.

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 November from Stations 8 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 obtianed, 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 1980, and the known values are listed in Tables B-4 through B-8.

C. 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 Program, Fermi-2
Preoperational, 1980

Shoreline Sediments - Independent Laboratory Results
Gamma Emitting Nuclides

Quarter	Collection Date	Sampling Location	Results in Units of pCi/kg, dry ± 2σ										
			Bi-214	Pb-214	Ra-226	Bi-212	Pb-212	Tl-208	Ac-228	K-40	Cs-134	Cs-137	Th-228
4	11-12-80	8	NR(1)	NR	LT300(2)	NR	NR	NR	NR	11000 ± 1000	LT 20	LT 20	3100 ± 30(3)
	11-12-80	10	NR	NR	LT300	NR	NR	NR	NR	13000 ± 1000	LT 30	LT 20	2900 ± 30

(1) NR - Not Reported

(2) LT - Less Than

(3) Th-228 concentration was calculated using Pb-212 and Bi-212 gamma energies

TABLE B-2

Environmental Radiological Monitoring Program
Preoperational, 1980

Surface Water - Independent Laboratory Results

Gamma Emitting Nuclides/Tritium

Quarter	Collection Date	Sampling Location	Results in Units of pCi/l $\pm 2\sigma$		
			Cs-137	Others	H-3
4	12-28-80	12	LT 6[1]	ND[2]	170 ± 100
	12-28-80	14	LT 9	ND	240 ± 100

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

TABLE B-3

Environmental Radiological Monitoring Program
Preoperational, 1980

Milk - Independent Laboratory Results

Gamma Emitting Nuclides

Quarter	Collection Date	Sampling Location	Results in Units of pCi/l ± 2σ		
			Cs-137	K-40	Others
4	12-28-80	7	LT 7[1]	800 ± 100 900 ± 100[2]	ND[3]

(1) LT = Less Than

(2) Revised result from independent laboratory

(3) ND = Not Detected

TABLE B-4

United States Environmental Agency
Intercomparison Program - 1980

Analytical Results - Gross Beta in Water

Month	Known Value pCi/l ± 3	NUS Value pCi/l[1]
January	45 ± 15	50
March	22 ± 15	25
May	14 ± 15	22
July	38 ± 15	92 (49)[2]
September	21 ± 15	24
November	13 ± 9	16

(1) Mean of three reported values

(2) The value originally reported to EPA for this program was high due to the use of an incorrect gross beta transmission factor curve. The number in parentheses is the corrected calculation.

TABLE B-5

United States Environmental Protection Agency
Intercomparison Program - 1980

Analytical Results - Gamma in Milk

	Known Value (pCi/l ± 3σ)				NUS Value[1] (pCi/l)			
Month	I-131	Cs-137	Ba-140	K(mg/l ± 3)	I-131	Cs-137	Ba-140	K(mg/l)
January	.01 ± .3	40 ± 15	.01 ± .3	1600 ± 240	LT 14[2]	43	LT 12	1767
April	33 ± 15	28 ± 15	0 ± .3	1190 ± 180	LT 200	28	LT 150	1400
July	0	35 ± 15	0	1550 ± 230	LT 31	34	LT 32	1667

(1) Mean of reported values
(2) LT = Less Than

TABLE B-6

United States Environmental Protection Agency
Intercomparison Program - 1980

Analytical Results - Tritium

Month	Known Value (pCi/l ± 3σ)	NUS Value (pCi/l)(1)
February	1750 ± 1023	1660
April	3400 ± 1080	3003
June	2000 ± 1035	1947
August	1210 ± 987	1200
October	3200 ± 1080	3067

(1) Mean of reported values

TABLE B-7

United States Environmental Protection Agency
Intercomparison Program - 1980

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	101 ± 15	11 ± 15	25 ± 15	51 ± 15	10 ± 15	30 ± 15	110		[illegible]	54	10	33
October	86 ± 15	16 ± 15	25 ± 15	46 ± 15	20 ± 15	12 ± 15	LT 190[2]	18	28	LT 100	17	14

(1) Mean of reported values

(2) LT - Less Than

TABLe B-8

United States Environmental Protection Agency
Intercomparison Program - 1980

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

	Known Value (pCi $\pm 3\sigma$)		NUS Value (pCi) (1)	
Month	Cs-137	Gross Beta	Cs-137	Gross Beta
March	20 $\pm$ 15	41 $\pm$ 15	27	45
June	12 $\pm$ 15	28 $\pm$ 15	16	29
September	10 $\pm$ 9	10 $\pm$ 9	11	11

(1) Mean of reported values

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).