NUREG-0769

Final Environmental Statement
related to the operation of Enrico Fermi Atomic Power Plant, Unit No. 2

Docket No. 50-341

Detroit Edison Company

U.S. Nuclear Regulatory Commission

Office of Nuclear Reactor Regulation

August 1981

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SUMMARY AND CONCLUSIONS

This Environmental Statement was prepared by the U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Reactor Regulation (NRR) (the staff).

1. The action is administrative.

2. The proposed action is the issuance of an operating license to the Detroit Edison Company for the startup and operation of the Enrico Fermi Atomic Power Plant Unit 2 (Fermi-2)* (Docket No. 50-341), located on Lake Erie in Monroe County, approximately 13 km (8 mi) east-northeast of Monroe, Michigan.

   This facility will employ a boiling-water reactor (BWR) to produce up to 3292 megawatts thermal (MWt). A steam-turbine generator will use this heat to provide approximately 1093 net megawatts electrical (MWe) of electrical power capacity. The exhaust steam will be condensed by water circulated through wet natural-draft cooling towers; makeup water for the cooling system will be drawn from Lake Erie.

3. The information in this statement represents the second assessment of the environmental impact associated with Fermi-2, pursuant to the guidelines of the National Environmental Policy Act of 1969 (NEPA) and Title 10 of the Code of Federal Regulations/Part 51 (10 CFR 51) of the Commission's regulations. After an application to construct this plant was received in 1969, the staff reviewed impacts that would occur during the construction and operation of this plant. The staff evaluation was issued as a Final Environmental Statement (FES) in July 1972. As the result of that environmental review, a safety review, an evaluation by the Advisory Committee on Reactor Safeguards, and public hearings in Monroe, Michigan, and Washington, D.C., the AEC (now NRC) issued a permit in September 1972 for the construction of Fermi-2. As of March 1981, the construction of Fermi-2 was 80% complete. With a proposed fuel-loading date of November 1982, the applicant has applied for a license to operate Fermi-2 and submitted (in October 1974) the required safety and environmental reports to support this application. The staff has reviewed the activities associated with the proposed operation of this plant, and the potential impact, with both beneficial and adverse effects, is summarized as follows:

   a. A total of about 454 ha (1120 acres) will be used for the Fermi-2 site; of this, approximately 56 ha (138 acres) will be used for permanent plant facilities. Approximately 129 ha (318 acres) have been disturbed during plant construction. It is anticipated that 24 ha (58 acres) of this disturbed area, devoted to temporary construction

*Enrico Fermi Unit 1, a liquid metal, fast breeder reactor owned by Detroit Edison Company, is presently on the site. The Unit 1 nuclear reactor has been decommissioned; however, the electrical generating equipment will continue to be operated by Detroit Edison as an oil-fired peaking unit.

facilities, laydown, and dredge and fill areas, will be restored upon completion of construction. The remaining parts of the site will be retained in their present natural state. Most transmission lines will be located in existing corridors; the remainder will be routed across farmland.

b. The major source of water for the plant's cooling system will be Lake Erie. An average of 2.1 m^3/s (33,000 gpm) will be withdrawn by the service water system, principally for cooling-tower operation and makeup supply. An average of 1.3 m^3/s (20,000 gpm) will be returned to the lake. Approximately 0.83 m^3/s (13,100 gpm) is lost from the cooling towers because of evaporation and drift.

c. The average heated discharge flow (1.3 m^3/s (13,100 gpm)) is very small compared with the volume of Lake Erie water in the vicinity of Fermi-2; the temperature of the discharge water will be about 10°C (18°F) higher than that of the intake water. There will be no significant increase in the temperature of the totally mixed water. Estimates of the extent of the thermal plume under conservative conditions are small, and the effect on Lake Erie biota is not considered significant (Sections 5.3.1.2 and 5.4.2.2).

d. Discharge of uncombined sulfite ions from a manual dechlorination system may expose Lake Erie biota to reduced oxygen conditions in the immediate vicinity of the discharge. This is not expected to be a severe impact (Section 4.3.5).

e. The closed-cycle cooling design will minimize fish entrainment and impingement, with losses likely to be 1 to 3 orders of magnitude less than at other nearby once-through-cooling power plants (Section 4.4.2.1).

f. The environmental risk from accidental radiation exposure is very low (Section 6).

g. No significant environmental impacts are anticipated from normal operational releases of radioactive materials. The approximate radiation dose from all Fermi-2 releases to the estimated population in the year 2000 within 80 km (50 mi) of the site is 24 person-rems/year. This is a small fraction of the 880,000 person-rems/year that this population receives from natural background radiation (Table 4.7).

4. The following Federal, State, and local agencies were asked to comment on the Draft of this Environmental Statement:

Advisory Council on Historic Preservation
Federal Emergency Management Agency
Federal Energy Regulatory Commission
U.S. Department of Agriculture
U.S. Department of the Army, Corps of Engineers
U.S. Department of Commerce
U.S. Department of Education

U.S. Department of Energy
U.S. Department of Health and Human Services
U.S. Department of Housing and Urban Development
U.S. Department of the Interior
U.S. Department of Transportation
U.S. Environmental Protection Agency

Attorney General, State of Michigan
Governor, State of Michigan
Great Lakes River Basin Commission
Department of Natural Resources, State of Michigan
Supervisor, Frenchtown Township, Michigan
Southeast Michigan Council of Governments
Wayne County Planning Commission

Argonne National Laboratory
Atomic Industrial Forum
Brookhaven National Laboratory
Detroit Edison Company

5. A draft of this Final Environmental Statement was made available to the public, to the Environmental Protection Agency, and to other specified agencies in April 1981.

   The following persons and organizations submitted comments on the draft of this Statement:

   Alexander, Robert - Houston, Texas
   Detroit Edison Company
   Lochstet, W. A. - University Park, Pa.
   Monroe County, Michigan Planning Commission
   Southeast Michigan Council of Governments*
   U.S. Department of Agriculture, Soil Conservation Service
   U.S. Department of Commerce
   U.S. Department of Health and Human Services, Food and Drug Administration
   U.S. Environmental Protection Agency, Region V

6. On the basis of the analysis and evaluation set forth in this Statement, and, after weighing the environmental, economic, technical, and other benefits against environmental costs and considering available alternatives at the construction stage, the staff has concluded that the action called

*The Southeast Michigan Council of Governments transmitted copies of comments it had received from the following: City of Monroe; County of Oakland - Division of Planning, EMS/Disaster Control, and Public Works Department; Detroit Area Agency on Aging; Frenchtown Charter Township; Jefferson Schools; Macomb County - Planning Commission and Health Department; Monroe County Planning Department and Commission; Southeast Michigan Transportation Authority; Washtenaw County Metropolitan Planning Commission; and Wayne County - Board of Education, Department of Health, and Planning Commission.

for under NEPA and 10 CFR Part 51 is the issuance of an operating license for the Enrico Fermi Atomic Power Plant Unit 2 subject to the following conditions recommended by the staff for the protection of the environment:

a. License Conditions

Before engaging in additional construction or operational activities which may result in a significant adverse environmental impact that was not evaluated or that is significantly greater than that evaluated in this Environmental Statement, the applicant shall provide written notification to the Director, Office of Nuclear Reactor Regulation, and shall receive written approval before proceeding with such activities.

b. Significant Environmental Protection Requirements

Limitations and monitoring requirements necessary for the protection of the aquatic environment are imposed through procedures under the Federal Water Pollution Control Act and are prescribed in the NPDES permits. A copy of these permits is included as Appendix D to this statement.

Requirements for protection of other segments of the environment will include, but not be limited to, the following:

(1) The applicant will implement the environmental monitoring programs outlined in this statement. The specific requirements of these monitoring programs will be included in the Radiological Effluent Technical Specifications which will be incorporated in the operating license for Fermi-2 (Section 5).

(2) Any occurrence of an unusual or important event that indicates or could result in significant environmental impact causally related to plant operation shall be reported promptly to NRC, as specified in the environmental protection requirements in the operating license.

CONTENTS

CONTENTS (Continued)

CONTENTS (Continued)

CONTENTS (Continued)

CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

FOREWORD

This supplement to environmental statement was prepared by the U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Reactor Regulation (NRR)(the staff), in accordance with Title 10 of the Code of Federal Regulations Part 51, the Commission's regulations (10 CFR 51), which implements the requirements of the National Environmental Policy Act of 1969 (NEPA).

The NEPA states that the Federal government has the continuing responsibility to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the nation may

- Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.
- Assure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings.
- Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences.
- Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice.
- Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities.
- Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

Further, with respect to major Federal actions significantly affecting the quality of the human environment, Section 102(2)(C) of the NEPA calls for preparation of a detailed statement on

(1) the environmental impact of the proposed action,

(2) any adverse environmental effects which cannot be avoided should the proposal be implemented,

(3) alternatives to the proposed action,

(4) the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity, and

(5) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

An environmental report accompanies each application for a construction permit or a full-power operating license. A notice of availability is published in

the Federal Register. Any comments on the report by interested persons are considered by the staff. In conducting the required NEPA review, the staff meets with the applicant to discuss items of information in the environmental report, to seek new information from the applicant that might be needed for an adequate assessment, and generally to ensure that the staff has a thorough understanding of the proposed project. In addition, the staff seeks information from other sources that will assist in the evaluation and visits and inspects the project site and surrounding vicinity. Members of the staff may meet with State and local officials who are charged with protecting State and local interests. On the basis of all the foregoing and other such activities or inquiries as are deemed useful and appropriate, the staff makes an independent assessment of the considerations specified in Section 102(2)(C) of NEPA and 10 CFR Part 51.

This evaluation leads to the publication of a draft environmental statement, prepared by the Office of Nuclear Reactor Regulation, which is then circulated to Federal, State, and local government agencies for comment. A summary notice of availability for the applicant's environmental report and the draft environmental statement is published in the Federal Register. Interested persons are also invited to comment on the proposed action and the draft statement. Comments should be addressed to the Director, Division of Site Safety and Environmental Analysis, at the address shown below.

After receipt and consideration of comments on the draft statement, the staff prepares a final environmental statement which includes (1) a discussion of questions and objections raised by the comments and the disposition thereof; (2) a final benefit-cost analysis, which considers and balances the environmental impacts of the facility and the alternatives available for reducing or avoiding such impacts; and (3) after the environmental, economic, technical, and other benefits are weighed against environmental costs and after available alternatives have been considered, a conclusion as to whether, with respect to environmental issues, the proposed permit or license should be issued, denied, or appropriately conditioned to protect environmental values.

This environmental review deals with the impact of operation of the Enrico Fermi Atomic Power Plant Unit 2 (Fermi-2). Assessments that are found in this statement supplement those described in the Final Environmental Statement (CP-FES) that was issued in July 1972 in support of issuance of a construction permit for Unit 2. The information to be found in the various sections of this statement updates the FES-CP in four ways: (1) by identifying differences between environmental effects of operation (including those which would enhance as well as degrade the environment) currently projected and the impacts that were described in the preconstruction review; (2) by reporting the results of studies that had not been completed at the time of issuance of the FES-CP and which were required by the NRC to be completed before initiation of the operational review; (3) by evaluating the applicant's preoperational monitoring program and factoring the results of this program into the design of a postoperational surveillance program and into the development of Radiological Effluent Technical Specifications; and (4) by identifying studies being performed by the applicant that will yield additional information relevant to the environmental impacts of operating Fermi-2.

NRC staff contributors to this environmental statement include M. Kaltman, Environmental Review coordinator, socioeconomic impact; R. B. Samworth, water quality; C. R. Hickey, aquatic ecology and fisheries; G. LaRoche, terrestrial ecology; J. R. Levine, meteorology; E. N. Fields, cost benefit; M. H. Fliegel, hydrology; R. B. Codell, liquid pathways; W. W. Meinke, radiological assessment; C. P. Patel, effluent systems; and W. E. Rodak, cultural resources. NRC staff contributors to Section 6, "Environmental Impacts of Postulated Accidents," include M. L. Wohl, R. W. Houston, S. Acharya (Section 6.1.4, Appendix H), F. Akstulewicz, (Sections 6.1.3.1, 4.1), S. Baker (Section 6.1.4.6), R. Codell and F. Recreo, (Section 6.1.4.5), C. Ferrell and A. Sinisgalli (Sections 6.1.3.2, 4.2), R. Gotchy (Section 6.1.1.3), J. Levine and J. Hawxhurst (Section 6.1.4.2), D. Nash (Section 6.1.4.4), S. Ramos (Section 6.1.3.3) and M. Taylor (Appendix G). Argonne National Laboratory personnel contributors to this statement include C. Dungey, meteorological dispersion; B. Siskind, chemistry; and G. Marmer, thermal hydrology.

Copies of this statement are available for inspection at the NRC Public Document Room, 1717 H Street NW., Washington, D.C. 20555, and at the Monroe County Library, 3700 South Custer Road, Monroe, Michigan. Copies of this statement may be purchased from the

NRC/GPO Sales Program
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Lester Kintner is the NRC Licensing Project Manager for this project; Mr. Kintner may be contacted at (301) 492-8344.

1 INTRODUCTION

1.1 History

On April 29, 1969, the Detroit Edison Company (applicant) filed an application with the Atomic Energy Commission (AEC) (now the Nuclear Regulatory Commission (NRC)) for a permit to construct the Enrico Fermi Atomic Power Plant Unit 2 (Fermi-2). Construction Permit No. CPPR-87 was issued accordingly on September 26, 1972, following reviews by the AEC Regulatory staff and its Advisory Committee on Reactor Safeguards (ACRS), as well as public hearings dealing with environmental matters before an Atomic Safety and Licensing Board in Michigan on July 26-27, 1972. The conclusions of the staff's environmental review were issued as a Final Environmental Statement (FES) in July 1972. As of March 1981, Fermi-2 was approximately 80% complete, and the reactor is expected to be ready for fuel loading in November 1982. The unit has a boiling-water reactor (BWR) that will normally produce 3292 megawatts thermal (MWt) and a net electrical output of about 1093 megawatts electrical (MWe) of electrical power capacity.

In October 1974, the Detroit Edison Company submitted an application, including a Final Safety Analysis Report (FSAR) and Envrionmental Report (ER-OL), requesting issuance of an operating license for Fermi-2. These documents were docketed on April 4, 1975, and the operational safety and environmental reviews were initiated at that time.

Fermi-2 is co-owned by Detroit Edison (80%), Northern Michigan Electric Cooperative (11.22%), and Wolverine Electric Cooperative (8.78%).

1.2 Permits and Licenses

The applicant has provided a status listing of environmentally related permits, approvals, and licenses required from Federal, regional, State, and local agencies in connection with the proposed project. This information may be found in Chapter 12 of the ER-OL. The staff has reviewed that listing and has discussed the status of required permits with the State of Michigan and the U.S. Environmental Protection Agency (EPA). Two environmental issues were identified by the staff during these discussions: (1) preoperational and operational aquatic environmental monitoring and (2) the control of chlorine residuals. The staff has deferred to the State of Michigan on these matters.

The applicant has obtained three NPDES permits from the State of Michigan Water Resources Commission covering various aspects of the project. Permit No. MI-0037028 addresses discharge of process wastes and other monitoring requirements during operation. This permit is included here as Appendix D. Permit No. MI-0039110 addresses discharges of process water during the final stages of construction. Permit No. MI-0039365 governs the discharge of overflow from the dredge spoils disposal basin. The specific effluent limitations and monitoring requirements from these latter two permits are also included in Appendix D.

The staff is not aware of any non-NRC licensing activities that would preclude or significantly delay the scheduled operation of the plant.

2 THE SITE

2.1 Résumé

The staff visited the Fermi-2 site in October 1978 to determine what changes had occurred in the site and its environs since the preconstruction environmental review of 1972. Because population in the vicinity of Fermi-2 has increased since issuance of the FES-CP, demographic projections have been updated to present the estimated population at the time plant operation is scheduled to begin (Section 2.2.1); changes in site land use are discussed in Section 2.2.2. Information pertaining to regional water use (Section 2.3.1), groundwater characterization (Section 2.3.3), surface and groundwater quality (Section 2.3.3 and 2.3.4), and characterization of the aquatic biota of Lake Erie in the vicinity of the plant (Section 2.5) has also been updated. In addition, data not presented in the FES-CP concerning Lake Erie current and temperature patterns (Section 2.3.2) and the temporary effect on groundwater during the construction of Fermi-2 (Section 2.3.3) have been included.

2.2 Regional Demography and Land Use

2.2.1 Regional Demography

Section II.B of the FES-CP describes the general socioeconomic characteristics of the region, including population and land use.

The population growth of Monroe County during the last 50 years has been greater than the average population growth of the nation and of the State of Michigan. Most of this growth occurred around the City of Monroe and in the metropolitan areas of Toledo and Detroit. The 1980 population of Monroe County was 134,659. The population is expected to grow to 209,440 by the year 2000, or at a compound growth rate of .0223.[1]

The 1980 distribution of estimated population and the projected population for the year 2000 within 80 km (50 mi) of the site are presented in Tables 2.1 and 2.2. The population data indicate that the area within 80 km (50 mi) of Fermi-2 will remain stable between 1980 and 2000. The largest urban concentration in this area is Detroit, which is approximately 27 miles north-northeast of the Fermi Site. Detroit's 1970 population was 1.5 million. Other large concentrations of population within 80 km (50 mi) of the site include Dearborn (40 km (25 mi) north); Toledo (40 km (25 mi) southwest), Windsor, Ontario (45 km (28 mi) north-northeast); and Warren (66 km (41 mi) north-northeast). Table 2.2-1 of the ER is a list of towns and cities within 80 km (50 mi) of the Fermi Station and their 1970 population. The Fermi facility is located in Frenchtown Township, one of the 15 townships in Monroe County. The area within 16 km (10 mi) of the plant had an estimated population of 84,825 in 1980. This area is expected to grow at a compound rate of 0.007 between 1980 and the year 2000.

2.2.2 Changes in Land Use

There has been no major change in land use in the region surrounding the Fermi site since issuance of the FES-CP (See Section II.B).

Table 2.1 1980 distribution of estimated population

	Distance from Site (mi)*										
Direction from Site	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50	0-50
N	29	263	177	79	197	14,912	105,823	530,643	686,014	312,537	1,650,674
NNE	0	102	12	90	81	7,618	100,866	615,106	1,026,606	363,659	2,113,866
NE	0	259	131	12	0	0	11,180	10,183	18,877	549	41,191
ENE	0	0	0	0	0	0	6,960	16,547	14,248	16,899	54,690
E	0	0	0	0	0	0	610	7,056	17,294	3,207	29,067
ESE	0	0	0	0	0	0	0	0	2,849	0	2,849
SE	0	0	0	0	0	0	0	401	6,713	47,673	54,787
SSE	0	0	0	0	0	0	0	1,052	16,653	21,920	39,625
S	41	576	51	0	0	0	0	6,568	15,655	35,130	58,021
SSW	0	710	21	0	0	0	3,004	107,943	22,580	38,523	172,781
SW	0	208	9	0	117	936	11,008	319,037	78,578	23,552	433,445
WSW	0	24	846	2,236	1,779	34,474	6,715	9,531	10,064	9,468	160,923
W	0	58	29	165	600	4,491	5,640	11,222	27,702	29,887	79,794
WNW	0	18	31	52	109	3,806	6,195	17,271	11,078	12,496	51,056
NW	3	76	353	639	318	4,942	7,398	98,185	116,185	37,802	265,901
NNW	0	140	243	64	77	2,621	19,545	120,357	77,607	69,070	289,724
TOTAL	73	2,434	1,903	3,337	3,278	73,800	284,944	1,957,514	2,148,739	1,022,372	5,498,394

Source: ER-OL

*To convert miles to kilometers, multiply by 1.6093.

Table 2.2 Distribution of projected population in year 2000

Direction from Site	Distance from Site (mi)*										
	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50	0-50
N	37	335	225	100	251	12,367	80,617	404,245	712,580	384,721	1,595,478
NNE	0	130	15	114	103	6,016	77,351	554,465	943,019	448,530	2,029,419
NE	0	329	167	15	0	0	13,198	12,021	22,283	648	48,661
ENE	0	0	0	0	0	0	8,215	19,534	16,820	19,949	64,518
E	0	0	0	0	0	0	720	8,330	20,415	3,785	33,250
ESE	0	0	0	0	0	0	0	0	3,356	0	3,363
SE	0	0	0	0	0	0	0	467	7,804	52,282	60,553
SSE	0	0	0	0	0	0	0	1,225	19,291	23,242	43,758
S	52	733	65	0	0	0	0	7,036	17,432	37,136	62,454
SSW	0	903	27	0	0	0	2,858	112,942	32,285	55,081	204,096
SW	0	265	11	0	149	1,190	14,001	310,191	76,691	28,302	430,800
WSW	0	31	1,076	2,844	2,263	43,849	8,540	12,122	11,825	11,975	94,525
W	0	74	37	210	763	5,712	7,173	13,934	33,400	35,952	97,255
WNW	0	23	39	66	139	4,841	7,879	21,130	13,431	15,071	62,619
NW	4	97	449	813	404	6,286	5,636	116,337	140,874	92,109	363,009
NNW	0	178	309	81	98	3,263	14,889	92,050	72,099	106,183	289,150
TOTAL	93	3,098	2,420	4,243	4,170	83,524	241,077	1,685,705	2,143,612	1,314,966	5,482,908

Source: ER-OL

*To convert miles to kilometers, multiply by 1.6093.

The area within a 16-km (10-mi) radius of the site, like the majority of Monroe County, is predominantly agricultural. The land-use pattern of Monroe County in 1975, as represented by the percentage of total land area devoted to major land-use categories, was as follows: agricultural and vacant, 83.7%; residential, 4.8%; commercial, 0.2%; industrial, 1.0%; public, 0.8%; and other urban land, including transportation, utility corridors, and quasi-public land, 9.5%.[1]

Subsequent to the issuance of the FES-CP, the initially proposed 441-ha (1088-acre) construction site was increased to 454 ha (1120 acres), of which a total of 126 ha (310 acres) have been disturbed during construction (ER-OL, Supp. 5). Since the FES-CP was issued, two onsite land use changes have been proposed. These are

(1) A 929 m^2 (10,000 ft^2) Technical Support Center to be built adjacent to the present Office Service Building. This area has already been disturbed for the construction of Fermi-2.

(2) A 3.2 ha (7.9 acre) Nuclear Operations Center to be built in the southwest section of the site near the Quarry lakes. The area is presently occupied by an early successional stage of vegetation.

2.2.3 Cultural Resources

Since the issuance of the FES-CP, the U.S. Department of the Interior has revised its National Register of Historic Places, which includes properties of historical significance within 16 km (10 mi) of the plant site (Table 2.3) Several houses are listed in the Register[2] for Monroe, Monroe County (11 km (7 mi) southwest of the site); these are the Fix House, Governor Robert McClelland House, Sawyer House, and Rudolph Nims House. The Navarre-Anderson Trading Post, St. James Episcopal Church, and North Maumee Bay in the vicinity of Monroe are also listed. No prehistoric resources have been nominated for inclusion in the Register.

There is no listing in the Department of the Interior National Register of Historic Landmarks for the area within 16 km (10 mi) of the Fermi site.[3]

2.3 WATER USE

With the exception of small increases in domestic water use, as a result of the growing population of Monroe County (Section 2.2.1), there have been no major changes in water use patterns since the FES-CP was issued.

2.3.1 Regional Water Use

Within a 16-km (10-mi) radius of the plant, potable water is supplied by four municipal water systems (Detroit, Monroe, Flat Rock, and Toledo) and about 4300 privately owned wells. In the areas serviced by these water systems, approximately 15% of the homeowners still obtain water from individually owned wells; however, water for newly constructed homes must be obtained from the appropriate municipal system. The well water is of poor quality and there are plans to extend the availability of the municipal systems. Data on municipal water intakes from nearby Lake Erie are presented in Table 2.4. Data on municipal

Table 2.3 National Register properties in Monroe County

Property	Location	Registration date
Fix House	Sterling State Park	3-16-72
Governor Robert McClelland House	47 E. Elm St.	9-3-71
Rudolph Nims House	206 W. Noble Ave.	10-18-72
Sawyer House	820 E. Front St.	11-23-77
Navarre-Anderson Trading Post	West of Monroe at N. Custer (MI 130) and Rainsville Rds.	7-31-72
St. James Episcopal Church	25150 E. River Rd. Grosse, IL	11-19-71
North Maumee Bay	Archeological District Erie Vicinity, Monroe County	2-12-80

Table 2.4 Municipal water intakes from Lake Erie in the vicinity of the Fermi site

Intake point	Year	Withdrawal 10^6 L/yr (10^6 gal/yr)	Number of people served	Percent to industry	Percent to residents	Distance from site in km (mi)
Monroe	1972	7,600 (2,000)	40,000	35	65	3.2 (2)
Toledo	1972	110,500 (29,200)	500,000	40	60	45 (28)
Kingsville	1972	591 (156)	1,400	10	90	45 (28)
Leamington	1972	1,700 (450)	10,000	50	50	52 (32)
Port Clinton	1971	2,180 (580)	12,000	10	90	60 (37)
Wheatley	1972	432 (114)	1,059	54	46	68 (42)
Sandusky	1972	14,990 (3,960)	47,000	60	40	77 (48)
Huron	1972	1,700 to 1,900 (450 to 500)	7,500	33	67	85 (53)
Vermilion	1972	125 (33)	9,000	-	-	100 (62)

Source: ER-OL, p. 2.2-43.

systems in the plant area not drawing from Lake Erie are presented in Table 2.5 (ER-OL, Section 2.2.5.1).

Also within the 16-km (10-mi) radius of the plant are four industrial users of Lake Erie water and one such user of River Raisin water (Table 2.6). There are no major industrial users of well water (ER-OL, Sections 2.2.5.5 and 2.2.5.6).

There is only one agricultural user of surface water within 16 km (10 mi) of the plant, the Smith and Sons farm, which uses water from Swan Creek, taken about 13 km (8 mi) northwest of the plant. This water is used for irrigation and cattle watering (ER-OL, Section 2.2.5.2).

Monroe County's Lake Erie shoreline is used for recreational activities such as swimming, water skiing, motor boating, and sport fishing.

2.3.1.1 Commercial Fishery

Commercial fishing occurs in the Michigan waters of Lake Erie, but at low levels of effort. During 1974-1980, five to nine fishermen (categorized as part-time or casual[4]) had annual harvests of between 167,375 - 280,319 kg (369,000 - 618,000 lbs) of fish worth \$26,000 - \$86,000 (Table 2.7). According to Gale C. Jamsen of the Michigan Department of Natural Resources (DNR), during 1980, only one of the five licensed fishermen actually fished. During the period 1974 to 1979, the composition of the Michigan harvest was: carp, 75 - 88%; catfishes, 3 - 11%; buffalo, 4 - 8%; white bass 1 - 3%; bullheads, $\leq$ 2%; yellow perch, $\leq$ 1%; gizzard shad, 0 - 2%; and sheepshead and suckers, $\leq$ 1% each. Harvests from Michigan waters have been between about 4 - 7% of the total commercial harvest in weight and about 1 - 3% of the total dollar value of the U.S. commercial fishery of Lake Erie (which includes the States of Michigan, Ohio, Pennsylvania, and New York). Fishing primarily is by haul seine and trap net, with haul seine accounting for about 97% of the Michigan harvest[4]. Michigan DNR personnel report that fishing occurs near Monroe and to the South, with most of the harvest (~73 - 86%) landed at Luna Pier, Michigan; however, they report no commercial fishing near the Fermi site or to the north in the Detroit River.

2.3.1.2 Recreational Fishery

Recreational fishing occurs in the Michigan waters of Lake Erie and its tributaries--the Detroit River, Swan Creek (near the Fermi site), River Raisin, and others. During 1976 - 1979, an estimated 35,000 - 53,000 anglers had annual harvests between 2.8 - 4.6 million fish from Lake Erie (Table 2.8). Those estimates were derived from annual mail questionnaire surveys of licensed anglers by the Michigan Department of National Resources[5]. Yellow perch has dominated the harvest (66 - 76%), followed by crappies and white bass, 5 - 12%; catfishes, 6 - 8%; walleye and saugers, 2 - 13%; sunfishes 4 - 6%; and others. Salmonids (trout and salmon) have been less than 0.1% of the harvest. According to Jamsen, more than 97% of the angler fishing effort in 1979 was for warm-water species (non-salmonid). Salmonids are stocked in Lake St. Clair, the Detroit

Table 2.5 Municipal water systems in the plant area not drawing from Lake Erie

System	Source	Distance and direction from plant	Annual production	Region served
Village of Dundee	River Raisin	31 km (19 mi) W	2.68×10^8 L (70.8×10^6 gal)	Village of Dundee
Village of Petersburg	2 wells	34 km (21 mi) WSW	2.01×10^8 L (53.0×10^6 gal)	Village of Petersburg
Flat Rock	Huron River	16 km (10 mi) N	10.1×10^8 L (26.6×10^7 gal)	Parts of Brownstone Township and Rockwood

Source: ER-OL, p. 2.2-16 and p. 2.2-19.

Table 2.6 Industrial users of water within 16 km (10 mi) of the Fermi Site

User	Water Source	Annual Water Intake
Fermi-1 Power Plant:		
Cooling water	Lake Erie - on site	4.2×10^{10} L (1.1×10^{10} gal)[a]
Potable water	Lake Erie - on site	7.2×10^7 L (1.9×10^7 gal)[b]
Monroe Power Plant:		
Industrial use water[c]	Lake Erie and River Raisin - 10 km (6 mi) SSW of Fermi site	2.8×10^{12} L (7.4×10^{11} gal)[d]
Union Camp Corporation:		
Industrial use water[c]	Lake Erie - 7.2 km (4.5 mi) SW of Fermi site	4.2×10^9 L (1.1×10^9 gal)
Consolidated Packaging Corp:		
Industrial use water[c]	Lake Erie - 7.2 km (4.5 mi) SW of Fermi site	3.6×10^9 L (9.5×10^8 gal)
Ford Motor Company's Monroe Plant:		
Industrial use water[c]	River Raisin - 1.9 km (1.2 mi) inland from Lake Erie	1.7×10^{10} L (4.4×10^9 gal)

Source: ER-06, Section 2.2.2.5

[a]This is the 1972 figure; the unit ran 41% of the time.
[b]In 1972.
[c]Potable water is obtained from the Monroe water system.
[d]Assuming 22,000 L/s (350,000 gal/min) for each of the four units.

Table 2.7 Annual harvest (lbs, $ value) and number of licensed fishermen of the commercial fishery of Lake Erie, Michigan during 1974 - 1980

Yr	Lbs[f]	$ Value	Number of Licensed Fishermen
1974[a]	374,000	26,344	9
1975[b]	500,900	41,560	8
1976[c]	618,300	86,093	8
1977[d]	471,243	67,943	-
1978[d]	368,986	51,086	-
1979[d]	452,013	61,013	-
1980[e]	604,000	78,000	5

[a]"Fishery Statistics of the United States 1974," Statistical Digest No. 68, U.S. Department of Commerce, Washington, D.C.

[b]"Fishery Statistics of the United States 1975," Statistical Digest No. 69, U.S. Department of Commerce, Washington, D.C., December 1978.

[c]"Fishery Statistics of the United States 1976," Statistical Digest No. 70, U.S. Department of Commerce, Washington, D.C., October 1980.

[d]"Commercial Catch - Lake Erie," data supplied by Robert Hass, State of Michigan Department of Natural Resources.

[e]Data supplied by Gale C. Jamsen, State of Michigan Department of Natural Resources.

[f]To convert lbs to kg, multiply by 0.454.

Table 2.8 Estimated annual harvest (in number of fish) and fishing effort (numbers of anglers and angler days) of the recreational fishery of Lake Erie, Michigan during 1976 - 1979*

Year	Harvest**	Number of anglers	Number of angler days
1976	2,830,240	36,320	336,640
1977	3,079,608	34,615	432,446
1978	4,623,120	51,360	421,200
1979	4,256,160	52,640	498,080

*Data supplied by Gale C. Jamsen, State of Michigan Department of Natural Resources.

**Harvest estimates are derived from surveys of a small portion (< 1%) of licensed anglers; thus, confidence intervals are large.

River, and the Huron River (all north of Fermi), as well as in the Ohio and Pennsylvania waters of Lake Erie[6]. Those stockings, as well as fish movements into Lake Erie from Huron River, are the sources of the salmonids harvested in the Michigan waters of Lake Erie. Recreational harvests in Lake St. Clair and connecting waters (St. Clair River and Detroit River) during 1976 - 1979 were 2 - 3 times higher than in Lake Erie, Michigan, and the fishing effort was 3 - 5 times higher.

Fishing is done by both shore-based and boat anglers. The boat fishery is almost entirely for yellow perch and walleye.[4] According to the Michigan DNR, the 1980 harvest (May - August) of 494,000 fish by boat anglers was walleye, 55%; yellow perch, 37%; channel catfish, 4%; freshwater drum, 3%; and white bass, 1%. Good walleye fishing occurs a few miles offshore of the Stony Point - Fermi area. The shore fishery primarily is for white bass, especially in power plant thermal discharge plumes, according to DNR personnel. Recreational fishing in the thermal plume of the Monroe Power Plant is very heavy during spring by boat anglers seeking white bass, and at times there is a crowd-control problem, according to R. C. Haas and Robert Basch of the DNR. Heavy fishing by shore, wading, and boat anglers also occurs in the thermal plume of the J. R. Whiting Plant near the Michigan/Ohio border, according to Haas and Daniel Talhelm of the Department of Fisheries and Wildlife of Michigan State University. Talhelm also reports that fishing there is for white bass, carp, and other species.

Recreational harvests are reported in numbers of fish and not in weight; thus, a direct comparison of recreational and commercial harvests is not possible. Some approximate comparisons can be made, however, by using average weights of harvested fish and the numbers harvested. During the 1970s, the average total length of commercially harvested yellow perch was less than ~20 cm (8 in.) and the average weight was 114 g (4 oz) or less[7]. Assuming a similar length-weight makeup for the recreational harvest results in annual recreational harvest estimates of 212,534 - 388,754 kg (468,560 - 857,060 lbs) from the Michigan waters of Lake Erie during the 1976 - 1979 period. Similarly, the calculated mean weights of commercially caught walleye in the Micigan water of Lake Erie during 1962 - 1969 were 0.52 - 1.07 kg (1.1 - 2.4 lbs).[8] Assuming a similar size (~1.5 lbs) for recreational walleye results in annual harvest estimates of 35,815 - 385,914 kg (78,960 - 850,800 lbs) during the 1976 - 1979 period. Disregarding species differences and just comparing estimated harvests in poundage, the recreational fishery in Michigan waters of Lake Erie exceeds that of the commercial fishery by several times.

2.3.2 Surface Water Hydrology

The Fermi site is located within the Swan Creek drainage basin. This basin, with an area of about 282 km^2 (104 mi^2), is smaller than either the 2352-km^2 (908-mi^2) Huron River drainage basin to the north or the 2776-km^2 (1072-mi^2) River Raisin basin to the south (ER-OL, Section 2.5.1). The Swan Creek basin has an elliptical shape and extends in a northwest-southeast direction, descending to Lake Erie from an elevation of 213 m (700 ft) at Ypsilanti, about 40 km (25 mi) inland. The infiltration capacity of the basin soils, (mostly lacustrine clay) is low, a condition which results in poor surface drainage (ER-OL, Section 2.5.1.1).

Some recent discharge data for these three streams, as well as for the Detroit River, are listed in Table 2.9. Flooding of streams in the site area most often occurs in early spring. The combined effects of frozen ground, high precipitation, and ice jams at the river mouth can produce severe flooding. For Swan Creek, a mean annual flood of about 71 m^3/s (2500 cfs) is possible. This is a very conservative value when compared with the 0.52 m^3/s (18.5 cfs) actually measured in 1972 (ER-OL, Section 2.5.2.2.1).

Lake-induced flooding can occur in the lagoons that adjoin the site to the north, south, and west as a result of wind-driven lake level setup and wave action. Because the water can drain freely from the lagoons, the high water levels produced by overtopping the barrier beach are limited to relatively brief periods of high easterly winds. The lagoon levels rapidly come to equilibrium with the prevailing lake levels (ER-OL, Sec. 2.5.2.2.2).

The discussion of floodplain effects, in compliance with Executive Order 11988, is in Section 4.

Either of two primary wind-driven current patterns may be observed in Lake Erie in the vicinity of the station during ice-free conditions, depending on wind direction. Winds from the northwest clockwise through northeast produce a general southwestward flow over the entire embayment.

Winds from the east-southeast clockwise through west produce northward currents along the shore, with a clockwise eddy off the Pointe Mouillee marshes. Other wind directions produce variable patterns generally of short duration as the currents shift from one primary pattern to another. During winter, under ice cover, when wind-induced currents are negligible, the incoming water from the Detroit River produces a southward current flow. The velocities of the northward and southward currents range from 0.2 to 0.5 km/hr (0.1 to 0.3 mph) except during ice-cover conditions, when the current is predominantly southerly with a velocity of less than 0.2 km/hr (0.1 mph). Northerly current patterns occur with a probability of 30%, variable patterns with a probability of 20% (ER-OL, Section 2.5.1.2).

During very hot and calm weather in the summer, the water in the western part of Lake Erie will occasionally stratify thermally for short periods, leading to oxygen depletion in the cooler layer of water near the bottom. This phenomenon is relatively common in the deeper central and eastern portions of the lake (ER-OL, Section 2.5.2.1.2), but it is rare near of the Fermi-2 intake and discharge.

2.3.3 Groundwater Hydrology

The uppermost bedrock stratum at the site consists of upper Silurian dolomite of the Bass Island Group. Groundwater occurs in the fractured upper zones of this dolomite. The overlying glacial till and clayey lacustrine deposits are relatively impervious, confining the groundwater in the dolomite (ER-OL, Section 2.5.3.1.2). Overburden soils in the site vicinity, ranging from 2 to 9 m (5 to 30 ft) in depth, consist predominantly of lacustrine clay, which grades to fine lacustrine sand to the west. Organic soils were removed from the plant site itself and replaced by crushed rock fill during Fermi-2 construction.

Table 2.9 Water quality summary for rivers in the plant vicinity[a]

River	Water Year	Water Temperature (°C)			pH			Dissolved O_2 (mg/L)			Biochemical O_2 (mg/L)		
		High	Low	Mean[b]	High	Low	Mean[b]	High	Low	Mean[b]	High	Low	Mean[b]
Huron River at Ypsilanti	1976-1977	25.0	0.0	11.7	8.3	7.7	8.0	14.2	6.6	10.1	6.1	0.5	3.2
River Raisin near Manchester	1976-1977	24.5	0.0	11.9	8.2	7.8	8.0	14.0	5.1	9.7	3.0	0.1	2.0
Detroit River	1976-1977	24.5	0.5	--	8.3	7.3	7.8	15.6	8.5	11.6	--	--	--
Swan Creek[c]	1971-1972	20	0	13	8.2	7.1	7.6	--	--	--	--	--	--

[a]Except for Swan Creek, data from Water Resources Data for Michigan, Water Year 1977, U.S. Geological Survey Water-Data Report MI-77-1.

[b]Except for Swan Creek data, mean values calculated as average of individual measurements given in reference.

[c]ER-OL, p. 2.5-12 and p. 2.5-38.

Prior to development of the site vicinity, all groundwater discharged upward, either through confining beds into the lake and its bordering marshes or by plant transpiration. The development of the area with a large number of domestic wells reversed the natural discharge pattern and decreased groundwater levels. In addition, pumping from the excavation at Fermi-2 temporarily altered the groundwater regime (ER-OL, Section 2.5.3.3.5).

2.3.4 Water Quality

As a result of the Water Quality Act of 1965 and the Clean Water Restoration amendments of 1966, measurements of the chemical constituents in Lake Erie water have been made periodically at 14 lake stations in order to assess the water quality. The physical and chemical quality of western Lake Erie is shown by the data Table 2.10. A more detailed description of the water chemistry is given in the ER-OL (Section 2.5.2.1.2 and Appendix 2C).

Table 2.10 Water quality data for western Lake Erie at the Fermi site, May 14, 1976 - April 13, 1977

Determination	Maximum	Minimum	Average
Acidity, total ($CaCO_3$)	6	0	2
Alkalinity, methyl orange ($CaCO_3$)	125	80	91
Alkalinity, phenolphthalein ($CaCO_3$)	8	0	1
Aluminum (Al)	0.7	<0.1	<0.3
Ammonia (N)	0.49	<0.1	<0.19
Bicarbonate ($CaCO_3$)	125	76	90.3
Biochemical oxygen (O_2) demand	4	<1	<1.8
Cadmium (Cd)	0.01	0.005	<0.009
Calcium (Ca)	53	29	36
Carbon (C) total	40	27	31
Carbonate (CO_3)	16	0	2
Cesium (Cs), g/L	<0.5	-	<0.5
Chemical oxygen (O_2) demand	20	6	11
Chloride (Cl)	35	14	21
Chromium (Cr^{+6})	<0.002	-	<0.002
Chromium (Cr) total	<0.03	-	<0.03
Cobalt (Co)	0.5	0.1	0.2
Copper (Cu)	0.04	<0.02	<0.02
Hardness ($CaCO_3$)	182	106	125
Iron (Fe) soluble	0.14	0.02	<0.03

Table 2.10 (Continued)

Determination	Maximum	Minimum	Average
Lead (Pb)	0.08	<0.05	<0.05
Magnesium (Mg)	12	7.2	8.7
Manganese (Mn)	0.04	<0.02	<0.03
Mercury (Hg), μ/L	0.6	<0.2	<0.2
Nickel (Ni)	0.07	<0.02	<0.02
Nitrate (N)	1.9	<0.2	<0.3
Nitrite (N)	0.02	<0.01	<0.02
Nitrogen, Kjeldahl (N)	1.1	0.34	0.66
Phosphorus (P) total	0.13	0.04	0.07
Potassium (K)	2.7	1.3	1.8
Silica (Si) total	7.4	0.5	2.8
Sodium (Na)	22	7.8	12.4
Solids, dissolved	266	123	167
Solids, suspended	31	1	10
Solids, total	297	136	180
Specific conductance, μmhos/cm	385	170	268
Strontium (Sr)	0.5	0.1	0.2
Sulfate (S)	15	<10	<10.2
Sulfide (S)	<0.02	0	<0.02
Tin (Sn)	<2	-	<2
Zinc (Zn)	0.24	<0.02	<0.04

Information taken from ER-OL, Tables 2C-74, -75, and -76. Units as mg/L unless otherwise noted.

These data indicate that the greatest water quality stress in Lake Erie is the high nutrient loading which has resulted in the overproduction of aquatic plants, particularly microscopic algae. The second major pollution stress, the bacterial content of the waste discharges into the lake, poses a health hazard. Coliform concentrations near Detroit, Toledo, and Cleveland may run as high as a million or more organisms per liter (ER-OL, Section 2.5.2.1.2).

Because 90% of Lake Erie inflow comes from the Detroit River, this river has a major impact on circulation and chemical properties of the western basin of the lake. As water passes from the Great Lakes through the Detroit River, its

quality declines somewhat because of discharges from the Detroit area. Information about the quality of the Detroit River and the three other streams in the Fermi-2 site vicinity is given in the ER-OL (Sec. 2.5.2.1.2).

Chemical analyses of groundwater samples from the site vicinity show that the pH ranges from 7.3 to 8.1, chloride from 21 to 1164 ppm, and sulfate from 1168 to 1865 ppm (ER-OL, p. 2.5-50). Many of the samples contain high concentrations of calcium sulfate, have the odor of hydrogen sulfide, are very hard, and have high iron concentrations. When compared with the Federal (HEW-1962) standards for chloride and sulfate in drinking water (that is, 250 mg/L, as given in Reference 9), it will be noted that the concentrations of these constituents for some samples exceed these standards. In some locations near the Fermi site, the groundwater may be contaminated because of the widespread use of septic systems (ER-OL, Section 2.5.3.2).

2.4 Meteorology

The regional climate remains as described in the FES-CP as no significant changes in meteorological parameters have been observed. A brief synopsis of the area's climate follows; a detailed summary of the climate can be found in the Environmental Report.

The weather in the site region is classified as continental. However, there are some local perturbations, such as lake-breeze effects and moderated temperature variations, due to Lake Erie. Long-term meteorological records (1940 - 1969) from Monroe, Michigan, show extreme recorded temperatures of 38.8°C (102°F) in July 1941 and -26.7°C (-16°F) in January 1941.[10] Wind information collected onsite at the 60-m (197-ft) tower from July 1974 through May 1975 indicates that the predominant wind flow over the site is from the southwest quadrant (ER-OL).

An average of 35 thunderstorm days per year occur in the vicinity of the site.[11] From January 1951 through 1974, a total of 51 tornadoes was reported within an 80-km (50-mi) radius of the Fermi site. The probability of a tornado striking a specific point is 6.4×10^{-4} or a recurrence frequency of once in 1560 years.[12] There were 93 reports of hail from 1962 through 1974. For a 93-year period (1871 - 1963), only five storms of tropical origin passed within 400 km (250 mi) of the site.[13] Heavy fog reducing visibility to 0.4 km (0.2 mi) or less is observed on the average at one or more hourly intervals 24 days per year (ER-OL).

2.5 Site Ecology

2.5.1 Terrestrial Ecology

General Site Characteristics

The Fermi-2 site covers an area of about 454 ha (1120 acres). About 64% of the site surface is covered by water, including lagoons, open waters of Lake Erie, and parts of Swan Creek; about 9% of the area is marshland, 15% wooded, and 12% old field habitat in various stages of plant succession (ER-OL, Table 2.7-10). The distribution of these habitats on the site is shown in Figure 2.7-13 of the ER-OL.

Past disturbances, unrelated to construction activities, have markedly influenced the biota of the site. Dutch Elm disease destroyed a mature forest stand of Ulmus americana[14], a dominant species in wooded areas on the site. In 1973, high lake levels flooded wooded areas killing many trees and woody shrubs and leaving a large number of dead trees in and around the wetlands. The high water levels also adversely impacted emergent aquatic plants such as reeds (Phragmites) and cattails (Typha) that provided food and shelter for the fauna at the site. Water level varied by 3 m (10 ft) between April 27, 1966, and February 16, 1967 (ER-OL, Table 2.5-6). Based on historical records, the staff expects the maximum flood range to be even greater over a longer period. The U.S. Fish and Wildlife Service indicates that no endangered or threatened species are likely to be found within the project area.[15] Except for these natural changes, the site cover types remain essentially the same as described in the FES-CP.

Twenty-six species on the Michigan State list of endangered species have a geographic range that includes the Fermi-2 site (Table 2.11). Three of these species were seen on the site: the American lotus (Nelumbo lutea), swamp rose-mallow (Hibiscus palustris), and the Eastern fox snake (Elaphe vulpina gloydi).

2.5.2 Aquatic Ecology

The data on aquatic biota collected during 1976-1977[16,17] represent the only site-specific information thus far available for use in assessing the potential impacts at the Fermi-2 site. The assessment of impacts described in the FES-CP were based upon some operating experience at Fermi-1 and on data collected at the nearby fossil-fueled Monroe Power Plant.

For the purposes of assessing the various discharge structure alternatives, the 1976 - 1977 aquatic studies at Fermi-2 concentrated on adult, juvenile, and planktonic fishes, and on benthic fauna. Details of the sampling program, results, and historical accounts of studies and biota composition in the Fermi-2 region were provided by the applicant.[16,17,18,19]

2.5.2.1 Phytoplankton

Phytoplankton populations in the Western Basin of Lake Erie indicate that this basin is highly eutrophic.[20,21,22] Data on the various taxa from the Monroe and Fermi site areas are shown in the ER-OL (pp. 2.7-48 through 2.7-54). There were 86 diatom (Bacillariophyceae), 79 green algae (Chlorophyceae), and 21 blue-green algae (Cyanophyceae) taxa. Phytoplankton densities were similar at both nearshore and offshore stations, and no definite pattern of spatial difference was observed. A pronounced seasonal shift in the relative abundance of many algal taxa was noted. Mean total phytoplankton densities (primarily chlorophyta and cyanophyta) were highest during the warm months (maximum mean density of 41,015 cells/mL occurred in August) and lowest during the cold months (minimum mean density of 286 cells/mL occurred in February). The 1976 - 1977 Fermi-site phytoplankton are in essential agreement with similar information from other studies in the Western basin of Lake Erie (ER-OL, pp. 2C-52 through 2C-60).[22,23,24,25,26]

2.5.2.2 Zooplankton

The applicant recorded 22 cladoceran and 16 copepod taxa at the Fermi site during the 1976 - 1977 sampling (ER-OL, Appendix 2C, pp. 2C-44 to 51 and 2C-150 to 162).

Table 2.11 Endangered and threatened species in the Michigan Endangered Species Program that could occur at the Fermi-2 site[a]

Endangered		Threatened	
Common Name	Scientific Name	Common Name	Scientific Name
Plants			
American lotus	Nelumbo lutea[b]	Arrowhead	Sagittaria montevidensis
			Juncus brachcarpus
		Wild hyacinth	Camassia scilloides
		Prairie fringed orchid	Habenaria ciliaris
		Sand grass	Triplasis purpurea
			Justicia americana
		Cup-plant	Silphium laciniatum
		Swamp rose-mallow	Hibiscus palustris[b]
		Seedbox	Ludwigia alternifolia
		Geradia	Geradia gattingeri
Amphibians			
Small-mouthed Salamander	Ambystoma texanum		
Reptiles		Black Rat Snake	Elaphe obsoleta
		Eastern Fox Snake	Elaphe vulpina gloydi[b]
Birds			
Peregrine Falcon	Falco peregrinus[b]	Cooper's Hawk	Accipiter cooperi[d]
Kirtland's Warbler	Dendroica kirtlandii[c]	Red-shouldered Hawk	Butec lineatus[d]
Double-crested Cormorant	Phalacrocorax auritus[d]	Bald Eagle	Haliaeetus leucocephalus[b]
		Marsh Hawk	Circus cyaneus[d]
		Osprey	Pandion haliaetus[d]
		Piping Plover	Charadrius melodus
		Barn Owl	Tyto alba[d]
Mammals			
Indiana Bat	Myotis sodalis[c]	Southern Bog Lemming	Synatomys cooperi

[a]Table based on "List of Endangered and Threatened Species in Michigan Department of Natural Resources, Fisheries and Wildlife Divisions, January 22, 1980.

[b]Seen onsite.

[c]Also on U.S. Fish and Wildlife list.

[d]Also on Audubon Blue list.

Fourteen rotifer taxa were reported from the Monroe area in an earlier study (ER-OL, Appendix 2C, p. 2C-149). Quantitative studies of zooplankton were limited to crustaceans. Mean densities ranged from a maximum of 221,487 organisms/m^3 in July 1976 to a minimum of 9918 organisms/m^3 in April 1977. As is typical of Great Lakes zooplankton, highest numbers were recorded in summer, lowest in winter and early spring.[25,26,27]

Neither total densities nor the densities of dominant species varied between nearshore and offshore stations. There was little spatial variability in zooplankton populations.[28,29,30]

2.5.2.3 Benthic Macroinvertebrates

Ten phyla of macroinvertebrates, including 85 taxa, were collected during the May 1976 - April 1977 study period (ER-OL, Section 2.7 and Appendix 2C, pp. 2C-10, 2C-11, 2C-137 through 146). Historically, the bottom fauna of the Western Basin has been changing in composition from less pollution-tolerant species to pollution-tolerant forms. A decrease in burrowing mayflies (such as Hexagenia spp.) and proliferation of tubificids at the mouths of the Detroit, Maumee, and Raisin rivers is indicative of this change.[31]

Macroinvertebrates were collected at the Fermi site in January, May, July, and October 1976. The predominant substrate type was soft clay and silt with a fine top layer of organic detritus. Near shore at Station 1, north of the plant (see ER-OL, Appendix 6A, Figure 4.1-1, and Chapter 6, Figure 6.1-1 for location of sampling stations), oligochaetes accounted for about 8 to 68% of the total sample. Other organisms observed included naidids, polychaete worms, and cladocerans. In August, a limpet (Ferrissia sp.) was the dominant organism, constituting about 23% of the total sample. Station 1 was the only station at which limpets were observed in large numbers. At Station 2, farther offshore, oligochaetes also dominated, and in the July sample the cladoceran Leptodora kindtii attained its greatest abundance, constituting about 90% of the sample. At Station 3, near the pumphouse and discharge, densities of benthic organisms varied widely throughout the seasons, probably as a result of nearby dredging. The number of species present was greatest in May, decreased in June (the dredging period), and began to increase again in August. The pre-dredging samples were dominated by naidids, polychaete worms, and cladocerans. At Station 4, farther offshore from the pumphouse, the dominant taxon was again the cladoceran Leptodora kindtii, accompanied by many immature oligochaetes. At Station 5, near shore by the intake, tubificid oligochaetes were numerically dominant and the midges (Chironomidae) were well represented. At Station 6, farther offshore from the intake, tubificids were the dominant invertebrates; Limnodrilus was the most abundant genus. Although Leptodora kindtii was collected only in July, it was collected in large numbers and comprised about 60% of the sample during that month. Diversity indices (Shannon, evenness, and richness) fluctuated greatly at all stations during the study period (see ER-OL, Section 2.7, pp. 2.7-3 and 2.7-58, and Figure 2.7-12 for further data).

2.5.2.4 Fish - Juvenile and Adults

The most abundant species at Fermi were emerald shiner, 42% of total catch; gizzard shad, 19%; alewife, 18%; yellow perch, 7%; carp, 5%; and spottail shiner, 5%. These six species comprised about 96% of the total number of fishes taken during the study (ER-OL). Young-of-the-year individuals (determined by age length

relationships) made up about 35% of the total catch. Alewife, gizzard shad, smelt, spotfin shiner, spottail shiner, and white bass were taken primarily as juveniles.

A total of 31 species of fishes and one hybrid were collected by all sampling methods. Shore-zone fishes were sampled by seine and were dominated (in order of abundance) by emerald shiner, gizzard shad, spottail and spotfin shiners, alewife and several lesser abundant species. Eighteen species were captured by seine, including juveniles and adults of several species. All gizzard shad captured by seine were juvenile. Numbers and species of fishes captured by seine varied with sampling date. April sampling yielded 1,638 adult emerald shiner which accounted for 57.8% of the entire 8-month seine catch of fishes. Juvenile emerald shiner were capture during August - October. Juvenile gizzard shad, captured during July - October, were most abundant in July, and accounted for 22.7% of the entire seine catch of fishes. During the months of maximum seine catches, fishes were taken in greatest abundance at Seine Station C-7 near the north jetty of the intake canal. Shore-zone fish species composition at Fermi-2 appears to be similar to those of other western Lake Erie areas, and is composed of forage species--gizzard shad/alewife (primarily juveniles) and shiners (adult and juvenile). The seine station nearest the shoreline intake site (Station B-3) produced 11.8% of the total seine harvest of fishes. Station C-7 near the intake jetties produced 76.7% of the total.

Offshore fishes were sampled by gill net and otter trawl. Gill net sampling collected 24 species and one hybrid and was dominated by alewife, 28.5%; yellow perch, 24.2%; spottail shiner, 11.0%; gizzard shad, 6.8%; emerald shiner, 3.0%; freshwater drum, 1.8%; walleye, 1.7%; and several lesser abundant species. Ninety-eight percent of the fishes captured by gill net were adult. Alewife were most abundant in September. Yellow perch were taken in all months sampled, but were most abundant during July and September. Carp were also taken during all months and were most abundant during July - August. Spottail shiner were taken predominatly during May. Gizzard shad were taken in small numbers during all months except May. Emerald shiner were taken only in April. Drum and Walleye were taken in small numbers in all months except November and April when none were caught. None of the gill net stations appears substantially different with respect to species occurrence or abundance.

Gear selectivity differences between seine, trawl, and gill net could be expected to bias the catch by each, but all three gear types often are necessary to properly characterize a fish community with respect to adult and juvenile specimens, and benthic, pelagic, and shore-zone inhabitants. Such was apparently the case at Fermi. Even though each gear type was selective to some degree, general subjective characterizations of the shore-zone versus offshore fish communities with respect to dominant or important species are as follows:

Shore-zone - dominated by shiners (adult and juvenile) and by juvenile gizzard shad; several lesser abundant species occurred sporadically; few specimens of recreational or economic value were present.

Offshore - dominated by alewife (adult and juvenile), yellow perch (adult), and carp (adult), with lesser numbers of emerald and spottail shiners (adult and juvenile), and gizzard shad (adult and juvenile); species of recreational or economic value (other than yellow perch and perhaps carp) which occurred in

greater abundance than in shore-zone areas were rainbow smelt (juvenile), white bass (primarily juvenile), catfish (adult), walleye (adult), and freshwater drum (adult).

Fish species considered to be endangered or threatened by the U.S. Department of the Interior[32] and the State of Michigan[33] are not present in Lake Erie in the vicinity of the Fermi-2 site.

2.5.2.5 Fish Eggs and Larvae

The western basin of Lake Erie in the Fermi-2 site region does function as a nursery area for several species of fishes, as indicated by the presence of young-of-the-year and juveniles (discussed above). Spawning also occurs in the Fermi-2 vicinity as indicated by the applicant's ichthyoplankton sampling program during 1976-1977[16,17] and other studies.[34,35]

Twelve families were represented. The total catch was composed of larvae, 86%; juveniles, 9%; eggs, 4%; yearling and older fish, less than 1%. The taxa and developmental states of ichthyoplankton taken during the sampling period are summarized in the ER-OL (Tables 9-39, pp. 2C-89 through 132). Fish larvae were present in all net collections from May 12 to September 26 and were essentially absent from October through March. On August 2, all densities were extremely low and variable. No fish eggs or larvae were taken in the collections of January 13 and 25 or April 6, 1977. The first indications of 1977 spawning in the area came with samples taken on April 26. A maximum of 15 taxa were represented in the July 12, 1976 sample. From May through October, clupeids (gizzard shad, alewife) accounted for 82% of the catch. Emerald shiner (5%), white bass (3%), logperch (2%), and unidentified larvae (2%) accounted for most of the remainder. Burbot and walleye larvae were taken exclusively offshore (ER-OL, Section 2.7, p. 2.7-3).

The period of peak abundance was May through early July. Maximum densities of clupeid larvae at Fermi exceeded $1700/100m^3$ at a 152-m (500-ft) offshore station on June 7 and exceeded $1000/100m^3$ at a 6096-m (2000-ft) offshore station on July 9 - 12, 1976. Maximum densities observed for other larval species taken in oblique plankton samples were:

Species	Density (no/$100m^3$)	Date in 1976
Yellow perch (larvae)	14.9	May 12 - 14
White bass	17.4	June 7
Rainbow smelt	23.0	May 12 - 14
Emerald shiner	56.1	July 9 - 12
Spottail shiner	5.5	May 26
Freshwater drum	34.3	July 2
Carp	8.7	July 9 - 12
Logperch	17.0	July 2

Several species tended to be more abundant inshore than offshore, although variations with time were evident. Fish eggs collected by plankton net and pump and juveniles collected by plankton net were more abundant inshore than offshore at Fermi. Larvae of yellow perch, white bass, shiners, and drum tended to be more abundant inshore (152-m (500-ft) station); smelt larvae were more abundant offshore (6096-m (2000-ft) station); and clupeid larvae were variable with sampling date. An egg and larvae study conducted throughout much of the western basin during 1975 - 1976 described similar species composition and abundant levels and generally showed that much of the basin apparently serves as a spawning area.[34] That study sampled inshore and offshore areas of the western basin as well as bay and island areas, but did not sample the northwestern sector of the basin near Monroe or Fermi. The study was conducted during the same time period as the study at Fermi, however, and tended to confirm the general findings and comparatively illustrate the non-uniqueness of the Fermi site with respect to ichthyoplankton composition and abundance. Yellow perch larval concentrations may be as much as an order of magnitude higher along the Ohio coastline than in Michigan coastal waters.[35]

In summary, the ichthyoplanktonic component of the fish community near the Fermi-2 site appears to be similar to that of the Lake Erie western basin as a whole. Both the nearshore and offshore areas apparently serve as spawning grounds for several species of fishes. Larvae of some species were more abundant nearshore (152-m (500-ft) station) than offshore (6096-m (2000-ft) station), notably yellow perch, white bass, shiners, and drum. The Fermi-2 site vicinity does not appear to be unique with respect to occurrence or abundance of planktonic fishes.

2.6 References

Documents marked with an asterisk (*) are available from the NRC/GPO Sales Program, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, and the National Technical Information Service (NTIS), Springfield, VA 22161. Documents marked with two asterisks (**) are available for inspection and copying for a fee in the NRC Public Document Room, 1717 H Street N.W., Washington, D.C. 20555. Except as specifically noted, all other documents can be found in public technical libraries.

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3 THE PLANT

3.1 Résumé

During this environmental review, construction of the Fermi-2 station was approximately 80% complete (March 1981). Major changes in plant design since the FES-CP was issued include: (1) a reduction of the size of the effluent water holding pond from 2.0 × 10^5 m^2 (50 acres) to 2.2 × 10^4 m^2 (5.5 acres) (Section 3.2.2); (2) plans to add a manual chemical dechlorination system (Section 3.2.4); and (3) a change in location of the station discharge line (Section 3.2.2). The most recent plans submitted by the applicant for nonradioactive chemical, sanitary, and other waste treatment operations are presented (Section 3.2.4) and updated plans for radioactive waste treatment are given (Section 3.2.3). An initially planned segment of transmission corridor will not be constructed (Section 3.2.5).

3.2 Design Parameters

3.2.1 Plant Water Use

The major water uses are condenser cooling and steam generation. Water will also be used for the potable water and essential service systems. All water will be taken from Lake Erie. Figure 3.1, a schematic flow diagram of water usage, shows the expected average daily flow rates for each system. Most plant water will be recycled; thus, intake and consumptive use will be far below rates shown for the major water systems.

The condenser-cooling system will cycle 53.0 m^3/s (840,300 gpm) of water through the cooling towers (ER-OL, Figure 3.3-1). To compensate for evaporation and drift losses from the cooling towers (average 0.83 m^3/s or 13,100 gpm) and the circulating water reservoir (0.005 m^3/s or 80 gpm), an average blowdown* of 1.3 m^3/s (20,000 gpm) and losses from other minor systems, makeup water will be added to the system at an average rate of 2.1 m^3/s (33,300 gpm) (ER-OL, p. 3.3-3).

3.2.2 Heat Dissipation System

At maximum power (1150 MWe), approximately 8.0 × 10^6 MJ/hr (7.53 × 10^9 Btu/hr) of waste heat will be produced. This will be transferred to the 53 m^3/s (840,000 gpm) of cooling water. The temperature of this water, flowing from the cooling towers through the main condenser, will be increased by about 10°C (18°F).

3.2.2.1 Cooling Towers

Most of the waste heat will be transferred to the atmosphere via two cross-flow natural-draft cooling towers. Each of these towers will be about 120 m (400 ft) high and 137 m (450 ft) in diameter at the base.

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*Blowdown, a portion of water continuously discharged from the condenser cooling system, is necessary to prevent the buildup of dissolved solids.

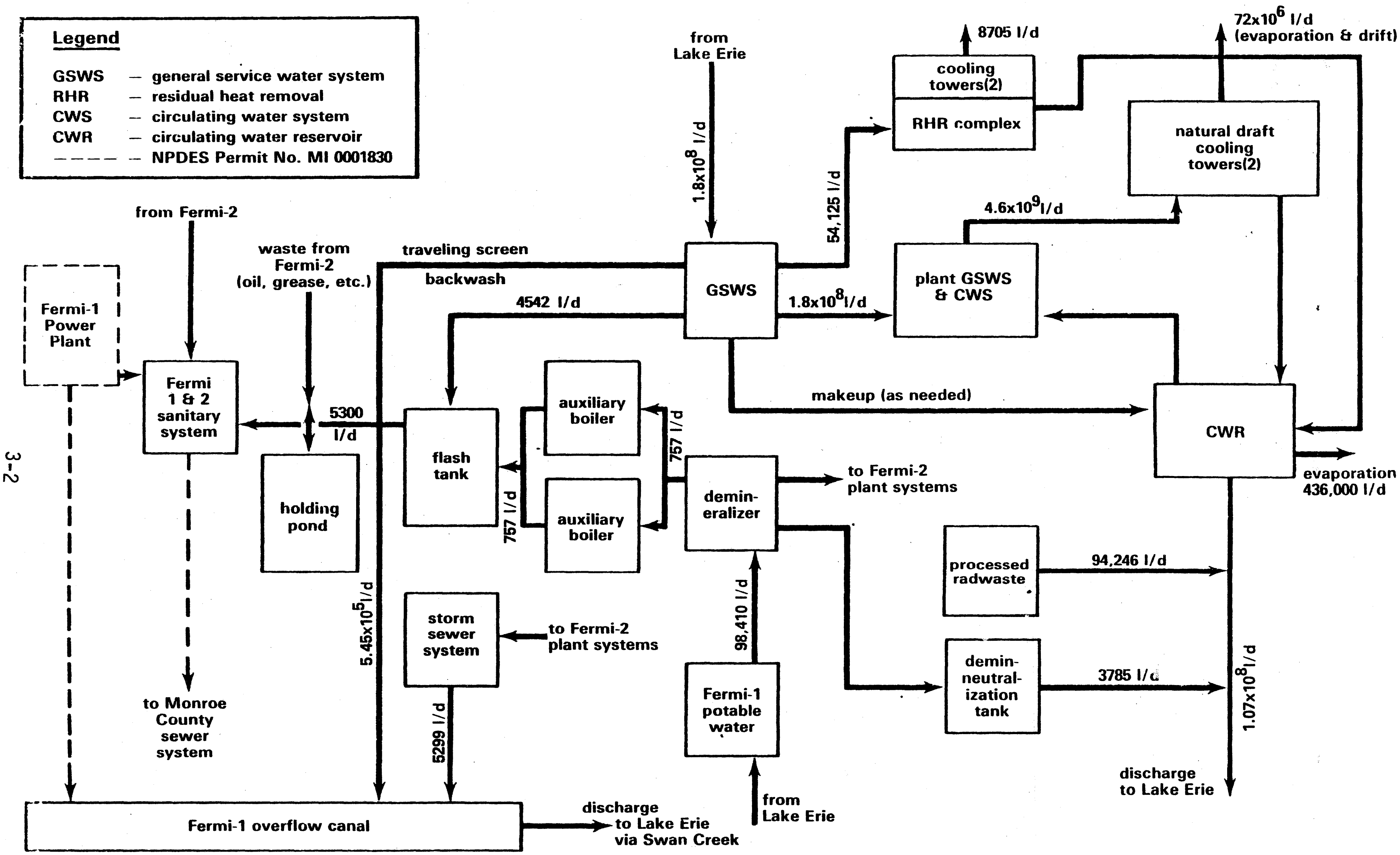

Figure 3.1 Schematic of proposed water flow daily averages (estimated)

Five circulating water pumps will be used to pump water from the circulating water reservoir to the main condenser and then to the towers. The water will be pumped to the heat-exchange section within the tower and allowed to flow by gravity through a fill material; this serves to slow the falling water and to break it into small droplets, greatly increasing both the time and area of contact between water and air. Although most of the cooling results from evaporation of a small portion of the circulating water, sensible-heat transfer by conduction to air also contributes to the cooling process.

Air is forced through the towers by the density difference between the ambient air and the warmed air inside the towers. Drift eliminators, placed inside the tower, trap water droplets to ensure that the volume of liquid lost from the tower (drift) compared with that of the circulating water flow is extremely small (<0.1%).

3.2.2.2 Intake Structure

All water withdrawn from Lake Erie for Fermi-2 will pass through the Fermi-1 intake canal (for a schematic of the Fermi-2 intake structure, see FES-CP, Figure III-1A). The Fermi-2 intake screenhouse is located on the north side of the canal just upstream of the Fermi-1 intake. The Unit 2 intake flow will represent a 24% increase over the amount of water withdrawn by Unit 1 when it is operating; with both units operating, water velocity in the canal will reach a maximum of 0.04 m/s (0.13 fps).

The Fermi-2 intake flow of 2.1 m^3/s (33,300 gpm) will produce a maximum water velocity across the screens of 0.3 m/s (1.0 fps). Trash racks placed in front of the twin traveling screens will prevent large debris from damaging the screens, and the screens themselves will be backwashed to remove debris and impinged organisms. All screen washings from Unit 2 will be routed through the Unit 1 overflow pipe to Swan Creek. The intake canal serving both units will be dredged as necessary to maintain a favorable channel depth.

3.2.2.3 Discharge System

The FES-CP issued in July 1972 included an assessment of the environmental impacts resulting from the cooling tower blowdown discharge structure which incorporated a submerged open pipe located some 152 m (500 ft) offshore in Lake Erie. The staff reviewed this design and found that it would result in an acceptable level of impact. It was theorized, however, that this design might disturb the lake bottom and that it would be too close to the lake surface. Thus the applicant investigated placement of a diffuser structure at the lakeward end of the pipe. Installation of a diffuser system would have required the extension of the discharge pipeline to an area 490 - 610 m (1400 - 2000 ft) offshore (3 - 35 m (10 - 12 ft) depth), and the lake bottom would have to be dredged to allow placement of the effluent pipeline. In view of the additional costs of constructing the discharge/diffuser system offshore, Detroit Edison developed plans for a shoreline discharge system. After the FES was issued, Detroit Edison proposed to redesign and relocate the cooling tower blowdown discharge structure. The revised structure utilized a surface blowdown line located at the shoreline, which discharged into an open channel extending approximately 15 m (50 ft) into Lake Erie.

Blowdown will now be discharged from the circulating water reservoir to Lake Erie by means of a 0.91-m (36-in.) diameter pipe to an onshore discharge structure, (shown in Figure 3.2). The blowdown from the discharge structure will enter an open channel which is 1.5 m (5 ft) wide by 0.9 m (3 ft) deep. The channel slopes into the lake for 30 m (100 ft) at a slope of 1:100 and then proceeds an additional 15 m (50 ft) horizontally. Riprap is provided along the initial 30 m (100 ft) for protection against wave action, ice damage, and erosion. The reservoir will contain approximately $1.05 \times 10^5 m^3$ (27.5×10^6 gal) of water with a surface area of about $2.2 \times 10^4 m^2$ (5.5 acres). This is a reduction in size from the $2.0 \times 10^3 m^2$ (50 acres) originally planned (FES-CP, III-5). Residence time of water in the smaller reservoir will be approximately 30 minutes; this amounts to about one tenth of the residence time that would characterize the larger reservoir originally called for. The discharge velocity at shoreline discharge structure will range between 0.85. - 1.34 m/s (2.8 - 4.4 fps), compared with a range of 1.71 - 3.38 m/s (5.6 - 11.1 fps) for the previously proposed offshore submerged open pipe discharge. The discharge temperature of the blowdown has not changed.

3.2.3 Radioactive-Waste-Management System

Part 50.34a of Title 10 of the Code of Federal Regulations requires an applicant for a permit to construct a nuclear power reactor to include a preliminary description of the design of equipment to be installed for keeping levels of radioactive materials in effluents released to unrestricted areas as low as is reasonably achievable (ALARA). ALARA means as low as is reasonably achievable taking into account the state of technology and the economics of improvement in relation to benefits to public health and safety and other societal and socioeconomic considerations and in relation to the utilization of atomic energy in the public interest. Appendix I to 10 CFR Part 50 provides numerical guidance on design objectives for light-water-cooled nuclear power reactors to meet the ALARA requirements.

To meet the requirements of 10 CFR Part 50.34a, the applicant has elected to meet the requirements of the Annex to Appendix I, dated September 4, 1975, in lieu of performing a cost-benefit analysis as required by Section II.D of Appendix I. The applicant has provided final designs of radwaste systems* and effluent control measures for keeping levels of radioactive materials in effluents to unrestricted areas ALARA within the requirements of Appendix I to 10 CFR 50 and the requirements of the Annex to Appendix I. In addition, the applicant has provided an estimate of the quantity of each principal radionuclide expected to be released annually to unrestricted areas in liquid and gaseous effluents produced from normal operation including anticipated operational occurrences.

The staff's detailed evaluation of the radwaste system and the capability of these systems to meet the requirements of Appendix I is reported in Chapter 11 of the Fermi-2 Safety Evaluation Report (NUREG-0798). The quantities of radioactive material calculated by the staff to be released from the plant are presented in Section 4.5 of this Environmental Statement, with the calculated

*The applicant indicated by a letter dated June 17, 1981, that the liquid and solid radwaste systems are being upgraded. The upgraded system is also designed to meet the ALARA guidelines.

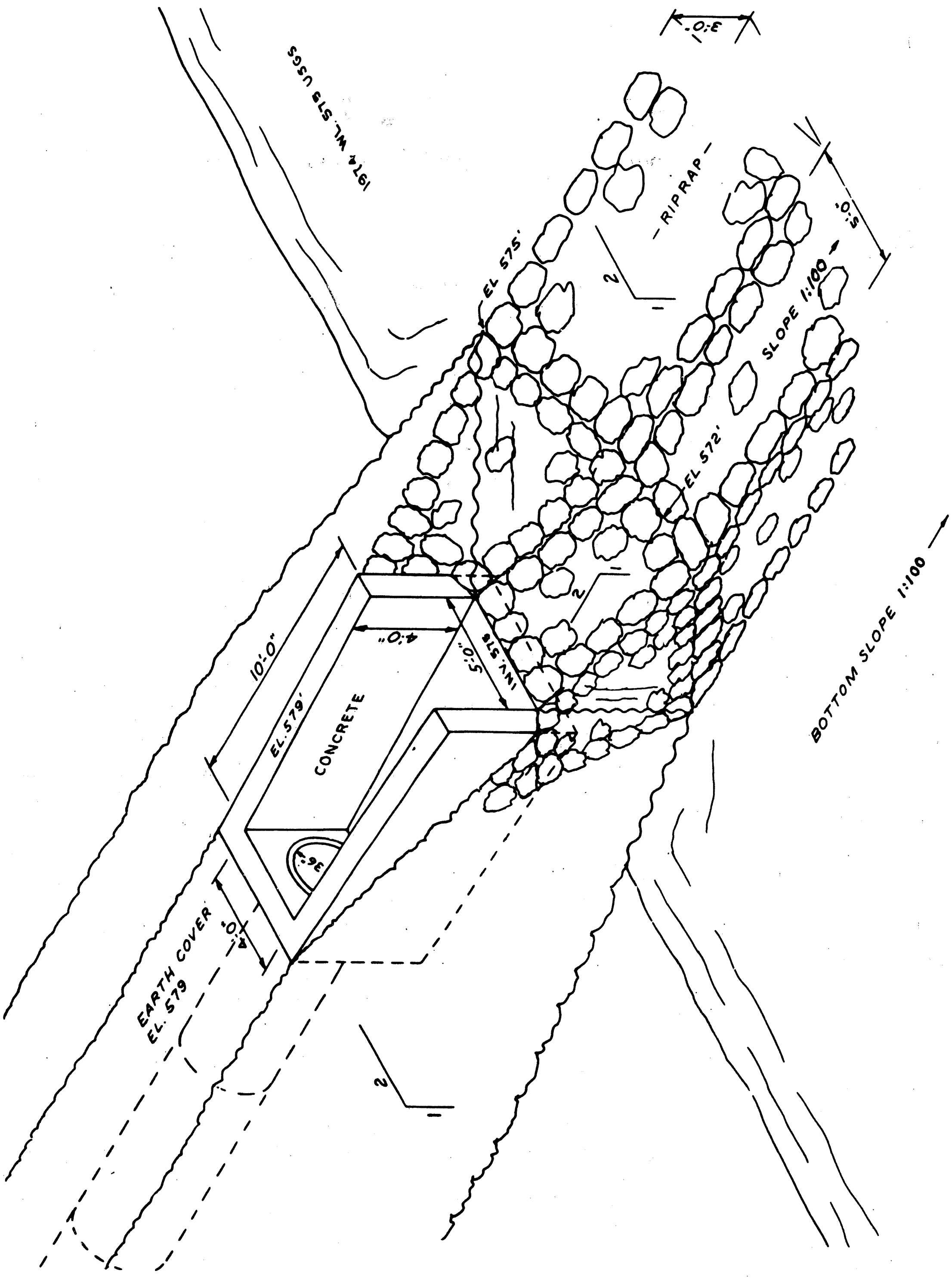

Figure 3.2 Shoreline surface discharge structure

doses to individuals and the population that will result from these effluent quantities.

Before the operating license is issued, the applicant will be required to submit Technical Specifications which will establish release rates for radioactive material in liquid and gaseous effluents and which provide for the routine monitoring and measurement of all principal release points to ensure that the facility operates in conformance with the radiation-dose-design objectives of Appendix I to 10 CFR 50.

3.2.4 Chemical, Sanitary, and Other Waste Treatment

Two paths are planned for the discharge of effluent streams from Fermi-2 into Lake Erie, the circulating water reservoir (CWR) decant line and the Fermi-1 cooling water discharge canal, the latter via Swan Creek. The CWR blowdown, the processed radwaste, and the demineralizer regenerant waste solutions will all feed into the CWR decant line. The traveling screen backwash and the Fermi-2 storm sewer system will feed into the Fermi-1 discharge canal. In addition, it is expected that there will be 38,000 L (10,000 gal) of sewage discharged daily via the Frenchtown Township sewer line into the Monroe sewage treatment plant. This figure represents less than 0.1% of the 4.5×10^7 to 5.7×10^7 L (1.2×10^6 to 1.4×10^6 gal) of sewage treated at the Monroe plant daily (ER-OL, Sections 3.3.2.2 and 3.6 and pp. A.4-30 to A.4-32).

Chemical additions to these effluent streams will result from the treatment of the general service water and the circulating water and from regeneration of the demineralizers, which supply makeup water to the steam supply system and to the other closed loop heat exchanger systems. Anticipated usage of chemicals and biocide is summarized in Table 3.1.

To inhibit bacterial and fungal growths, which impair heat exchanger operation, the water in the circulating water system (CWS) and the general service water system (GSWS) will be chlorinated. Based on effluent limitations for total residual chlorine (as discussed in Section 5.3.4), a tentative chlorination procedure has been developed. The chlorine will be obtained and stored as Cl_2 in 900-kg (1-ton) cylinders. The GSWS and the CWS will be chlorinated concurrently at a dose rate of 5 ppm for one hour each day. A manually operated dechlorination system will be on standby to feed sodium sulfite (Na_2SO_3) solution into the CWR or the suction side of the decant pumps at a feed rate which could be as much as 1.5 times the stoichiometric quantity required for the quantity of chlorine added. The actual amount used will be determined from experience as needed to meet the State-imposed residual chlorine limit (ER-OL, pp A.4-20 to A.4-22).

At present, there are no plans to use corrosion inhibitors in either the CWS or the GSWS, but the daily addition of about 2700 kg (5900 lb) of sulfuric acid to the CWR will be required to maintain the pH between 7.0 and 7.5 for the purpose of limiting scale formation on heat exchanger surfaces (ER-OL, Section 3.6 and pp. A.4-34 and A.4-35).

The demineralized water makeup system will have a capacity of 3.2 L/s (50 gpm). This system will include the following major components:

(1) dechlorination or activated carbon bed
(2) cation exchange bed
(3) anion exchange bed
(4) mixed-resin exchange bed
(5) regeneration equipment, including tanks of 93% sulfuric acid and 20% caustic (NaOH)

Each demineralizer system regeneration requires up to 154 kg (340 lb) of acid and 126 kg (278 lb) of caustic and is followed by a backwash with up to 27,200 L (7200 gal) of water.

The backwash will be routed to a neutralization tank in which the acid and caustic backwash solutions are to be mixed, yielding a solution containing about 9000 ppm total dissolved solids (TDS), primarily sodium sulfate, with a pH between 6.5 and 7.5. Discharge of this neutralized product is planned for a period of about 36 minutes each week at a rate of 13 L/s (200 gpm) to the circulating water decant line. Table 3.2 shows the effect of regeneration on effluent quality. The carbon filter backwash, together with the auxiliary boiler blowdown, will be routed through the Fermi-1 chemical waste pond via the Frenchtown Township sewer line to the Monroe sewage treatment facility (ER-OL, Section 3.6).

Table 3.1 Anticipated chemical usage[a]

Chemical	System	Daily Max (kg)[b]	Monthly Usage (kg)[b] Max	Summer Avg	Winter Avg
Cl_2 (as gas)[c]	GSWS, CWS	513	15,400	15,400	15,400
Na_2SO_3[d]	Blowdown	1,155[e]	34,660	34,660	34,660
H_2SO_4	CWS	2,940	88,190	80,351	66,960
H_2SO_4	Demineralizer[f]	154	617	617	617
NaOH	Demineralizer[f]	126	504	504	504

[a]Based on 30-day month. Information from ER-OL, p. A. 4-35.

[b]To convert kg to lb, multiply by 2.2046.

[c]CWS requires 93% of Cl_2 used; therefore, the seasonal variation for flow of GSW is negligible. Variation in usage in CWS will not be known until facility is operational.

[d]Assumes dechlorinating agent is added to the maximum allowable (according to NPDES Permit No. MI 0037028), 1.5 times the stoichiometric amount of Cl_2. Until the plant becomes operational and the chlorination procedures are finalized, the exact quantity used will not be known. It is anticipated that it will be less than that shown.

[e]The staff calculates that 1366 kg of Na_2SO_3 corresponds with the 1.5 times the stoichiometric amount needed to completely react with the 513 kg of chlorine.

[f]These numbers are based on daily regeneration once per week, four weeks per month.

Table 3.2 Demineralizer regeneration wastes[a,b]

Analysis	A Regenerant Waste Composition[c]	B Nominal Decant Line Composition[d]	C Composition of Water Discharged to Lake[e]	Required Quality
pH	6.5 - 7.5	7.5	7.5	6.0 - 9.0
Na	2800	34	88	-
Ca	400	70	76	-
Mg	75	21	22	-
SO_4	5700	158	267	-
TDS	8975	400	568	750[f]

[a]Modified from ER-OL, Table 3.6-1.

[b]In ppm except pH.

[c]Solution from the neutralization tank containing the mixed acid and caustic backwash wastes.

[d]Assumes a 2X concentration factor.

[e]This assumes a 630 L/s (10,000 gpm) decant flow to dilute the 13 L/s (200 gpm) backwash sump waste flow. Discharge of makeup wastes occurs approximately 36 minutes per week. Column C was calculated as follows:

$$C = A \times \frac{200}{10,200} + B \times \frac{10,000}{10,200}$$

[f]A 750 ppm TDS maximum is permitted for temporary discnarge outside of the initial mixing zone by the State of Michigan (ER-OL, Section 5.4.3).

Blowdown will be used to maintain the TDS concentration of the water in the CWR within a concentration range from 1.8 to 2.1 times the TDS concentration of the lake water. The TDS concentration of the CWR water, assuming a concentration factor of 2.0 and the solids additions for pH and chemistry control discussed, is summarized in Table 3.3.

Other than the chemical usage discussed above, no significant revision of estimates of the nonradioactive wastes has occurred since the issuance of the FES-CP (ER-OL, Sec. 3.7).

3.2.5 Transmission Lines

The transmission lines connected to the Fermi-2 plant are the same as those described in the FES-CP, except for one 16 km (10-mi) line; the segment from Sumpter to Milan, Michigan will not be constructed.

Table 3.3 Effluent water quality description[a]

Analysis	Lake Erie Influent Water: Average Concentration of Impurities in Western Lake Erie Water[b]	Estimated Plant Effluent Water: Blowdown from Circulating Water Reservoir[c]	Estimated Plant Effluent Water: Discharge Composition During Ion Exchange Waste Discharge[d]
pH	8.3	7.5	7.5
Bicarbonate (HCO_3)	93.0	70.0[e]	70.0
Chloride (Cl)	20.0	40.0	40.0
Sulfate (SO_4)	31.0	158.0	267.0
Calcium (Ca)	35.0	70.0	76.0
Magnesium (Mg)	10.4	20.8	21.9
Sodium (Na)	17.0	34.0	88.0
Potassium (K)	2.0	4.0	4.0
Fluoride (F)	0.09	0.18	0.18
Total Phosphate (P)	0.21	0.42	0.42
Ortho Phosphate (PO_4)	0.07	0.14	0.17
Iron (Fe)	0.72	1.47[f]	1.48
Manganese (Mn)	0.016	0.032	0.032
Strontium (Sr)	0.17	0.34	0.34
Copper (Cu)	0.035	0.126[f]	0.144
Zinc (Zn)	0.019	0.061[f]	0.068
Total Dissolved Solids	218.03	407.069	577.234

[a]Modified from ER-OL, Table 3.3-2. Measurements in ppm except pH.

[b]Data taken from Lake Erie Ohio Intake Water Quality Summary, 1969; Lake Erie Ohio, Pennsylvania, New York Intake Water Quality Summary, 1970; and Perry Nuclear Power Plant Environmental Report; refer to Table 3.3-2.

[c]Based on a circulating-water-system concentration factor of 2.

[d]During weekly 36-minute discharge period.

[e]Reduction due to reaction with H_2SO_4 and CO_2 evolution.

[f]Corrosion product pickup from system is calculated to be 0.03 ppm Fe, 0.056 ppm Cu, and 0.023 ppm Zn.

4 ENVIRONMENTAL EFFECTS OF STATION OPERATION

4.1 Résumé

Land use impacts in the vicinity of the Fermi-2 station are basically as predicted during the FES-CP stage. Other assessments which presently remain valid are those that pertain to sanitary wastes, surface water supply, and groundwater. Impact from transmission line construction has been more limited than originally expected because a segment originally called for will not be constructed (see Section 4.2.2). Additional discussion of the terrestrial ecology of the site, as it relates to effects of cooling tower drift, is provided in Section 4.4.1; additional discussion of potential bird kills on the Fermi-2 cooling towers is presented in Section 4.4.1. The closed-cycle cooling design will minimize fish entrainment and impingement, with losses likely to be 1 - 3 orders of magnitude less than at other nearby once-through-cooling power plants (Section 4.4.2.1). Since issuance of the construction permit, the applicant has received an NPDES permit (Appendix D) from the State of Michigan; the contents of the permit are discussed in Section 4.3.4. Using new plant operation information supplied by the applicant, the staff has reassessed plant operational effects on Lake Erie water quality, particularly the ability of the applicant to comply with effluent water quality limitations and criteria (Section 4.3.5). The information presented in the FES-CP (Section V.B.2) concerning the effects of the proposed cycles of concentration and the proposed chlorination-dechlorination scheme has been updated to take into account the latest information submitted by the applicant (Section 4.3.2). The aquatic impacts of the discharge predicted in the FES-CP will not be substantially different during plant operation because of the relocation of the discharge line from offshore to the shoreline (Section 4.4.2.2 and Reference 1). There is more potential for attracting fishes to the thermal plume of the shoreline discharge, and there is some potential for recreational fishing there on a seasonal basis. However, an increase in biotic impact could occur as a result of effluents from manual dechlorination (Section 4.4.2). The potential socioeconomic impact of operational workers who will reside in Monroe County, which was not assessed in the FES-CP, is presented in Section 4.7 of this Environmental Statement.

4.2 Impacts on Land Use

The Fermi site is within the 1% chance (100-yr) floodplain of Lake Erie (see Figure 4.1). The elevation of the 1% flood at the site is 175.9 m (577 ft) mean sea level (msl). Plant grade was raised to elevation 177.7 m (583 ft) msl by the addition of fill. This fill operation and all major plant structures were substantially complete at the time Executive Order 11988, Floodplain Management, was signed by President Carter in May 1977. The staff, therefore, concludes that consideration of alternate locations above the floodplain for the site is neither required nor practicable.

Because plant grade was raised, by fill, to elevation 177.7 m (583 ft) msl, the site is protected from the effects of the 1% chance flood at elevation 175.9 m (577 ft) msl. Additionally, the plant has been designed to withstand the effects of the Probable Maximum Surge, a considerably more severe flood event, without endangering the health and safety of the public.

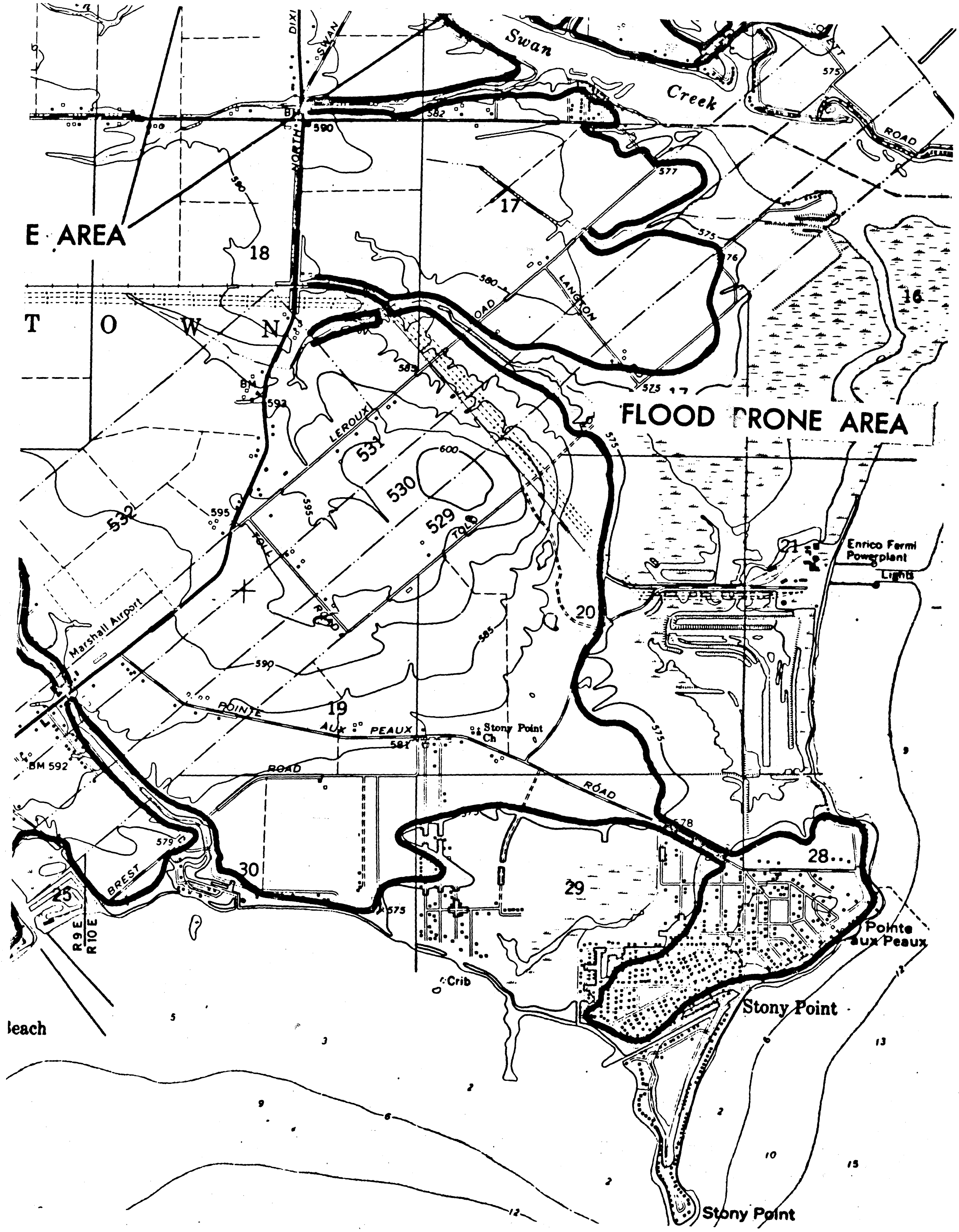

Figure 4.1 One percent chance flood plain, Fermi site vicinity

The staff also has concluded that the plant will have negligible effect on offsite water levels during a flood event. This is because the volume of fill used to raise the elevation at the site is negligible relative to that above the lake and floodplain available for flood storage.

4.2.1 Station Operation

There should be no measurable impacts on land use resulting from operation of Fermi-2. Because all facilities are to be located on the site itself or on inshore sections of Lake Erie which constitute part of the site, no direct effects of facilities on offsite land use should occur. No major increases in residential or industrial development of land in the vicinity of the site are expected to occur because of the presence or operation of the nuclear station.

4.2.2 Transmission Lines

The staff has reviewed sources of environmental impact which could be associated with the operation of transmission lines. These potential sources are (1) ozone production, (2) induced electrical currents, (3) electric fields, and (4) corridor maintenance and herbicide use.

It has been the staff's experience that ozone production by transmission lines is so small it does not present a problem. The applicant grounds all objects that have the potential to pick up an electric charge from their transmission lines. Once the lines are energized, all complaints are investigated. Therefore, induced electric currents should not be a problem.

The staff has found no convincing or compelling argument to prohibit the operation of 500 kV lines. Therefore, Fermi's 345 kV lines should pose no problems.

The applicant does use herbicides in maintaining its transmission corridor rights-of-way. These chemicals are applied according to State and Federal regulations under the supervision of the utility's forester.

4.2.3 Historical, Archeological, and Natural Landmarks

The status of historical, archeological, or natural landmarks on the plant site remain as stated in Section II.C of the FES-CP; there are still no known historical or archaeological resources or natural landmarks on the site. The operation and maintenance of the plant are not expected to produce any adverse impacts on cultural resources not yet identified because these activities are not expected to disturb below-ground sites. The State Historical Preservation Officer has concurred with this evaluation.*

4.3 Impacts on Water Use

4.3.1 Thermal Discharge

4.3.1.1 Applicant's Thermal Analysis

Table 4.1 lists Lake Erie temperature data used by the staff and applicant to calculate the extent of the thermal plume. The data consist of the monthly

*Letter dated March 17, 1981 from Mr. Don Westen, Assistant to the Michigan SHPO, to A. Schwencer, NRC. See Appendix E.

Table 4.1 Blowdown and lake temperature data[a]

Month	Max Allowable Lake Temp, °C	Lake Temp, °C			Blowdown Temp, °C			Blowdown Excess Temp., °C		
		Max	Av	Min	Max	Av	Min	Max	Av	Min
Jan	7.2	3.9	2.3	1.1	20.6	15.3	8.3	19.4	12.9	4.4
Feb	7.2	5.0	2.3	1.1	19.3	15.6	9.9	18.2	10.6	4.9
Mar	7.2	7.8	3.6	1.1	22.7	17.5	14.2	21.6	13.9	6.4
Apr	15.6	13.3	8.2	3.3	26.7	21.1	17.2	23.3	12.9	3.9
May	21.1	18.3	13.3	8.3	28.3	25.6	20.8	20.0	12.2	2.5
June	23.9	23.9	17.2	14.4	32.2	28.1	24.3	17.0	10.1	0.4
July	26.7	24.4	21.2	17.2	32.2	28.3	25.7	14.9	7.1	1.2
Aug	29.4	24.4	22.1	19.4	31.9	28.3	26.4	12.5	6.2	1.9
Sept	26.7	23.9	20.1	16.7	31.4	26.4	23.6	14.7	6.3	-0.3
Oct	21.1	20.6	15.4	10.6	27.5	23.1	18.9	16.9	7.6	-1.7
Nov	15.6	16.1	9.1	3.3	23.3	19.2	15.3	20.0	10.1	-0.8
Dec	10.0	7.8	3.7	1.7	22.2	16.2	12.3	20.6	12.4	4.6

[a]Modified from the ER-OL, Table 5.1-3.

maximum, average, and minimum water temperatures measured by the applicant at the Fermi-1 potable water intake between January 1969 and December 1973 (ER-OL pp. 5.1-3,4).

Maximum, average, and minimum blowdown temperatures were determined by the applicant from the cooling-tower design curve (ER-OL Figure 5.1-4) utilizing meteorological data from the Detroit Metropolitan Airport (ER-OL pg. 5.1-4). The staff considers this approach to be reasonable. Along with the maximum permissible lake temperatures outside the mixing zone, blowdown excess temperatures are listed on Table 4.1.

Using an empirical model developed by Jen and Wiegel,[2] the applicant analyzed the extent of the thermal plume (ER-OL p. 5.1-6) for six different meteorological and hydrological conditions (Table 4.2). Combinations of ambient lake and blowdown temperatures were chosen to maximize the excess temperature and thus the maximum impact to the lake. The lake level chosen was 175.3 m (575 ft), the maximum average 1973 winter lake level.

The size and extent of the thermal plumes for the six cases listed in Table 4.2 are found in the ER-OL (Figures 5.1-8 through 5.1-11 for the unbent plumes (stagnant lake) and Figures 5.1-14 through 5.1-17 for the bent plumes (shoreline ambient velocity)). Calculated areas enclosed by the 1.67°C (3°F) excess isotherm are also listed in Table 4.2.

4.3.1.2 Staff's Thermal Analysis

Numerous analytical models have been developed to describe the physical characteristics of surface discharges. Many of these models have been reviewed by Dunn and others.[1,3] Dunn's report concluded that no validated model over the complete range of discharge and ambient conditions exists. The report stated, "the available models, in their present stage of development, may be used to give only general estimates of plume characteristics, precise predictions are not currently possible."

The staff has chosen two models to provide those general estimates in the Fermi-2 case. The integral model developed by Shirazi and Davis[1,4] assumes that the heated effluent is discharged from a rectangular channel into a large, deep body of water that is either at rest or moving at a uniform constant velocity. The phenomenological Pritchard Model No. 2 was developed to include bottom interactions.[1,5]

Areas enclosed by the 1.67°C (3°F) isotherm are listed in Table 4.2 for the six cases. As can be seen, the results differ by more than an order of magnitude, with the applicant's results somewhere between. This is not unexpected considering the principal conclusions of the report by Dunn and others. Another cause of the differences in model predictions is that bottom interactions are considered only in the Pritchard Model No. 2.

The results for Case 2 are also not unexpected. In this case, the plume is bent over, remaining in very shallow water, and bottom-limited over most of its extent, thus greatly increasing the predicted plume size relative to the

Table 4.2 Staff and applicant results of thermal plume analysis

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
	April	April	June	June	June	March
Blowdown temp, °C	26.7	26.7	32.2	32.2	32.2	17.5
Lake temp, °C	3.3	3.3	14.4	14.4	14.4	3.6
Water level, m (USGS)	175.3	175.3	175.3	175.3	175.3	175.3
Discharge rate, m^3/s	0.63	0.63	1.26	1.26	0.63	0.63
Discharge velocity, m/s	0.85	0.85	1.34	1.34	0.85	0.85
Ambient velocity, m/s	0.0	0.12	0.0	0.12	0.0	0.0
Discharge flow depth, m	0.5	0.5	0.6	0.6	0.5	0.5
Area Enclosed within 1.67°C isotherm, m^2						
Applicant	7.1×10^4	7.1×10^4	4.9×10^4	4.9×10^4	4.2×10^4	2.2×10^4
Staff[a]	17.8×10^4	0.25×10^4	-	-	-	-
Staff[b]	0.86×10^4	155×10^4	2.4×10^4	-	0.82×10^4	0.58×10^4

[a]Shirazi-Davis Model.
[b]Pritchard Model No. 2.

unbent case (from the Pritchard Model). Because the Shirazi-Davis model assumes deep water and no shoreline interaction, the ambient velocity improves the mixing process and results in a plume smaller than the one in the unbent case. The applicant's model has built into it the incorrect assumption that the areas are equal with and without an ambient current present.

4.3.1.3 State Thermal Water Quality Standards

The Michigan water quality standards[6] require that at the Fermi site

(1) Records of the natural daily and seasonal temperature fluctuations of the receiving waters be preserved

(2) The temperature rise at the edge of the mixing zone be no more than 1.67°C (3°F)

(3) The temperature of the receiving body at the edge of the mixing zone not exceed the monthly maxima listed in Table 4.1

(4) All mixing zones established by the Water Resources Commission of Michigan be determined on a case-by-case basis

The extent of the mixing zone for the Fermi-2 discharge was defined in the NPDES permit as that area equivalent to a circle of radius 304.8 m (1000 ft) which is equivalent to 2.9×10^5 m^2 (72 acres) (see Appendix D). The required mixing zone shall not increase the temperature by more than 1.67°C (3°F) above the existing natural temperature or above the monthly maximum temperatures listed in Table 4.1. However, the applicant may exceed the monthly maximum when natural temperatures exceed the monthly maximum, but any such increase at the edge of the mixing zone shall not exceed the natural water temperature plus 1.67°C.

4.3.1.4 Conclusions

Examination of the results listed in Table 4.2 indicates that for the most part the areas enclosed within the 1.67°C isotherms are from 2 to 50 times smaller than allowed by the water quality standards. The large prediction by Pritchard Model No. 2 for Case 2 may be an anomaly of the model because it is known from other studies[7] that this model tends to overpredict the areas contained within the excess isotherms in the far field. The interpretation that there is a trend for the size of the plume to increase with ambient current is, in the staff's opinion, correct. The staff believes that operational monitoring will be necessary to establish compliance with the Michigan Thermal Water Quality Standards (see Section 5.3.2.2) and the applicant will conduct such monitoring under the requirements set forth in the NPDES permit issued by the State.

4.3.2 Industrial Chemical Waste

The analysis presented in the FES-CP (Section V.B.2) remains qualitatively valid. A twofold rather than a threefold increase in the concentration of dissolved solids is now anticipated in the water returned to Lake Erie due to the applicant's design decrease in the cycles of concentration. As described in Section 3.2.4,

the chemical discharges from the Fermi-2 power plant into Lake Erie will consist of circulating-water-reservoir (CWR) blowdown, processed radwaste, and demineralizer regenerant waste solution. The initial composition of the lake water and the composition of the effluents returned to the lake were shown in Table 3.2. None of the substances is at a concentration which would impair other uses of the lake water. Therefore, no adverse impacts from these chemical substances is expected.

4.3.3 Sanitary Wastes

As noted in Section 3.2.4, no significant revision of the estimated quantities or treatment of sanitary wastes has occurred since the FES-CP was issued in July 1972 (ER-OL, Section 5.5).

4.3.4 Effluent Guidelines and Limitations

Chemical and sanitary waste discharges from Fermi-2 will be required to meet the Michigan water quality standards, the U.S.EPA Steam Electric Power Generating Point Source Category Effluent Guidelines and Standards (40 CFR 423, July 1, 1977), and other effluent limitations established by the Michigan Water Resources Commission through the National Pollutant Discharge Elimination System (NPDES) Permit. In accordance with procedures established under the Federal Water Pollution Control Act (33 U.S.C 1251 et seq.), the State of Michigan issued Permit No. MI-0037028, which contains the specific monitoring provisions and effluent limitations governing the operation of Fermi-2. This permit is reproduced as Appendix D to this report.

4.3.5 Effects on Aquatic Biota Through Changes in Water Quality

The analysis given in the FES-CP (Section V.B) remains valid in general, although the details have changed (for example, the water returned to Lake Erie from the CWR will contain a twofold rather than a threefold increase in the concentration of the dissolved solids). With the possible exception of products of chlorination and dechlorination, the staff expects that plant effluents will not affect the quality of Lake Erie water to an extent that it would be harmful to biota. The applicant's program for chlorination is described in Section 3.2.4. Because the chlorine in the discharge will have to meet the requirements set forth in the NPDES permit, dechlorination may be required. Sodium bisulfite ($NaHSO_3$) has been used as a dechlorinating agent at the Trojan Nuclear Power Plant in Oregon, and it is reported[8] that "zero chlorine discharge" (that is, less than 0.1 mg/L total residual chlorine) can be maintained. Dechlorinating agents such as sodium sulfite (Na_2SO_3), which is specifically permitted by the NPDES permit, and sodium bisulfite and sulfur dioxide (SO_2), which have been used or considered for use at other power plants, will chemically reduce the chlorine to yield chloride and sulfate ions. The staff thus expects that effective dechlorination should be attainable at Fermi-2. However, the staff also notes that according to the terms of the NPDES permit, the applicant may use a quantity of dechlorinating agent up to 1.5 times the stoichiometric amount needed for dechlorination of the total chlorine applied. The staff believes that the use of this quantity of dechlorinating agent will prove to be unnecessary. Furthermore, any excess dechlorinating agent will eventually be oxidized to sulfate. Unoxidized dechlorinator will be discharged into the lake, where, because of its tendency to react with the dissolved oxygen, it could result in exposing aquatic life forms to reduced oxygen levels.

If chlorine were added at the anticipated maximum rate of 5 mg/L and if sodium sulfite were added at a stoichiometric ratio of 1.5 times that necessary to react with all of the added chlorine, but if instead the chlorine were reduced by naturally occurring substances, then the discharge would contain enough sulfite to reduce the stoichiometric equivalent of dissolved oxygen. That is, about 1.7 mg/L of oxygen would be removed from the discharge stream. This is obtained as follows:

$$\text{Reduction in oxygen} = 1.5 \times 5 \frac{16}{35.5} \times \frac{1}{2}$$

where 5 = the initial chlorine feed concentration

1.5 = the permissible stoichiometric excess of sulfite

$\frac{16}{35.5}$ = the ratio of atomic weights of oxygen to chlorine

and the factor 1/2 corrects for the relative oxidation numbers.

This calculation is conservative, and even so, the result would not be a severe impact. Nevertheless, the staff believes that the use of a quantity of dechlorinating agent based on the amount of chlorine measured in the decant stream would be a sound approach with regard to the potential for environmental impacts.

The staff also notes that sodium thiosulfate ($Na_2S_2O_3$), considered by the applicant as an alternative dechlorinating agent, is not recommended for this purpose by one of the standard works on dechlorination[9] for two reasons. First, sodium thiosulfate seems to dechlorinate by an unspecified stepwise reaction mechanism (that is, chemical intermediates must be formed before the final reaction products are produced, thus delaying the completion of the reaction), and second, sodium thiosulfate has been known to impart odors and tastes to the water. The staff expects the impact of this alternative to be minor because of the distance of Lake Erie water intakes from the site.

It was noted in Section 2.3.3 that the groundwater in the area is confined in the upper zone of the Bass Island dolomite by overlying, relatively impervious, glacial till and lacustrine clay. Groundwater movement across the site is towards Lake Erie with an upward pressure gradient. In addition, the holding ponds on site have been lined with clay which is a relatively impervious liner (ER-OL, p. A.4-38). The staff thus expects that seepage of chemical solutions in any of these ponds will be minor and unlikely to interfere with use of the groundwater.

4.3.6 Effects on Surface Water Supply

As noted in the FES-CP (Section V.B.3), Fermi-2 is expected to have a negligible effect on the surface-water supplies of Lake Erie. The water lost by evaporation from the cooling towers and the CWR (0.83 m^3/s (1.9×10^7 gpd)), (ER-OL, Figure 3.3-1) is a minute quantity when compared with the Lake Erie volume of

4.6×10^{11} m^3 (110 mi^3), and the recharge from the Detroit River of 5300 m^3/s (1.2×10^{11} gpd) (ER-CP, Section 2.2.4).

4.3.7 Effects on Groundwater Supplies

The applicant does not anticipate use of groundwater at the plant site. As noted in Section 2.3.3, pumping from excavations during the construction of Fermi-2 temporarily altered the groundwater regime, but the staff does not expect operation of the Fermi-2 plant to affect the groundwater discharge and water-level pattern in the site vicinity.

4.4 Environmental Impacts

4.4.1 Impacts on the Terrestrial Environment

4.4.1.1 Station

The operation of Fermi-2 will have little, if any, impact on terrestrial biota, except for the partial continuation of the disruptive effects of construction. These impacts were described in detail in the FES-CP.

The staff examined the potential for impact to terrestrial biotic communities during operation as a result of the dissolved solids that will be deposited on vegetation wherever drift from the cooling towers touches down. According to the ER-OL (Section 5.1.4.2.6) and confirmed by the staff, the predicted maximum dissolved-solids deposition rate will be about 561 g/ha (0.5 lb/acre) per year. There are no measurable effects of salt deposition on vegetation at deposition rates below 3.4×10^5 g/ha (300 lb/acre) per year.[10] As the prevailing winds are southwesterly (toward Lake Erie), the actual deposition of solids on vegetation will be even less than the maximum given above, and any effects will be negligible.

As indicated in Section 2.5.1, a State of Michigan endangered plant (the American lotus), a State threatened plant (the swamp-rose hibiscus), and a threatened animal (the Eastern fox snake) occur on site. Because station operation will not involve destruction of habitat beyond that which has already occurred during construction, the staff believes that these species will not be affected.

The cooling towers, which have already been constructed, represent some hazard to migrating birds. Lately, only a few bird kills have been observed at the Fermi-2 towers, but in September 1973, 50 dead birds were found (ER-OL, Section 5.1-5.2). So few bird kills do not represent a threat to any species.

As indicated in Section 2.4.6, major noise sources during station operation will be the two natural-draft cooling towers and passenger, maintenance, and delivery vehicles. In the staff's opinion, operational noise levels will be more acceptable to wildlife than were the construction noises, and will have no adverse impact on wildlife areas adjacent to the Fermi-2 station.

The circulating water reservoir will provide a surface area of 2.2 ha (5.5 acres) of open water that will be at 16°C (60°F) in winter (ER-OL, Section 3.4.1.1), at a time when site area wetlands and lagoons will be covered with ice. This warm pond could provide an attractive resting spot for gulls, ducks, and other

birds wintering over. It is unlikely that such birds would suffer from a build-up of toxic substances in the pond because the blowdown and the input of makeup water will maintain a concentration of dissolved solids at only about twice the level of dissolved solids already in Lake Erie (ER-OL, Section 3.4.1.1 and Table 3.3).

4.4.1.2 Transmission Lines

Fermi-2 transmission lines will, for the most part, share existing corridors; the remainder will be routed across cultivated farmland. The impacts of transmission line construction have been discussed in the FES-CP (Section III.B) Because of the highly disturbed nature of the terrain over which the lines will be operated, the staff expects no additional impact from maintenance procedures.

4.4.1.3 Endangered and Threatened Species

Because operation of the Fermi-2 plant will not involve destruction of habitat beyond that which has already occurred during the construction phase, it is unlikely that any of endangered and threatened species that could be associated with the site (see Table 2.5.1) will be further affected by normal plant operation.

4.4.2 Impacts on the Aquatic Environment

Effects from the plant will be limited to organisms found in Lake Erie in the vicinity of the plant. The following mechanisms for impact were investigated: (1) intake effects involving phytoplankton, zooplankton, and ichthyoplankton entrainment and fish impingement, and (2) effects related to discharges into Lake Erie including an increase of temperature in the thermal plume and the effects of chemical and biocidal discharges on aquatic organisms.

4.4.2.1 Intake Impacts

The structures of the intake, including the 213-m (700-ft) dikes, dredged channel, and Fermi-1 intake (see ER-OL, Figure 2.1-4), have been in existence since the early 1960s. Additional construction on the north side of the channel, for the Fermi-2 intake, produced no important aquatic impacts. Periodic dredging of the channel to maintain an optimal depth for water withdrawal will disrupt the benthic community in the affected portions of the channel. The staff considers this impact to be negligible in magnitude because of the very small area to be affected.

<u>Entrainment</u>

Phytoplankton, zooplankton, and ichthyoplankton drawn into the intake could experience 100% mortality as a result of passage through the cooling system.

The applicant has calculated that 1315 kg (2900 lb) of phytoplankton would be lost per day under worst-case conditions. Based on an assumed uniform distribution of zooplankton in the intake water and the most conservative case (highest ambient density of organisms), the staff expects a somewhat lower biomass of zooplankton to be entrained. Because of the high population densities of both phytoplankton and zooplankton that would remain in the lake, as well as their short generation times, the staff anticipates no adverse environmental impacts to the aquatic food chain from the loss of these organisms. A portion of the

dead organisms will be consumed by predators (mostly forage fish) after discharge. The remainder will decompose with an increase in biological oxygen demand (BOD); the applicant predicts a total increase in BOD of about 0.2 ppm in the vicinity of the discharge. The staff considers the consequences of this to be insignificant, particularly since the intake water from Lake Erie is essentially saturated with oxygen (ER-OL, Supplement 5, pp. A.4-82 to 84).

Entrainment of ichthyoplankton (fish eggs and larvae) into the intake flow will be directly proportional to the amount of lakewater used and to the concentration of organisms in it. The impact of the discharge plume entrainment will depend upon the volume of cooling water discharged, its temperature, and the numbers, kinds, and stages of ichthyoplankton present in the nearby area of the discharge plume. Based on the applicant's 1976 - 77 ichthyoplankton sampling study at the Fermi site (ER-OL, Supplement 4, pp. 2C-27 to 38 and 2C-76, Figure 1), 82% of the total fish larval catch was clupeids (gizzard shad and alewife), 5% was emerald shiner (another forage species), and 3% was white bass (a game fish). Logperch (forage fish) was found in low densities of about 5%, and the remaining 5% of the catch was composed of several larval species (for example, yellow perch <1%; walleye <1%; and so forth) (see ER-OL, Supplement 5, pp. A.4-64 through 80). Ichthyoplankton species that are more abundant inshore and that will be most susceptible to entrainment are clupeids, yellow-perch, white bass, emerald shiners, and freshwater drum. In addition to the predominance of forage species at Fermi, the period of peak ichthyoplankton abundance was limited to May through early July. Also, the most dense spawning of fish in the Western Basin of Lake Erie was a considerable distance away, ranging from 24 to 65 km (15 to 40 mi) near the Sister, Bass, Kelley, Catawba, and Pelee islands, close to Put In Bay and the southern beaches extending from the Maumee River to Put In Bay (ER-OL, p. 2C-38, Figure 2.1-2). The Fermi site area is not a unique fish spawning ground. Because of these factors and because of the use of cooling towers with comparatively low makeup water requirements (1.4 m^3/s or 22,500 gpm annual average, about 1/40th of the water required for once-through cooling of a similar-sized station) and the relatively low temperature of the cooling water discharged, the staff does not anticipate significant damage to the Lake Erie fish populations due to the ichthyoplankton losses resulting from the intake and/or discharge flows of the Fermi-2 station. Losses of entrained fish larvae during 1975 - 1977 at Fermi-1 were estimated to have been between 2 - 6 million per year.[14] Those losses were 1 to 3 orders of magnitude lower than at other nearby once-through-cooling power plants, probably because of a combination of lower water withdrawal requirements, site location, and intermittant operation of Fermi-1. A comparison of estimated ichthyoplankton entrainment losses at the closed-cycle-cooling Davis-Besse Nuclear Power Station on the western basin of Lake Erie, Ohio showed that losses at Davis-Besse were 1 to 2 orders of magnitude lower for fish larvae and 3 to 4 orders lower for fish eggs than at other nearby once-through-cooling power plants.[15] Similar low levels of entrainment losses during operation of Fermi-2 should not add measureably to the total entrainment impact to fishes resulting from the several power plants operating on western Lake Erie. Because of low makeup requirements, no entrainment impacts of importance to the phytoplankton or zooplankton populations are anticipated by the staff.

Impingement

Studies conducted at various power-plant intakes have shown that the magnitude of impingement is largely the result of the presence or absence of large populations of fish in the vicinity of the intake.[11,12,13] The location, siting,

design, and flow velocity of an intake and its associated structures influence the impingement rate. Intake structures, similar to that at Fermi-2, but located on Lake Michigan, impinge large numbers of fish (200,000 individuals and more annually[11]). The staff has examined the 316(b) demonstration for Fermi-1,[16] which contains information on impingement losses as a result of the operation of that plant from June 1974 to August 1975. With a net electrical output of only 161 MWe, and under conditions of intermittent operation, approximately 222,000 fish were impinged. However, that study was conducted for only 111 hours during 31 weeks of the 16-month period.[17] Reliable impingement loss estimation requires sampling at a much greater frequency. The loss estimate at Fermi-1, therefore, must have very wide confidence intervals. That study, however, provides some indication of the species (and relative proportions) likely to be impinged at Fermi-2. Gizzard shad (61%) and emerald shiner (24%) constituted the majority of impinged fishes. Economically important species impinged were yellow perch, 5.6%; walleye, <0.1%; crappies, 1.1%; sunfishes, 0.4%; white bass, 0.7%; catfishes, 0.3%; and carp, 0.5%. A similar species composition of impinged fishes is likely to occur at Fermi-2, with clupeids (especially juveniles) and shiners comprising the majority of the loss. Experience with other power plants in the western and central basins of Lake Erie has shown that gizzard shad and shiners often comprise between about 63 to 97% of the impingement losses. The closed-cycle-cooling design with low makeup water requirements will help to minimize losses and impacts, as is the case at the closed-cycle-cooling Davis-Besse Nuclear Power Station.[15]

The State of Michigan has approved the intake for Fermi-1 under Section 316(b) of the Clean Water Act* and is requiring monitoring (via the NPDES Permit) to determine the loss of fishes at the intake for Fermi-2.

4.4.2.2 Discharge Impacts

After the issuance of FES-CP for Fermi-2 (in July 1972), the applicant proposed to redesign and relocate the blowdown discharge structure from a submerged open pipe location approximately 152 m (500 ft) offshore in Lake Erie[18] to a shoreline surface facility utilizing an open discharge channel extending approximately 76.2 m (50 ft) into the lake.[19] In support of this proposed change, the applicant submitted results of his aquatic ecological studies for the period May - October 1976[20] and November 1976 - April 1977.[21]

Based upon a review of all available data and information, the staff found that the proposed shoreline discharge for the cooling tower blowdown as described in Supplements 3 and 4 to the ER-OL to be acceptable.** This conclusion is based upon the following:

(1) The juvenile/adult fish species composition at the Fermi site is similar to that of other nearby Lake Erie areas. The fish communities at 609.6 m (2000 ft) and 91.4 m (300 ft) offshore should not be substantially different,

*Personal communication with Robert Basch, State of Michigan Department of Natural Resources, March 2, 1981.

**Memorandum from R. B. Samworth, Aquatic Resources Section, Environmental Specialists Branch, DSE, to C. A. Haupt, Project Manager, Environmental Projects Branch 1, DSE, April 5, 1978

while the fish community structure could be different for the shore zone area and the 1189-m (3900-ft) area. The potential for impact upon fishes for either discharge alternative is judged to be low.

(2) The fish larval compositions probably do not differ substantially at either the 609.6-m (2000-ft) or the 1189-m (3900-ft) locations, while larvae of some species were more abundant at the 152-m (500-ft) location. Only the most inshore fish larval species would be potentially influenced to any degree by any of the discharge alternatives. Small plumes would result from both the offshore and the shoreline discharge alternatives and should have no measureable effect upon egg or larval populations in either the site area or the Western Basin of Lake Erie.

(3) Although the data on benthos at the site are few, the instability of the offshore area to a distance of at least 609.6 m (2000 ft) is suggested, and it seems reasonable to assume that the benthos at 1189 m (3900 ft) are not substantially different from those at 609.6 m (2000 ft) Neither the 152-m (500-ft) nor the 1189-m (3900-ft) alternative discharge location appears to offer substantial advantages over the other with respect to potential impacts on benthos. Although no data were collected at the immediate onshore discharge location (within 76.2 m (50 ft) of the shoreline), the area is naturally unstable with respect to benthos. Furthermore, the plume is predicted to be of small size, and the thermal effluent from the shoreline discharge should result in minimal and probably negligible impacts to benthic invertebrates in the area. It is also expected that considerably more benthos and habitat would be disrupted during the construction of an offshore discharge structure as compared to the shoreline alternative.

(4) The aquatic environment in the vicinity of the Fermi site is not unique from other areas of the western basin of Lake Erie.

The effluent is expected to be about 10°C (18°F) warmer than the Lake Erie intake water. The maximum extent of the 5.4°C (3°F) isotherm plume for all cases studied by the applicant was well within the 300-m (1000-ft) radius inferred by the Michigan Department of Natural Resources in Rule 1070 (ER-OL, Section 5.1, p. 5.1-4). Although some alteration of aquatic life (benthic defaunation and phytoplankton enrichment) as a result of the warmed water is inevitable, the staff concludes that the size of the thermal plume will be so small that, even under worst-case meteorological conditions, no meaningful adverse environmental impact to the local aquatic ecosystem is expected to occur. Because of the small size of the plume, plankton losses due to entrainment in the plume are considered by the staff to be generally negligible. Fish may be preferentially attracted to the thermal plume of the discharge, and some fish may become adapted to the warmed plume water. If the station's power is gradually reduced for nonemergency shutdown, these fish will readapt to ambient temperature. That is, under normal circumstances of gradual shutdown, mortality because of temperature reductions is expected to be negligible because warm blowdown from the reservoir will continue to flow into the lake during and after reactor shutdown, resulting in a gradual lowering of the differential temperature (ΔT) between the discharge and the ambient lake water. This will allow the fish in the thermal plume to acclimate; thus, no major losses are likely to occur (ER-OL, pp. A.4-58 through 63 and A.4-94). Should a sudden shutdown of the plant take place in winter or spring, when the differential temperature (ΔT) between the discharge and the cold lake water (see Section 4.3.1.1 and Tables 4.1 and 4.2)

ranges from 14 to 23°C (25° to 42°F), some fish entrained in the plume could be killed as a result of cold shock. In any event, because the number of fish likely to be entrained in the thermal plume will be very small in relation to the number of fish in the western basin of Lake Erie, no important adverse impact on the ecosystem due to cold shock losses is expected by the staff.

Fishes attracted to the plume, especially during spring and fall, could include recreational species such as white bass. A small fishery thus could occur seasonally in the Fermi plume area, if anglers have access to it either at the shoreline or by boat. The magnitude of such a fishery, however, will be limited and much smaller than those at other power plants using once-through cooling (such as Monroe and J. R. Whiting).

Chemical

Chemical discharges from the plant will include trace metals, TDS, and sulfate (see Section 3.2.4 and ER-OL, Section 3.3, pp. 3.3-3 through 3.3-5). If the proposed (temporary) manual dechlorination system does not work as planned, small amounts of chlorine residuals might also be released. The staff finds that potential impacts are mitigated by the discharge limitations contained in the NPDES permit (see ER-OL Appendix A, pp. A.4-97 through A.4-102). No chemical impacts of importance on the fish or other aquatic biota in Lake Erie are anticipated by the staff (ER-OL, pp. 5.4-1 through 5.4-33 and A.4-20 through A.4-26).[22,23]

Sulfate ion will be discharged to Lake Erie from the addition of sulfuric acid to the cooling water (see Section 3) and from the oxidation of sulfite if this ion should be added for the purpose of manual chemical dechlorination (see Sections 4.3.5 and 5.4.2.2). The proposed discharge concentrations would cause no impact because sulfate and sulfite ions are relatively nontoxic to aquatic biota.

If the use of sulfite for dechlorination is not carefully controlled, it could result in the discharge of water with reduced oxygen content, potentially impacting fish and other aquatic life in the vicinity of the outfall. The effect would likely be less than the effect of high chlorine concentration. The applicant has indicated that he plans to use a manual dechlorination system. In the event that such a system is used, the staff believes that the amount of dechlorinating agent added to the decant stream should be linked to the amount of chlorine actually present in the discharge rather than to the amount of chlorine initially added.

4.5 Radiological Impacts From Routine Operation

4.5.1 Exposure Pathways

The environmental pathways that were considered in preparing this section are shown in Figure 4.2. The specific pathways evaluated were

(1) direct radiation from the plant

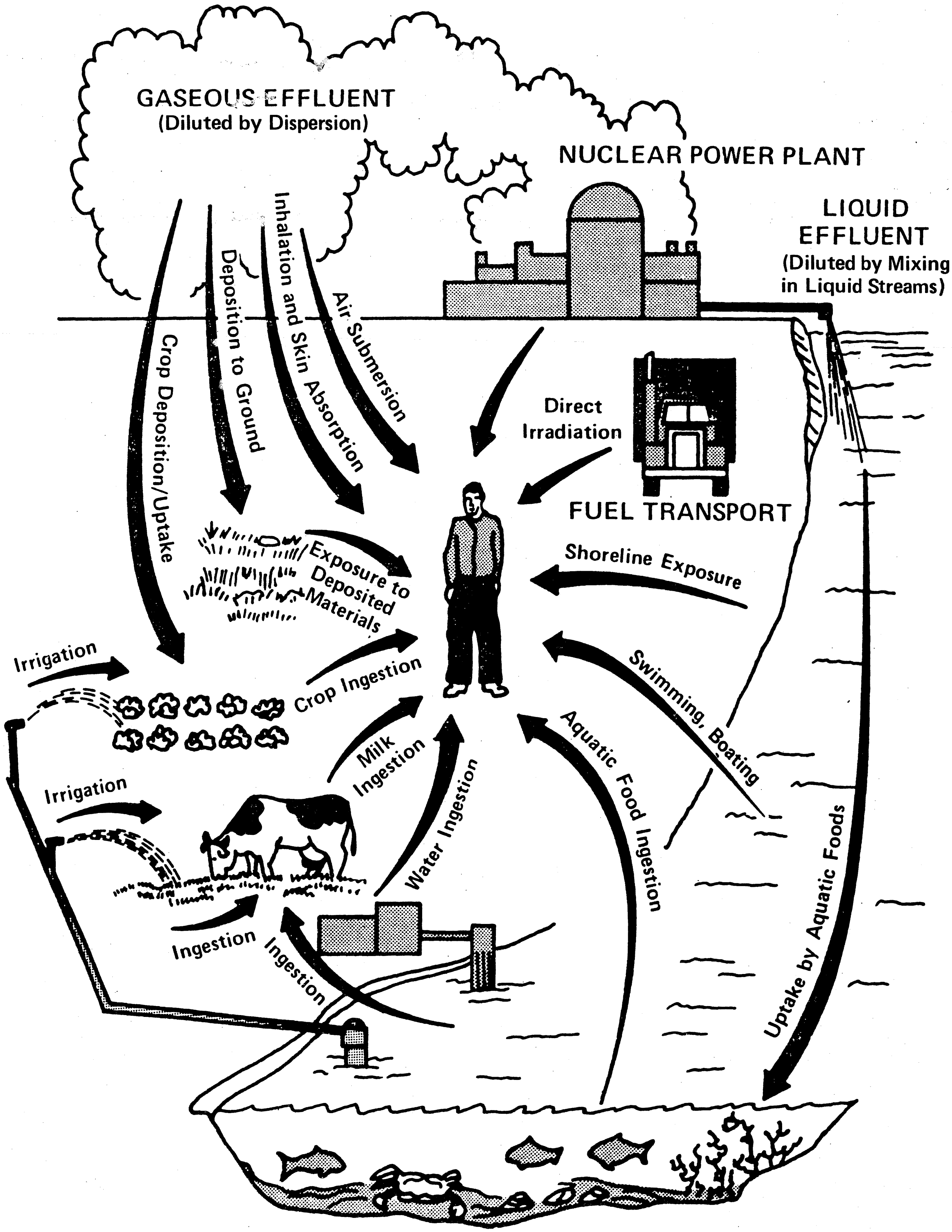

Figure 4.2 Exposure pathways to humans

(2) for gaseous effluents

- immersion in the gaseous plume
- inhalation of iodines and particulates
- ingestion of iodines and particulates through the milk cow, goat, meat animal, and vegetation pathways
- Radiation from iodines and particulates deposited on the ground

(3) for liquid effluents

- drinking water
- ingestion of fish and invertebrates
- shoreline activities, boating and swimming in water containing radioactive effluents

Only those pathways associated with gaseous effluents reported to exist at a single location were combined to calculate the total exposure to a maximally exposed individual. Pathways associated with liquid effluents were combined without regard to location and were assumed to be associated with a maximally exposed individual other than the individual exposed from gaseous effluent pathways.

The models and considerations for environmental pathways leading to estimates of radiation doses to individuals near the plant and to the population within an 80-km (50-mi) radius of the plant resulting from plant operations are discussed in detail in Regulatory Guide 1.109. Use of these models with additional assumptions for environmental pathways leading to exposure to populations outside the 80-km radius are described in Appendix B of this statement.

4.5.2 Dose Commitments

The quantities of radioactive material that may be released annually from the plant are estimated based on the description of the radwaste systems given in the applicant's environmental report and FSAR and using the calculational model and parameters described in NUREG-0016, Revision 1 ("Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Boiling Water Reactors"). The applicant's site and environmental data provided in the environmental report and in subsequent answers to NRC staff questions were used extensively in the dose calculations. Using these quantities of radioactive materials released and exposure pathway information, the dose commitments to individuals and the population were estimated. Population doses were based on the projected population distribution for the year 2000.

The dose commitments in this statement represent the total dose received over a period of 50 years following the intake of radioactivity for one year under the conditions existing 15 years after the station is started up. For the younger age groups, changes in organ mass with age after the initial intake of radioactivity are accounted for in a stepwise manner.

In the analysis of all effluent radionuclides released from the plant, tritium, carbon-14, cesium, cobalt, krypton, and xenon inhaled with air and ingested with food and water were found to account for essentially all total-body dose commitments to individuals and the population within 80 km of the plant.

Dose Commitments from Radioactive Releases to the Atmosphere

Radioactive effluents released to the atmosphere from the Fermi-2 facility will result in small radiation doses to individuals and populations. NRC staff estimates of the expected gaseous and particulate releases listed in Table 4.3, and the site meteorological data discussed in Section 5.2.1 of this statement and summarized in Table 4.4 were used to estimate radiation doses to individuals and populations. A discussion of the results of the calculations follows.

(1) Radiation Dose Commitments to Individuals

Individual nearest pathway locations used for the "maximally exposed"* individual are listed in Table 4.5. The estimated dose commitments to the maximally exposed individual from radioiodine and particulate releases at selected offsite locations are listed in Tables 4.6, 4.7, and 4.8. The individual exposed to maximum doses is assumed to consume well above average quantities of the foods considered (see Table E-5 in Regulatory Guide 1.109).

The maximum annual beta and gamma air dose and the maximum total-body and skin dose to an individual, at the site boundary, are presented in Tables 4.6, 4.7, and 4.8.

(2) Radiation Dose Commitments to Populations

Annual radiation dose commitments from airborne radioactive releases from Fermi-2 are estimated for two populations in the year 2000: (1) the population within 80 km of the station (Table 4.7) and (2) the entire U.S. population (Table 4.9). Dose commitments beyond 80 km are based on the assumptions discussed in Appendix B. For perspective, annual background radiation doses are given for both populations. The calculated total body dose to the population within 80 km of the site from airborne radioactive releases from Fermi-2 (about 14 person-rems) is a small fraction (less than 0.002%) of the corresponding dose to the population from natural background radiation (about 880,000 person-rems). The total-body population dose to the entire U.S. population from airborne radioactive releases from Fermi-2 (about 36 person-rems) is an even smaller fraction (less than 0.0002%) of the corresponding dose to the U.S. population from natural background radiation (about 27 million person-rems).

Dose Commitments from Radioactive Liquid Releases to the Hydrosphere

Radioactive effluents released to the hydrosphere from the Fermi-2 facility during normal operation will result in small radiation doses to individuals and populations. NRC staff estimates of the expected liquid releases listed

*Maximally exposed refers to that individual who would be expected to receive the highest radiation dose from all appropriate pathways

Table 4.3 Calculated releases of radioactive materials in gaseous effluents from Fermi-2 (Ci/yr)

Nuclides	Reactor Building (Periodic)[a]	Reactor Building (Continuous)	Turbine Building (Continuous)	Radwaste Building (Continuous)	Total
Ar-41	b	25	b	b	25
Kr-83m	b	51	b	b	51
Kr-85m	b	95	68	b	160
Kr-85	b	280	b	b	280
Kr-87	b	320	130	b	450
Kr-88	b	320	230	b	550
Kr-89	b	1,300	b	b	1,300
Xe-131m	b	7	b	b	7
Xe-133m	b	4	b	b	4
Xe-133	2,300	310	250	10	2,900
Xe-135m	b	130	650	b	780
Xe-135	350	410	630	45	1,400
Xe-137	b	1,500	b	b	1,500
Xe-138	b	1,200	1,400	b	2,600
Total Noble Gases					12,000
Cr-51	c	6×10^{-4}	1.3×10^{-2}	c	1.4×10^{-2}
Mn-54	c	6×10^{-3}	6×10^{-4}	3×10^{-4}	6.9×10^{-3}
Fe-59	c	8×10^{-4}	5×10^{-4}	1.5×10^{-4}	1.5×10^{-3}
Co-58	c	1.2×10^{-3}	6×10^{-4}	4.5×10^{-5}	1.9×10^{-3}
Co-60	c	2×10^{-2}	2×10^{-3}	9×10^{-4}	2.3×10^{-2}
Zn-65	c	4×10^{-3}	2×10^{-4}	c	4.2×10^{-3}
Sr-89	c	1.8×10^{-4}	6×10^{-3}	c	6.2×10^{-3}
Sr-90	c	1×10^{-5}	2×10^{-5}	3×10^{-6}	3.3×10^{-5}
Zr-95	c	8×10^{-4}	1×10^{-4}	c	9×10^{-4}
Sb-124	c	4×10^{-4}	3×10^{-4}	c	7×10^{-4}
Cs-134	c	8×10^{-3}	3×10^{-4}	c	8.3×10^{-3}
Cs-136	c	6×10^{-4}	6×10^{-5}	c	6.6×10^{-4}
Cs-137	c	1.1×10^{-2}	6×10^{-4}	c	1.2×10^{-2}
Ba-140	c	8×10^{-4}	1.1×10^{-2}	c	1.2×10^{-2}
Ce-141	c	2×10^{-4}	6×10^{-4}	2.6×10^{-5}	8.3×10^{-4}
Total Particulates					9.3×10^{-2}
C-14	b	9.5	b	b	9.5
H-3	-	74.0	-	-	74.0
I-131	3×10^{-2}	4×10^{-2}	1.9×10^{-1}	5×10^{-2}	6.7×10^{-1}
I-133	b	1.6	7.6×10^{-1}	1.8×10^{-1}	2.6

[a]Periodic release, 4 times/yr, of 24-hour duration each.

[b]Less than 1.0 Ci/yr for noble gases and carbon-14; less than 10^{-4} Ci/yr for iodine.

[c]Less than 1% of total nuclide.

Table 4.4 Summary of atmospheric dispersion factors and deposition values for maximum site boundary and receptor locations near Fermi-2[a]

Location	Source[b]	χ/Q (s/m^3)	Relative Deposition (m^{-2})
Nearest[c] site land boundary (0.92 km NW)[d]	A	4.4×10^{-6}	3.7×10^{-8}
	B	2.3×10^{-6}	2.6×10^{-8}
	C	4.3×10^{-6}	5.7×10^{-8}
	D	1.1×10^{-6}	1.4×10^{-8}
Nearest milk animal (3.2 km NW)[d]	A	3.3×10^{-7}	2.1×10^{-9}
	B	2.1×10^{-7}	1.7×10^{-9}
	C	5.8×10^{-7}	6.4×10^{-9}
	D	1.0×10^{-7}	1.1×10^{-9}

[a]These factors are corrected for radioactive decay and cloud depletion from deposition, where appropriate, in accordance with Regulatory Guide 1.111, Rev. 1, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Reactors," July 1977. The Gaussian model of this Guide has been modified to consider air recirculation over the site that results from the periodic changing of airflow direction.

[b]Source A is turbine building, continuous release; source B is radwaste building, continuous release; source C is reactor building, periodic release; and source D is reactor building, continuous release.

[c]"Nearest" refers to that type of location where the highest radiation dose is expected to occur from all appropriate pathways.

[d]To convert mi to km, multiply by 1.6093.

Table 4.5 Nearest pathway locations used for dose commitments for the maximally exposed individual

		Distance	
	Sector	km	mi
Site boundary[a]	NW	0.92	0.57
Residence[b]	NNW	1.13	0.7
Garden	WNW	1.13	0.7
Milk cow	NW	4.8	3.0
Milk goat	NNW	3.2	2.0
Meat animal	N	2.6	1.6

[a]Beta and gamma air doses, total body, and skin doses from noble gases are determined at site boundaries.

[b]Dose pathways including inhalation of atmospheric radioactivity, exposure to deposited radionuclides, and submersion in gaseous radioactivity are evaluated at residences.

Table 4.6 Annual dose commitments to a maximally exposed individual near Fermi-2

Location	Pathway	Annual Dose Commitment			
		Noble Gases in Gaseous Effluents[a]			
		Total Body, mrem	Skin, mrem	Gamma Air Dose, mrad	Beta Air Dose, mrad
Nearest[b] site boundary (0.92 km NW)[c]	Direct radiation from plume	2.7	5.9	4.1	3.3
		Iodine and Particulates in Gaseous Effluents[a]			
		Total Body, mrem		Thyroid, mrem	
Nearest[d] milk goat (3.2 km NNW)[c]	Ground deposit	0.03		0.03	
	Inhalation[e]	<0.001		0.10	
	Vegetation[e]	-		-	
	Milk[e]	0.04		6.9	
	Meat[e]	-		-	
		Liquid Effluents			
		Total Body, mrem	Thyroid, mrem	Bone, mrem	
Nearest drinking water at Monroe	Water ingestion	0.04	0.28	0.02	
Nearest fish at plant discharge area	Fish ingestion	1.6	0.10	2.6	

[a]The doses for gaseous effluents presented in this table and Tables 4.7 and 4.8 are corrected for radioactive decay and cloud depletion from deposition, where appropriate, in accordance with Regulatory Guide 1.111, Rev. 1, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light Water Reactors," July 1977.

[b]"Nearest" refers to that site boundary location where the highest radiation doses due to gaseous effluents have been estimated to occur.

[c]To convert km to mi, divide by 1.6.

[d]"Nearest" refers to the location where the highest radiation dose to an individual from all applicable pathways has been estimated.

[e]To an infant; assumes infant does not consume vegetables or meat.

Table 4.7 Calculated Appendix I dose commitments to a maximally exposed individual and the population from operation of Fermi-2

	Annual Doses	
	Individual	
	Appendix I Design Objectives[a]	Calculated Doses[b]
Liquid effluents		
Dose to total body from all pathways	3 mrem	1.6 mrem
Dose to any organ from all pathways	10 mrem	2.7 mrem
Noble gas effluents (at site boundary)		
Gamma dose in air	10 mrad	4.1 mrad
Beta dose in air	20 mrad	3.3 mrad
Dose to total body of an individual	5 mrem	2.7 mrem
Dose to skin of an individual	15 mrem	5.9 mrem
Radioiodines and particulates[c]		
Dose to any organ from all pathways	15 mrem	7.0 mrem
	Population Within 80 km (50 mi)	
	Total Body (person-rem)	Thyroid (person-rem)
Natural radiation background[d]	5.9×10^5	
Liquid effluents	9.9	9.8
Noble gas effluents	11	11
Radioiodines and particulates	3	31

[a]Design objectives from Sections II.A, II.B, II.C, and II.D of Appendix I, 10 CFR Part 50, consider doses to a maximally exposed individual and population per reactor unit.

[b]See footnote a/ of Table 4.6.

[c]Carbon-14 and tritium have been added to this category.

[d]"Natural Radiation Exposure in the United States," U.S. Environmental Protection Agency, ORP-SID-72-1, June 1972; using the average Michigan State background dose (107 mrem/yr) and year 2000 projected population of 5,480,000.

Table 4.8 Calculated RM-50-2 dose commitments to a maximally exposed individual from operation of Fermi-2

	Annual Dose per Site	
	RM-50-2 Design Objectives[a]	Calculated Doses[b]
Liquid effluents		
Dose to total body or any organ from all pathways	5 mrem	2.7 mrem
Activity release estimate, excluding tritium	5 Ci	0.27 Ci
Noble gas effluents (at site boundary)		
Gamma dose in air	10 mrad	4.1 mrad
Beta dose in air	20 mrad	3.3 mrad
Dose to total body of an individual	5 mrem	2.7 mrem
Dose to skin of an individual	15 mrem	5.9 mrem
Radioiodine and particulates[c]		
Dose to any organ from all pathways	15 mrem	7.0 mrem
I-131 activity release	1 Ci	0.67 Ci

[a]Annex to Appendix I to 10 CFR Part 50

[b]See footnote a/ of Table 4.6.

[c]Carbon-14 and tritium have been added to this category.

Table 4.9 Annual total body population dose commitments in the year 2000

Category	U.S. Population Dose Commitment, person-rem/yr
Natural background radiation	27,000,000[a]
Fermi-2 nuclear plant operation	
Plant workers	1,600[b]
General public:	
Radioiodine and particulates	24
Liquid effluents	24
Noble gas effluents	12
Transportation of fuel and waste	7

[a]Using the average U.S. background dose (100 mrem/yr) and year 2000 projected U.S. population from "Population Estimates and Projections," Series II, U.S. Dept. of Commerce, Bureau of the Census, Series P-25, No. 541, February 1975. See also footnote a/ of Table 4.6.

[b]Particular plants have experienced average lifetime annual doses as high as 1600 person-rems.[25] The average reactor annual dose is 650 person-rems.

in Table 4.10 and the site hydrological considerations discussed in Section 2.3 of this statement and summarized in Table 4.11 were used to estimate radiation dose commitments to individuals and populations. A discussion of the results of the calculations follows.

(1) Radiation Dose Commitments to Individuals

The estimated dose commitments to the maximally exposed individual from liquid releases at selected offsite locations are listed in Tables 4.7, 4.8, and 4.9. The maximally exposed individual is assumed to consume well above average quantities of the foods considered and spend more time at the shoreline than the average person (see Table E-5 in Regulatory Guide 1.109).

(2) Radiation Dose Commitments to Populations

Annual radiation dose commitment from liquid radioactive releases from Fermi-2 are estimated for two populations in the year 2000: (1) the population within 80 km of the station (Table 4.7) and (2) the entire U.S. population (Table 4.9). Dose commitments beyond 80 km are based on the assumptions discussed in Appendix B. For perspective, annual background radiation doses are given for both populations. The calculated total body dose to the population within 80 km of the site from liquid radioactive releases from Fermi-2 (about 10 person-rem) is a small fraction (less than 0.002%) of the corresponding dose to the population from natural background radiation (about 880,000 person-rem). The calculated total body population dose to the entire U.S. population from liquid radioactive releases from Fermi-2 (about 24 person-rem) is an even smaller fraction (less than 0.0001%) of the corresponding U.S. population dose from natural background radiation (about 27 million person-rem).

<u>Direct Radiation</u>

(1) Radiation from the Facility

Radiation fields are produced in nuclear plant environs as a result of radioactivity contained within the reactor and its associated components. The applicant has calculated a direct radiation dose of 32 mrem/yr at a site boundary located 1.1 km WNW of the plant.

Direct radiation doses from sources within the plant are primarily due to nitrogen-16, a radionuclide produced in the reactor core. In boiling-water reactors (BWRs), nitrogen-16 is transported with the primary coolant to the turbine building. The orientation of piping and turbine components in the turbine building determines, in part, the exposure rates outside the plant. Because of variations in equipment layout, exposure rates are strongly dependent upon overall plant design.

Based on radiation surveys that have been performed around several operating BWRs, it appears to be very difficult to develop a reasonable model to predict direct shine doses.

Table 4.10 Calculated releases of radioactive materials in liquid effluents from Fermi-2

Nuclide	Ci/Yr	Nuclide	Ci/Yr
	Corrosion and Activation Products		
Na-24	1.1×10^{-2} [a]	Ni-65	7×10^{-5}
P-32	3.5×10^{-4}	Cu-64	3.3×10^{-2}
Cr-51	8.9×10^{-3}	Zn-65	3.6×10^{-4}
Mn-54	1.1×10^{-3}	Zn-69m	2.3×10^{-3}
Mn-56	1.2×10^{-2}	Zn-69	2.4×10^{-3}
Fe-55	1.8×10^{-3}	Zr-95	1.4×10^{-3}
Fe-59	5×10^{-5}	Nb-95	2×10^{-3}
Co-58	4.4×10^{-3}	W-187	4.1×10^{-4}
Co-60	9.4×10^{-3}	Np-239	1.1×10^{-2}
	Fission Products		
Br-83	8.3×10^{-4}	Te-131	3×10^{-5}
Br-84	2×10^{-5}	I-131	1.3×10^{-2}
Sr-89	1.8×10^{-4}	Te-132	2×10^{-5}
Sr-90	1×10^{-5}	I-132	7.7×10^{-3}
Sr-91	3.7×10^{-3}	I-133	3.7×10^{-2}
Y-91m	2.4×10^{-3}	I-134	2×10^{-3}
Y-91	9×10^{-5}	Cs-134	1.4×10^{-2}
Sr-92	2.5×10^{-3}	I-135	2×10^{-2}
Y-92	5.7×10^{-3}	Cs-136	3.5×10^{-4}
Y-93	3.9×10^{-3}	Cs-137	2.5×10^{-2}
Zr-95	1×10^{-5}	Ba-137m	1.2×10^{-3}
Nb-95	1×10^{-5}	Cs-138	4.1×10^{-4}
Nb-98	8×10^{-5}	Ba-139	7.2×10^{-4}
Mo-99	3.3×10^{-3}	Ba-140	7.1×10^{-4}
Tc-99m	1.5×10^{-2}	La-140	1×10^{-4}
Ru-103	1.8×10^{-4}	La-141	2.9×10^{-4}
Rh-103m	4×10^{-5}	Ce-141	6×10^{-5}
Tc-104	2×10^{-5}	La-142	5.2×10^{-4}
Ru-105	9.8×10^{-4}	Ce-143	4×10^{-5}
Rh-105m	9.8×10^{-4}	Pr-143	7×10^{-5}
Rh-105	2.4×10^{-4}	Ce-144	5.2×10^{-3}
Ru-106	2.4×10^{-3}	All others[a]	5×10^{-5}
Ag-110m	4.4×10^{-4}		
Te-129m	7×10^{-5}		
Te-129	5×10^{-5}		
Te-131m	1.4×10^{-4}		
		Total (except H-3)	2.7×10^{-1}
		H-3	11

[a]Nuclides with release rates of less than 10^{-5} Ci/yr are not listed individually but are included in the category "all others."

Table 4.11 Summary of hydrologic transport and dispersion for liquid releases from Fermi-2[a]

Location	Transit Time (hr)	Dilution Factor
Nearest drinking water intake (Monroe, 2 mi S)[b]	1.0	5
Nearest sport fishing location (plant discharge area)[c]	0.1	5
Nearest shoreline (site boundary)	0.1	1

[a]See Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing, Appendix I," April 1977.

[b]To convert mi to km, multiply by 1.6.

[c]Assumed for purposes of an upper limit estimate, detailed information not available.

For newer BWR plants with a standardized design, dose rates have been estimated using sophisticated Monte Carlo techniques. The turbine island design proposed in the Final Safety Analysis Report for the Braun Plant[24] is estimated to have direct radiation and skyshine dose rates on the order of 20 mrem/yr per unit at a typical site boundary distance of 0.6 km (0.4 mi) from the turbine building. This dose rate is assumed to be typical of the new generation of BWRs. The integrated population dose from such a facility would be less than one person-rem/yr per unit.

Low-level radioactivity storage containers outside the plant are estimated to contribute less than 0.01 mrem/yr at the site boundary.

(2) Occupational Radiation Exposure

The dose to nuclear plant workers varies from reactor to reactor and can be projected for environmental impact purposes by using the experience to date with modern BWRs. Most of the dose to nuclear plant workers is due to external exposure to radiation from radioactive materials outside of the body rather than from internal exposure from inhaled or ingested radioactive materials. Recently licensed 1000-MWe BWRs are designed and operated in a manner consistent with the new (post-1975) regulatory requirements and guidance. These new requirements and guidance place increased emphasis on maintaining occupational exposure at nuclear power plants as low as is reasonably achievable (ALARA), and are outlined in 10 CFR Part 20, Standard Review Plan Chapter 12, and Regulatory Guide 8.8. The applicant's proposed implementation of these requirements and guidelines are reviewed by the NRC staff at the construction-permit licensing stage, at the operating-license licensing stage, and during actual operation. Approval is granted only after the review indicates that an ALARA program can be implemented.

Based on actual operating experience, it has been observed that occupational dose has varied considerably from plant to plant and from year to year. Average individual and collective dose information is available from more than 125 reactor years of operation between 1974 and 1979. (The dose data for years prior to 1974 is primarily from reactors with average rated capacities below 500 MWe.) These data indicate that the average reactor annual dose at BWRs has been about 650 person-rems, with particular plants experiencing an average lifetime annual dose as high as 1600 person-rems.[25] These dose averages are based on widely varying yearly doses at BWRs. For example, annual collective doses for BWRs have ranged from 44 to 3142 person-rems per reactor; the average annual dose per nuclear plant worker has been about 0.8 rem.[25]

The wide range of annual doses (44 to 3142 person-rems) experienced by U.S. BWRs is dependent on a number of factors, such as the amount of required routine and special maintenance and the degree of reactor operations and inplant surveillance. Because these factors can vary in an unpredictable manner, it is impossible to determine in advance a specific year-to-year or average annual occupational radiation dose for a particular plant over its operating lifetime. The need for high doses can occur, even at plants with radiation protection programs that have been developed to ensure that occupational radiation doses will be kept at levels that are ALARA. Consequently, the staff occupational dose estimates for environmental impact purposes for Fermi-2 are based on the conservative assumption that the Fermi-2 plant may have a higher-than-average level of special maintenance work. Based on the staff's review of the applicant's Safety Analysis Report as well as occupational dose data from more than 125 BWR reactor operating years, the NRC staff projects that the occupational doses at the Fermi-2 site could average as much as 1600 person-rems/yr per unit when averaged over the life of the plant. However, actual year-to-year doses at Fermi-2 may differ greatly from this average, depending on actual plant operating conditions.

The risk of various occupations, including nuclear plant workers, are given in Table 4.12 below.[26] Based on the comparisons in this table, the staff

Table 4.12 Incidence of job-related fatalities

Occupational group	Fatality incidence rates (premature deaths/10^5 person-year)
Underground metal miners	1275
Uranium miners	422
Smelter workers	194
Mining	61
Agriculture, forestry, and fisheries	35
Contract construction	33
Transportation and public utilities	24
Nuclear plant worker	23
Manufacturing	7
Wholesale and retail trade	6
Finance, insurance, and real estate	3
Services	3
Total private sector	10

concludes that the risk to nuclear plant workers from plant operation is comparable to the risks associated with other occupations.

(3) Transportation of Radioactive Material

The transportation of cold fuel to a reactor, of irradiated fuel from the reactor to a fuel reprocessing plant, and of solid radioactive waste from the reactor to burial grounds is within the scope of the NRC report entitled "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants" (see Table 4.13). The estimated population dose commitments associated with transportation of fuels and wastes are listed in Tables 4.9 and 4.13.

4.5.3 Radiological Impact on Humans

The actual radiological impact associated with the operation of the proposed Fermi-2 nuclear power station will depend, in part, on the manner in which the radioactive waste treatment system is operated. Based on the staff evaluation of the potential performance of the radwaste system, it is concluded that the system, as proposed, is capable of meeting the dose design objectives of 10 CFR Part 50, Appendix I, and those of RM-50-2,* contained in the annex to Appendix I.

The applicant chose to show compliance with the design objectives of RM-50-2 as an optional method of demonstrating compliance with the cost-benefit section of Appendix I, Section II.D. Table 4.8 compares the calculated maximum individual doses to the dose design objectives. However, because the facility's operation will be governed by operating license Technical Specifications and because the Technical Specifications will be based on the dose design objectives of 10 CFR Part 50, Appendix I (as shown in the first column of Table 4.8), the actual radiological impact of plant operation may result in doses close to the dose design objectives. Even if this situation exists, the individual doses will still be very small compared to natural background doses (~ 100 mrem/yr) or of the dose limits specified in 10 CFR Part 20. As a result, the staff concluded that there will be no measurable radiological impact on humans from routine operation of the plant.

Effective December 1, 1979, the licensee will also be regulated according to the Environmental Protection Agency's 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations," which specifies that the annual dose equivalent cannot exceed 25 mrems to the whole body, 75 mrems to the thyroid, and 25 mrems to any other organ of any member of the public as the result of exposure to planned discharges of radioactive materials, radon and its daughters excepted, to the general environment from uranium fuel-cycle operations and radiation from these operations.

*"Concluding Statement of Position of the Regulatory Staff," Docket No. RM-50-2, February 20, 1974.

Table 4.13 Environmental impact of transportation of fuel and waste to and from one light-water-cooled nuclear power reactor

	Normal Conditions of Transport		
Heat (per irradiated fuel cask in transit)			260 MJ/hr
Weight (governed by Federal or State restrictions)			33,000 kg per truck; 90,000 kg per cask per rail car
Traffic density:			
Truck			< 1 per day
Rail			< 3 per month

Exposed Population	Estimated Number of Persons Exposed	Range of Doses to Exposed Individuals[a] (mrem per reactor year)	Cumulative Dose to Exposed Population (person-rem per reactor year)[b]
Transportation workers	200	0.01 to 300	4
General Public			
Onlookers	1,100	0.003 to 1.3	
Along route	600,000	0.0001 to 0.06	3
	Accidents in Transport		
Radiological effects		Small[c]	
Common (nonradiological) causes		1 fatal injury in 100 reactor years 1 nonfatal injury in 10 reactor years $475 property damage per reactor year	

[a]The Federal Radiation Council has recommended that the radiation doses from all sources of radiation other than natural background and medical exposures be limited to 5000 mrem/yr for individuals as a result of occupational exposure and to 500 mrem/yr for individuals in the general population. The dose to individuals due to average natural background radiation is about 130 mrem/yr.

[b]Person-rem is an expression for the summation of whole body doses to individuals in a group. Thus, if each member of a population group of 1000 people were to receive a dose of 0.001 rem (1 mrem), or if 2 people were to receive a dose of 0.5 rem (500 mrem) each, the total cumulative dose in each case would be 1 person-rem.

[c]Although the environmental risk of radiological effects stemming from transportation accidents cannot currently be numerically quantified, the risk remains small regardless of whether it is being applied to a single reactor or a multireactor site.

Source: Data supporting this table are given in the NRC's "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," WASH-1238, December 1972, and Supplement I, NUREG-75/038, April 1975. The number 130 mrem/yr in note (a) to this table is not in current use. About 100 mrem/yr is currently used for average background radiation in the U.S.

4.5.4 Radiological Impacts on Biota Other Than Humans

Depending on the pathway and radiation source, terrestrial and aquatic biota will receive doses approximately the same or somewhat higher than humans receive. Although guidelines have not been established for acceptable limits for radiation exposure to these species, it is generally agreed that the limits established for humans are also conservative for other species. Experience has shown that it is the maintenance of population stability that is crucial to the survival of a species, and species in most ecosystems suffer rather high mortality rates from natural causes. While the existence of extremely radiosensitive biota is possible, and while increased radiosensitivity in organisms may result from environmental interactions with other stresses (for example, heat, biocides, and so forth), no biota have yet been discovered that show a sensitivity (in terms of increased morbidity or mortality) to radiation exposures as low as those expected in the area surrounding Fermi-2. Furthermore, there have been no cases of exposures that can be considered significant in terms of harm to the species or that approach the exposure limits to members of the public permitted by 10 CFR Part 20 in any of the plants where an analysis of radiation exposure to biota other than humans has been made.[27] Because the BEIR Report[28] concluded that the evidence to date indicates that other living organisms are not much more radiosensitive than humans, no measurable radiological impact on populations of biota is expected as a result of the routine operation of this plant.

4.5.5 Environmental Effects of the Uranium Fuel Cycle

The staff evaluation of the environmental impacts of the uranium fuel cycle is given in Appendix C to this statement. The relevance of these environmental effects to this operating license decision is discussed in Section 9.7.

4.6 Noise

The major sources of operational noise will be the two natural-draft cooling towers. Estimates of their cumulative sound levels at four points along the site boundary have been made by the applicant (letter from Evelyn Madsen, Detroit Edison Co., to R. Zussman, Argonne National Laboratory, September 19, 1979). These levels range from 44 to 55 L_{dn}* d(B)A. According to information adapted from U.S.EPA figures, these noise levels will not interfere with public health and welfare. The closest residence is near the southern boundary of the site where the noise levels are at the low end of the range.

Another possible source of noise would be the testing of the early notification system to be installed as a part of the emergency preparedness plan.

4.7 Socioeconomic Impacts

The socieconomic impacts of operation are discussed in Section V.A. of the FES-CP. The analysis below contains updated information on the socioeconomic impacts to be expected during the operating phase.

With the exception of tax payments to Monroe County, Frenchtown Township, and the local school district, socioeconomic effects are expected to be minimal. The applicant has estimated that local property taxes paid to the above jurisdictions will correspond to $23.0 million per year over the expected 40-yr life

*L_{dn} = day-night level.

of the plant, or over $200 million present worth to the initial year of operation. The additional tax benefits to the county, township, and school district will enable these jurisdictions to finance improvements in public services and capital infrastructure, or to lower tax rates on property, or some combination of both. The use of tax beneifts by recipient jurisdictions is subject to prevailing political values and the political process; as such, the application of local tax benefits cannot be predicted with any level of confidence.

Since 1978, the construction force at the Fermi-2 has been declining, as the number of people preparing to operate the facility has been rising. This trend will continue until 1982 when construction will be completed. The applicant estimates that approximately 260 employees (of whom 150 are currently employed at the plant site) will be required to operate Fermi-2 (Table 4.14). Of the remaining 108 employees the applicant estimated that approximately 75 would live in Monroe County.* The applicant's experience with operating work forces also indicates that the majority of operating workers not living in Monroe County will move to or stay in the Wayne County towns of Southgate, Trenton, Woodhaven,

Table 4.14 Fermi-2 onsite employment

Job Category	1981	1982	1983	1984
Supervisory staff	7	8	8	8
Engineers	40	39	39	39
Supervisors	29	30	31	31
Technicians	31	47	48	48
Operators (licensed)	38	38	38	38
Operators (nonlicensed)	24	24	24	24
Skilled maintenance	38	52	56	60
Janitors/Laborers	3	10	10	10
Subtotals	210	248	254	258
Contractors	75	85	50	25
Nuclear Operations Center Employees	-	-	197	197
Totals	285	333	501	480

Source: ER-OL

*An additional 175 employees are expected to work at the Nuclear Operations Center. The applicant has not estimated where these workers live. If all 175 employees decide to live in Monroe County, they and the 75 operating worker households would represent only 0.6% of the 1980 estimated household population living in the county.

Grosse Ile, Rockwood, and Flatrock. Because of the relatively small number of operating workers required to operate Fermi-2 and their dispersed settlement pattern, the staff expects that housing, community infrastructure, and traffic impacts will be minimal.

Indirect benefits to the local economy will arise from the payroll at Fermi-2 and possibly the purchase of materials and supplies. Income spent by operating workers residing in Monroe and by nonresidents will provide a benefit to local businessmen involved in selling commodities and services. However, because of the small number of operating worker households--[illegible]5 versus an estimated 45,000 resident households--the staff concludes that the local benefit would be small and probably would not measurably contribute to increased local employment or the expansion of local businesses. The applicant has not indicated what the pattern of purchases of materials and supplies will be: local, low-cost suppliers or central purchase of supplies. However, based on experience with other nuclear plants, the staff expects that if purchases of materials and supplies other than fuel and mechanical parts were made locally, they would be a small percentage of the Fermi-2 operating budget and would have a minimal impact on the regional economy.

4.8 References

Documents marked with an asterisk (*) are available from the NRC/GPO Sales Program, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, and the National Technical Information Service (NTIS), Springfield, VA 22161. Documents marked with two asterisks (**) are available for inspection and copying for a fee in the NRC Public Document Room, 1717 H Street NW., Washington, D.C. 20555. Except as specifically noted, all other documents can be found in public technical libraries.

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18. U.S. Atomic Energy Commission, "Final Environmental Statement Related to Operation of Enrico Fermi Atomic Power Plant Unit 2. Docket No. 50-341," USAEC Directorate of Licensing, July 1972.**

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5 ENVIRONMENTAL MONITORING

5.1 Résumé

A survey of the background levels of various chemical, radiological, thermal, and biological parameters for the Fermi site (including Unit 1) and the adjacent areas of Lake Erie was initiated in 1958. Since that time, various studies have ceased or been modified by the applicant to reflect program objectives. Certain aspects of the preoperational aquatic monitoring program were modified or deleted by the applicant.

In 1976, the applicant committed to conduct a preoperational aquatic monitoring program at Fermi-2. This commitment was consistent with condition 7b of the FES-CP. The staff reviewed this program and found it acceptable, provided certain modifications were made. However, in February 1979, the applicant indicated he would not conduct such a program. The decision was based upon two principal factors: (1) the applicant's interpretation of the Yellow Creek Decision* and (2) the fact that the NPDES permits issued for Fermi-2 do not require such a program. The staff has discussed aquatic monitoring at Fermi extensively with the Michigan Department of Natural Resources, and staff recommendations were presented to the State. The NPDES Permit process and the 401 certification specify monitoring programs for assuring protection of the aquatic environment. The State has approved the applicant's operational entrainment and impingement study which will be initiated at plant startup and continued for one year.

5.2 Preoperational Monitoring Programs

5.2.1 Meteorological Monitoring

The onsite meteorological program was initiated in November 1973. A 60-m (200-ft) tower was constructed and located 730 m (2400 ft) southwest of the Fermi-2 reactor building. Instrumentation measured wind speed, wind direction, and temperature at 10-m and 60-m (30-ft and 200-ft) levels. Dew point was measured at the 10-m (30-ft) level and precipitation at ground level. Diffusion estimates were calculated using the data acquired from the 60-m (200-ft) tower for the period from June 1, 1974 to May 31, 1975. The data obtained from this tower were checked for representation of site meteorological conditions by reinstrumenting a 150-m (490-ft) tower located 730 m (2400 ft) south of Fermi-2 with identical instrumentation at the 10-m and 60-m levels and comparing results from June 1, 1974 to May 31, 1975. The comparison was favorable. The instrumentation on both towers meets the position in Regulatory Guide 1.23.

*Tennessee Valley Authority, Yellow Creek Nuclear Plant, Units 1 and 2, Docket Nos. 50-566/567. Decision of the Atomic Safety and Licensing Appeal Board (ALAB-515), December 27, 1978.

Calibrations were made every six months on sensors, electronics, and recording equipment. Service and maintenance trips to the 60-m (200-ft) tower were made twice a week. Digital systems were checked daily. In the opinion of the staff, the applicant's onsite preoperational meteorological program is adequate.

5.2.2 Groundwater Monitoring

A description of the groundwater aquifers within 5 km (3 mi) of the site was obtained from borings and 1957 water-well inventories that were compiled as part of the safety analysis for Fermi-1. Onsite pump tests were performed in 1959 in order to evaluate the hydraulic properties of the bedrock in the site area (ER-OL, Section 6.1.2). As a result of an evaluation of the dewatering requirements for Fermi-1, a series of wells was installed for monitoring the groundwater level. Piezometers were installed in six test borings (ER-OL, Section 6.1.2.1.1). Groundwater monitoring was also associated with quarrying operations that began in 1969 and ended in 1972. Both onsite observation wells and privately owned offsite wells were monitored to ascertain the effects of the quarrying operations (ER-OL, Section 6.1.2.1.2).

During the 1969 boring program, water samples were obtained from the bedrock aquifer on site. Groundwater samples were tested for pH, sulfate content, and chloride content. Water samples from onsite and offsite wells were analyzed for pH, conductivity, hardness (as $CaCO_3$), alkalinity (as $CaCO_3$), chloride (as Cl), sulfate (as SO_4), hydrogen sulfide (H_2S), sodium (Na), and total solids. In addition, a spectrographic analysis was performed on suspended solids (ER-OL, Sec. 6.1.2.2).

5.2.3 Aquatic Monitoring

A one-year survey of the ecological characteristics of Lake Erie near the Fermi site was conducted during the period May 1976 through April 1977. Details of the program are provided in ER-OL Supplement 4, Section 6.1.1.1. Samples were collected along three transects running perpendicular to the shoreline: one transect at the intake channel, one transect at the discharge structure, and one transect north of the discharge near the lagoon. Additionally, sampling occurred within the intake channel and outside the channel near the north dike (see ER-OL Supplement 4, Figure 6.1-1).

Sampling for ichthyoplankton was conducted using nets and pumps every two weeks, as weather permitted, from May through October 1976, twice during the winter, and in April 1977. Samples were taken at inshore and offshore stations along all three transects, as well as within the intake channel. Fishes were sampled monthly using gill nets and other trawls at offshore transect stations and via beach seines at near-shore transect stations. Seines and gill nets also were used to sample within the intake channel. Benthic invertebrates and sediments were sampled by Ponergrab on a seasonal basis at inshore and offshore transect locations. Zooplankton and phytoplankton were sampled monthly via net and pump respectively at inshore and offshore transect locations and within the intake channel.

Water quality parameters (temperature, pH, dissolved oxygen, conductivity) were sampled every two weeks at all stations. Additionally, temperature, pH and DO were measured whenever biological samples were collected throughout the study period. Solids (dissolved, suspended, total) also were measured on the same basis beginning in July 1976.

5.2.4 Terrestrial Monitoring

The applicant's baseline terrestrial ecology studies represent the preoperational terrestrial ecology of and around the Fermi site. These studies are discussed in Section 5.3.6 of the FES.

5.2.5 Radiological Environmental Monitoring

Radiological environmental monitoring programs are established to provide data on measurable levels of radiation and radioactive materials in the site environs. Such monitoring programs verify the effectiveness of inplant systems used to control the release of radioactive materials and ensure that unanticipated buildups of radioactivity do not occur in the environment. Secondarily, the monitoring programs could identify the (highly unlikely) existence of unmonitored releases of radioactivity. A surveillance (land census) program is established to identify changes in the use of unrestricted areas to provide a basis for modifications of the monitoring programs.

The preoperational phase of the monitoring program should provide for the measurement of background levels and their variations along the anticipated important pathways in the area surrounding the plant, the training of personnel, and the evaluation of procedures, equipment, and techniques. This is discussed in greater detail in NRC Regulatory Guide 4.1, Rev. 1, "Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants," and in the NRC Radiological Assessment Branch Technical Position, Rev. 1, November 1979, "An Acceptable Radiological Environmental Monitoring Program."

The applicant has proposed a radiological environmental monitoring program to meet the objectives discussed. The second year of this proposed preoperational program (as described in the ER-OL, Section 6.1.5) is summarized in Tables 5.1 and 5.1a. The applicant has already initiated parts of the program, with the remaining portions to begin either six months or one year prior to operation of the facility.

The staff finds that the preoperational radiological monitoring program of the applicant is acceptable.

5.3 Operational Monitoring Programs

5.3.1 Meteorological Monitoring

The meteorological monitoring program for the operational phase will involve the 60-m (200-ft) tower described in the preoperational stage (Section 5.2.1). Meteorological monitoring will continue during the operational lifetime of the plant. The system, to be run in full compliance with Regulatory Guide 1.23, is considered adequate.

Table 5.1 Preoperational environmental radiological monitoring program, second year

Type of Sample	Location of Sample*	Sampling Device	Sampling Frequency	Analysis Type	Analysis Frequency	Remarks
Direct radiation	NE - Estral Beach NW - Site boundary NNW - Site boundary WNW - Site Boundary N - Site boundary NNE - Residence NE - Community (same as above, NE - Estral Beach) Control - Farm 11 or 13 mi[a] W	Two TLDs at each location	Continuous sampling, TLDs changed quarterly	Gamma dose	Quarterly	Locations selected by ranking mixed-mode annual average D/Q; NE - Estral Beach serves as closest sector as well as closest community with highest D/Q
Fish (yellow perch)	Vicinity of discharge Control - Celeron Island, 9.5 mi NNE	Nets or equivalent	Semi-annually, spring and fall as weather permits	Gamma isotopic (edible portion)	Semi-annually[b]	Yellow perch selected on basis of being a relatively abundant specie that is both food and sport in Lake Erie
Shoreline sediments	S - Pointe Aux Peaux NE - Estral Beach E - Fermi-2 discharge	Grab sample	Semi-annually, spring and fall as weather permits	Gamma isotopic	Semi-annually[b]	

*See also Supplementary TLD Stations S-1 through S-30 on Table 5.1a.

Table 5.1 (continued)

Type of Sample	Location of Sample	Sampling		Analysis		Remarks
		Device	Frequency	Type	Frequency	
Airborne particulates[c]	NE - Estral Beach NW - Site boundary NNW - Residence	1. Particulate sampler, continuous	Change filters weekly	1a. Gross beta[c]	Weekly,[b] following each filter change	1. Initiate sampling program on gross beta and gamma isotopic, January
				1b. Gamma isotopic	Quarterly[b] composite by location	
	NE - Community (same as above, NE - Estral Beach)	2. Radioiodine canister	Change weekly	2. Iodine-131	Weekly[b]	2. Initiate sampling program on Iodine-131, June
	Control - Farm 11 or 13 mi[a] W					
Surface water	Fermi-1 potable water intake	Composite sampler	Monthly	1. Gamma isotopic	Monthly[b]	Composite sampler must be capable of collecting an aliquot at hourly time intervals relative to monthly compositing period
	Control - Trenton Channel Power Plant intake			2. Tritium	Quarterly[b] composite by location	
Drinking water[c]	City of Monroe water intake	Composite sampler	Monthly	1. Gross beta[c]	Monthly[b]	Composite sampler must be capable of collecting an aliquot at hourly time intervals relative to monthly compositing period
	Control - Detroit water intake at Fighting Island			2. Gamma isotopic	Monthly[b] composite by location	
				3. Tritium	Quarterly[b] composite by location	

Table 5.1 (continued)

Type of Sample	Location of Sample	Sampling		Analysis		Remarks
		Device	Frequency	Type	Frequency	
Milk	Goat - 2 mi[a] NW Cow - 3 mi[a] NW	Goat, cow	1. Monthly	1. Gamma isotopic	Monthly	1. Initiate sampling program on gamma isotopic, January
	Control - Farm 11 or 13 mi[a] W		2. Semi-monthly when animals on pasture	2. Iodine - 131	Semi-monthly when animals on pasture	2. Initiate sampling program for Iodine-131 when grazing season starts May-October

[a] To convert mi to km, multiply by 1.6.

[b] Samples analyzed in duplicate.

[c] If gross beta in air or water is greater than 10 times the mean of control samples for any medium, gamma isotopic performed on individual samples.

Table 5.1a Supplementary TLD stations

Sector	Station No.	Location
NW	S-1	Pole NE corner Dixie Hwy and Post Rd (2 mi ring)
NNW	S-2	Pole NW corner Dixie Hwy and Swan Creek (2 mi ring)
N	S-3	Pole (#DE5240G5) on Masserant-South on SE corner of driveway to abandoned barn (2 mi ring)
NNE	S-4	Pointe Mouillee-W Jefferson and Campau Rd, pole (#DE7045GC3) on SE corner of bridge (5 mi ring)
NE	S-5	Pointe Mouillee Game Area-Field Office, pole near tree north area of parking lot (5 mi ring)
NNE	S-6	Labo and Dixie Hwy, pole (#175W3909) on SW corner with light (5 mi ring)
N	S-7	Labo and Brandon, pole (#DE6150G4) on SE corner near RR (5 mi ring)
NNW	S-8	Pole (#R56DE27305) behind post office in Newport (5 mi ring)
WNW	S-9	Pole (#R45DE40-2-30) on SE corner of War and Post Rd (5 mi ring)
W	S-10	Pole (#MO-78SP-G7-35) on NE corner Nedau and Lapard-near mobile home park (5 mi ring)
SW	S-11	Pole (#DEC03740-6) on NW corner Mentel and Hurd (5 mi ring)
SW	S-12	Pole (#DE71-4-40H) in parking lot of Department of Natural Resources Office Building-Sterling State Park (5 mi ring)
W	S-13	Pole (#DE74-5-40GC) on Williams Rd-school complex approximately 200 yd S of Jefferson High (special area)
WSW	S-14	Pole (#DE45-35G6R60) N side of Pearl-Woodland Beach (pop. area)
S	S-15	Pole (#DE76-40H5) S side of Long and Point Aux Peaux (site boundary)
SSW	S-16	Pole (#DE58-40-G5RG69) S side of Point Aux Peaux, next to vent pipe (site boundary)

Table 5.1a (continued)

Sector	Station No.	Location
SW	S-17	Fermi gate along Point Aux Peaux Rd-on fence post W of gate
WSW	S-18	Pole (#DEC034-35) on S corner of Toll Rd S of main gate
W	S-19	Pole (#DE74-40H5) on Toll Rd, first residence from Enrico Fermi Dr
SSW	S-20	Pole (#DE7785BB1) at end of Front St-in front of Detroit Edison Generation Plant (special area)
SW	S-21	Pole (#8-78-150) junction of Mortor and Laplaisance (10 mi ring)
WSW	S-22	Junction of Dixie Hwy and Laplaisance/Albain (10 mi ring)
WSW	S-23	Pole (#DE4940B4) Custer (St. Mary's) Park corner of N Custer and Dixie (Monroe St) (N side, next to river) (special area)
WSW	S-24	Pole (#DECO 31-60A) Milton "Pat" Munson Recreational Reserve-N Custer Rd (10 mi ring)
WNW	S-25	Pole (#MTBC2) corner Stoney Creek and Finzel Rd (10 mi ring)
NW	S-26	Pole (#DECO 5028) N corner Grafton and Ash Rd
NNW	S-27	Pole (#DECO 35 6 40) junction of Port Creek and Will-Carlton Rd
N	S-28	Pole (#064 Y-7224) SE side of I-75, corner Pace and S Huron River Dr (special area)
N	S-29	Pole (#DECO 45 4 40) N side of Cahill and Gibralter Rd (10 mi ring)
NNE	S-30	Pole (#DE 55 40G4) S corner of Adams and Gibralter (across from Humbug Marina) (special area)

5.3.2 Aquatic Monitoring

5.3.2.1 Water Quality

The applicant proposes to conduct a special surveillance program for a period of up to two years after the startup of Fermi-2 in order to determine the extent of the plant's environmental impact. The results of this program will be used to ascertain which environmental parameters should be monitored for the operational life of the plant (ER-OL, Section 6A.4.0). The staff believes that the objective of such a program should be to provide a comparison with earlier studies so that the impacts of plant operation may be assessed and, if warranted, mitigative procedures designed and implemented.

For a period of one year, samples of lake water will be collected near the site for chemical analysis in order to monitor changes in water quality. Sampling for laboratory measurements will be done seasonally. Field measurements of the temperature, pH, dissolved oxygen, and turbidity will be performed monthly. The sampling schedule will be arranged to coincide with the biotic monitoring programs. The full year of data will be compared with the preoperational data (ER-OL, Section 6A.4.1).

5.3.2.2 Thermal

During the first year of commercial operation, the applicant intends to conduct water quality surveys by boat to determine the extent and orientation of the thermal plume under a variety of plant operational and environmental conditions (ER-OL, p. 6.2-15). These surveys will include variations in plant power output, blowdown flow, wind direction and speed, and ambient lake temperature.

5.3.2.3 Chemical Effluents

According to the specifications of the NPDES permit, the cooling system blowdown must be monitored for total residual chlorine (TRC), pH, and oil and grease; likewise, the demineralizer regeneration wastes and the radwaste treatment system effluent must be monitored for total suspended solids and for oil and grease (see Appendix D for the NPDES permit).

The NPDES permit requires that the applicant conduct a 12-month study to determine the magnitude of the free chlorine component of the TRC. If, as a result of the study, it is demonstrated that the free chlorine cannot be reduced to at most 25% of the TRC in any seasons of the year, the applicant will be required during those seasons to reduce the TRC to the acute toxicity threshold value defined by the Freshwater Criteria Curve of J. S. Mattice and H. E. Zittel (see p. 6 of 9 of Part I of the NPDES permit).

5.3.2.4 Aquatic Biological Studies

In response to a requirement of the State of Michigan NPDES permit, the applicant submitted an operational aquatic biological study in May 1979 for approval by the Michigan Department of Natural Resources. This program was proposed by the applicant as a replacement of the original study submitted to NRC. NRC

reviewed the new study proposal and provided comments to the State in July 1979. The State of Michigan approved the study in August 1979, subject to certain modifications. The study consists of two phases: Phase 1 will start within 90 days of initiation of blowdown from the circulating water reservoir and will be continued for one year. Phase 1 includes intake entrainment and impingement monitoring at the general service water pumphouse. The Phase 2 scope and schedule are not specified by the applicant because the elements of Phase 2 will be defined to a large extent by the results of Phase 1. At present, however, the applicant plans to start Phase 2 following the designation of commercial operation status for Fermi-2.

5.3.3 Terrestrial Monitoring

The applicant has proposed an operational monitoring program in the ER-OL (Section 2.5.2 and pages 6A-4-8 and 4.9). The staff agrees that terrestrial monitoring is best accomplished by means of infared aerial photography with accompanying ground truth. The frequency and duration of the program will be specified when the Environmental Protection Plan is issued. This plan will also cover any occurrence of unusual or important events that potentially could result in significant environmental impact causally related to station operation, such as excessive bird impaction, onsite plant and animal disease outbreaks, or mortality of any species protected by the Endangered Species Act of 1973.

5.3.4 Radiological Environmental Monitoring

The operational, offsite radiological monitoring program is conducted to measure radiation levels and radioactivity in plant environs. It assists and provides backup support to the effluent monitoring program as recommended in NRC Regulatory Guide 1.21, "Measuring, Evaluating and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water Cooled Nuclear Power Plants."

The applicant states that during the first 3 years the operational program will be maintained at a level similar to that conducted the last 6 months of the preoperational program described above. During and after this period, the operational program will be reevaluated to determine where the sample frequency, types of samples, and types of analyses can be reduced without jeopardizing the achievement of program objectives. The proposed operational program will be reviewed before plant operation begins. Modification will be based upon anomalies and/or exposure pathway variations observed during the preoperational program.

The final operational monitoring program proposed by the applicant will be reviewed in detail by the NRC staff, and the specifics of the required monitoring program will be incorporated into the Operating License Radiological Technical Specifications.

6 ENVIRONMENTAL IMPACT OF POSTULATED ACCIDENTS

6.1 Résumé

The staff has considered the potential radiological impacts on the environment of possible accidents at the Enrico Fermi Atomic Power Plant Unit 2 in accordance with a Statement of Interim Policy published by the Nuclear Regulatory Commission on June 13, 1980.[1] The following discussion reflects these considerations and conclusions.

The first section deals with general characteristics of nuclear power plant accidents including a brief summary of safety measures to minimize the probability of their occurrence and to mitigate their consequences if they should occur. Also described are the important properties of radioactive materials and the pathways by which they could be transported to become environmental hazards. Potential adverse health effects and impacts on society associated with actions to avoid such health effects are also identified.

Next, actual experience with nuclear power plant accidents and their observed health effects and other societal impacts are described. This is followed by a summary review of safety features of the Fermi-2 facility and of the site that act to mitigate the consequences of accidents.

The results of calculations of the potential consequences of accidents that have been postulated in the design basis are then given. Also described are the results of calculations for the Fermi-2 site using probabilistic methods to estimate the possible impacts and the risks associated with severe accident sequences of exceedingly low probability of occurrence.

6.1.1 General Characteristics of Accidents

The term accident, as used in this section, refers to any unintentional event not addressed in Section 4.5 that results in a release of radioactive materials into the environment. The predominant focus, therefore, is on events that can lead to releases substantially in excess of permissible limits for normal operation. Such limits are specified in the Commission's regulations at 10 CFR Part 20.

There are several features which combine to reduce the risk associated with accidents at nuclear power plants. Safety features in the design, construction, and operation comprising the first line of defense are to a very large extent devoted to the prevention of the release of these radioactive materials from their normal places of confinement within the plant. There are also a number of additional lines of defenses that are designed to mitigate the consequences of failures in the first line. Descriptions of these features for the Fermi Unit 2 plant may be found in the applicant's Final Safety Analysis Report[2] and in the staff's Safety Evaluation Report.[3] The most important mitigative features are described in Section 6.1.3.1 below.

These safety features are designed taking into consideration the specific locations of radioactive materials within the plant, their amounts, their

nuclear, physical, and chemical properties and their relative tendency to be transported into and for creating biological hazards in the environment.

6.1.1.1 Fission Product Characteristics

By far the largest inventory of radioactive material in a nuclear power plant is produced as a byproduct of the fission process and is located in the uranium oxide fuel pellets in the reactor core in the form of fission products. During periodic refueling shutdowns, the assemblies containing these fuel pellets are transferred to a spent fuel storage pool so that the second largest inventory of radioactive material is located in this storage area. Much smaller inventories of radioactive materials are also normally present in the water that circulates in the reactor coolant system and in the systems used to process gaseous and liquid radioactive wastes in the plant.

These radioactive materials exist in a variety of physical and chemical forms. Their potential for dispersion into the environment is dependent not only on mechanical forces that might physically transport them, but also upon their inherent properties, particularly their volatility. The majority of these materials exist as nonvolatile solids over a wide range of temperatures. Some, however, are relatively volatile solids and a few are gaseous in nature. These characteristics have a significant bearing upon the assessment of the environmental radiological impact of accidents.

The gaseous materials include radioactive forms of the chemically inert noble gases krypton and xenon. These have the highest potential for release into the atmosphere. If a reactor accident were to occur involving degradation of the fuel cladding, the release of substantial quantities of these radioactive gases from the fuel is a virtual certainty. Such accidents are very low frequency but credible events (see also Section 6.1.2). It is for this reason that the safety analysis of each nuclear power plant incorporates a hypothetical design basis accident that postulates the release of the entire contained inventory of radioactive noble gases from the fuel into the containment structure. If further released to the environment as a possible result of failure of safety features, the hazard to individuals from these noble gases would arise predominantly through the external gamma radiation from the airborne plume. The reactor containment structure is designed to minimize this type of release.

Radioactive forms of iodine are formed in substantial quantities in the fuel by the fission process and in some chemical forms may be quite volatile. For this reason, they have traditionally been regarded as having a relatively high potential for release from the fuel. The chemical forms in which the fission product radioiodines are found are generally solid materials at room temperatures, however, so that they have a strong tendency to condense (or "plate out") upon cooler surfaces. In addition, most of the iodine compounds are quite soluble in, or chemically reactive with, water. Although these properties do not inhibit the release of radioiodines from degraded fuel, they do act to mitigate the release from containment structures that have large internal surface areas and that contain large quantities of water as a result of an accident. The same properties affect the behavior of radioiodines that may "escape" into the atmosphere. Thus, if rainfall occurs during a release, or if there is moisture on exposed surfaces (for example, dew), the radioiodines will show a strong tendency to be absorbed by the moisture. Because of

radioiodine's distinct radiological hazard, its potential for release to the atmosphere has also been reduced, as a result of special consideration in the safety analysis of postulated accidents, by the use of special filter systems and/or containment spray systems. If released to the environment, the principal radiological hazard associated with the radioiodines is ingestion into the human body and subsequent concentration in the thyroid gland.

Other radioactive materials formed during the operation of a nuclear power plant have lower volatilities and, therefore, by comparison with the noble gases and iodine, a much smaller tendency to escape from degraded fuel unless the temperature of the fuel becomes quite high. By the same token, such materials, if they escape by volatilization from the fuel, tend to condense quite rapidly to solid form again when transported to a lower temperature region and/or dissolve in water when present. The former mechanism can have the result of producing some solid particles of sufficiently small size to be carried some distance by a moving stream of gas or air. If such particulate materials are dispersed into the atmosphere as a result of failure of the containment barrier, they will tend to be carried downwind and deposit on surface features by gravitational settling or by precipitation (fallout), where they will become "contamination" hazards in the environment.

All of these radioactive materials exhibit the property of radioactive decay with characteristic half-lives ranging from fractions of a second to many days or years (see Table 6.1). Many of them decay through a sequence or chain of decay processes and all eventually become stable (nonradioactive) materials. The radiation emitted during these decay processes is the reason that they are hazardous materials.

6.1.1.2 Exposure Pathways

The radiation exposure (hazard) to individuals is determined by their proximity to the radioactive material, the duration of exposure, and factors that act to shield the individual from the radiation. Pathways for the transport of radiation and radioactive materials that lead to radiation exposure hazards to humans are generally the same for accidental as for "normal" releases. These are depicted in Figure 4.2. There are two additional possible pathways that could be significant for accident releases that are not shown in Figure 4.2. One of these is the fallout onto open bodies of water of radioactivity initially carried in the air. The second would be unique to an accident that results in temperatures inside the reactor core sufficiently high to cause melting and subsequent penetration of the basemat underlying the reactor by the molten core debris. This creates the potential for the release of radioactive material into the hydrosphere through contact with ground water. These pathways may lead to external exposure to radiation, and to internal exposures if radioactivity is inhaled, or ingested from contaminated food or water.

It is characteristic of these pathways that, during the transport of radioactive material by wind or by water, the material tends to spread and disperse, like a plume of smoke from a smokestack, becoming less concentrated in larger volumes of air or water. The result of these natural processes is to lessen the intensity of exposure to individuals downwind or downstream of the point of release, but they also tend to increase the number who may be exposed. For a release into the atmosphere, the degree to which dispersion reduces the concentration in the plume at any downwind point is governed by the turbulence

Table 6.1 Activity of radionuclides in the Fermi 2 reactor core at 3430 mWt

Group/Radionuclide	Radioactive Inventory (millions of Curies)	Half-Life (days)
A. NOBLE GASES		
Krypton-85	0.60	3,950
Krypton-85m	26	0.183
Krypton-87	51	0.0528
Krypton-88	73	0.117
Xenon-133	183	5.28
Xenon-135	37	0.384
B. IODINES		
Iodine-131	91	8.05
Iodine-132	129	0.0958
Iodine-133	183	0.875
Iodine-134	204	0.0366
Iodine-135	161	0.280
C. ALKALI METALS		
Rubidium-86	0.028	18.7
Cesium-134	8.1	750
Cesium-136	3.2	13.0
Cesium-137	5.1	11,000
D. TELLURIUM-ANTIMONY		
Tellurium-127	6.3	0.391
Tellurium-127m	1.2	109
Tellurium-129	33	0.048
Tellurium-129m	5.7	34.0
Tellurium-131m	14	1.25
Tellurium-132	129	3.25
Antimony-127	6.6	3.88
Antimony-129	35	0.179
E. ALKALINE EARTHS		
Strontium-89	101	52.1
Strontium-90	4.0	11,030
Strontium-91	118	0.403
Barium-140	172	12.8
F. COBALT AND NOBLE METALS		
Cobalt-58	0.84	71.0
Cobalt-60	0.31	1,920
Molybdenum-99	172	2.8
Technetium-99m	151	0.25
Ruthenium-103	118	39.5
Ruthenium-105	77	0.185
Ruthenium-106	27	366
Rhodium-105	53	1.50

Table 6.1 (Continued)

Group/Radionuclide	Radioactive Inventory (millions of Curies)	Half-Life (days)
G. RARE EARTHS, REFRACTORY OXIDES AND TRANSURANICS		
Yttrium-90	4.2	2.67
Yttrium-91	129	59.0
Zirconium-95	161	65.2
Zirconium-97	161	0.71
Niobium-95	161	35.0
Lanthanum-140	172	1.67
Cerium-141	161	32.3
Cerium-143	140	1.38
Cerium-144	91	284
Praseodymium-143	140	13.7
Neodymium-147	65	11.1
Neptunium-239	1800	2.35
Plutonium-238	0.061	32,500
Plutonium-239	0.023	8.9×10^6
Plutonium-240	0.023	2.4×10^6
Plutonium-241	3.7	5,350
Americium-241	0.0018	1.5×10^5
Curium-242	0.54	163
Curium-244	0.025	6,630

NOTE: The above grouping of radionuclides corresponds to that in Table 6.3.

characteristics of the atmosphere which vary considerably with time and from place to place. This fact, taken in conjunction with the variability of wind direction and the presence or absence of precipitation, means that accident consequences are very much dependent upon the weather conditions existing at the time.

6.1.1.3 Health Effects

The cause and effect relationships between radiation exposure and adverse health effects are quite complex,[4] but they have been more exhaustively studied than any other environmental contaminant.

Whole-body radiation exposure resulting in a dose greater than about 10 rem for a few persons and about 25 rem for nearly all people over a short period of time (hours) is necessary before any physiological effects to an individual are clinically detectable. Doses about 10 to 20 times larger than the latter value, also received over a relatively short period of time (hours to a few days), can be expected to cause some fatal injuries. At the severe but extremely low-probability end of the accident spectrum, exposures of these

magnitudes are theoretically possible for persons in the close proximity of such accidents if measures are not or cannot be taken to provide protection, such as by sheltering or evacuation.

Lower levels of exposures may also constitute a health risk, but the ability to define a direct cause and effect relationship between any given health effect and a known exposure to radiation is difficult, given the backdrop of the many other possible reasons why a particular effect is observed in a specific individual. For this reason, it is necessary to assess such effects on a statistical basis. Such effects include cancer in the exposed population and genetic changes in future generations after exposure of a prospective parent. Cancer in the exposed population may begin to develop only after a lapse of 2 to 15 years (latent period) from the time of exposure and then continue over a period of about 30 years (plateau period). However, in the case of exposure of fetuses (<u>in utero</u>), cancer may begin to develop at birth (no latent period) and end at age 10 (that is, the plateau period is 10 years). The health consequences model currently being used is based on the 1972 BEIR Report of the National Academy of Sciences.[5]

Most authorities are in agreement that a reasonable--and probably conservative--estimate of the statistical number of health effects of low levels of radiation exposure to a large number of people is within the range of about 10 to 500 potential cancer deaths (although zero is not excluded by the data) per million person-rem. The range comes from the latest NAS BEIR III Report[6] (1980), which also indicates a probable value of about 150. This value is virtually identical to the value of about 140 used in the current NRC health effects models. In addition, approximately 220 genetic changes per million person-rem would be projected by BEIR III over succeeding generations. That also compares well with the value of about 260 per million person-rem currently used by the NRC staff.

6.1.1.4 Health Effects Avoidance

Radiation hazards in the environment tend to disappear by the natural process of radioactive decay. Where the decay process is a slow one, however, and where the material becomes relatively fixed in its location as an environmental contaminant (for example, in soil), the hazard can continue to exist for a relatively long period of time--months, years, or even decades. Thus, a possible consequential environmental societal impact of severe accidents is the avoidance of the health hazard rather than the health hazard itself, by restrictions on the use of the contaminated property or contaminated foodstuffs, milk, and drinking water. The potential economic impacts that this can cause are discussed below.

6.1.2 Accident Experience and Observed Impacts

The evidence of accident frequency and impacts in the past is a useful indicator of future probabilities and impacts. As of mid-1980, there were 69 commercial nuclear power reactor units licensed for operation in the United States at 48 sites, with power generating capacities ranging from 50 to 1130 megawatts electric (MWe). (The Fermi Unit 2 plant is designed for 1123 MWe.) The combined experience with these units represents approximately 500 reactor years of operation over an elapsed time of about 20 years. Accidents have

occurred at several of these facilities.[7] Some of these have resulted in releases of radioactive material to the environment, ranging from very small fractions of a curie to a few million curies. None is known to have caused any radiation injury or fatality to any member of the public, nor any significant individual or collective public radiation exposure, nor any significant contamination of the environment. This experience base is not large enough to permit a reliable quantitative statistical inference. It does, however, suggest that significant environmental impacts due to accidents are very unlikely to occur over time periods of a few decades.

Melting or severe degradation of reactor fuel has occurred in only one of these units, during the accident at Three Mile Island - Unit 2 (TMI-2) on March 28, 1979. In addition to the release of a few million curies of xenon-133, it has been estimated that approximately 15 curies of radioiodine was also released to the environment at TMI-2.[8] This amount represents an extremely minute fraction of the total radioiodine inventory present in the reactor at the time of the accident. No other radioactive fission products were released in measurable quantity.

It has been estimated that the maximum cumulative offsite radiation dose to an individual was less than 100 millirem.[8,9] The total population exposure has been estimated to be in the range from about 1000 to 3000 person-rem. This exposure could produce between none and one additional fatal cancer over the lifetime of the population. The same population receives each year from natural background radiation about 240,000 person-rem and approximately a half-million cancers are expected to develop in this group over its lifetime,[8,9] primarily from causes other than radiation. Trace quantities (barely above the limit of detectability) of radioiodine were found in a few samples of milk produced in the area. No other food or water supplies were impacted.

Accidents at nuclear power plants have also caused occupational injuries and a few fatalities but none attributed to radiation exposure. Individual worker exposures have ranged up to about 4 rem as a direct consequence of accidents, but the collective worker exposure levels (person-rem) are a small fraction of the exposures experienced during normal routine operations that average about 500 person-rem per reactor year.

Accidents have also occurred at other nuclear reactor facilities in the United States and in other countries.[7] As a result of inherent differences in design, construction, operation, and purpose of most of these other facilities, their accident record has only indirect relevance to current nuclear power plants. Melting of reactor fuel occurred in at least seven of these accidents, including the one in 1966 at the Enrico Fermi Atomic Power Plant Unit 1. This was a sodium-cooled fast breeder demonstration reactor designed to generate 61 MWe. The damages were repaired and the reactor reached full power in four years following the accident. It operated successfully and completed its mission in 1973. This accident did not release any radioactivity to the environment.

A reactor accident in 1957 at Windscale, England, released a significant quantity of radioiodine, approximately 20,000 curies, to the environment. This reactor, which was not operated to generate electricity, used air rather than water to cool the uranium fuel. During a special operation to heat the large amount of graphite in this reactor, the fuel overheated and radioiodine

and noble gases were released directly to the atmosphere from a 125-m (405-ft) stack. Milk produced in a 517-km^2 (200-mi^2) area around the facility was impounded for up to 44 days. This kind of accident cannot occur in a water-cooled reactor like Fermi-2, however.

6.1.3 Mitigation of Accident Consequences

Pursuant to the Atomic Energy Act of 1954, the Nuclear Regulatory Commission is conducting a safety evaluation of the application to operate Fermi-2. Although this evaluation will contain more detailed information on plant design, the principal design features are presented in the following section.

6.1.3.1 Design Features

Fermi-2 contains features designed to prevent accidental release of radioactive fission products from the fuel and to lessen the consequences should such a release occur. Many of the design and operating specifications of these features are derived from the analysis of postulated events known as design basis accidents. These accident preventive and mitigative features are collectively referred to as engineered safety features (ESF). The possibilities or probabilities of failure of these systems is incorporated in assessments discussed in Section 6.1.4.

The containment system, one such ESF, is a passive mitigating system designed to minimize accidental radioactivity releases to the environment. The containment system is composed of two parts. The primary containment encloses the reactor vessel, the reactor coolant recirculation loops, and other reactor coolant system components. The secondary containment (also known as the reactor building) encloses the primary containment, the spent fuel pool, and other auxiliary equipment.

An emergency core cooling system (ECCS) is designed to provide cooling water to the reactor core during an accident to prevent or minimize fuel damage. A pressure suppression system is installed to prevent containment failure due to overpressure following an accident.

The standby gas treatment system (SGTS) is designed to establish and maintain a negative pressure in the secondary containment following the signal for its isolation in the event of release of radioactivity to this building in an accident. Negative pressure, with respect to the outside atmosphere, would prevent out-leakage of radioactivity from this building to the environment, except along the release path controlled by the SGTS. Radioactive iodine and particulate fission products would be substantially removed from the flow stream by activated charcoal and high-efficiency particulate air filters.

The main steam isolation valve leakage control system is designed to control the release of fission products through the main steam isolation valves.

The mechanical systems mentioned above are supplied with emergency power from onsite diesel generators in the event that normal offsite station power is interrupted.

Much more extensive discussions of the safety features and characteristics of Fermi Unit 2 may be found in the applicant's Final Safety Analysis Report.[2] The staff evaluation of these features are addressed in the safety evaluation report.[3] In addition, the implementation of the lessons learned from the TMI-2 accident, in the form of improvements in design and procedures, and operator training, will significantly reduce the likelihood of a degraded core accident which could result in large releases of fission products to the containment. Specifically, the applicant will be required to meet those TMI-related requirements specified in NUREG-0737. As noted in Section 6.1.4.7, no credit has been taken for these actions and improvements in discussing the radiological risk of accidents.

6.1.3.2 Site Features

In the process of considering the suitability of the site of Fermi-2, pursuant to the NRC Reactor Site Criteria in 10 CFR Part 100, consideration was given to site features that lower the risk and lessen the potential impact of accidents. The site features considered were grouped into the following: exclusion area, low population zone (LPZ), nearest population center, and offsite hazards.

The 1120 acre site has an exclusion area as required by 10 CFR Part 100. The exclusion area consists of the area enclosed within a circle of 915 m (3000 ft) from the reactor containment structure. Since the plant is situated within a few hundred feet of the shoreline, part of the exclusion area extends into Lake Erie. The land portion of the exclusion area is owned by the applicant, and there are no roads or railroads traversing the land portion of the exclusion area. The applicant states that the Lake Erie shoreline at the plant site is unsuitable for beach activities and is posted as private property. Based on its experience with the Fermi Unit 1 reactor on this site, the applicant also indicates that the public has made little use of the water portion of the exclusion area because of its poor fishing and shallow water characteristics. The staff will require that the applicant make arrangements with the U.S.Coast Guard to control traffic on Lake Erie within the exclusion area in the event of emergency, as required by 10 CFR Part 100. Based upon ownership of the land area plus suitable arrangements made with the Coast Guard, the applicant has the authority, required by Part 100, to determine all activities within the exclusion area including removal of persons and property in an emergency.

Beyond and surrounding the exclusion area is a low population zone (LPZ), as required by 10 CFR Part 100. As described in 10 CFR Part 100, the LPZ size is such that an individual located at any point on its outer boundary who is exposed to a postulated release of fission products would not receive a total radiation dose in excess of the guidelines contained therein. For Fermi-2, this is an area within 4.8 km (3 mi) of the reactor. Within this zone, the applicant must assure that there is a reasonable probability that appropriate measures could be taken on behalf of the residents in the event of a serious accident. In case of a radiological emergency, the applicant has made arrangements with the State and local governments to control traffic on nearby roads; the staff will require that the applicant make arrangements to also control traffic on the portion of Lake Erie that falls within the LPZ in event of an emergency.

The 1970 population within the LPZ was about 5400 persons and is projected to reach 5611 persons by the year 2000. There are five schools with a 1972 total enrollment of 2351 pupils located within the LPZ. The nearest of these, the Brest school with an enrollment of 163 pupils, is located about 4 km (2.5 mi) west-southwest of the plant. Several beaches--namely Estral, Stony Point, and Woodland Beaches--are also located within the LPZ. The nearest major recreational area, Sterling State Park, is located about 8 km (5 mi) southwest of the site. There is no significant transient population within the LPZ.

10 CFR Part 100 also requires that the nearest population center of about 25,000 or more persons be no closer than 1-1/3 times the outer radius of the LPZ. The purpose of this criterion is to provide for protection against excessive exposure doses to people in large centers. The basis for this is the recognition that accidents of greater hazards potential than those commonly postulated as representing an upper limit are conceivable, although highly improbable.

The nearest population center containing more than about 25,000 people is Monroe, Michigan, located about 8.8 km (5.5 mi) southwest of the site. The 1970 population of Monroe was about 24,000, an increase of 4% over the 1960 population. The distance from the plant to the nearest boundary of the population center is greater than 1-1/3 times the LPZ radius of 4.8 km (3 mi) as required by 10 CFR Part 100. The City of Detroit, Michigan, with a 1975 population of about 1,335,000 persons, is located about 43 km (27 mi) north-northeast of the site, while the City of Toledo, Ohio, with a 1975 population of about 367,000 persons, is located about 43 km southwest of the site.

The safety evaluation of the Fermi-2 site has included a review of the potential external hazards (that is, offsite activities that might adversely affect the operation of the plant and cause an accident). This review included nearby industrial, transportation, and military facilities that could create explosive, missile, toxic gas, or similar hazards. The risk to the Fermi-2 plant from such hazards was found to be negligibly small. A more complete discussion of the compliance with the Commission's siting criteria, including the offsite hazards is provided in the staff's SER.

6.1.3.3 Emergency Preparedness

Emergency preparedness plans including protective action measures for the Fermi-2 facility and environs are in an advanced, but not yet fully completed stage. In accordance with the provisions of 10 CFR Section 50.47, effective November 3, 1980, no operating license will be issued to the applicant unless a finding is made by the NRC that the state of onsite and offsite emergency preparedness provides reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency. Among the standards that must be met by these plans are provisions for two Emergency Planning Zones (EPZ). A plume exposure pathway EPZ of about 16 km (10 mi) in radius and an ingestion exposure pathway EPZ of about 80 km (50 mi) in radius are required. Other standards include appropriate ranges of protective actions for each of these zones, provisions for dissemination to the public of basic emergency planning information, provisions for rapid notification of the public during a serious reactor emergency, and methods, systems, and equipment for assessing and monitoring actual or potential offsite consequences in the EPZs of a radiological emergency condition.

NRC findings will be based upon a review of the Federal Emergency Management Agency (FEMA) findings and determinations as to whether State and local government emergency plans are adequate and capable of being implemented, and on the NRC assessment as to whether the applicant's onsite plans are adequate and capable of being implemented. (NRC findings are reported in the SER.) Although the presence of adequate and tested emergency plans cannot prevent the occurrence of an accident, it is the judgment of the staff that they can and will substantially mitigate the consequences to the public if one should occur.

6.1.4 Accident Risk and Impact Assessment

6.1.4.1 Design Basis Accidents

As a means of assuring that certain features of the Fermi-2 plant meet acceptable design and performance criteria, both the applicant and the staff have analyzed the potential consequences of a number of postulated accidents. Some of these could lead to significant releases of radioactive materials to the environment, and calculations have been performed to estimate the potential radiological consequences to persons offsite. For each postulated initiating event, the potential radiological consequences cover a considerable range of values depending upon the particular course taken by the accident and the conditions, including wind direction and weather, prevalent during the accident.

In the safety analysis and evaluation of Fermi-2, three categories of accidents have been considered by the applicant and the staff. These categories are based upon their probability of occurrence and include (1) incidents of moderate frequency, that is, events that can reasonably be expected to occur during any year of operation, (2) infrequent accidents, that is, events that might occur once during the lifetime of the plant, and (3) limiting faults, that is, accidents not expected to occur but that have the potential for significant releases of radioactivity. The radiological consequences of incidents in the first category, also called anticipated operational occurrences, are discussed in Section 4. Some of the initiating events postulated in the second and third categories for Fermi-2 are shown in Table 6.2. These are designated design basis accidents in that specific design and operating features as described in Section 6.1.3.1 are provided to limit their potential radiological consequences. Approximate radiation doses that might be received by a person at the nearest site boundary are also shown in the table, along with a characterization of the time duration of the releases. The results shown in the table reflect the expectation that engineered safety and operating features designed to mitigate the consequences of the postulated accidents would function as intended. An important implication of this expectation is that the radioactive releases considered are limited to noble gases and radioiodines and that any other radioactive materials (for example, in particulate form) are not expected to be released. The results are also quasi-probabilistic in nature in the sense that the meteorological dispersion conditions are taken to be neither the best nor the worst for the site, but rather at an average value determined by actual site measurements. In order to contrast the results of these calculations with those using more pessimistic, or conservative, assumptions described below, the doses shown in Table 6.2 are sometimes referred to as "realistic" doses.

Table 6.2 Approximate 2-hr radiation doses from design basis accidents at exclusion area boundary[1]

Infrequent Accidents	Duration of Release	Whole Body Dose (rem)
Radioactive waste system failure:		
Equipment leakage or malfunction	< 2 hr	0.03
Release of waste-gas storage tank contents	< 2 hr	0.12
Release of liquid-waste storage contents	< 2 hr	<0.0005
Small-break LOCA[2]	hrs-days	<0.00005
Fuel handling accident (Fuel-cask crop)	< 2 hr	0.045
Limiting Faults		
Main steam line break	< 2 hr	0.0055
Control rod drop	hrs-days	0.0015
Large-break LOCA	hrs-days	0.0125

[1]Plant exclusion area boundary distance, 915 m.
[2]LOCA-Loss of Coolant Accident; the TMI-2 accident was one kind of a small-break LOCA.

Calculated population exposures for these events range from a small fraction of a person-rem to about 158 person-rem for the population within 80 km (50 mi) of the Fermi-2. These calculations for both individual and population exposures indicate that the risk of incurring any adverse health effects as a consequence of design basis accidents is exceedingly small. By comparison with the estimates of radiological impact for normal operations shown in Chapter 4, the staff also concludes that radiation exposures from design basis accidents are roughly comparable to the exposures to individuals and the population from normal station operations over the expected lifetime of the plant.

The staff has also carried out calculations to estimate the potential upper bounds for individual exposures from the same initiating accidents in Table 6.2 for the purpose of implementing the provisions of 10 CFR Part 100, "Reactor Site Criteria." The results of these calculations are reported in the staff safety evaluation report and include much more pessimistic (conservative or worst case) assumptions regarding the course taken by the accident and the prevailing conditions. These assumptions include much larger amounts of

radioactive material released by the initiating events, additional single failures in equipment, operation of ESFs in a degraded mode,* and very poor meteorological dispersion conditions.

The results of these calculations show that, for these events, the limiting whole-body exposures are not expected to exceed 14 rem to any individual at the site boundary. They also show that radioiodine releases have the potential for offsite exposures ranging up to about 68 rem to the thyroid. For such an exposure to occur, an individual would have to be located at a point on the site boundary where the radioiodine concentration in the plume has its highest value and inhale at a breathing rate characteristic of a person jogging, for a period of two hours. The health risk to an individual receiving such a thyroid exposure is the potential appearance of benign or malignant thyroid nodules in about 2 out of 100 cases, and the development of a fatal cancer in about 1 out of 1000 cases.

None of the calculations of the impacts of design basis accidents described in this section take into consideration possible reductions in individual or population exposures as a result of taking any protective actions.

6.1.4.2 Probabilistic Assessment of Severe Accidents

In this and the following three sections, there is a discussion of the probabilities and consequences of accidents of greater severity than the design basis accidents identified in the previous section. As a class, they are considered less likely to occur, but their consequences could be more severe, both for the plant itself and for the environment. These severe accidents, heretofore frequently called Class 9 accidents, can be distinguished from design basis accidents in two primary respects: they involve substantial physical deterioration of the fuel in the reactor core, including overheating to the point of melting, and they involve deterioration of the capability of the containment system to perform its intended function of limiting the release of radioactive materials to the environment.

The assessment methodology employed is that described in the Reactor Safety Study (RSS) which was published in 1975.[10]** However, the sets of accident sequences that were found in the RSS to be the dominant contributors to the risk in the prototype BWR (Peach Bottom Unit 2) have recently been updated[11] ("rebaselined"). The rebaselining has been done largely to incorporate peer group comments[12] and better data and analytical techniques resulting from research and development after the publication of the RSS. Entailed in the rebaselining effort was the evaluation of the individual dominant accident sequences-as they are understood to evolve. The earlier technique of grouping a number of accident sequences into the encompassing Release Categories, as was done in the RSS, has been largely eliminated.

*The containment system, however, is assumed to prevent leakage in excess of that which can be demonstrated by testing, as provided in 10 CFR Part 100.11(a).
**Because this report has been the subject of considerable controversy, a discussion of the uncertainties surrounding it is provided in Section 6.1.4.7.

Fermi Unit 2 is a General Electric-designed BWR having similar design and operating characteristics to the RSS-prototype BWR. Therefore, the present assessment for Fermi-2 has used as its starting point the rebaselined accident sequences and sequence groups referred to above and more fully described in Appendix G. Characteristics of the sequences (and sequence groups) used (all of which involve partial to complete melting of the reactor core) are shown in Table 6.3. Sequences initiated by natural phenomena such as tornadoes, floods, or seismic events and those that could be initiated by deliberate acts of sabotage are not included in these event sequences. The radiological consequences of such events would not be different in kind from those which have been treated. Moreover, it is the staff's judgment, based upon design requirements of 10 CFR Part 50, Appendix A, relating to effects of natural phenomena, and safeguards requirements of 10 CFR Part 73, that these events do not contribute significantly to risk.

Calculated probability per reactor year associated with each accident sequence (or sequence group) used is shown in the second column in Table 6.3. As in the RSS, there are substantial uncertainties in these probabilities. This is due, in part, to difficulties associated with the quantification of human error and to inadequacies in the data base on failure rates of individual plant components that were used to calculate the probabilities.[12] The probability of accident sequences from the Peach Bottom plant were used to give a perspective of the societal risk at Fermi-2 because, although the probabilities of particular accident sequences may be substantially different and even improved for Fermi-2, the overall effect of all sequences taken together is likely to be within the uncertainties (see Section 6.1.4.7 for a discussion of uncertainties in risk estimates).

The magnitudes (curies) of radioactivity releases for each accident sequence or sequence group are obtained by multiplying the release fractions shown in Table 6.3 by the amounts that would be present in the core at the time of the hypothetical accident. These are shown in Table 6.1 for the Fermi Unit 2 plant at the core thermal power level of 3430 megawatts.

The potential radiological consequences of these releases have been calculated by the consequence model used in the RSS[13] and adapted to apply to a specific site. The essential elements are shown in schematic form in Figure 6.1. Environmental parameters specific to the Fermi-2 site have been used and include the following:

(1) meteorological data for the site representing a full year of consecutive hourly measurements and seasonal variations

(2) projected population for the year 2000 extending throughout regions of 80 km (50 mi) and 560 km (350 mi) radius from the site (the latter region includes parts of Canada)

(3) the habitable land fraction within the 560 km (350-mi) radius

(4) land use statistics, on a state-wide basis, including farm land values, farm product values (including dairy production), and growing season information for the State of Michigan and each surrounding State within the 560-km (350-mi) region

Table 6.3 Summary of atmospheric releases in hypothetical accident sequences in a BWR (rebaselined)

Accident Sequence or Sequence Group[b]	Probability (reactor-yr^{-1})	Fraction of Core Inventory Released[a]						
		Xe-Kr	I	Cs-Rb	Te-Sb	Ba-Sr	Ru[c]	La[d]
$TC\gamma'$	2.0×10^{-6}	1.0	0.45	0.67	0.64	0.073	0.052	0.0083
$TW\gamma'$	3.0×10^{-6}	1.0	0.098	0.27	0.41	0.025	0.028	0.005
$TQUV\gamma'$ $AE\gamma'$ $S_1E\gamma'$ $S_2E\gamma'$	3.0×10^{-7}	1.0	0.095	0.3	0.36	0.034	0.027	0.005
$TC\gamma$	8.0×10^{-6}	1.0	0.07	0.14	0.12	0.015	0.01	0.002
$TW\gamma$	1.0×10^{-5}	1.0	0.003	0.11	0.083	0.011	0.007	0.001
$TQUV\gamma$ $AE\gamma$ $S_1E\gamma$ $S_2E\gamma$	1.0×10^{-6}	1.0	0.02	0.055	0.11	0.006	0.007	0.0013

(a) Background on the isotope groups and release mechanisms is presented in Appendix VII, WASH 1400 (Ref. 10).

(b) See Appendix G for description of the accident sequences and sequence groups.

(c) Includes Ru, Rh, Co, Mo, Tc.

(d) Includes Y, La, Zr, Nb, Ce, Pr, Nd, Np, Pu, Am, Cm.

NOTE: Please refer to Section 6.1.4.7 for a discussion of uncertainties in risk estimates.

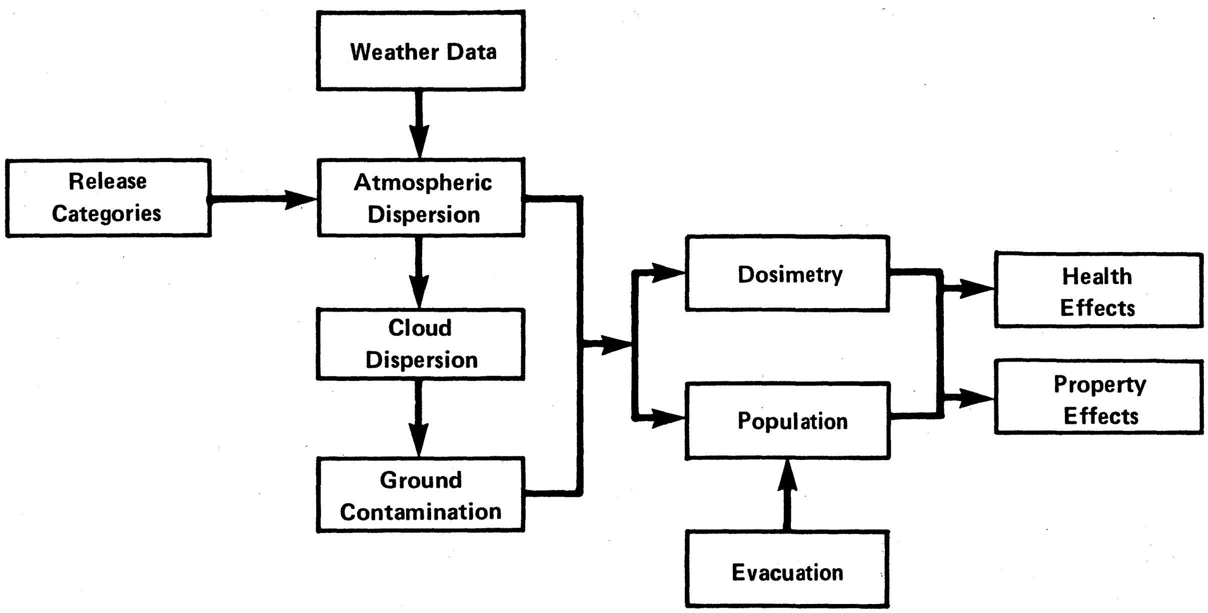


Figure 6.1 — Schematic Outline of Consequences Model

(5) land use statistics including farm land values, farm product values (including dairy production), and growing season information for the adjoining regions of Canada, within 560 km (350 mi), based on comparison with the values for the nearby states of the U.S.

To obtain a probability distribution of consequences the calculations are performed assuming the occurrence of each accident release sequence at each of 91 different "start" times throughout a one-year period. Each calculation utilizes the site-specific hourly meteorological data and seasonal information for the time period following each "start" time. The consequence model also contains provisions for incorporating the consequence-reduction benefits of evacuation and other protective actions. Early evacuation of people would considerably reduce the exposure from the radioactive cloud and the contaminated ground in the wake of the cloud passage. The evacuation model used (see Appendix H) has been revised from that used in the RSS for better site-specific application. The quantitative characteristics of the evacuation model used for the Fermi-2 site are best-estimate values made by the staff and based upon evacuation time estimates prepared for the applicant. Actual evacuation effectiveness could be greater or less than that characterized but would not be expected to be very much less.

The other protective actions include: (1) either complete denial of use (interdiction), or permitting use only at a sufficiently later time after appropriate decontamination of food stuffs such as crops and milk, (2) decontamination of severely contaminated environment (land and property) when it is considered to be economically feasible to lower the levels of contamination to protective action guide (PAG) levels, and (3) denial of use (interdiction) of severely contaminated land and property for varying periods of time until the contamination levels reduce to such values by radioactive decay and weathering so that land and property can be economically decontaminated as in (2) above. These actions would reduce the radiological exposure to the people from immediate and/or subsequent use of or living in the contaminated environment.

Early evacuation within the plume exposure pathway EPZ and other protective actions as mentioned above are considered as essential sequels to serious nuclear reactor accidents involving significant release of radioactivity to the atmosphere. Therefore, the results shown for Fermi-2 reactor include the benefits of these protective actions.

There are also uncertainties in the estimates of consequences, and the error bounds may be as large as they are for the probabilities. It is the judgment of the staff, however, that it is more likely that the calculated results are overestimates of consequences rather than underestimates.

The results of the calculations using this consequence model are radiological doses to individuals and to populations, health effects that might result from these exposures, costs of implementing protective actions, and costs associated with property damage by radioactive contamination.

6.1.4.3 Dose and Health Impacts of Atmospheric Releases

The results of the calculations of dose and health impacts performed for the Fermi Unit 2 facility and site are presented in the form of probability distributions in Figures 6.2, 6.3, 6.4, and 6.5 and are included in the impact Summary Table 6.4. All of the accident sequences and sequence groups shown in

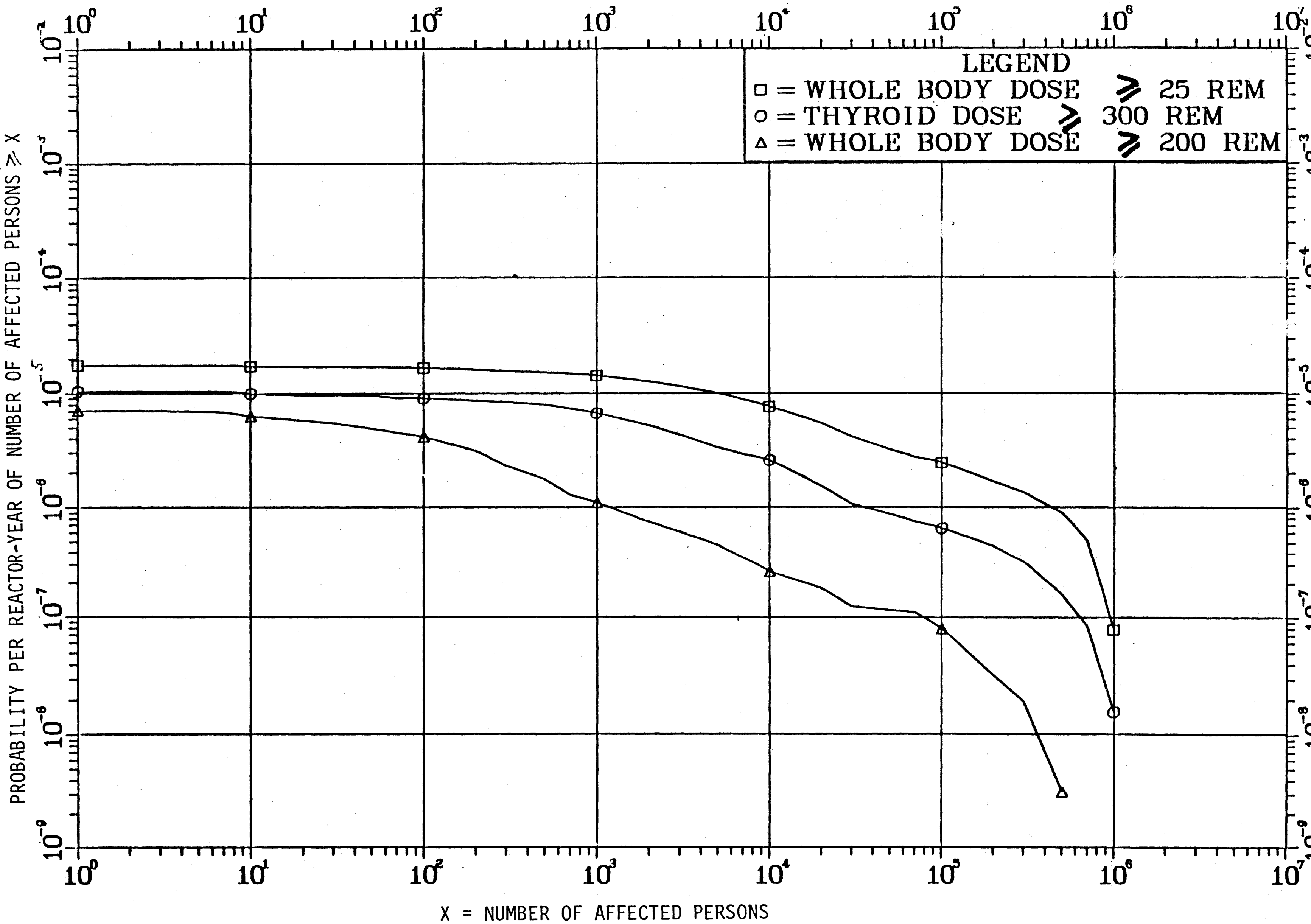


Figure 6.2 Probability distribution of individual dose impacts

Note: See Section 6.1.4.7 for a discussion of uncertainties in risk estimates.

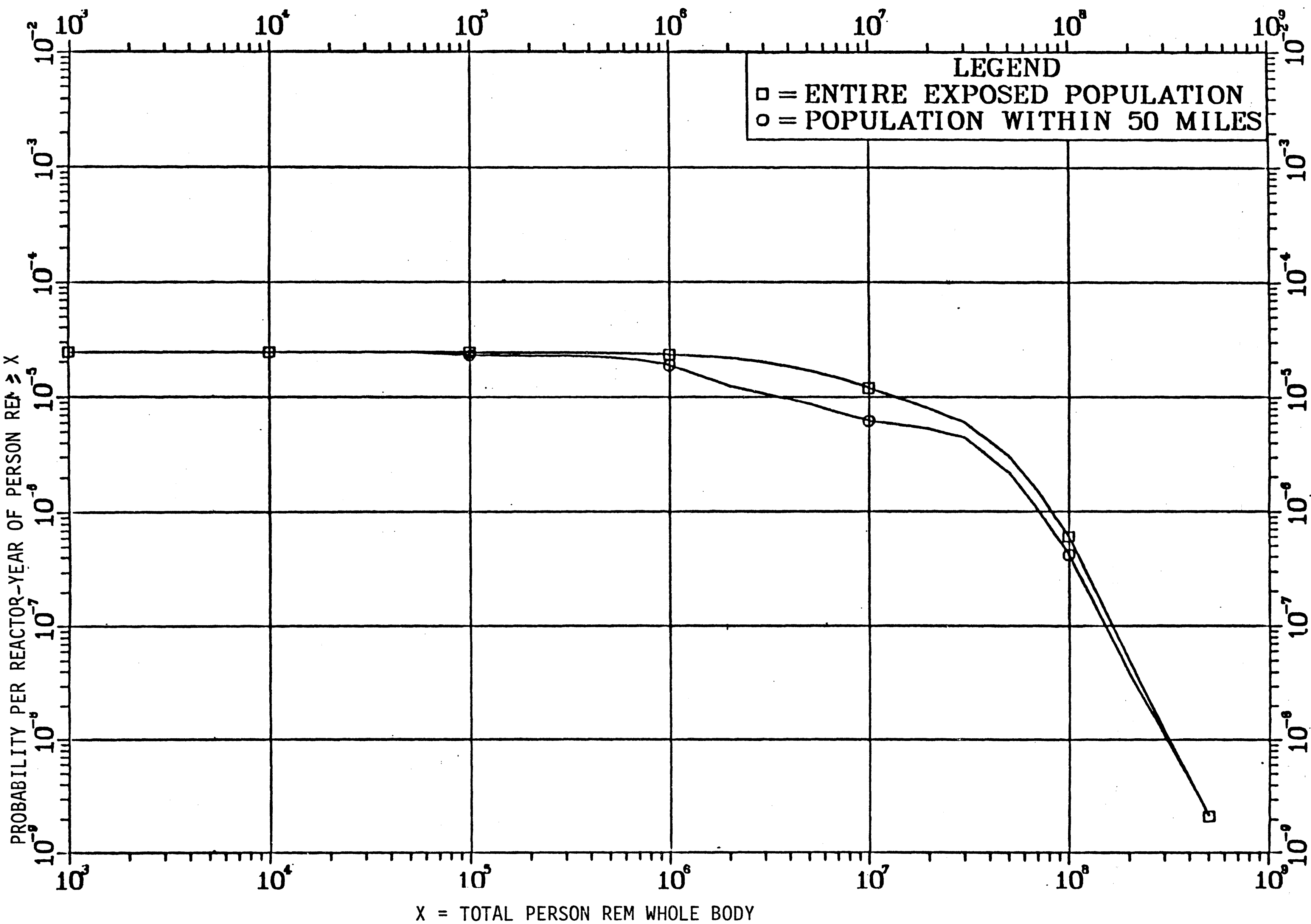


Figure 6.3 Probability distributions of population exposures

Note: See Section 6.1.4.7 for a discussion of uncertainties in risk estimates.

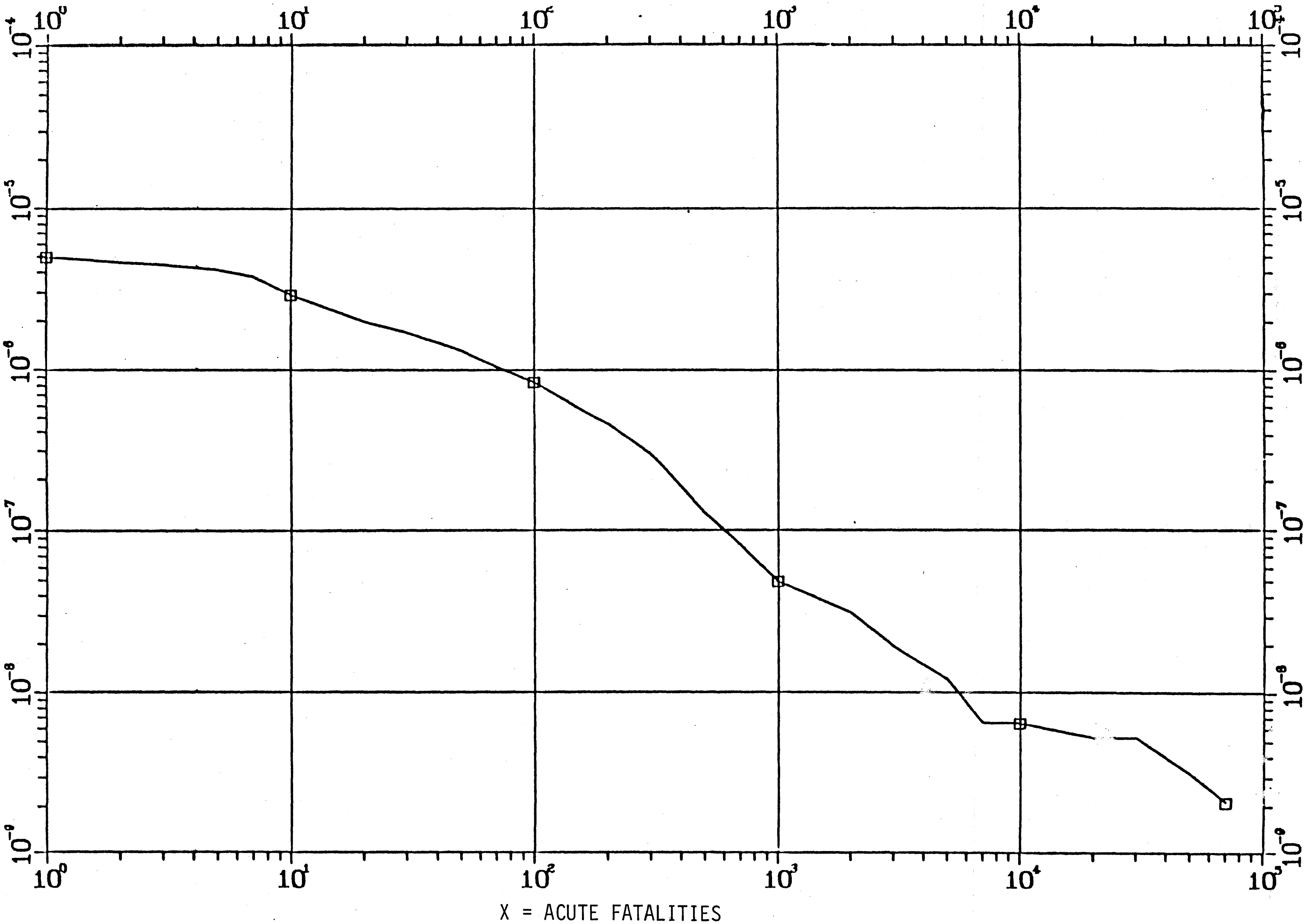


Figure 6.4 Probability distribution of acute fatalities

Note: See Section 6.1.4.7 for a discussion of uncertainties in risk estimates.

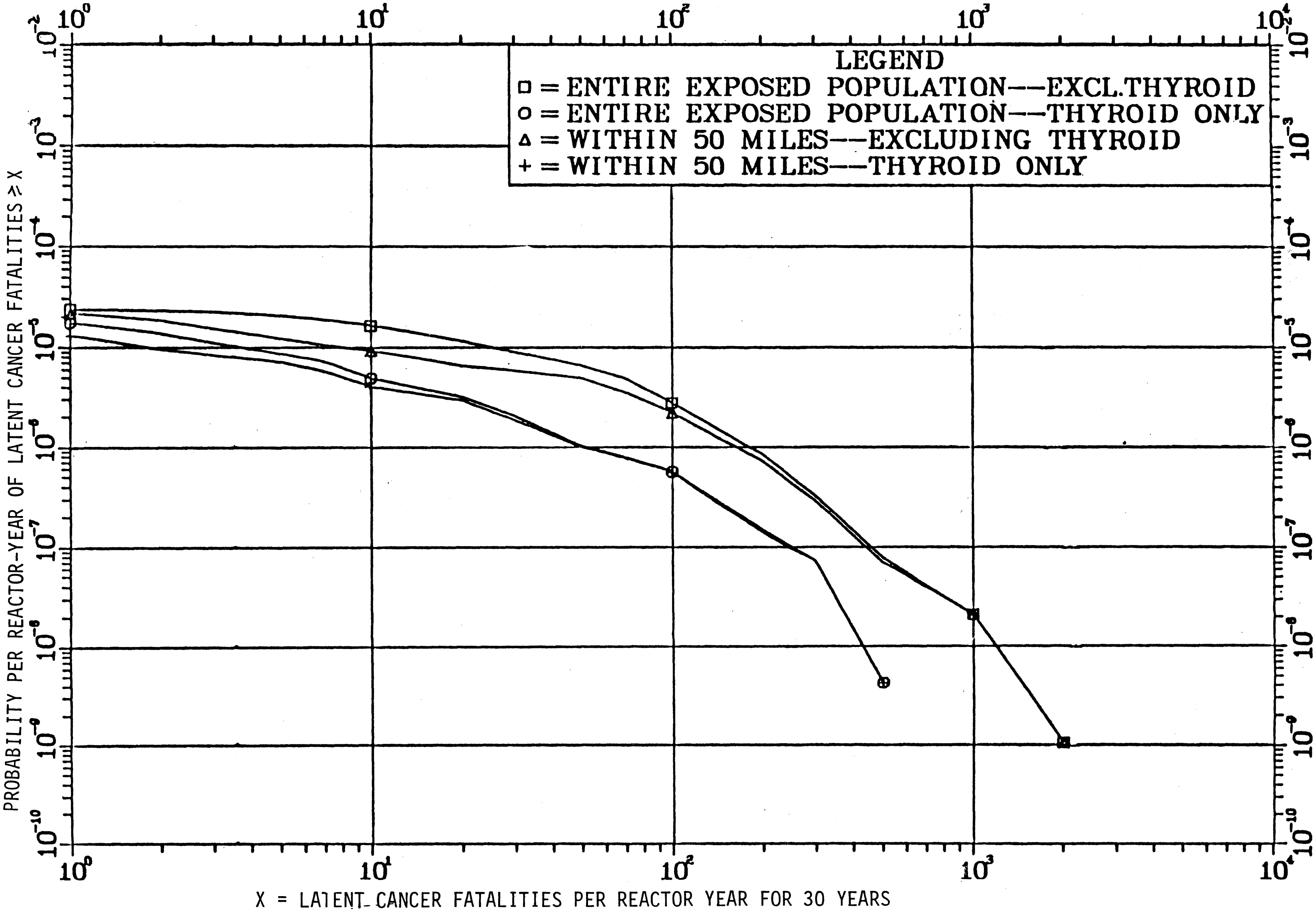


Figure 6.5 Probability distribution of cancer fatalities

Note: See Section 6.1.4.7 for a discussion of uncertainties in risk estimates.

Table 6.4 Summary of environmental impacts and probabilities

Probability of Impact Per Reactor-Year	Persons Exposed over 200 rem	Persons Exposed over 25 rem	Acute Fatalities	Population Exposure Millions of person-rem, 80 km/total	Latent* Cancers, 80 km/ total	Cost of Offsite Mitigating Actions ($ million)
10^{-4}	0	0	0	0/0	0/0	0
10^{-5}	0	5000	0	3.4/13	290/830	370
5×10^{-6}	55	25,000	1	22/34	1,600/2,300	1,300
10^{-6}	1,200	420,000	75	72/82	6,400/7,000	4,100
10^{-7}	80,000	920,000	600	150/160	20,000/21,000	17,000
10^{-8}	350,000	- - -	5,500	320/320	45,000/45,000	27,000
Related Figure	6.2	6.2	6.4	6.3	6.5	6.6

*Includes cancers of all organs. Thirty times the values shown in the Figure 6.5 are shown in this column reflecting the 30-year period over which cancers might occur. Genetic effects would be approximately twice the number of latent cancers.

NOTE: Refer to Section 6.1.4.7 for a discussion of uncertainties in risk estimates.

Table 6.5 Average values of environmental risks due to accidents per reactor-yr

Population exposure	
person-rem within 80 km	340
person-rem total	520
Acute fatalities	0.00074
Latent cancer fatalities	
all organs excluding thyroid	0.032
thyroid only	0.008
Cost of protective actions and decontamination	$23,000

Note: See Section 6.1.4.7 for discussions of uncertainties in risk estimates

Table 6.3 contribute to the results, the consequences from each being weighted by its associated probability.

Figure 6.2 shows the probability distribution for the number of persons who might receive whole body doses equal to or greater than 200 rem and 25 rem, and thyroid doses equal to or greater than 300 rem from early exposure,* all on a per-reactor-year basis. The 200-rem whole-body dose figure corresponds approximately to a threshold value for which hospitalization would be indicated for the treatment of radiation injury. The 25-rem whole body (which has been identified earlier as the lower limit for a clinically observable physiological effect) and 300-rem thyroid figures correspond to the Commission's guideline values for reactor siting in 10 CFR Part 100.

The figure shows in the left-hand portion that there are less than 2 chances in 100,000 (that is, 2×10^{-5}) per reactor-year that one or more persons may receive doses equal to or greater than any of the doses specified. The fact that the three curves run almost parallel in horizontal lines initially shows that if one person were to receive such doses, the chances are about the same that several tens to hundreds would be so exposed. The chances of larger numbers of persons being exposed at those levels are seen to be considerably smaller. For example, the chances are less than 1 in 10,000,000 (that is, 10^{-7}) per reactor year that 100,000 or more people might receive doses of 200 rem or greater. A majority of the exposures reflected in this figure

*Early exposure to an individual includes external doses from the radioactive cloud and the contaminated ground, and the dose from internally deposited radionuclides from inhalation of contaminated air during the cloud passage. Other pathways of exposure are excluded.

would be expected to occur to persons within a 32-km (20-mi) radius of the plant. Virtually all would occur within a 160-km (100-mi) radius.

Figure 6.3 shows the probability distribution for the total population exposure in person-rem, i.e., the probability per reactor-year that the total population exposure will equal or exceed the values given. Most of the population exposure up to 10 million person-rem would occur within 80 km (50 mi) but the more severe releases (as in the first three accident sequences or sequence groups in Table 6.3) would result in exposure to persons beyond the 80 km range as shown.

For perspective, population doses shown in Figure 6.3 may be compared with the annual average dose to the population within 80 km of the Fermi-2 site due to natural background radiation of 880,000 person-rem, and to the anticipated annual population dose to the general public from normal station operation of 67 person-rem (excluding plant workers) (Section 4.5, Tables 4.7 and 4.9).

Figure 6.4 shows the probability distributions for acute fatalities, representing radiation injuries that would produce fatalities within about one year after exposure. Virtually all of the acute fatalities would be expected to occur within the 32-km (20-mi) radius. The results of the calculations shown in this figure and in Table 6.4 reflect the effect of evacuation within the 16-km (10-mi) plume exposure pathway EPZ only. For the very low-probability accidents having the potential for causing radiation exposures above the threshold for acute fatality at distances beyond 16 km, it would be realistic to expect that authorities would evacuate persons at all distances at which such exposures might occur. Acute fatality consequences would therefore reasonably be expected to be very much less than the numbers shown. Figure H-1 of Appendix H illustrates the potential benefits of evacuation within 32 km.

Figure 6.5 represents the statistical relationship between population exposure and the induction of fatal cancers that might appear over a period of many years following exposure. The impacts on the total population and the population within 80 km are shown separately. Further, the fatal, latent cancers have been subdivided into those attributable to exposures of the thyroid and all other organs.

6.1.4.4 Economic and Societal Impacts

As noted in Section 6.1.1, the various measures for avoidance of adverse health effects, including those due to residual radioactive contamination in the environment, are possible consequential impacts of severe accidents. Calculations of the probabilities and magnitudes of such impacts for the Fermi Unit 2 facility and environs have also been made. Unlike the radiation exposure and health effect impacts discussed above, impacts associated with adverse health effects avoidance are more readily transformed into economic impacts.

The results are shown as the probability distribution for cost of offsite mitigating actions in Figure 6.6 and are included in the impact Summary Table 6.4. The factors contributing to these estimated costs include the following:

- evacuation costs
- value of crops contaminated and condemned
- value of milk contaminated and condemned
- costs of decontamination of property where practical
- indirect costs due to loss of use of property and incomes derived therefrom

The last named cost would derive from the necessity for interdiction to prevent the use of property until it is either free of contamination or can be economically decontaminated.

Figure 6.6 shows that at the extreme end of the accident spectrum these costs could exceed several billion dollars but that the probability that this would occur is exceedingly small, less than 1 chance in 100,000 per reactor-year.

Additional economic impacts that can be monetized include costs of decontamination of the facility itself and the costs of replacement power. Probability distributions for these impacts have not been calculated but they are included in the discussion of risk considerations in Section 6.1.4.6 below.

6.1.4.5 Releases to Groundwater

A pathway for public radiation exposure and environmental contamination that could be associated with severe reactor accidents was identified in Section 6.1.1.2. Consideration has been given to the potential environmental impacts of this pathway for Fermi Unit 2. The principal contributors to the risk are the core-melt accidents. The penetration of the basemat of the containment building can release molten core debris to the strata beneath the plant. The soluble radionuclides in the debris can be leached and transported with groundwater to downgradient domestic wells used for drinking water or to surface water bodies used for drinking water, aquatic food, and recreation. Releases of radioactivity to the groundwater underlying the site could also occur via depressurization of the containment atmosphere or contaminated ECCS and suppression pool water through the failed containment.

An analysis of the potential consequences of a liquid pathway release of radioactivity for generic sites was presented in the "Liquid Pathway Generic Study" (LPGS).[14] The LPGS compared the risk of accidents involving the liquid pathway (drinking water, irrigation, aquatic food, swimming, and shoreline usage) for four conventional, generic land-based nuclear plants and a floating nuclear plant, for which the nuclear reactor would be mounted on a barge and moored in a water body. Parameters for each generic land-based site were chosen to represent averages for a wide range of real sites and were thus "typical" but represented no real sites in particular. The discussion in this section is a summary of an analysis performed to determine whether or not the liquid pathway consequences of a postulated accident at the Fermi-2 site would be unique when compared to the generic Great Lakes land-based site considered in the LPGS. The method of comparison consists of a direct scaling up or down of the LPGS population doses based on the relative values of key parameters characterizing the LPGS Great Lakes site and the Fermi-2 site. The parameters

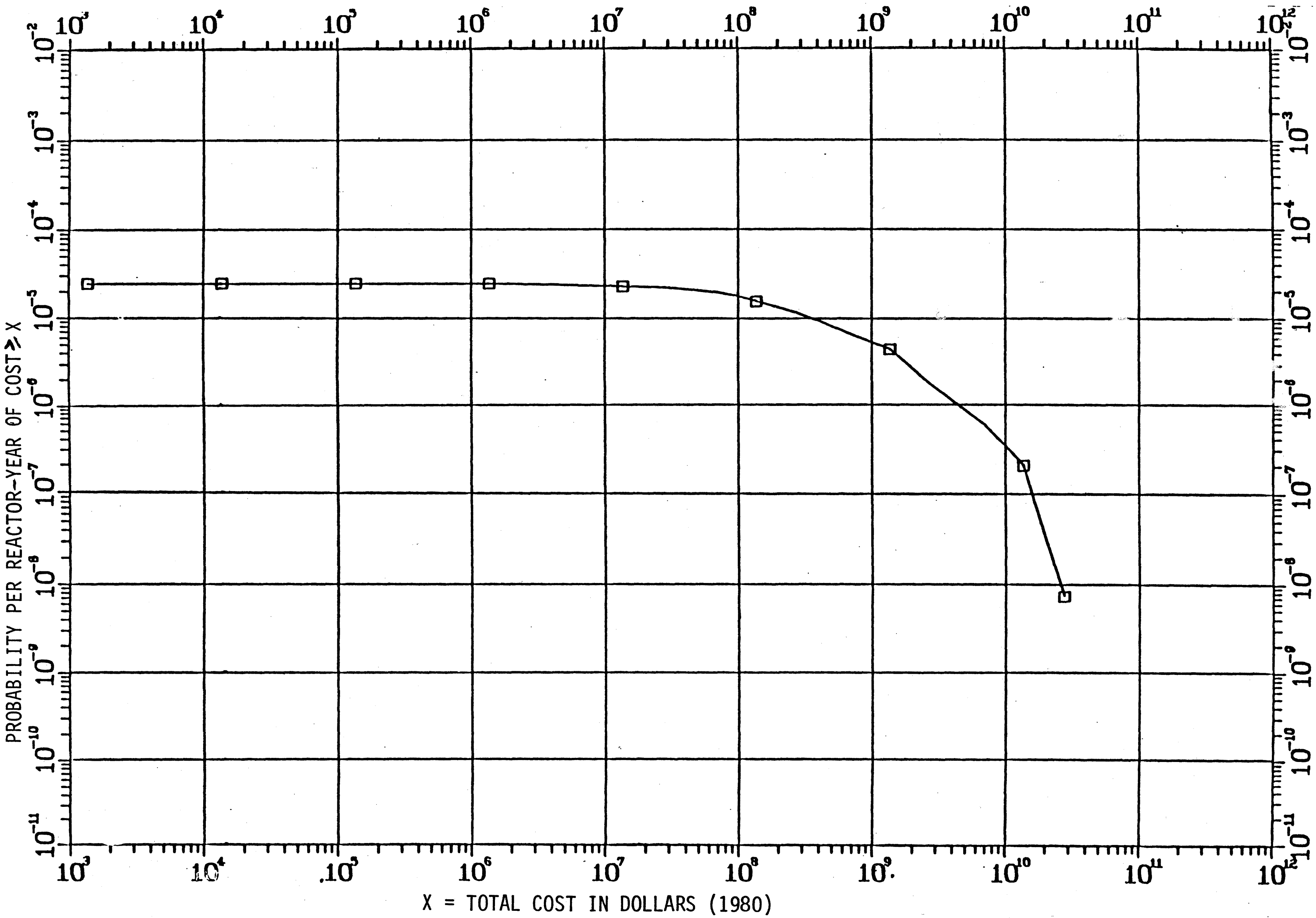


Figure 6.6 Probability distribution of mitigation measures cost

Note: See Section 6.1.4.7 for discussion of uncertainties in risk estimates.

which were evaluated include the amounts and rate of release of radioactive materials to the ground, groundwater travel time, sorption on geological media, surface water transport, drinking water usage, aquatic food consumption, and shoreline usage.

All of the reactors considered in the LPGS were Westinghouse PWRs with ice condenser containments. There are likely to be significantly different mechanisms and probabilities of releases of radioactivity for the Fermi-2 BWR. The staff is not aware of any studies which indicate the probabilities or magnitudes of liquid releases for BWRs. It is unlikely however that the liquid release for a BWR would be any larger than that conservatively estimated for similarly sized PWRs in the LPGS. The source term used for Fermi-2 in this comparison, therefore, is assumed to be equal to that used in the LPGS.

Doses to individuals and populations were calculated in the LPGS without consideration of interdiction methods such as isolating the contaminated groundwater or denying use of the water. In the event of surface water contamination, alternative sources of water for drinking, irrigation, and industrial uses would be expected to be found, if necessary. Commercial and sports fishing, as well as many other water-related activities might be restricted. The consequences would, therefore, be largely economic or social, rather than radiological. In any event, the individual and population doses for the liquid pathway range from fractions to very small fractions of those that can arise from the airborne pathways.

The Fermi-2 site is located on the western shore of Lake Erie. The site area is presently a lagoon separated from the lake by a barrier beach that forms the eastern boundary of the site. The lagoon is connected to Lake Erie by Swan Creek, a perennial stream. Groundwater at the site exists in bedrock formations which are overlain by thick and highly impermeable till and lacustrine clay deposits. The bed rock is fractured, locally vuggy dolomite of Silurian age, and is about 30 m (100 ft) thick in the site area.

The foundations of the containment building are in the dolomite bedrock. Contaminants released in a core-melt accident would be initially deposited in the bedrock and be transported in the direction of the lake by the natural groundwater movement. There are no groundwater users downgrade of the site. Groundwater in the fractured dolomite enters the lake by diffusing vertically upward through several feet to tens of feet of lake sediments which are of low permeability. The bedrock outcrops into the lake approximately 500 m (1600 ft) offshore, and is covered by lake deposits. The contaminated ground water would therefore enter the lake over a wide diffuse region spanning from the shore line to the outcropping of the dolomite 500 m offshore.

The minimum distance which must be traveled by the contaminated groundwater before it can enter the lake is about 145 m (460 ft). From the range of measured physical properties of the fractured dolomite aquifer the staff estimated the ground water travel time to the shoreline to range between 2 and 20 yr. Transport times tending toward the higher end of this range have been independently inferred from site dewatering data. For groundwater travel times of several years or longer, the most important contributors to population dose are Cs-137 and Sr-90. Values of retardation factors, which reflect the

effects of sorption of the radionuclides within the aquifer, were conservatively estimated to be 23 for Sr and 219 for Cs. The minimum travel times therefore range from about 43 to 430 yr for Sr-90 and 438 to 4380 yr for Cs-137. This compares to a travel time of 5.7 yr for Sr-90 and 51 yr for Cs-137 employed in the LPGS. The quantity of Sr-90 which could enter the lake in the Fermi-2 case would, therefore, be diminished, due to radioactive decay, by at least a factor of 2.4. Virtually no Cs-137 could enter the lake before decaying.

In the case of the LPGS Great Lakes site, approximately 51% of the calculated population dose was from drinking water ingestion, 49% from shoreline exposure and 1% from fish ingestion. Virtually all the population dose in this case was due to only two isotopes, Sr-90 and Cs-137. Strontium-90 was responsible for about 91% of the dose in drinking water and 36% of the dose from fish consumption. Almost all of the beach shine was due to Cs-137 alone.

Since in the Fermi-2 case virtually none of the Cs-137 can reach the lake via the liquid pathway, the shoreline exposure pathway will be negligibly small and can be eliminated from further consideration. It is also clear that the drinking water pathway could far outweigh the fish consumption pathway. The doses at the Fermi-2 site can, therefore, be based on the drinking water pathway alone with little loss of generality.

The LPGS dose estimates were based on Lake Ontario hydrology and a U.S. population served of 2.0 million. Radioactivity contaminated water released from the Fermi-2 plant would affect the drinking water of both Lake Erie and Lake Ontario. Lake Erie has a smaller volume than Lake Ontario but a similar flowrate. If the effects of sediment scavanging, which is unimportant for Sr-90, are neglected Lake Erie would be about 1.3 times as effective as Lake Ontario in transmitting dose per capita, based on the concentrations in both lakes. About 94% of the Sr-90 discharged to Lake Erie would eventually enter Lake Ontario and thereby affect the population served there. The U.S. populations affected in the Fermi-2 case would be approximately 9.5 million in Lake Erie and 1.9 million in Lake Ontario. For this case, therefore, the relative population dose inflicted on the U.S. population from the drinking water pathway could be about 7 times greater for each curie of Sr-90 discharged at the Fermi-2 site than at the LPGS Great Lakes site. This ratio would be smaller if Canadian populations using the lakes were also taken into account in both the Fermi-2 and LPGS cases.

The staff estimated an upper limit of total body population dose for the postulated liquid release accident at Fermi-2 of about 1.4 times greater than the LPGS case. This is based on the relatively larger population served but relatively smaller release to the lake in the former case. The staff believes this ratio to be highly conservative because the most pessimistic values were chosen for groundwater velocity, retardation and travel distance between the site and the lake. The inclusion of the Canadian populations would have further reduced this ratio.

The Fermi-2 liquid pathway contribution to population dose, therefore, has been demonstrated to be of the same order of magnitude as that predicted for the LPGS Great Lakes site. Thus the Fermi-2 site is not unique in its liquid pathway contribution to risk.

Finally, there are measures which could be taken to minimize the impact of the liquid pathway. The staff estimated that the minimum ground water travel time from the Fermi-2 site to Lake Erie would be about 2 yr, and that the holdup of much of the radioactivity would be even greater. This would allow ample time for engineering measures such as slurry walls and well point dewatering to isolate the radioactive contamination near the source.

6.1.4.6 Risk Considerations

The foregoing discussions have dealt with both the frequency (or likelihood of occurrence) of accidents and their impacts (or consequences). Since the ranges of both factors are quite broad, it is also useful to combine them to obtain average measures of environmental risk. Such averages can be particularly instructive as an aid to the comparison of radiological risks associated with accident releases and with normal operational releases.

A common way in which this combination of factors is used to estimate risk is to multiply the probabilities by the consequences. The resultant risk is then expressed as a number of consequences expected per unit of time. Such a quantification of risk does not at all mean that there is universal agreement that peoples' attitudes about risk, or what constitutes an acceptable risk, can or should be governed solely by such a measure. At best, it can be a contributing factor to a risk judgment, but not necessarily a decisive factor.

Table 6.5 shows average values of risk associated with population dose, acute fatalities, latent fatalities, and costs for evacuation and other protective actions. These average values are obtained by summing the probabilities multiplied by the consequences over the entire range of distributions. Since the probabilities are on a per-reactor-year basis, the averages shown are also on a per-reactor-year basis.

The population exposures and latent cancer fatality risks may be compared with those for normal operation shown in Section 4.5. The comparison (excluding exposure to the plant personnel) shows that the accident risks are comparable to those for normal operation.

There are no acute fatality nor economic risks associated with protective actions and decontamination for normal releases; therefore, these risks are unique for accidents. For perspective and understanding of the meaning of the acute fatality risk of 0.00074/yr; however, it should be noted that a good approximation of the population at risk is that within about 16 km (10 mi) of the plant, about 195,000 persons in the year 2000. Accidental fatalities per year for a population of this size, based upon overall averages for the United States, are approximately 43 from motor vehicle accidents, 15 from falls, 6 from drowning, 5.7 from burns, 2.3 from firearms (Reference 4, p. 577).

Figure 6.7 shows the calculated risk expressed as whole-body dose to an individual from early exposure as a function of the distance from the plant within the plume exposure pathway EPZ. The values are on a per-reactor-year basis and all accident sequences and sequence groups in Table 6.3 contributed to the dose, weighted by their associated probabilities.

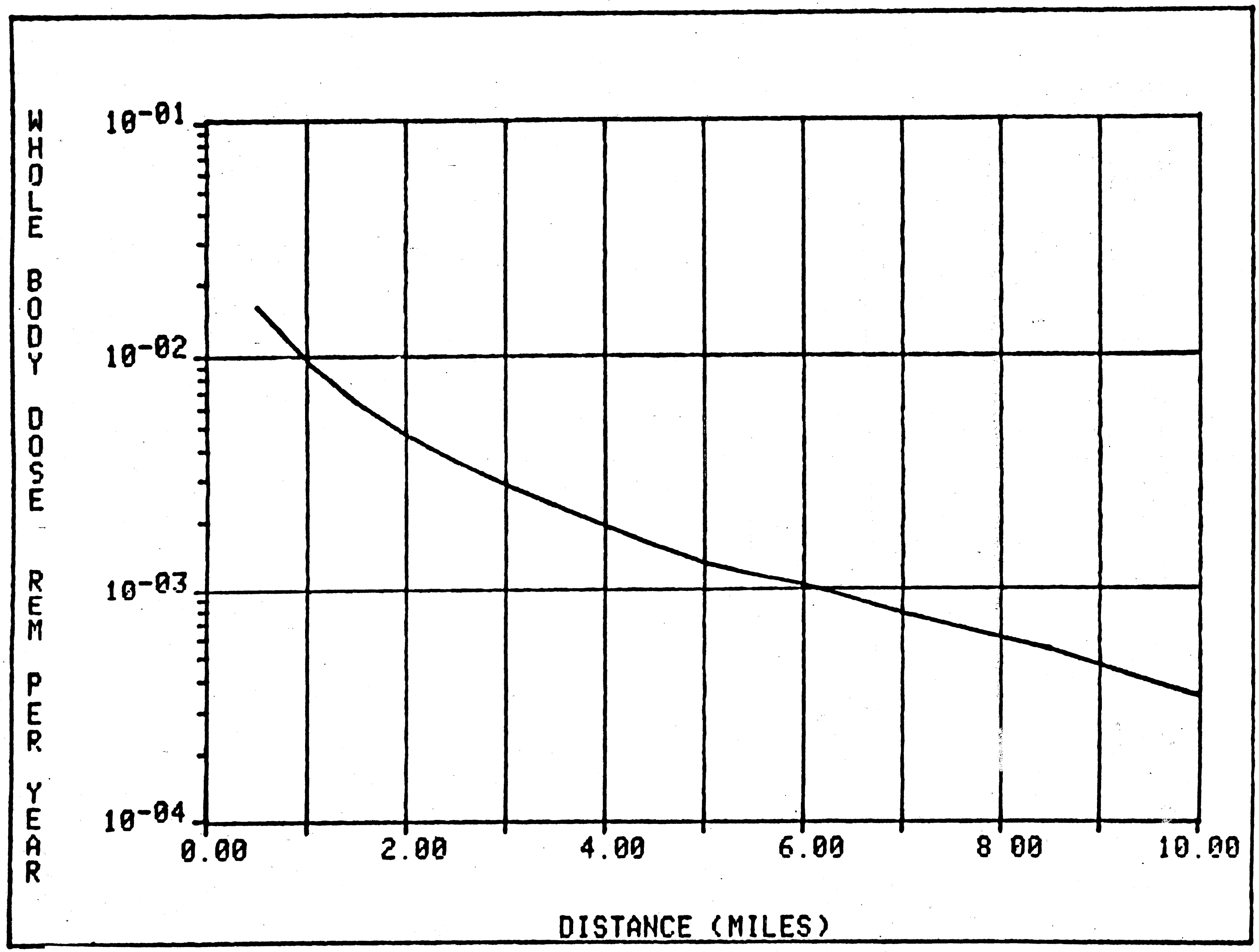


Figure 6.7 Individual risk of dose as a function of distance

Note: See Section 6.1.4.7 for a discussion of uncertainties in risk estimates.

Evacuation and other protective actions reduce the risks to an individual of acute and latent cancer fatalities. Figures 6.8 and 6.9, respectively, show curves of constant risks per reactor-year to an individual, living within the plume exposure pathway EPZ of the Fermi-2 plant, of acute death and of death from latent cancer as functions of distance due to potential accidents in the reactor. Directional variation of these curves reflect the variation in the average fraction of the year the wind would be blowing into different directions from the plant. For comparison the following risks of fatality per year to an individual living in the U.S. may be noted (Reference 4, p. 577): automobile accident, 2.2×10^{-4}; falls, 7.7×10^{-5}; drowning, 3.1×10^{-5}; burning, 2.9×10^{-5}; and fire arms, 1.2×10^{-5}.

The economic risk associated with evacuation and other protective actions could be compared with property damage costs associated with alternative energy generation technologies. The use of fossil fuels (coal or oil, for example) would emit substantial quantities of sulfur dioxide and nitrogen oxides into the atmosphere, and, among other things, lead to environmental, and ecological damage through the phenomenon of acid rain (Reference 4, p. 559-560). This effect has not, however, been sufficiently quantified to draw a useful comparison at this time.

There are other economic impacts and risks that can be monetized that are not included in the cost calculations discussed in Section 6.1.4.4. These are accident impacts on the facility itself that result in added costs to the public, that is, ratepayers, taxpayers, and/or shareholders. These are costs associated with decontamination of the facility and costs for replacement power.

No detailed methodology has been developed for estimating the contribution to economic risk to the licensee associated with cleanup and decontamination of a nuclear power plant that has undergone a serious accident, toward either a decommissioning or a resumption of operation. Experience with such costs is currently being accumulated as a result of the Three Mile Island accident. It is already clear, however, that such costs can approach or even exceed the original capital cost of such a facility. In addition to damage to or loss of the facility resulting from accidents, the other major additional cost is that of replacement power.

These costs are affected by the point in the lifetime of the plant at which an accident might occur. The present worth cost is highest for an accident occurring at the beginning of the plant operating life and decreasing over the plant life. It is assumed for these calculations that a totally disabling accident occurs at Fermi-2, and that it is decontaminated and brought back to service after 8 years at a cost of one billion dollars. For illustrative purposes, the costs and economic risk have been estimated for the 1093 megawatt (electric) Fermi-2 plant by postulating the accident in the first year of a projected 30-yr operating life. Net replacement power cost of 33.5 mills/kwh is assumed as the difference between fuel oil/coal costs and nuclear fuel costs. The applicant operates both coal and oil plants. Because coal plants cost less to operate, they are likely to already be fully used, and much of the additional capacity would come from oil-fired plants. Using a 60% capacity factor, the annual cost of replacement power would be $193 million for the unit in 1984

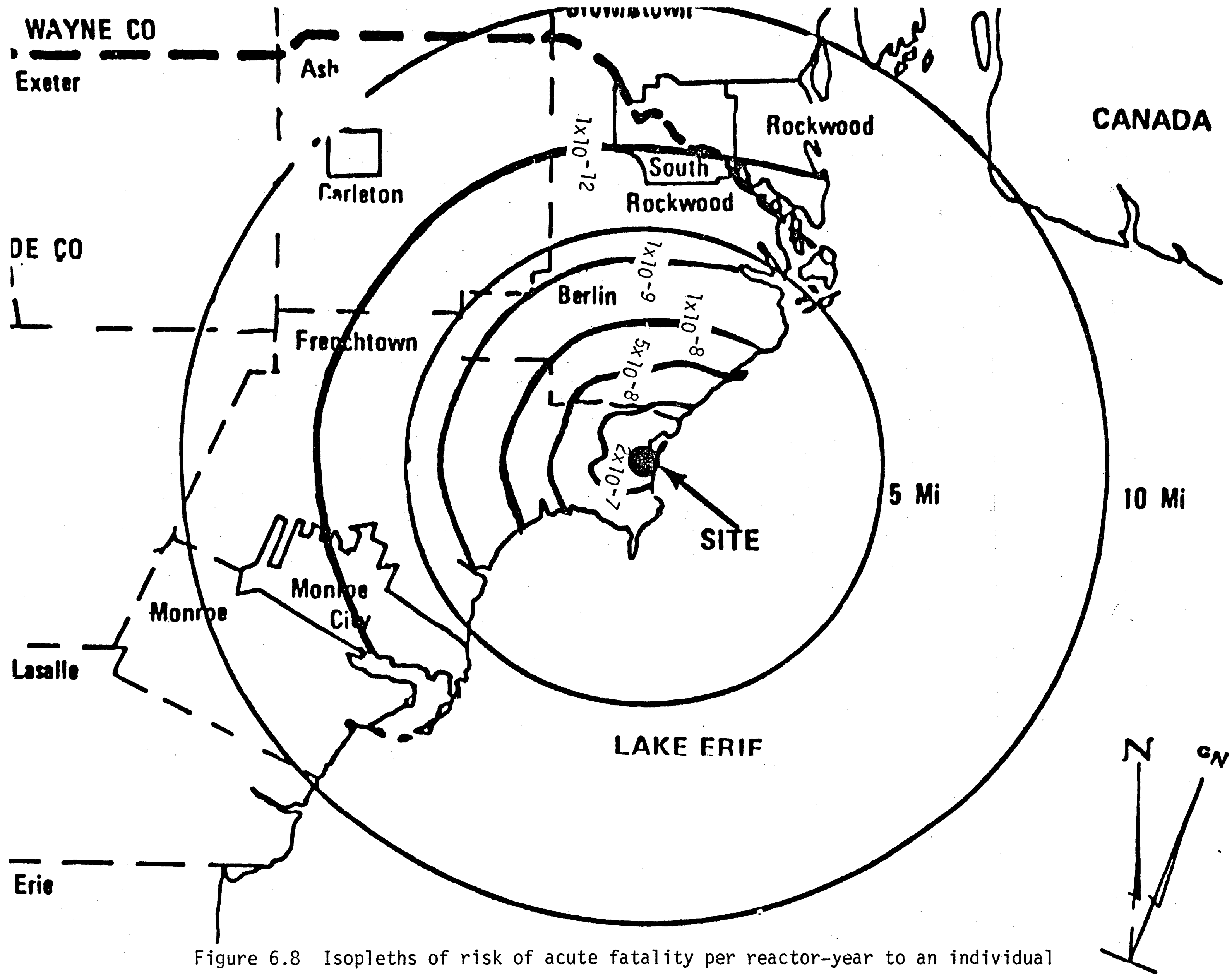


Figure 6.8 Isopleths of risk of acute fatality per reactor-year to an individual

Note: See Section 6.1.4.7 for discussion of uncertainties in risk estimates.

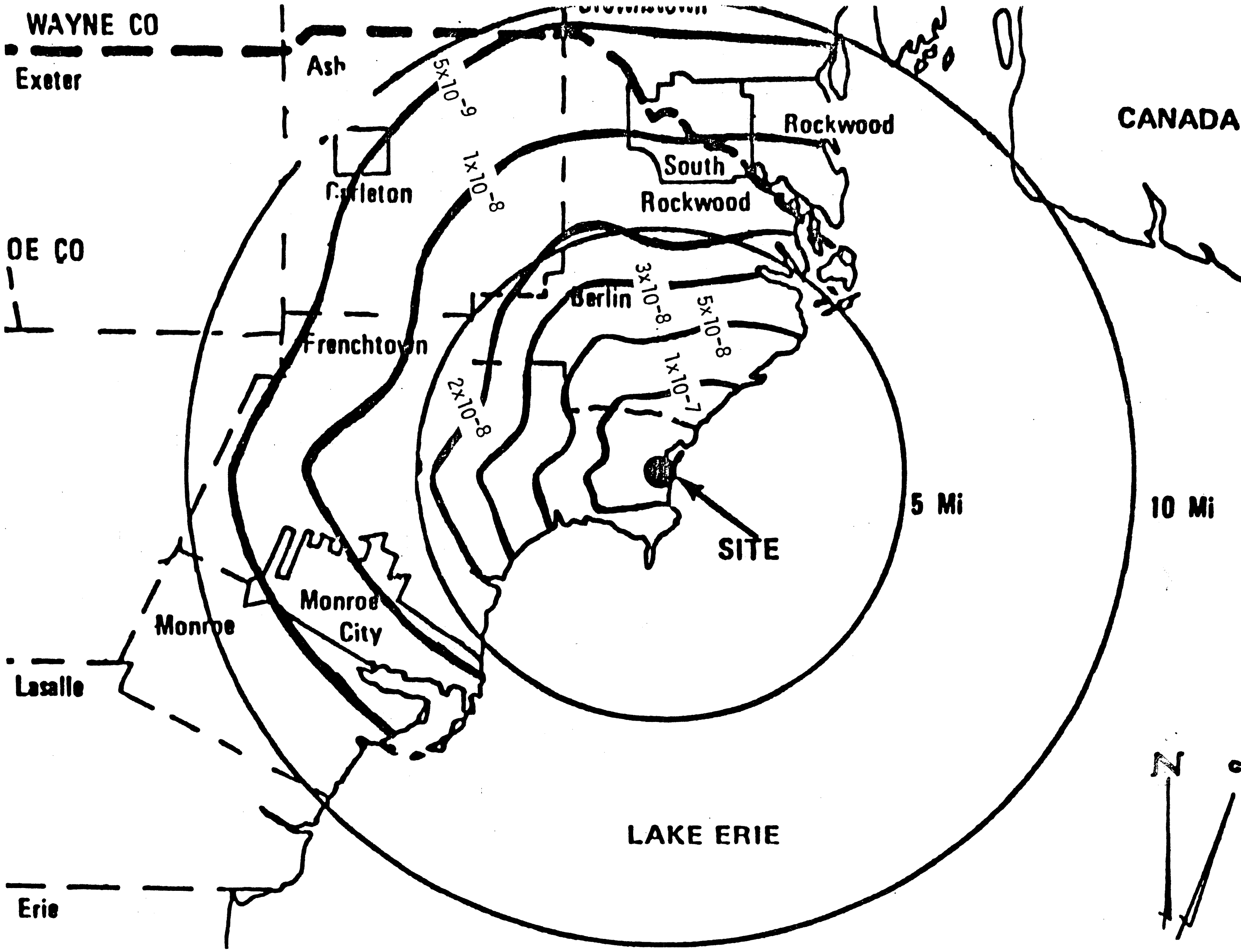


Figure 6.9 Isopleths of risk of latent cancer fatality per reactor-year to an individual

Note: See Section 6.1.4.7 for a discussion of uncertainties in risk estimates.

dollars. The additional capital costs as a result of the decontamination and cleanup are about $63 million per year, spread over 22 years, in 1980 dollars.

If the probability of sustaining a total loss of the original facility is taken as the probability of the occurrence of a core melt accident (approximated by the sum of the probabilities for the accident sequences and sequence groups in Table 6.3, that is, about 2.4 chances in 100,000 per year), then the average contribution to economic risk that would result from a loss early in the operating life of Fermi-2 is about $6,200 per year until the damaged unit is returned to service and $1,500 per year additional capital costs for the assumed remaining 22 years of plant service. A worse situation, not evaluated here, is one where the plant must be decontaminated for safety reasons, but is not put back in operation. A new plant then has to be built. Decontamination cost in that case, however, should be somewhat less than the case where the plant is made suitable for operation.

6.1.4.7 Uncertainties

The foregoing probabilistic and risk assessment discussion has been based upon the methodology presented in the Reactor Safety Study (RSS)[8] which was published in 1975.

In July 1977, the NRC organized an Independent Risk Assessment Review Group to (1) clarify the achievements and limitations of the Reactor Safety Study, (2) assess the peer comments thereon and the responses to the comments, (3) study the current state of such risk assessment methodology, and (4) recommend to the Commission how and whether such methodology can be used in the regulatory and licensing process. The results of this study were issued September 1978.[12] This report, called the Lewis Report, contains several findings and recommendations concerning the RSS. Some of the more significant findings are summarized below.

(1) A number of sources of both conservatism and nonconservatism in the probability calculations in RSS were found which were very difficult to balance. The Review Group was unable to determine whether the overall probability of a core melt given in the RSS was high or low, but they did conclude that the error bands were understated.

(2) The methodology, which was an important advance over earlier methodologies that had been applied to reactor risk, was sound.

(3) It is very difficult to follow the detailed thread of calculations through the RSS. In particular, the Executive Summary is a poor description of the contents of the report, should not be used as such, and has lent itself to misuse in the discussion of reactor risk.

On January 19, 1979, the Commission issued a statement of policy concerning the RSS and the Review Group Report. The Commission accepted the findings of the Review Group.

The accident at Three Mile Island occurred in March 1979 at a time when the accumulated experience record was about 400 reactor years. It is of interest to note that this was within the range of frequencies estimated by the RSS for an accident of this severity (Reference 4, p. 553). It should also be noted that the Three Mile Island accident has resulted in a very comprehensive evaluation of reactor accidents like that one, by a significant number of investigative groups both within NRC and outside of it. Actions to improve the safety of nuclear power plants have come out of these investigations, including those from the President's Commission on the Accident at Three Mile Island, and NRC staff investigations and task forces. A comprehensive "NRC Action Plan Developed as a Result of the TMI-2 Accident" (NUREG-0660, Vol. I, May 1980) collects the various recommendations of these groups and describes them under the subject areas of Operational Safety; Siting and Design; Emergency Preparedness and Radiation Effects; Practices and Procedures; and NRC Policy, Organization, and Management. The action plan presents a sequence of actions, some already taken, that will result in a gradually increasing improvement in safety as individual actions are completed. The Fermi-2 plant is receiving and will continue to receive the benefit of these actions on the schedule indicated in NUREG-0660. The improvement in safety from these actions has not been quantified, however, and the radiological risk of accidents discussed in this section does not reflect these improvements.

6.1.5 Conclusions

The foregoing sections consider the potential environmental impacts from accidents at the Fermi-2 facility. These have covered a broad spectrum of possible accidental releases of radioactive materials into the environment by atmospheric and groundwater pathways. Included in the considerations are postulated design basis accidents and more severe accident sequences that lead to a severely damaged reactor core or core melt.

The environmental impacts that have been considered include potential radiation exposures to individuals and to the population as a whole, the risk of near- and long-term adverse health effects that such exposures could entail, and the potential economic and societal consequences of accidental contamination of the environment. These impacts could be severe but the likelihood of their occurrence is judged to be small. This conclusion is based on (1) the fact that considerable experience has been gained with the operation of similar facilities without significant degradation of the environment, (2) the fact that, in order to obtain a license to operate the Fermi-2 facility, it must comply with the applicable Commission regulations and requirements, and (3) a probabilistic assessment of the risk based upon the methodology developed in the Reactor Safety Study. The overall assessment of environmental risk of accidents, assuming protective action, shows that it is roughly comparable to the risk from normal operation although accidents have a potential for acute fatalities and economic costs that cannot arise from normal operations. The risks of acute fatality from potential accidents at the site are small in comparison with risks of acute fatality from other human activities in a comparatively sized population.

The staff concluded that there are no special or unique circumstances about the Fermi-2 site and environs that would warrant special or mitigation features for the Fermi-2 plant.

6.2 References

Documents marked with an asterisk (*) are available from the NRC/GPO Sales Program, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, and the National Technical Information Service (NTIS), Springfield, VA 22161. Documents marked with two asterisks (**) are available for inspection and copying for a fee in the NRC Public Document Room, 1717 H Street NW., Washington, D.C. 20555. Except as specifically noted, all other documents can be found in public technical libraries.

1. Statement of Interim Policy, "Nuclear Power Plant Accident Considerations Under the National Environmental Policy Act of 1979," 45 Federal Register 40101-40104, June 13, 1980.

2. Detroit Edison Co., "Final Safety Analysis Report for the Fermi Unit No. 2," Docket No. 50-341, April 4, 1975, as amended.**

3. U.S. Nuclear Regulatory Commission, "Safety Evaluation Report related to the operation of Enrico Fermi Nuclear Power Plant, Unit 2," USNRC Report NUREG-0798, July 1981.

4. "Energy in Transition 1985 - 2010," Final Report of the Committee on Nuclear and Alternative Energy Systems (CONAES), National Research Council, Chapter 9, pp 517-534 1979 (also C. E. Land, Science, 209, September 12, 1980).

5. BEIR Report, "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," Advisory Committee on the Biological Effects of Ionizing Radiation, National Academy of Sciences/National Research Council, November 1972 (available from NTIS).

6. BEIR Report, "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," Committee on the Biological Effects of Ionizing Radiations (BEIR III), National Academy of Science/National Research Council, July 1980 (available from NTIS).

7. H. W. Bertini and others, "Descriptions of Selected Accidents that Have Occurred at Nuclear Reactor Facilities," Nuclear Safety Information Center, Oak Ridge National Laboratory, ORNL/NSIC-176, April 1980; also, "Evaluation of Steam Generator Tube Rupture Accidents," L. B. Marsh, NUREG-0651, March 1980.*

8. "Three Mile Island - A Report to the Commissioners and the Public," Vol. I Summary Section 9, Mitchell Rogovin, Director, Nuclear Regulatory Commission Special Inquiry Group, January 1980.**

9. "Report of the President's Commission on the Accident at Three Mile Island," Commission Findings B, Health Effects, October 1979.**

10. U.S. Nuclear Regulatory Commission, "Reactor Safety Study," WASH-1400 (NUREG-75/014), October 1975 (available from NTIS).

11. "Task Force Report on Interim Operation of Indian Point," USNRC Report NUREG-0715, August 1980.*

12. H. W. Lewis and others, "Risk Assessment Review Group Report to the U. S. Nuclear Regulatory Commission," USNRC Report NUREG-CR-0400, September 1978.*

13. "Overview of the Reactor Safety Study Consequences Model," USNRC Report NUREG-0340, October 1977.*

14. "Liquid Pathway Generic Study," USNRC Report NUREG-0440, February 1978.*

7 ALTERNATIVES TO THE PROPOSED ACTION

7.1 Résumé

During the construction permit stage of the licensing process, the staff thoroughly analyzed alternative sites, alternative plant designs, and alternative sources of generation, including the alternative of not adding new production capacity. The staff concluded that additional capacity was needed and that the Fermi Unit 2 Nuclear Station (Fermi-2), at a specified site and of a specified design, was acceptable from an environmental perspective. Since that time, Fermi-2 has been constructed. Moreover, in February 1977 a 20 percent ownership interest was sold to the Northern Michigan and the Wolverine Electric Coöperatives. Many of the economic and environmental costs associated with the plant have already been incurred and must be viewed as "sunk costs" in any future directed assessment. As a result, the number of alternatives available at the operating license stage of the licensing process is significantly less. Essentially, the staff's assessment of alternatives is limited to a determination as to whether or not Fermi-2 should be permitted to operate.

When the FES-CP was issued in July 1972, the staff concluded that Fermi-2 should be allowed to operate to ensure, among other things, the reliability of service on the Detroit Edison (DEC) and Consumers Power Co. (CP) systems (collectively the Michigan Electric Coordinated System (MECS)). At that time, Fermi-2 was scheduled to begin commercial operation in October 1975. This online date was predicated on an expected growth rate in peak demand on the Detroit Edison system of about 7.9% a year during the decade of the 1970s. However, the actual annual growth rate from 1970 to 1980 was only about 2.1%. This decline in the expected growth rate of electrical energy usage is not unique to the Detroit Edison service area; rather, it is representative of a national trend, attributable in part to higher prices for electricity, to conservation, and to an overall slowdown in economic growth. Prompted by this low load growth and other unforeseen factors--such as financial difficulties and increased regulatory requirements--the applicant has delayed the commercial availability of the Fermi unit. Current scheduling calls for Fermi-2 to begin commercial operation in November 1983.

7.2 Alternatives

At the OL review stage of the licensing process, the staff's analysis of alternatives reflects the fact that Fermi-2 has already been constructed and that the principal economic and environmental costs associated with this project have already been incurred. Thus, these "sunk costs" will be borne by society whether or not the units are permitted to operate. At this stage, it is imprudent to consider different sites, dramatic plant modifications, or the construction of new and different energy sources as alternatives to the existing Fermi unit. These alternatives would require significant environmental and capital commitments over and above the costs already incurred during Fermi's construction. These additional costs would be prohibitive when compared to the expense of the proposed operation of Fermi-2--such expense being primarily limited to the cost of fuel, operation, and maintenance (see Section 7.2.2).

The staff believes the only alternative available at the operating license stage is denying the operation of the facility and thereby not permitting the constructed nuclear facility to be added to Detroit Edison Company's generating system. This alternative would necessarily require purchasing suitable replacement capacity and energy, if available, in lieu of the potential power deliveries from the Fermi unit. Concurrently, construction schedules for other planned generating facilities would have to be accelerated and/or new facilities included to offset the capacity shortfall resulting from the removal of the Fermi facility from DEC's bulk power resources.

7.2.1 Relative Benefits of Operating Versus Not Operating Fermi-2

The potential benefits of operating the Fermi unit include (1) lower overall system production costs than those which would be incurred if the plant were not allowed to operate; (2) increased diversity of generating resources; and (3) increased operating capacity for DEC and MECS.

7.2.1.1 Production Costs

The Fermi-2 unit was constructed to provide an economical source of baseload energy. Because substantial capital and the environmental expenses associated with construction have already been incurred, the only economic factors that are relevant for consideration now are fuel costs and operation and maintenance (O&M) costs. A DEC production-cost analysis provides acceptable evidence in support of issuing an operating license for the Fermi unit.

In the applicant's analysis, the annual generation costs are estimated on the basis of a specified mix of generating capacity and projected energy requirements. The study was performed for the 5-yr period 1984-1988, both with and without the Fermi unit, and under three different load-growth scenarios. The results of this study are presented in Table 7.1. The values listed represent DEC's best estimate of the annual savings in system fuel costs that will result from having the Fermi-2 unit on line versus costs that will be incurred if the unit is not allowed to operate. Table 7.2 lists the major assumptions made in the conduct of the analysis. Capacity factors for Fermi-2 were estimated to range between 50 and 76% during the study period. The applicant's response to a staff questionnaire implies that the major portion of replacement energy in lieu of Fermi generation would be obtained through purchases. Other "make-up" energy would be generated by the system's intermediate coal, oil, and gas facilities. Table 7.2 includes estimated average costs of replacement energy from these intermediate facilities.

The study results indicate that operation of Fermi-2 provides measurable savings in system production expenses for both DEC and MECS.

After reviewing the underlying assumptions in the applicant's production cost analyses, the staff concludes that the estimates of system fuel cost savings are reasonable. However, the applicant's assumption of a 76% capacity factor

Table 7.1 Detroit Edison Co. (DEC) and Michigan Electric Coordinated System (MECS) 5-yr production costs, assuming three different scenarios

	Annual Load Growth, %		Production Costs with Fermi-2, $million		Production Costs without Fermi-2, $million	
Scenario	DEC	MECS	DEC	MECS	DEC	MECS
1	2.9	3.35	7365.4	14,262.0	8549.8	15,495.3
2	1.45	1.68	6443.9	12,276.2	7359.2	13,130.1
3	0.0	0.0	5724.6	10,759.6	6467.4	11,484.0

Table 7.2 Applicant's operating and cost parameters used in production cost analysis

Fermi-2 capacity factor and generation cost			
	Yr	Capacity Factor	
	1984	50	
	1985	61	
	1986	63	
	1987	76	
	1988	64	
Average cost of replacement energy from external sources			
	Yr	Cost	
	1984	44.82 $/MWh	
	1985	48.87 $/MWh	
	1986	57.50 $/MWh	
	1987	65.01 $/MWh	
	1988	76.71 $/MWh	
Average cost of replacement energy from internal sources			
	Coal	Oil	Gas
1984 generation cost	$26.5/MWh	$87/MWh	$100/MWh
Typical escalation rate-percent	12	11.5	24

during the 1987 operating year appears to be somewhat optimistic, particularly for the initial years of operation. If a lower capacity factor were assumed (on the order 55 to 65%), production savings that year would be reduced. However, it is unlikely that that reduction would have an overly significant effect on the total 5-yr savings.

In conclusion, the staff views applicant's assessment of potential savings as reasonable. The production cost study assessed savings for a 5-yr period only. In actuality, savings would continue as long as Fermi were operating--a period of approximately 30 years. These potential economic savings would constitute a significant benefit to the MECS system and its customers.

7.2.1.2 Diversity of Supply

Regardless of the relative economics of nuclear energy versus energy from other sources, it is to the advantage of a public utility to have diverse sources of power available. Any number of contingencies could arise regarding the availability of fuel to generate electricity. If imported oil were not available, if further limits were placed on the use of natural gas as a boiler fuel, if coal piles were to freeze or prolonged strikes were to occur, or if shortages of enrichment facilities were to develop, heavy reliance on one or two fuels--especially for baseload operation--could impede a utility's ability to reliably serve its customers. Currently, coal-fired capacity accounts for more than 80% of DEC energy sales and nearly 70% of MECS energy sales (see Table 7.3). With Fermi-2 in operation, DEC and MECS would be better prepared to meet unexpected changes in their supply of coal. The fact that operation of Fermi-2 will improve the diversity of fuel supply for the service area is an important element in support of issuing an operating license in a timely manner.

Table 7.3 Detroit Edison Co. (DEC) and Michigan Electric Coordinated System (MECS), energy generated, by fuel type and purchase power, 10^6 kWhr, for 1980*

Fuel Type	DEC	MECS
Coal	30,596	44,425
Nuclear	0	2,737
Oil	2,334	5,183
Gas	501	900
Purchase Power	3,936	11,102
Hydro + Pumped Storage, Net	-236	-319
Total	37,131	64,028

*Source: DEC response to NRC question.

7.2.1.3 Reliability Analysis

Between 1963 and 1970, DEC's electrical energy output and peak demand grew at average annual rates of 7.7 and 7.6%, respectively. For the 10-yr period 1970-1980, peak demand on the DEC system grew at an average annual rate of 2.1%, while MECS annual demand growth averaged 2.43% per yr. Comparable growth figures for electric energy generated were 1.77 and 2.25%, respectively. Current official projections for the DEC system estimate average annual rates of increase of approximately 2.9% for both peak demand and energy during the 1981 - 1990 period. MECS projections call for both demand and energy to increase at approximately 3.3% per yr.

Table 7.4 lists DEC and MEC reserve margins for 1984 through 1988, with and without Fermi-2 in operation.

Table 7.4 Detroit Edison Co. (DEC) and Michigan Electric Coordinated System (MECS), projections of summer peak loads, capacity, and reserves, 1984-1988

				Reserves			
				w/Fermi		w/o Fermi	
Yr	System Peak Demand, MW	Capacity, MW	Purchases (Sales)	MW	%	MW	%
			DEC				
1984	7593	10304	(15)	2696	35.5	1822	24
1985	7553	10968	(34)	3381	44.8	2507	33.2
1986	7754	11632	(54)	3824	49.3	2950	38.1
1987	8039	11632	(74)	3519	43.8	2645	32.9
1988	8460	11632	(94)	3078	36.4	2204	26.1
			MEC				
1984	12739	17647	160	5068	39.8	4194	32.9
1985	12993	18311	147	5468	42.1	4594	35.4
1986	13334	18975	125	5766	43.2	4892	36.7
1987	13779	18975	103	5299	38.5	4425	32.1
1988	14370	18340	81	4051	28.2	3177	22.1

Individually, neither DEC nor Consumers Power is required to maintain a specific reserve margin, nor does the MECS agreement require either utility to maintain a specific reserve margin for the other.

Both utilities endorse the 1-day-in-10 loss-of-load probability criterion. Both utilities examine their system in isolation, in order to assess the adequacy of reserve margin. Consumers Power specifically uses a loss-of-load probability assessment to arrive at its reserve margin of 24%. Detroit Edison uses a different technique, which translates into a 20 to 22% reserve margin requirement (ER-OL, p. 1.1-15).

In the period 1968 - 1977, the applicant's seasonal reserve margin--expressed as percent of (capability minus load)/load--varied from 8 to 39%. In 1976, when purchases were required, the applicant had a seasonal 37% reserve margin (ER-OL, Tables 1.1-1 and 1.1-7).

During peak periods, however, the reserve margin reflects both capability and actual purchases and sales. From 1969 to 1973, the applicant was a net purchaser of capability varying from 100 to 325 MW (325 MW was approximately 5% of the 1971 seasonal capability at that time). From 1974 to 1977, Detroit Edison sold power (56 to 318 MW).

During the period of purchases, 1969 to 1971, seasonal reserve capability was as high as 27% and as low as 8%. Although the reserve margin rose for three consecutive years (1970 - 1972), the applicant was purchasing an increasing amount of capability during peak (258 MW in 1970; 919 MW in 1972).

The following years (1973 - 1977) showed continued high seasonal reserves and a change from net purchasing to net selling of capacity. Despite this trend, Detroit Edison continued to be a receiver of power at the time of the system peak (with the exception of 1974). The principal source of power at the peak was Ontario Hydro.

For the purpose of examining the impact of Fermi-2, the required reserve margin for Detroit Edison is assumed to be 22%, and for the joint Consumers Power and Detroit Edison system, 20%.

Reserve margins with and without Fermi-2 are indicated in columns 5 and 6 of Table 7.4. Based on reserve margin criteria indicated earlier, the Fermi-2 unit, along with other units if added as planned, will provide more than adequate capacity through 1988. Sale of capacity to others would seem to be feasible as reserve margin rises to 49%. Without Fermi-2, reserve margin is adequate through the 5-yr study period for both DEC and MECS. Delay of the Fermi unit would not appreciably jeopardize reliability from the standpoint of DEC and MECS reserve margins. However, there is no overall economic advantage to delaying the plant. In fact, the systems and their customers suffer an economic penalty if the unit is delayed. Further, the impact of capacity unavailability on Wolverine Electric Cooperative and on Northern Michigan Electric Cooperative has not been assessed. Presumably it would be necessary for these utilities to purchase capacity elsewhere if Fermi-2 were not operated.

7.2.2 Costs Related to Operating Versus Not Operating Fermi-2

A decision to operate Fermi-2 will necessitate a decommissioning expense once the units are retired from service.

In Section 9 of this environmental statement,* the staff discusses the different decommissioning methods available and their estimated cost. For large BWR units (such as Fermi-2), the decommissioning cost per unit is estimated to range from $35 million to $60 million (in 1978 dollars). However, as discussed above, the cost of producing replacement energy is projected to be more than Fermi's production costs would be. With this fact considered along with decommissioning costs, total net cost would favor a decision to allow the Fermi unit to operate.

7.3 Conclusions

The results of the staff's assessment of alternatives support a decision to issue the operating license for Fermi-2 in the time frame proposed by the applicant. Of overriding importance is that the timely addition of this unit to the Detroit Edison System is expected to result in significant savings in system production costs. Furthermore, the operation of this unit will ensure greater diversity of generating resources and will increase system reliability.

The operation of this unit will undeniably result in increased environmental costs and limited increased risk. However, these issues have been addressed in this statement, and the findings are presented in other sections of this statement. The staff views these impacts as negligible to acceptable. Moreover, if the Fermi unit does not operate, replacement energy will have to be generated. This increased use of other power generation facilities could also result in increased environmental costs and risks. Finally, although decommissioning is identified as an incremental cost of operating nuclear facilities, it should be noted that this cost represents less than 50% of the projected production-cost savings resulting from Fermi operation for a single year.

*The operation of Fermi-2 will also result in environmental impacts and increased risk. These have been thoroughly evaluated by the staff, and the findings are presented elsewhere in this report. These impacts are viewed as negligible to acceptable.

8 EVALUATION OF THE PROPOSED ACTION

8.1 Résumé

The staff has reassessed the physical, social, and economic impacts that can be attributed to the operation of Fermi-2. Inasmuch as the station is currently nearing completion (80% complete as of March 1981), many of the predicted and expected adverse impacts of the construction phase have already occurred. The applicant is committed to a program of restoration and redress of the plant site that will begin at the termination of the construction period. Consequently, the operation phase of Fermi-2 will include restoration, reparation, and maintenance, with the possibility of enhancing the environs that existed prior to construction.

8.2 Adverse Effects That Cannot be Avoided

8.2.1 On Land

There is no expected operational impact to land.

8.2.2 On Surface Waters

The discharge of chemicals and heat in the station blowdown will cause a slight local degradation of Lake Erie water quality.

8.2.3 On Groundwater

No impacts to groundwater are expected.

8.2.4 On Air

The quantity of radioactive gaseous effluents released during operation will be small and insignificant in effect.

8.2.5 Terrestrial Ecology

Terrestrial biotic impacts of Fermi-2 station operation are expected to be unmeasurable and insignificant.

8.2.6 Aquatic Ecology

The staff expects no significant impacts on the biota of Lake Erie.

8.2.7 Radiological

Releases of radioactive materials to the environment will occur in small quantities and are not expected to have any measurable effects.

8.3 Relationship Between Short-Term Uses and Long-Term Productivity

8.3.1 The Site and Vicinity

The short-term uses of man's environment caused by the proposed project can be summarized in terms of the unavoidable adverse environmental impacts of operation given in Section 5 and summarized in Section 8.2.

The long-term cost or impact of the plant on man's environment will be at a maximum if the plant is not dismantled at the end of its operating life. In this case, "long-term" is defined as being that period of time after the productive life of the installation (about 30 to 40 years). Such impact may cease on removal of these buildings or may be ameliorated by conversion of these buildings to another use.

8.3.2 Land Uses and Productivity

Agricultural land in the transmission corridors will, for the most part, continue in agricultural use. Although trees will be removed from the transmission corridors, this area can still remain biologically productive through growth of low-growing plants, thus providing suitable habitat for fauna. The staff does not believe that there will be any serious impacts on short- or long-term productivity as a result of transmission corridor construction or operation.

8.4 Irreversible and Irretrievable Commitments of Resources

8.4.1 Scope

Irreversible commitments generally concern changes set in motion by the proposed action that, at some later time, could not be altered to restore the present order of environmental resources. Irretrievable commitments are generally the use or consumption of resources that are neither renewable nor recoverable for subsequent utilization. A detailed discussion of impacts can be found in Section 4.

The types of resources of concern in this case can be identified as (1) material resources, such as materials of construction, renewable resource material consumed in operation, and depletable resources consumed, and (2) nonmaterial resources, including a range of beneficial uses of the environment.

Resources that, generally, may be irreversibly committed by the operation are (1) individuals belonging to biological species or species' populations that may be killed; (2) construction materials that cannot be recovered and recycled with present technology; (3) materials rendered radioactive, which cannot be decontaminated, and materials consumed or reduced to unrecoverable waste, including the uranium-235 and uranium-238 consumed; (4) the atmosphere and water bodies used for disposal of heat and certain waste effluents to the extent that other beneficial uses are permanently curtailed; and (5) land areas rendered permanently unfit for other uses.

8.4.2 Biotic Resources

The individual organisms killed as a result of the operation of the plant are irreversibly committed. However, none of these organisms is listed as endangered

or threatened by the U.S. Fish and Wildlife Service. Therefore, the species to which these organisms belong will not be severely impacted. The numbered organisms expected to be killed will be small; thus, such losses will not result in significant biological impacts.

8.4.3 Materials of Construction

Construction materials are almost entirely from the depletable category of resources. Concrete and steel constitute the bulk of these materials; numerous other mineral resources are incorporated in the physical plant. No commitments have been made on whether these materials will be recycled when their present use terminates.

Some materials are of such value that economics clearly promotes recycling. Facility operation will contaminate only a portion of the plant to such a degree that radioactive decontamination would be needed to reclaim and recycle the constituents. Some parts of the facility will become radioactive by neutron activation. Radiation shielding around the reactor and around other components inside the primary neutron shield constitutes the major material in this category for which it is not feasible to separate the activation products from the base materials. Components that come in contact with reactor coolant or with radioactive wastes will sustain variable degrees of surface contamination, some of which would be removed if recycling is desired. The quantities of materials that could not be decontaminated for unlimited recycling probably represent very small fractions of the resources available in kind and in broad use in industry.

Many materials on the "List of Strategic and Critical Materials"[1] (for example, aluminum, asbestos, beryllium, cadmium, lead, nickel, platinum, silver, tin, tungsten, and zinc) are used in nuclear facilities. Construction materials are generally expected to remain in use for the full life of the facility, in contrast to fuel and other replaceable components discussed below. There will be a long period before terminal disposition must be decided. At that time, quantities of materials in the categories of precious metals, strategic and critical materials, or resources having small natural reserves must be considered individually, and plans to recover and recycle as much of these valuable depletable resources as is practicable will depend on need.

8.4.4 Other Replaceable Components and Consumable Materials

Other materials consumed, for practical purposes, are uranium, fuel-cladding materials, reactor-control elements, other replaceable reactor core components, chemicals used in processes such as water treatment and ion-exchanger regeneration, ion-exchange resins, and minor quantities of materials used in maintenance and operation.

The consumed resource materials have widespread usage. However, their use in the proposed operation is expected to be reasonable with respect to needs in other industries.

8.4.5 Water and Air Resources

An average of about 0.82 m^3/sec (29 cfs) of water will be lost from the Fermi-2 station through evaporation. This commitment of the water resources is not

significant where water is so abundant. Such usage will not have a long-term environment effect.

Operation of the Fermi-2 station will have no effect on regional air resources beyond the minimal impact caused by various equipment emissions.

8.4.6 Land Resources

The staff's assessment of land use has essentially not changed since the earlier review, except for an increase of about 13 ha (32 acres) in site size and a decrease of 16 km (10 mi) in transmission system length. Land is not irreversibly and irretrievably committed in the long term, although as a practical matter the applicant will probably continue to use the land for an extended period for electric power production. With adequate effort, at some future time the land could be further modified or restored for other useful purposes.

8.4.7 Decommissioning*

The technology for decommissioning nuclear facilities is well in hand, and, while technical improvements in decommissioning techniques are to be expected, at the present time decommissioning can be performed safely and at reasonable cost. Radiation doses to the public as a result of decommissioning activities should be very small and would primarily come from the transportation of decommissioning waste to waste burial grounds. Radiation doses to decommissioning workers should be a small fraction of the worker exposure over the operating lifetime of the facility; these doses usually will be well within the occupational exposure limits imposed by regulatory requirements. Decommissioning costs are, at least for the larger facilities such as reactors, a small fraction of the present-worth commissioning costs.

Decommissioning of nuclear facilities is not an imminent health and safety problem. However, planning for decommissioning can have an impact on health and safety as well as on cost. Essential to such planning activity is the decommissioning alternative to be used and timing. Also to be considered are (1) acceptable residual radioactivity levels for unrestricted use of the facility, (2) financial assurance that funds will be available for performing required decommissioning activities at the end of facility operation (including premature closure), and (3) the facilitation of decommissioning. Decommissioning of a nuclear facility generally has a positive environmental impact. At the end of facility life, termination of a nuclear license is required. Such termination requires decontamination of the facility so that the level of any residual radioactivity remaining in the facility or on the site is low enough to allow either unrestricted use of the facility and site or recommissioning of the facility as a nuclear or nonnuclear power plant.

Compared to operational requirements, the commitment of resources for decommissioning is generally small. The major environmental impact of decommissioning is the commitment of small amounts of land for the burial of waste. This is in

*The material in this section is based on USNRC Report NUREG-0586, "Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities," January 1981.

exchange for being able to reuse the facility and site for other nuclear or nonnuclear purposes. Because in many instances (such as at a reactor facility) the land has valuable resource capability, the return of this land to the commercial or public sector is highly desirable. In decommissioning nuclear facilities, the objective of NRC regulatory policy is to ensure that proper and explicit procedures are followed to mitigate any potential for adverse impact on public health and safety or on the environment.

Three alternative methods can be and have been used to decommission reactors. "DECON" means to remove immediately all radioactive materials down to levels which would permit the property to be released for unrestricted use. "SAFSTOR" is defined as those activities required to place and maintain a radioactive facility in such condition that (1) the risk to safety is within acceptable bounds and (2) the facility can be safely stored for as long a time as desired and subsequently decontaminated to levels which would permit release of the facility for unrestricted use. SAFSTOR consists of a short period of preparation for safe storage; a safe-storage period of variable length, of continuing care consisting of security, surveillance, and maintenance (up to 100 yr); and a short period of deferred decontamination. Several variations of SAFSTOR are possible. "ENTOMB" means to encase and maintain property in a strong and structurally long-lived material to ensure retention until radioactivity decays to a level acceptable for releasing the facility for unrestricted use. ENTOMB is intended for use where the residual radioactivity will decay to levels permitting unrestricted release of the facility within reasonable time periods.

Estimated costs of decommissioning vary, depending on the characteristics of the particular reactor and the decommissioning mode chosen. For a large BWR, DECON is estimated to cost $43.6 million (in 1978 dollars); SAFSTOR is estimated to cost $58.9 million with a 30-yr safe-storage period and $55.0 million with a 100-yr safe-storage period. ENTOMB is estimated to cost $35.0 million with the pressure vessel and its internals retained, and $40.6 million with the pressure vessel and internals removed, plus a $40,000 annual maintenance and surveillance cost in both cases.

8.5 Upgraded Emergency Preparedness Facilities

The applicant plans to construct emergency preparedness facilities to meet the Commission's upgraded emergency planning requirements contained in Appendix E to 10 CFR 50, "Emergency Planning and Preparedness for Production and Utilization Facilities." A technical support center will accommodate 25 personnel in an annex to the present office services building. An operational support center will be located within the turbine building. There will be a primary emergency operations facility designed for 40 persons within an onsite nuclear operations center. A backup emergency operations facility will be provided approximately 15 mi from the site. The construction of these additional onsite facilities will not significantly disturb the area relative to previous disturbances for construction of the plant. The offsite alternate emergency operations facility is expected to be in a conventional building, meeting applicable building and zoning requirements, and, therefore, is not expected to adversely impact the area.

8.6 References

The document referenced below is available in public libraries.

1. G. A. Lincoln, "List of Strategic and Critical Materials," Federal Register, 37(30): 4123 (1972).

9 BENEFIT-COST ANALYSIS

9.1 Résumé

Estimates of benefits and costs have changed somewhat since the issuance of the FES-CP. These changes, however, do not alter the staff's findings of a net positive project benefit. The benefits and costs of station operation are shown in Table 9.1. Reassessed benefits and costs in this statement are based on recent submittals by the applicant and on staff reassessments of environmental impacts.

9.2 Benefits

The primary benefit of the plant will be the electricity produced (5745×10^6 kWh/yr) for the Detroit Edison System, Northern Michigan Electric Cooperative, and Wolverine Electric Cooperative. The surplus energy produced will also tend to reduce the use of existing coal- and oil-fired power plants and should result in production cost savings.

9.3 Environmental Costs

The environmental costs of Fermi-2 station operation are as follows:

(1) Fish larvae, plankton, and drift macroinvertebrates are expected to be entrained in the cooling system. The impact of the accompanying entrainment loss is considered minor because of its limited magnitude and the subsequent recruitment from unaffected populations.

(2) Fishes will be killed upon impingement with the intake screens; however, the staff believes that the fish loss will be a minor environmental cost.

(3) Some birds will be killed upon collision with the cooling towers during certain meteorological conditions. Although the number killed will be small in relation to the number of birds in the flyway, the staff considers the loss to be an environmental cost.

(4) Low-level radioactive releases accompany nuclear power generation. The expected dose from nuclear power generation to individuals has not been shown to be harmful to people or the environment in the vicinity of the plant. The levels of release from nuclear power stations have always been compared favorably with low levels of radiation from any and all sources, including those of human origin and those occurring naturally. The environmental risk from accidental radiation exposure is very low.

9.4 Economic Costs

The economic costs associated with the operation of Fermi-2 include fuel expenses and the cost of operating and maintaining the facility (O&M costs). With a unit capacity factor of 60%, these costs will average about 11.9 mills/kWh and 8.8 mills/kWh (1981 dollars), respectively, during the early years of

Table 9.1. Benefit-cost summary

Primary Effect or Resource	Unit of Measure	Predicted Magnitude of Effect
Direct Benefits		
Energy (60% capacity factor)	kWh/yr x 10^6	5745
Capability	kW x 10^3	1093
Indirect Benefits		
Economic Costs:		
Operating (60% capacity factor)		
Fuel	mills/kWh (1981 dollars)	11.9
Operation and maintenance	mills/kWh (1981 dollars)	8.8
Decommissioning	mills/kWh (1981 dollars)	0.4-0.7
Environmental Costs:		
Effects of water use and discharge		
Consumption	m^3/yr acre-ft/yr	2.62 x 10^7 21,300
Heat discharge to Lake Erie	J/s Btu/hr	9.4 x 10^7 3.2 x 10^8 (maximum)
Chemical discharge to Lake Erie		
People		negligible
Aquatic biota		minor or locally significant
Water quality		negligible
Chemical discharge	TDS mg/L	400 to 570, negligible
Radionuclide discharge to Lake Erie	tritium all others	no significant effect no significant effect
Chemical discharge to groundwater		negligible
Radionuclide discharge to groundwater		negligible
Raising/lowering of groundwater levels		negligible

Table 9.1. Continued

Primary Effect or Resource	Unit of Measure	Predicted Magnitude of Effect
Natural water drainage		
Flood control		acceptable
Erosion control		acceptable
Effects on aquatic biota, intake/discharge structure, and cooling systems		
Plankton, benthic draft organisms, fish larvae	entrainment losses	some entrainment expected, negligible thermal effect
Forage fish	impingement losses	impingement losses expected
Fisheries		negligible
Effect on air		
Chemical discharge to ambient air	drift (g/s) μg/m³	22.7 < 2 μg/m³ negligible effect on air quality
Radiological discharge to ambient air		
Population dose during plant operation (year 2000) (Table 4.9)		
Plant workers	person-rem/yr	650 average; 1600 maximum (risk comparable to that of other occupations)
General public	person-rem/yr	67; negligible
Population exposure during accidents (Table 6.5)		
Within 80 km (50 mi)	person-rem/yr	340
Total	person-rem/yr	520
Fogging and icing		
Ground transportation	< 2 hr/yr	acceptable
Air transportation	visibility less than 1 km	plant does not affect landing patterns
Water transportation		not discernible
Plants		not discernible

Table 9.1. Continued

Primary Effect or Resource	Unit of Measure	Predicted Magnitude of Effect
Impacts on terrestrial biota		
Birds	bird kills on cooling towers	some kills expected
Mammals	habitat disturbance of the Indiana bat	negligible
Societal Costs:		
Operational fuel disposition		
Fuel transport (new)	trucks/yr	365
Fuel storage	metric tons	13,323
Waste products (spent fuel)	rail cars/yr	36
Station labor force	statement	negligible
Historical and archaeological sites	statement	acceptable
Esthetics	statement	acceptable

operation. These estimates are much greater than those which the staff feels are realistic. However, because these amounts were used in deriving the applicant's production cost estimates, the staff feels the cost savings resulting from the addition of the Fermi-2 unit are understated.

The cost of decommissioning is an additional cost of plant operation. The staff's estimates of the cost of decommissioning the Fermi-2 unit range from $35 million to $60 million (1978 dollars), depending upon the method selected.

9.5 Environmental Costs of the Uranium Fuel Cycle (Including Transportation)

The mining, milling, enrichment, transport, and fabrication of nuclear fuel supports activities in other parts of the country. Each of these activities generates radioactive wastes and handling problems. The industry is regulated at each activity site and must conform to total overall limits on radioactivity release. For the nation as a whole, these activities are found acceptable. The additional activity which operation of Fermi-2 will impose is considered miniscule. The staff has evaluated the environmental impacts of the uranium fuel cycle as given in Appendix C of this statement and has found these impacts to be sufficiently small so that when they are added to the other environmental impacts predicted for the proposed project, the fuel-cycle impacts would not alter the cost-benefit balance against issuance of the operating license.

9.6 Societal Costs

No other societal costs (direct or indirect) that could not be avoided by proper implementation of procedures instituted by utility or regulatory bodies were identified by the staff. Statements on procedure or caution are contained in this statement in the appropriate sections.

9.7 Summary of Benefit-Cost

As the result of this second review of potential environmental, economic, and social impacts, the staff has been able to provide additional insight into the effects of plant operation. No unique and/or unacceptable environmental impact of operation has, however, been identified by the staff in this assessment. Consequently, the staff concludes that the environmental and social costs of plant operation are acceptable, and the total costs (including economic) are outweighed by the benefits of added capacity, energy produced, potential production cost savings, and increased reliability.

10 DISCUSSION OF COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL STATEMENT

10.1 Background

Pursuant to 10 CFR 51.25, the Draft Environmental Statement related to the operation of Enrico Fermi Atomic Power Plant, Unit No. 2 was transmitted with a request for comments to

Advisory Council on Historic Preservation
Federal Emergency Management Agency
Federal Energy Regulatory Commission
U.S. Department of Agriculture
U.S. Department of the Army, Corps of Engineers
U.S. Department of Commerce
U.S. Department of Education
U.S. Department of Energy
U.S. Department of Health and Human Services
U.S. Department of Housing and Urban Development
U.S. Department of the Interior
U.S. Department of Transportation
U.S. Environmental Protection Agency

Attorney General, State of Michigan
Great Lakes River Basin Commission
Governor, State of Michigan
Department of Natural Resources, State of Michigan
Supervisor, Frenchtown Township, Michigan
Southeast Michigan Council of Governments
Wayne County Planning Commission

Argonne National Laboratory
Atomic Industrial Forum
Brookhaven National Laboratory
Detroit Edison Company

Ontario Ministry of the Environment

In addition, the NRC requested comments on the DES from interested persons by a notice published in the Federal Register on May 15, 1981 (46 FR 26958).

In response, the NRC received comments from

Alexander, Robert - Houston, Texas (Alexander)
Detroit Edison Company (DE)
Lochstet, W. A. - University Park, Pa. (Lochstet)
Monroe County, Michigan Planning Commission (MCPC)

Southeast Michigan Council of Governments (SMCOG)

City of Monroe Michigan
County of Oakland, Department of Public Works
County of Oakland, Division of Planning
County of Oakland, EMS/Disaster Control Division
Detroit Area Agency on Aging
Frenchtown Charter Township
Jefferson Schools
Macomb County Health Department
Macomb County Planning Commission
Monroe County Planning Department and Commission
Southeastern Michigan Transportation Authority
Washtenaw County Metropolitan Planning Commission
Wayne County Board of Education
Wayne County Department of Health
Wayne County Planning Commission

U.S. Department of Agriculture, Soil Conversation Service (USDA)
U.S. Department of Commerce (DOC)
U.S. Department of Health and Human Services, Food and Drug Administration (HHS-FDA)
U.S. Environmental Protection Agency, Region V (EPA)

The staff consideration of comments received and disposition of the issues involved is reflected in part by text revisions in other sections of this Statement and in part by the following discussion, which will reference the comments by use of the abbreviations indicated above. As noted earlier, all comments received are included in Appendix A of this statement.

The applicant's changes (DE, A-8, 9) regarding the ownership of Fermi Unit 1 and the capacity of Fermi Unit 2 have been incorporated into the Summary and Conclusions section of this report. Commentors' specific requests for copies of this Final Environmental Statement have been noted and will be filled.

10.2 The Site

10.2.1 Regional Demography and Land Use (DE, A-10; MCPC, A-39)

The applicant and the Monroe County Planning Commission both expressed concern that data used in the preparation of this report were dated. Although the 1980 population and new insights into local population dynamics may change Monroe County's view of population growth, the county has not developed revised population projections. The data incorporated in the revised paragraph in Section 2.2.1 are the only projection data currently available.

10.2.2 Water Use (DE, A-10; MCPC, A-39)

The applicant and the Monroe County Planning Commission both noted that the quality of the water near the County's Lake Erie shoreline has improved so that sports involving whole body contact with the water need not be avoided. Section 2.3.1 was revised to reflect this improvement in water quality.

The applicant's suggested corrections of the distance from the site of the Monroe municipal water system intake in Table 2.4 and the maximum value of mercury in western Lake Erie water in Table 2.10 were incorporated.

In response to the applicant's comments, in Table 2.6 the River Raisin was added as a water source for the Monroe Power Plant and a typographical error regarding the distance from the site was corrected.

The applicant's comment regarding the small amount of water for the Toledo municipal water system that comes from within 16 km of the Fermi site has been noted.

10.3 The Plant

10.3.1 Plant Water Intake Canal (DE, A-12; EPA, A-3; DOC/NOAA, A-45)

The applicant has stated that the plant water intake canal will be "dredged as necessary, depending on Lake Erie water levels, to maintain a favorable channel depth." Section 3.2.2.2 of the FES has been revised to reflect this comment.

The EPA commented that the applicant should evaluate the EPA toxicity methodology described in the May 19, 1980 Federal Register and include other specific information on dredging in the FES. Dredging of the intake canal requires permits from the Army Corps of Engineers and the Michigan Department of Natural Resources. The Corps permit (78-01-12) was issued October 5, 1978, based on approval given by EPA by a letter dated August 30, 1978. This permit allows dredging as necessary, through October 5, 1988, to maintain a depth of 11.5 ft in the intake canal.

Dredged material is placed in a diked disposal area on the site. Analyses of the quality of sediments were performed before dredging in 1978 and 1979. Sediment has not yet accumulated to an extent where redredging is necessary. Therefore, analysis by EPA's more recent methodology may not be meaningful.

Because of specific procedures for regulating dredging activities, it is expected that EPA will work out information requirements directly with the Corps of Engineers, the State, and the applicant.

The staff has forwarded to the applicant the request of the National Oceanic and Atmospheric Administration that the Office of Oceanography be notified of any change that would affect operation of the Office of Oceanography water gage. In a letter dated August 21, 1981[1], the applicant stated that the Office of Oceanography will be notified of any changes that may occur on the Fermi-2 site that would adversely impact gage operation or benchmark placement.

10.3.2 Radioactive-Waste-Management Systems (DE, A-12)

The applicant notified the NRC by a letter dated June 17, 1981, that liquid and solid radwaste systems are being upgraded. Details of the change have been provided in an amendment to the plant FSAR. The upgraded system is designed to meet the ALARA guidelines. This information has been noted in a footnote in Section 3.2.3 of this statement.

10.3.3 Chemical, Sanitary, and Other Waste Treatment (DE, A-12; Alexander, A-43)

The applicant's suggestion that a sentence in Section 3.2.4 be rewritten for clarity has been followed.

Mr. Alexander expressed concern that the staff has not accounted adequately for the presence of the Asiatic clam.

According to a telephone conversation between T. Freitag of the Corps of Engineers and C. R. Hickey of the NRC on July 21, 1981, the Asiatic clam (Corbicula sp.) is present in the western basin of Lake Erie and was first collected in 1980. Corbicula sp. has been found in or near the effluent discharge canals of several power plants in the western basin and Maumee Bay, including the Monroe Power Plant, which is 10 km south of Fermi on Lake Erie (according to a telephone conversation between Mr. Hickey and the applicant on July 20, 1981 and Reference 2). Corbicula sp. also has been found in Lake Erie along the 0.9 m-(3 ft-) depth contour near Sterling State Park, about 8 km SW of Fermi (according to Mr. Hickey's July 20, 1981, telephone conversation and Reference 3).

During April 1981 (at the time the Fermi-2 DES was published), the NRC Office of Inspection and Enforcement issued a Bulletin[4] to holders of operating licenses and construction permits that required them to submit to NRC information on the known occurrence of Corbicula sp. in the vicinity of nuclear plants; an inspection of plant equipment for fouling by Corbicula sp.; and a description of methods (in use or planned) for preventing and detecting fouling by Corbicula sp.

Corbicula sp. has not been found in the Fermi-2 site vicinity, either in the intake canal or in the lake (Mr. Hickey's July 20 telephone conversation and Reference 5). The presence of the clams in the western basin, and specifically at Monroe and Sterling State Park, renders their eventual presence near Fermi probable. Thermal discharges appear to be conducive to the clam's presence and survival in Lake Erie. The Fermi-2 discharge structure is small and at the shoreline, is not a deeply recessed canal, and is not in a bay area as are other power plant discharges where Corbicula sp. occurs in Lake Erie. The effluent from Fermi-2 could provide some thermal conditions desirable for Corbicula sp., but because of the small size of the Fermi-2 plume, the clams should not achieve the densities seen at other power plants.

Of concern, however, is the potential for colonization of Corbicula sp. within the circulating water reservoir (CWR) at Fermi-2, because the reservoir will be maintained at about 18°C (65°F) year-round (according to Mr. Hickey's July 20, 1981 telephone conversation). Corbicula sp. spawns between temperatures of about 13°C-32°C[6,7,8] and is capable of spawning continuously if the proper thermal conditions exist for extended periods. The CWR, therefore, could provide suitable habitat for colonization, reproduction, and survival of Corbicula sp.

The effectiveness of present control procedures for Corbicula sp. varies from power plant to power plant. The use of shock chlorination as the only method of controlling Corbicula sp. appears to be ineffective. Fouling at TVA plants has been reduced to acceptable levels by using continuous chlorination during peak spawning periods; clam traps; and mechanical cleaning during station outages. Heat has been shown to be an effective way of producing 100% mortality.[4] Exposure of Corbicula sp. to a temperature of 43°C or above for 30 min will produce 100% mortality.[9]

The licensee is committed to establish a program to prevent and detect future problems of Corbicula sp. in safety systems at Fermi-2. Details of the program will be completed and reported either before or during the initial startup of Fermi-2.[5]

10.4 Environmental Effects of Station Operation

10.4.1 Impacts on Water Use (DE, A-15; 16; EPA-A-3, 4)

The applicant took exception to the staff's conclusion that compliance with NPDES Permit MI 0037028 may result in reduced oxygen levels in Lake Erie because Lake Erie is saturated with oxygen, because the permit limits the discharge of chlorine to 160 min per day, and because the area of the discharge plume is very small in comparison to the size of the western basin.

The staff agrees with the applicant's observations. However, the staff reiterates that care is warranted to ensure that trying to eliminate a potential chlorine toxicity problem does not create a potential low oxygen problem.

The applicant's comments regarding the small size of the thermal plume relation to the size of the western basin have been noted.

EPA requested information on the ability of the applicant to meet its new Effluent Guidelines for Steam Electric Generating Stations; expressed concern about the use of sodium sulfite, sodium thiosulfate as dechlorination agents; and questioned the size of the thermal mixing plume described in Section 4.3.1.3.

The applicant will comply with the terms of the NPDES permit and will use the dechlorination system as necessary to comply with the chlorine limitations in the permit. The new EPA guidelines were issued for comment (Federal Register, October 14, 1980) but have not been reissued as final regulations.

The staff believes that close control of the use of sulfate as a dechlorinating agent would be preferable to adding another treatment operation. However, the NPDES permit regulates effluent quality. The EPA comments on dechlorination have been given to the appropriate State officials.

The text in Section 4.3.1.3 has been corrected to show that the area of the permissible mixing zone is 2.9×10^5 m^2 (72 acres). The plume sizes given in Table 4.2 are correct and are smaller than the permissible mixing zone.

10.4.2 Impacts on the Terrestrial Environment (DE, A-16; MCPC-39)

The applicant's comments that the early notification system will not add to noise have been noted.

The Monroe City Planning Commission Staff commented that habitat changes had not been addressed in the draft Environmental Statement. Because this is a concern at the construction permit stage, it was not discussed in the Operating License Environmental Statement. However, the information is given in Table IV-1 on page IV-3 of the CP-FES. (See Appendix F of the Draft Environmental Statement.)

In regard to the MCPC comments about noise, 10 CFR 50 requires annual audible testing of the emergency preparedness early notification system. It is anticipated that this annual test will be performed in conjunction with a joint Federal-State-local radiological emergency exercise. It is possible that this test could coincide with normally scheduled testing of local civil defense sirens.

Because the needs of the various users of this proposed common system may vary, the staff believes that the testing of the system may result in infrequent emanation of noise as a result of the operation of Fermi-2. However, because the testing is infrequent, scheduled, and part of a larger exercise that the local populace will be advised of in advance, no unacceptable impact on the surrounding community is expected.

10.4.3 Impacts on the Aquatic Environment (EPA, A-3)

EPA suggested consideration of a redesign of the intake structure using a porous dike at the mouth opening to the lake. The intake system is designed to have minimal and insignificant effects on the Lake Erie ecosystem and fisheries. The State of Michigan has determined: "...location, design, construction, and capacity of the Enrico Fermi Atomic Power Plant, Unit 2, intake structure reflects the best technology available for minimizing adverse impact..." The State will determine the need for further mitigation of intake impacts after completion of an intake monitoring study required by the NPDES permit (see Section 4.4.2.1 above).

10.4.4 Radiological Impacts from Routine Operation

10.4.4.1 Exposure Pathways (SMCOG, Wayne County Department of Health, A-5, City of Monroe, A-70)

In response to the suggestion from the Wayne County Department of Health, a copy of the DES was sent to Mr. L. Shenfeld, Chief of Air Quality and Meteorology, Ontario Ministry of the Environment, Toronto.

The staff forwarded to the applicant the concern expressed by the City of Monroe about radioactivity monitoring of the City's drinking water system. In a letter dated August 20, 1981,[10] the applicant stated:

> Fermi-2 will be operated according to the Radiological Effluent Technical Specifications (RETS) (NUREG-0473)[11] established for the plant. The radioactive effluent and dose requirements are set forth in 10 CFR Part 20 and 10 CFR Part 50, Appendix I.
>
> The Fermi-2 monitoring system(s) for radioactive liquids will adequately detect any routine releases of radioactive liquid to Lake Erie....six process monitors located throughout the Fermi-2 plant monitor the radioactivity of the water within the plant....The two of major significance are the radwaste monitor and the circulating water reservoir (CWR) decant line monitor.
>
> The radwaste effluent is discharged on an as-required batch-type basis to the CWR decant line where dilution occurs prior to discharge to Lake Erie. The automatic monitor is set to close the discharge

line isolation valve should the concentration of radioactivity reach the 10 CFR Part 20, Appendix B, Column 2 activity limits in the CWR decant line to Lake Erie (FSAR Section 11.4.2.9.2.1[12]. In addition, a second monitor measures directly the activity in the decant line.

Under the requirements of the RETS, a monitoring program has been conducted for Fermi-2 since 1978 which includes sampling the potable water intake for Fermi-2, located directly south of the CWR decant line discharge and the Monroe City water intake at Stoney Point, south of the Fermi-2 intake. The samplers are continuous, online devices that sample 8 minutes out of every 15 minutes. The composite samples are collected in a 5-gallon carboy and sent to a laboratory for analysis monthly. The samplers are such that the carboy can be removed at any time and grab samples taken for laboratory analysis. This continuous composite sampling method is quite different from the grab sample taken at the same locations during the operation of Fermi-1.

Should an inadvertent release of radioactive liquid to Lake Erie occur prior to isolation valve closure, a near realtime measurement can be obtained on grab samples from the Fermi-2 and Monroe City intakes for analysis. The Fermi-2 sample provides an early indication for the Monroe City intake which is further south and has a higher dilution factor. Estimated liquid dilution factors for the City intake are discussed in the FSAR Appendix 11A, page 9.

For the postulated accident discussed in FSAR Section 11.2.3 where the liquid radwaste is released to the building basement and the basement floor fails, the time required for the spilled liquid to reach Lake Erie via the ground water aquifer is 1985.5 days (5 years, 5 months). This provides sufficient time to sink wells to monitor the movement and level of activity prior to entering the Lake.

A monitoring device in Lake Erie at the end of the intake pipe would result in high maintenance and low reliability of operation. The present system is easily maintained, has high operational reliability, and provides a means for rapid sampling and assessment.

The staff has concluded that the radiological monitoring program of the applicant, including the present method of sampling drinking water in the City of Monroe water intake, is acceptable (see Section 5.2.5 of this statement). In the event of an accident of such severity that the city water intake must be closed, the disposal of contaminated water in the intake would be handled on an individual case basis. (See also Section 10.6 of this statement.)

10.4.4.2 Radiological Impact on Biota Other Than Humans (MCPC, A-39)

The Monroe County planning staff expressed concern that other living organisms will be affected to a greater extent than humans.

Data in NUREG-0743 (see Chapter 4, Reference 26) support the statement that "there have been no cases of exposure that can be considered significant in terms of harm to the species." The staff has found no reason to change its conclusion stated in Section 4.5.4: "No measurable radiological impact on

populations of biota is expected as a result of the routine operation of the plant."

10.4.4.3 Environmental Effects of the Uranium Fuel Cycle (EPA, A-2; DE, A-16; Lochstet, A-47)

The EPA made comments on Table S-3 with regard to radiation doses to workers and the public as a result of transportation of radwaste and on low-level waste disposal at land burial facilities, noting that three of six commercial low-level nuclear waste disposal sites have been closed.

NRC staff disagrees with the EPA assertion that "serious seepage of radioactive contaminants" has occurred at the three commercial disposal sites which have closed (that is, the Maxey Flats, Ky; the West Valley, NY; and the Sheffield, IL sites). The Maxey Flats and West Valley sites were closed as a result of complex practical, political, and technical problems. The Sheffield site was closed because the 10-acre licensed disposal area was filled to capacity. In no case do the commercial sites (both operating and closed) pose a health and safety hazard to the public. Monitoring programs by the states, the U.S. Geological Survey, NRC, and EPA have been underway and are continuing to ensure that activity levels pose no hazard to the public.

The major impact of the disposal of low-level wastes will be in the use of land at the existing commercial disposal sites. Based on solid waste shipment data submitted in semiannual release reports from BWR plants during years 1976 through 1980, the average annual waste volume shipped from a BWR unit was 37,000 ft^3. In 1980 the total waste volume disposed of at the three existing disposal sites (Barnwell, SC; Beatty, NY; and Hanford, WA) was 3,230,000 ft^3. If Fermi-2 generates the average volume of waste for a BWR (37,000 ft^3/yr), its waste generation will equal 1.1% of the total 1980 waste volume disposed.

The three existing sites have approximately 75 million ft^3 of remaining capacity. Assuming a trench utilization factor of 50% and a 37,000 ft^3/year generation rate for 30 years, the Fermi-2 facility will utilize 3% of the remaining disposal site capacity.

The projected annual and 30-year generation rates represent insignificant impacts with respect to the total annual disposal rate and the remaining capacity at the existing sites.

Because the disposal sites will accept only wastes suitable for disposal at the sites, the environmental effects of Fermi-2 wastes will be within the scope of disposal site operations and, therefore, no significant environmental effects are expected.

The applicant's comments regarding distance of the nearest residence from the site and the total body person-rems from natural radiation have been noted and incorporated into this Statement. Also noted was the applicant's statement that the liquid and solid radwaste systems are being upgraded. However, it should be pointed out that even with the present radwaste systems the applicant meets the design objectives of Appendix I to 10 CFR 50.

Dr. Lochstet contends "the health consequences of radon-222 emissions from the uranium fuel cycle are improperly evaluated" because the staff evaluated the

impacts of radon-222 releases from wastes generated in the fuel cycle for 1000 years or less, rather than for "the entire toxic life of the wastes." Lochstet estimates that radon-222 emissions from the wastes from each annual fuel requirement will cause 200,000 deaths.

The major difference between the estimates made by the staff and Lochstet is the time period over which dose commitments and health effects from long-lived radioactive effluents should be considered. Lochstet has integrated dose commitments and health effects over what amounts to an infinite time, whereas the staff has integrated dose commitments from radon-222 releases over periods of 100, 500, and 1000 years.

The staff has not estimated health effects for radon-222 emissions beyond 1000 years because predictions over periods greater than 100 years are subject to great uncertainties. These uncertainties result from, but are not limited to, political and social considerations, population size, health characteristics, and--for periods of thousands of years--geologic and climatologic effects. In contrast to Lochstet some authors[13] estimate that the long-term (thousands of years) impacts from the uranium used in reactors will be less than the long-term impacts from an equivalent amount of uranium left undisturbed in the ground. Consequently, the staff has limited its period of consideration for decision making and impact calculation to 1000 years or less.

10.5 Environmental Monitoring (DE, A-17)

The statement was revised to include the lists of supplementary radiation monitoring stations (see Table 5.1a of this report) and a change of control station for fish, as submitted by the applicant.

10.6 Environmental Impacts of Postulated Accidents (DE, A-16, 22, and 25; MPCC, A-39; HHS, A-42; SMCOG, A-50, 61, 62, and 70)

The applicant commented on the use of the Calculation of Reactor Accident Consequences (CRAC) computer code and on the use of individual risk of 10^{-12} per reactor year in the isopleths of the risk of acute fatality per reactor year (Figure 6.8).

The staff has not completed the review of the accident consequence calculations in the Limerick Risk Analysis Study referenced by the applicant. However, the staff is reviewing recent changes made to the CRAC code used at the Sandia National Laboratories and will incorporate any appropriate changes into the version of CRAC used in licensing actions. Regarding the use of individual risk of 10^{-12}, these levels are not meaningless when there would be a distribution of several million persons in the regions spanned by these isopleths. Societal risk from those regions would be on the order of 10^{-6} per reactor year, as directly derived by multiplying the individual risks and the number of persons in the regions.

The applicant's comments regarding Figure 6.7 and Table 6.3 have been noted. The applicant's comments regarding the captions for Figures 6.2 and 6.3 were noted and the appropriate changes made.

The Monroe County Planning Commission staff expressed concern about the staff's conclusion regarding the likelihood of severe accidents. These conclusions

are based on about 500 reactor years of power reactor operation, as well as on sound engineering principles, and conservatism was used in their evaluation. Moreover, these conclusions are supported by analytical evaluations of plant systems, and the experience base to date is accommodated within the theoretical calculations.

The Food and Drug Administration (HHS) suggested inclusion of a discussion of the lessons learned as a result of the accident at the Three Mile Island Nuclear Plant. However, safety actions resulting from TMI experiences that affect Fermi-2 are fully identified in NUREG-0737[14] and reported in the SER for Fermi-2 (Reference 3, Chapter 6).

Comments from the Wayne County Intermediate School District, Oakland County Disaster Control, the City of Monroe, and the Macomb County Planning Commission, forwarded by the Southeastern Michigan Council of Governments, expressed concern regarding the emergency plan for Fermi-2.

The plan is not included as part of this statement, but is part of the applicant's FSAR, which is available for public review at the local public document room, the Monroe County Public Library, 3700 South Custer Road, Monroe, Michigan. Moreover, DE has committed to advise the public as to what actions should be taken in case of any emergency at Fermi-2 by:

(1) publishing an annual newsletter that will be sent to "each occupiable and addressable dwelling" within a 16-km (10-mi) radius of the plant

(2) placing advertisements in the local daily and weekly newspapers at least annually which describe the actions to take in the event of an emergency at Fermi-2

(3) using other appropriate means for disseminating this information such as:

- a booth at the Monroe County Fair
- presentations to schools
- presentations to community groups

(See also Section 6.1.3.3.)

In response to the specific concerns raised by the Disaster Control Division of the City of Oakland, it should be noted that:

(1) Transportation accidents involving packages of radioactive materials are the same as other transportation accidents except for the possibilities of radioactively contaminated surfaces and increased radiation fields around the packages. Thus, capabilities to control transfer of radioactive material and to detect radiation are desirable.

(2) Federal help can be called to the scene.

(3) Local resources and actions for response to such an accident should be planned.

(4) Federal assistance in the forms of planning guidance and response training is available.

(5) Inasmuch as efficient orderly response is a product of both classroom and field experiences, and transportation accidents involving radioactive materials are not expected to happen often, local officials may want to consider periodic exercises.

If an accident occurs, the State or local government is primarily responsible for overseeing the response of carrier, shipper, and others and for taking any actions deemed necessary by the State or local government to protect public health and safety. To assist State and local governments at the accident scene, the Federal government has a program called the Federal Radiological Monitoring and Assessment Plan, through which 13 Federal agencies may provide facilities, personnel, and other properties. The program is coordinated by the Department of Energy (DOE) in eight regional coordinating offices, which are responsible to convene radiological assistance teams. When called, a team is prepared to report to the scene of an accident or other radiological emergency and advise State and local emergency response personnel already on the scene.

To assist State and local governments in planning emergency responses to radiological incidents at fixed sites or in transportation, the Federal government has an interagency program to coordinate planning, guidance and training (described in 40 Federal Register 59495). In this program, the Department of Transportation (DOT) supplies guidance on emergency response planning related to transportation of radioactive materials. The Federal Emergency Management Agency (FEMA) is the lead agency in this program.

A number of efforts are underway to guide and train State and local governments on these matters. These projects include the following:

(1) FEMA offers an 8-day course on radiological emergency response operations to State and local government (and some Federal) emergency response personnel. One of the simulated accidents to which students respond is a transportation accident involving radioactive material. The course is conducted 16 times per year at the DOE Nevada Test Site for 20 students per session. To date more than 700 students have attended the course.

(2) Other courses are available for developing State and local emergency response plans, for emergency response coordination, and for accident assessment. Inquiries on these courses may be addressed to FEMA, Washington, DC 20472.

(3) In 1975, the Western Interstate Nuclear Board (now the Western Interstate Energy Board) and Region VIII of the Conference of Radiation Control Program Directors, under contract to the NRC, developed preliminary guidance for State and local government radiological emergency response plans for transportation accidents. An interagency task force has been convened to update this guidance in fiscal year 1982.

(4) The DOT has issued an interim edition of a manual (DOT/RSPA/MTB-79/8, available from DOT, Washington, DC) to aid those who respond to transportation emergencies involving radioactive materials. The manual describes fundamentals of radiation, packaging of radioactive materials, and procedures for a first responder to an accident.

(5) The DOT, under contract with the National Fire Protection Association, has developed a 20-hour training course for firemen and policemen who would be responding to transportation accidents invovling any hazardous material. The principles described can be used in any accident. The DOT has also developed under contract a 6-hour supplement to this course which pertains specifically to transportation accidents involving radioactive materials.

The City of Monroe expressed concern about the possibility of an accident involving radioactive materials enroute to the site.

The environmental effects of a transportation accident involving radioactive materials are considered in Table 4.13. The supporting document for this Table, WASH-1238, discusses transportation accidents in detail for a variety of radioactive materials. As part of the NRC's reexamination of its regulations, a more comprehensive assessment of the effects of transportation accidents, NUREG-0170, was issued in December 1977. It reached a similar conclusion: the environmental effects of routine transportation and the risks attendant to accidents are sufficiently small to allow continued shipments by all modes. The NRC also concluded that present regulations are adequate to protect the public against unreasonable risk from the transport of radioactive materials (46 Federal Register 21619).

10.7 Alternatives to the Proposed Action (DE A-28, 29; Alexander, A-13)

The applicant commented that the delay in the availability of Fermi-2 is not solely attributable to changed load forecasts. The staff did not intend to imply this but only to imply that a decline in the annual load growth rate is a reasonable justification for modifying utility capacity expansion plans. However, to minimize any potential for misinterpretation, the text has been modified to reflect other factors that may have impacted the applicant's generation expansion program.

The applicant also stated that the staff may have been misled by the applicant's original production cost analysis submitted in response to a recent staff questionaire. The applicant has provided a revised version of production cost estimates which updates the previous version and is intended to remove any ambiguity. The original study did not adequatley quantify the interchange relationship between Detriot Edison and Consumers Power with respect to energy generated by Fermi-2. As a result, erroneous savings in production expenses were listed for DE. In addition to updated fuel and operation and maintenance costs, the new study reflects a more realistic dispersion of savings between the two systems. The staff has reviewed the results of the revised analysis and finds them to be within the range of costs typical of systems with generation mixes similar to Detroit Edison and MECS. The findings of this latest analysis have not materially altered the original conclusions of Chapter 7. However, portions of the text (Section 7.2.1.1 and Table 7.1) have been modified to reflect the values derived from the study. Tables 7.2 and 7.4 also have been revised to reflect the applicant's comments on costs and projected reserves.

Mr. Alexander states that the alternative of not adding the Fermi-2 capacity was not considered. On the contrary, however, a considerable portion of Chapter 7 (Section 7.2.1) is devoted to this topic.

10.8 Benefit - Cost Analysis (DE, A-33)

Staff estimates of the operating costs for Fermi 2 have been incorporated in this statement. These costs are based on data submitted by the applicant and are listed in Table 9.1.

10.9 References

Documents marked with one asterisk are available for inspection and copying for a fee in the NRC Public Document Room, 1717 H St., N.W., Washington, DC 20555. Documents marked with two asterisks may be purchased from the NRC/GPO Sales Program, Washington, DC 20555, and/or the National Technical Information Service, Springfield, VA 22161. Other material cited is available through public technical libraries.

1. Letter from Harry Tauber, DE, to B. J. Youngblood, NRC, dated August 21, 1981.*

2. Letter from R. P. Crouse, Toledo Edison Company, to J. G. Keppler, NRC, May 22, 1981, in response to NRC IE Bulletin No. 81-03.*

3. A. H. Clark, "Corbicula fluminea in Lake Erie," The Nautilus, 95(2):83-84, 1981.

4. NRC Office of Inspection and Enforcement, IE Bulletin 81-03: "Flow Blockage of Cooling Water to Safety System Components by Corbicula sp. (Asiatic clam) and Mytilus sp. (Mussel)," April 10, 1981.*

5. Letter from D. A. Wells, Detroit Edison Company, to J. G. Keppler, NRC, dated July 7, 1981, in response to NRC IE Bulletin No. 81-03.*

6. L. L., Eng, "Population Dynamics of the Asiatic Clam, Corbicula fluminea (Muller) in the Concrete-Lined Delta-Mendota Canal of Central California," pp. 39-68, in Proceedings, First International Corbicula Symposium, 1977.

7. D. R. Coldiron, "Some Aspects of the Biology of the Exotic Mollusk, Corbicula (Bivalvia: Corbiculidae)," MS Thesis, Texas Christian University, 1975.

8. D. W. Aldridge and R. F. McMahon, "Growth, Fecundity, and Bioenergetics in a Natural Population of the Asiatic Freshwater Clam, Corbicula manilensis Philippi, from North Central Texas," Journal of Molluscan Studies, 44:49-70, 1978.

9. J. S. Mattice, "Interactions of Corbicula sp. with Power Plants," pp. 119-138, in Proceedings, First International Corbicula Symposium, 1977.

10. Letter from C. M. Heidel, DE, to B. J. Youngblood, NRC, dated August 20, 1981.*

11. U.S. Nuclear Regulatory Commission, "Draft Radiological Technical Specification for BWRs," USNRC Report NUREG-0473, November 1978.**

12. Detroit Edison Company, "Final Safety Analysis Report for Fermi, Unit No. 2," Docket No. 50-341, April 4, 1975, as amended.

13. B. L. Cohen, "Radon; Characteristics, Natural Occurrence, Technological Enhancement, and Health Effects," Progress in Nuclear Energy, Vol. 4, 1979.

14. U.S. Nuclear Regulatory Commission, "Clarification of TMI Action Plan Requirements," USNRC Report NUREG-0737, November 1980.**

Appendix A

Comments on the Draft Environmental Statement

United States Department of Agriculture

Soil Conservation Service

1405 South Harrison Road, Room 101
East Lansing, Michigan
48823

May 28, 1981

Nuclear Regulatory Commission
Washington, D.C. 20555

Gentlemen:

We have reviewed the Draft Environmental Statement related to the operation of Enrico Fermi Atomic Power Plant, Unit No. 2 at Monroe, Michigan. We do not have any comments on this statement.

Thank you for the opportunity to provide comments.

Sincerely,

Homer R. Hilner

Homer R. Hilner
State Conservationist

HRH:rpc:glo 0767B

RECEIVED JUN 11 1981 U.S. NUCLEAR REGULATORY COMMISSION

The Soil Conservation Service is an agency of the Department of Agriculture

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION V
230 SOUTH DEARBORN ST
CHICAGO, ILLINOIS 60604

REPLY TO ATTENTION OF:

26 JUN 1981

RECEIVED
JUL 07 1981
U.S. NUCLEAR REGULATORY COMMISSION

Mr. B. J. Youngblood, Chief
Licensing Branch N..1
Division of Licensing
Nuclear Regulator Commission
Washington, D.C. 20555

RE: 81-060-703
D-NRC-F06011-MI

Dear Mr. Youngblood:

We have completed our review of the Draft Environmental Impact Statement (EIS) for the Enrico Fermi Unit 2 Operating License. It is planned that fuel-loading of the Fermi plant will begin in November of 1982. The impacts associated with the application for an operating license are those related to the generation of electricity at this facility and not from construction activities. Our comments on this EIS deal with the impacts related to the plant's normal operation.

Based upon our review of the Draft Environmental Impact Statement, we have rated the project as LO (Lack of Objection) and classified the EIS as Category I (Sufficient Information). The date and classification of our comments will be published in the Federal Register in accordance with our responsibility to inform the public of our views on other agencies' projects.

We appreciate the opportunity to review this Draft EIS. When the Final EIS is available, please forward three copies to us. If you or your staff has any questions in regard to our comments, please contact Bill Franz at 886-6687 or commercially at 312/886-6687.

Sincerely yours,

William D. Franz

Barbara Taylor Backley, Chief
Environmental Impact Review Staff
Office of Environmental Review

Attachment

Office of Environmental Review, U.S. Environmental Protection Agency Region V's Comments on the Draft Environmental Impact Statement for the Enrico Fermi Unit 2 Operating License

This Draft Environmental Impact Statement (EIS) has been written to assess the affects fuel-loading and power generation at this nuclear plant will have upon the environment. Enrico Fermi Unit 2 is a 3,428 megawatt thermal, 1150 megawatt electric boiling - water reactor. Exhaust steam will be condensed by circulating water through wet natural draft cooling towers; makeup water for the coolying system will be withdrawn from Lake Erie.

Water Quality Impacts

One of the most significant areas of potential environmental impact related to the operation of a power plant is the design and location of the intake structure. The intake structure for the Enrico Fermi plant is composed of an intake canal and flat traveling screens outside the pumphouse. The design of the intake structure has been approved by the Michigan Department of Natural Resources pending additional fish studies. These studies are to determine the fish loses at Fermi Unit 2 once the plant begins operation. The intake canal is a dike which extends into Lake Erie with its mouth open to the lake. The Final EIS should discuss whether or not consideration has ever been given to closing the mouth opening to the lake with a porous dike. A porous dike would act as a filter to aquatic organisms while permiting water to pass through the opening. The Final EIS should assess the benefits which could result from such a intake design modification and whether or not this modification is feasble.

The EIS has indicated the intake canal must be dredged periodically to maintain optimal depth within the canal. There is a need to determine the pollutional characterization of these sediments. The pollutional characterization will determine if special handling is required for disposal. The applicant should evaluate the sediments, using the E.P. Toxicity method described in the May 19, 1980 Federal Register, to determine if the material is hazardous, and a bulk sediment analysis should also be provided. From information in the Draft EIS, it appears that dredging has taken place periodically in the intake canal. The Final EIS should indicate the frequency of dredging, quantity of material, past pollutional characterization, and an environmental description of disposal site location. Information on previous dredging operations can provide an indication of future needs at the Fermi site.

Our Agency has recently published Effluent Guidelines for Steam Electric Generating Stations. These guidelines require the minimization of chlorine levels in the cooling water to control condenser fouling. Information should be provided on the ability of Detroit Edison to comply with these new Effluent Guidelines, and the levels of chlorine expected in the discharge. The EIS has indicated that there is the potential to have zero chlorine discharge. The Final EIS should indicate whether or not Detroit Edison will implement this program of zero discharge of chlorine.

The discussion on chlorination also indicates that the use of sodium sulfite as a dechlorinating agent has a tendency to reduce oxygen levels in the discharge water. To minimize this impact, consideration should be given to aerating the discharge prior to release to Lake Erie.

The discussion on dechlorination indicated another agent (sodium thiosulfate) could be substituted for sodium sulfite. Sodium thiosulfate has a longer reaction time, and does impart odors and tastes to the water. If sodium thiosulfate is used as a dechlorination agent, the discharge should be contained until the reaction has been completed.

The Michigan Water Quality Standards has established a mixing zone for the cooling tower blowdown as the area within the 1.67 C isotherm. This is discussed in Section 4.3.1.4 and Table 4.2. of the Draft EIS. Table 4.2 provides Nuclear Regulatory Commission and Detroit Edison Staff predictions on the size of the heated effluent plume. The plume sizes provided in Table 4.2 all exceed the State of Michigan's maximum plume size 1.67 C isotherm. However, the conclusion in the text indicates that the estimated plumes will be from 2 to 50 times smaller in area than the State Water Quality limits, and therefore, the impacts should not be adverse. We concur with your conclusion but find the text in Section 4.3.1.4 to be in error. Our calculations indicate the size of the 1.67 C isotherm to be 2.9x10 square meters not 2.91x10 square meters.

<u>Radiation Impacts</u>

The Draft EIS indicates the Enrico Fermi Unit 2 Nuclear Reactor meets the requirements of 10 CFR 50 Appendix I. The annual dose commitment to the general public in the unrestricted area for liquid effluent does not exceed 5 millirem to the whole body. Radiation dose commitment to the population from release of radioactivity to the biosphere is minimal and within established limits.

Reference was made to Table S-3 with regard to transportation dose to workers and the public, and for low-level waste disposal at land burial facilities. The Nuclear Regulatory Commission indicates there will be no significant radioactive releases to the environment." It should be noted that 3 of 6 commercial low-level nuclear waste disposal sites have been closed because of serious seepage of radioactive contaminants from these sites. The impact of the additional waste disposal that will be imposed on the three remaining sites need to be addressed in terms of land use and the effect on the environment.

Charles M. Heidel
Executive Vice President—Operations
(313) 237-8880

Detroit Edison

2000 Second Avenue
Detroit, Michigan 48226
(313) 237-8000

June 29, 1981
EF2 - 53,894

Director, Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Sir:

Reference: Draft Environmental Statement (NUREG-0769)
Enrico Fermi Atomic Power Plant, Unit 2
NRC Docket No. 50-341

Subject: Detroit Edison Comments

As requested, Detroit Edison is submitting the attached comments on the Draft Environmental Statement for the Enrico Fermi Atomic Power Plant, Unit 2, for Commission consideration.

Sincerely,

C. M. Heidel

cc: D. E. Howell, Esq.
L. L. Kintner
B. Little

DETROIT EDISON COMMENTS

ON

DRAFT ENVIRONMENTAL STATEMENT (NUREG - 0769)
RELATED TO THE OPERATION OF
ENRICO FERMI ATOMIC POWER PLANT, UNIT 2
APRIL 1981
DOCKET NO. 50 - 341

JUNE 1981

DETROIT EDISON COMMENTS

Detroit Edison has reviewed the Draft Environmental Statement (NUREG - 0769) related to the operation of the Enrico Fermi Atomic Power Plant, Unit 2 (Fermi 2) and concurs with the Staff's conclusion that under the National Environmental Policy Act of 1969 and 10 CFR Part 51 an operating license can be issued.

Edison's analysis of the information contained in NUREG - 0769 indicates that the Staff has performed an independent, conservative analysis of the information presented in the Applicant's Environmental Report (Operating License Stage). Specific comments on NUREG - 0769, as requested by the Commission, are presented on the following pages.

SUMMARY AND CONCLUSION

(piii) Footnote should read Enrico Fermi Power Plant, Unit 1, is presently owned by Detroit Edison Company not Power Reactor Development Company.

CHAPTER 1 INTRODUCTION

Section 1.1 History

(p. 1-1) The Applicant has applied for a license to operate a 3292 MWT (rated) nuclear power plant at the Fermi site. This plant will produce 1093 MW electric for distribution throughout the system.

CHAPTER 2 THE SITE

Section 2.2.1 Regional Demography

(p. 2-1) The statement in the second paragraph of this section concerning an accelerated population growth during the next three decades in the Monroe County area is not consistent with the trend established by the estimated 1980 population and the projected year 2000 population which shows a compound growth rate of 0.007 over the next 20 years. "Complan 2000", September 1976 (Reference 1) is no longer an accurate representation of the growth trend in the area and will be updated by Monroe County to reflect the 1980 population data and revised growth rates and trends.

Section 2.3.1 Regional Water Use

(p. 2-4) Figure 2-2.16 (ER-OL) indicates that very little water is supplied from the Toledo municipal system within the 10-mi. radius of the Fermi site.

(p. 2-6) Since municipal sewer systems have been expanded, the septic tanks in many areas of the Lake Erie shoreline in the vicinity of the site are no longer in use. As a result, Lake Erie water is considered suitable for swimming and total body contact by the State of Michigan.

(Table 2.6) The Monroe Power Plant is 6 miles SSW of the Fermi site, not 16 miles. The intake is on the Raisin River and draws cooling water from both the river and Lake Erie.

Section 2.3.4 Water Quality

(Table 2.10 The maximum value for mercury should be 0.6
p. 2-13)

CHAPTER 3 THE PLANT

Section 3.2.2.2 Intake Structure

(p. 3-3) The intake canal for Fermi 2 will be dredged as necessary, depending on Lake Erie water levels, to maintain a favorable channel depth.

Section 3.2.3 Radioactive Waste Treatment

(p. 3-4) As noted in the attached letter (EF-2-53702, June 17, 1981) the liquid and solid radwaste systems are being upgraded. Details of the changes will be provided in a forthcoming amendment to the FSAR. The upgraded system is designed to meet the requirements of ALARA.

Section 3.2.4 Chemical, Sanitary, and Other Waste Treatment

(p. 3-7) For clarification, the fourth paragraph should read; Each demineralizer system regeneration requires up to 154 kg (340 lb) of acid and 126 kg (278 lb) of caustic and is followed by a backwash with up to 27,200 lb (7200 gal) of water.

Detroit Edison
2000 Second Avenue
Detroit, Michigan 48226
(313) 237-8000

June 17, 1981
EF2-53702

Mr. L. L. Kintner
Division of Project Management
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Kintner:

Reference: Enrico Fermi Atomic Power Plant Unit 2
NRC Docket No. 50-341

Subject: Fermi 2 Radwaste System Modifications

This letter confirms that Detroit Edison has made the decision to substantially improve its present Radwaste system, and is actively engaged in detailed engineering of it. We are upgrading both our liquid radwaste system and solid system. The most significant changes will be to the latter, where we plan to install a completely new volume - reduction and solidification system. Details will be provided in a forthcoming amendment to the FSAR.

Sincerly,

William F. Colbert
Technical Director
Enrico Fermi 2

WFC/slm

CHAPTER 4 ENVIRONMENTAL EFFECTS OF STATION OPERATION

Section 4.3.1 Thermal Discharge

(p. 4-7) The Pritchard model used by the NRC Staff is an empirical model similar in nature to that used in the ER (OL) and was, in fact, derived from thermal discharges at shallow gradually sloping Great Lakes sites similar to Fermi. The model is, therefore, a good model from which predictions can be used as a comparison with the ER (OL) predictions. DES Table 4.2 shows the Pritchard model predicts lower 3°F surface areas than the ER (OL) for all cases except Case 2. For that latter case the DES notes, "The large prediction by Pritchard Model No. 2 for Case 2 may be an anomaly of the model because it is known for other studies that this model tends to overpredict the areas contained within the excess isotherms in the far field."

Under the conditions of a relatively large cross-current, the Shirazi-Davis model may be more appropriate than the Pritchard model because the mathematically singularity of the former is not encountered for the temperature of interest. However, the Shirazi-Davis model will underpredict areas because of the depth (no lake bottom interference) assumption.

The Staff's statement that the Applicant's model has built into it the incorrect assumption that the areas are equal with and without an ambient current present maybe true but is misleading. The model, which is based on actual operating data, implicity encompasses the conditions existing while taking the data. Therefore, the model may or may not underpredict under the given conditions of 0.4 fps ambient velocity, depending on the ambient velocity at the time the data was taken. However, it will certainly overpredict when applied to relatively stationary water.

Section 4.3.5 Effects on Aquatic Biota Through Changesin Water Quality

(pp. 4-8, 4-9, 4-15) Detroit Edison takes exception to the Staff's conclusion that compliance with NPDES Permit No. MI 0037 028 may result in a discharge of unoxidixed dechlorintor and cause reduced oxygen levels. There are several points to consider when discussing the possible depletion of oxygen in Lake Erie by unoxidized dechlorinator:

- Lake Erie water is saturated with oxygen (ER(OL) Supplement 5, pp. A 4-82 to 4-84)
- NPDES Permit No. MI 0037028 limits the discharge of chlorine to 160 minutes per day. Dechlorinating agent would only be added during chlorination.

- The area of the discharge plume is very small and nearfield when compared to the area of the Western Basin of Lake Erie (approximately 800 sq. miles).

Section 4.5.2 Dose Commitments

(p. 4-18, 4-24) Dose Commitments from Radioactive Liquid Releases to the Hydrosphere

As indicated in the Applicant's comment on DES Section 3.2.3, the liquid/solid radwaste systems are being upgraded. Preliminary results of Appendix I dose calculations indicate a further reduction in the dose from the liquid pathway.

(Table 4.5 p. 4-20) The nearest residence, like the nearest garden, is located 1.13 km WNW.

(Table 4.7 p. 4-22) The total body person-rems from natural radiation backround is $5.9 \times 10^{+5}$ not 8.8×10^{-5} As shown in DES Table 2.2, the 0 to 50 mile year 2000 population is about 5,480,000, not 8,200,000 as stated in Footnote(d) to Table 4.7.

Section 4.6 Noise

(p. 4-30) The early notification system is not expected to become another source of noise as a result of operation of Fermi 2 since it is anticipated to be an all purpose system to be used for all types of emergencies, including natural disasters and fires. In addition, the system will be configured around existing sirens that are presently used for such purposes.

CHAPTER 5 ENVIRONMENTAL MONITORING

Section 5.2.5 Radiological Environmental Monitoring

(p. 5-3) The number of direct radiation monitoring stations was expanded to 37 beginning the third quarter of 1980 to conform with Revision 1 of the Branch Technical Position. The network now includes 31 indicator stations, 4 special area stations, and 2 control stations. The locations of these stations are shown on the attached figure and table.

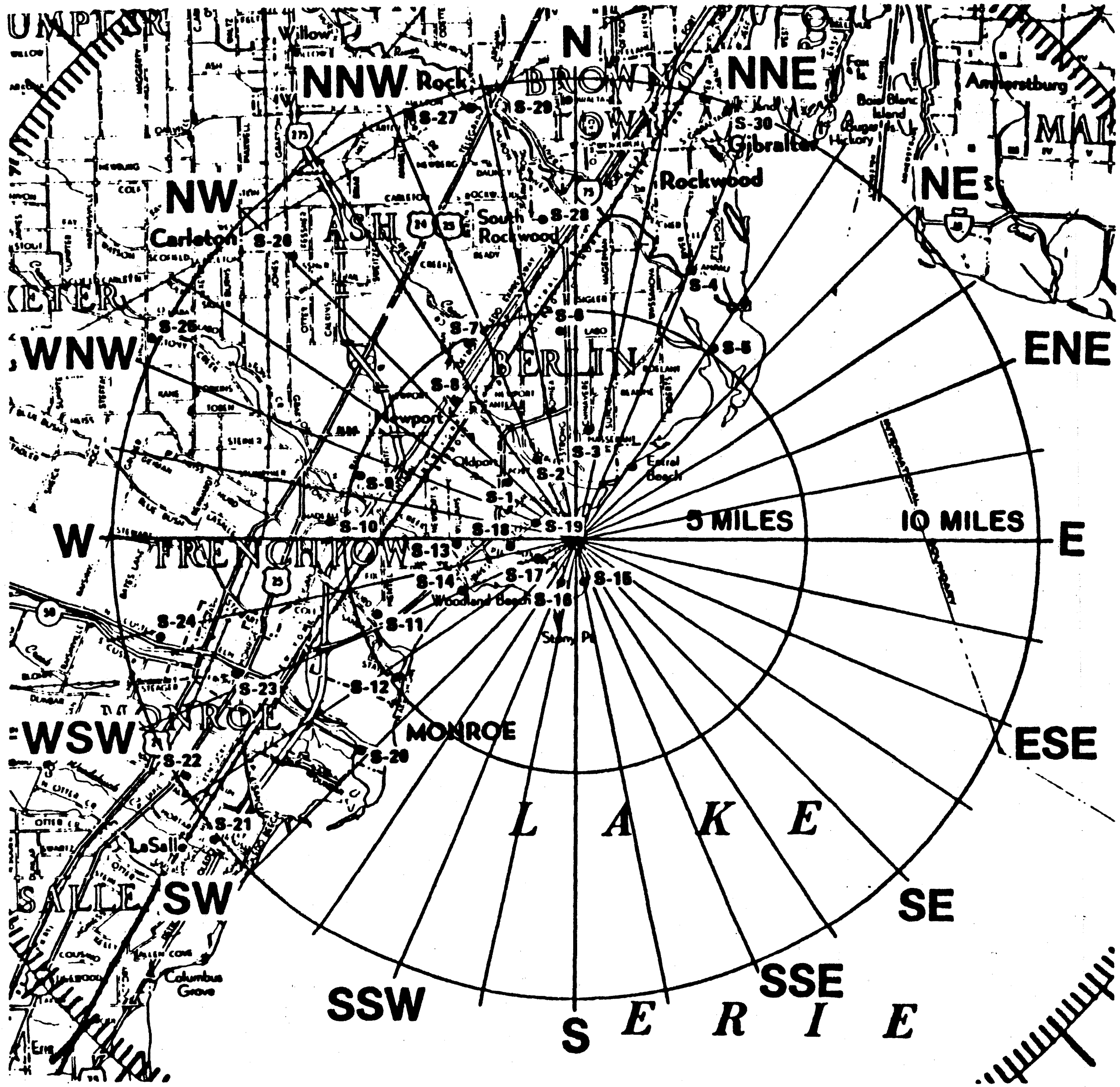
(Table 5.1 p. 5-4) The control station for fish was changed to the vicinity of Celeron Island approximately 9.5 miles NNE of the plant. This was necessary due to the low density of perch in the vicinity of the Trenton Channel Power Plant.

SUPPLEMENTARY TLD STATIONS

Sector/Station No.		Location
NW	S-1	Pole NE Corner Dixie Highway and Post Road (2 mi. ring)
NNW	S-2	Pole NW Corner Dixie Highway and Swan Creek (2 mi. ring)
N	S-3	Pole (#DE5240G5) on Masserant - South on SE corner of driveway to abandoned barn (2 mi. ring)
NNE	S-4	Pointe Mouillee - W Jefferson and Campau Road, Pole (#DE7045GC3) on SE corner of bridge (5 mi. ring)
NE	S-5	Pointe Mouillee Game Area - Field Office, pole near tree north area of parking lot (5 mi. ring)
NNE	S-6	Labo and Dixie Highway - Pole (#175W3909) on SW corner with light (5 mi. ring)
N	S-7	Labo and Brandon - Pole (#DE6150G4) on SE corner near RR (5 mi. ring)
NNW	S-8	Pole (#R56DE27305) behind post office in Newport (5 mi. ring)
WNW	S-9	Pole (#R45DE40-2-30) on SE corner of War and Post Rds. (5 mi. ring)
W	S-10	Pole (#MO-78SP-G7-35) on NE corner Nedau and Lapard - near mobile home park (5 mi. ring)
SW	S-11	Pole (#DEC03740-6) on NW corner Mentel and Hurd (5 mi. ring)
SW	S-12	Pole (#DE71-4-40H) in parking lot of Department of Natural Resources Office Building - Sterling State Park (5 mi. ring)
W	S-13	Pole (#DE74-5-40GC) on Williams Road - school complex approximately 200 yards S of Jefferson High (special area)
WSW	S-14	Pole (#DE45-35G6R60) N side of Pearl - Woodland Beach (pop. area)
S	S-15	Pole (#DE76-40H5) S side of Long and Point Aux Peaux (site boundary)
SSW	S-16	Pole (#DE58-40-G5RG69) S side of Point Aux Peaux - next to vent pipe (site boundary)

SUPPLEMENTARY TLD STATIONS (Continued)

Sector/Station No.		Location
SW	S-17	Fermi gate along Point Aux Peaux Road - on fence post W of gate
WSW	S-18	Pole (#DECO34-35) on S corner of Toll Road S of main gate
W	S-19	Pole (#DE74-40H5) on Toll Road, first residence from Enrico Fermi Drive
SSW	S-20	Pole (#DE7785BB1) at end of Front Street - in front of Detroit Edison Generation Plant (special area)
SW	S-21	Pole (#8-78-150) junction of Mortor and Laplaisance (10 mi. ring)
WSW	S-22	Junction of Dixie Highway and Laplaisance/Albain (10 mi. ring)
WSW	S-23	Pole (#DE4940B4) Custer (St. Mary's) Park corner of N Custer and Dixie (Monroe St.) (N side, next to river) (special area)
WSW	S-24	Pole (#DECO 31-60A) Milton "Pat" Munson Recreational Reserve - N Custer Road (10 mi. ring)
WNW	S-25	Pole (#MTBC2) corner Stoney Creek and Finzel Roads (10 mi. ring)
NW	S-26	Pole (#DECO 5028) N corner Grafton and Ash Roads
NNW	S-27	Pole (#DECO 35 6 40) junction of Port Creek and Will-Carlton Roads
N	S-28	Pole (#064 Y-7224) SE side of I-75, corner Pace and S Huron River Drive (special area)
N	S-29	Pole (#DECO 45 4 40) N side corner of Cahill and Gibralter Roads (10 mi. ring)
NNE	S-30	Pole (#DE 55 40G4) S corner of Adams and Gibralter (across from Humbug Marina) (special area)



LOCATION OF SUPPLEMENTARY TLD STATIONS

CHAPTER 6 ENVIRONMENTAL IMPACT OF POSTULATED ACCIDENTS

The Applicant concurs with the conclusions reached in Section 6.1.5 that there are no special or unique circumstances about the Fermi 2 site and environs that would result in different or substantially greater environmental impacts than those from other presently operating BWR's and that no special or additional engineered safety features should be recommended.

In general, the Applicant is in agreement with the Staff's analyses and evaluations, and believes that they meet with the intent of the Commission's interim policy regarding accident considerations.

Specific comments are listed below:

SPECIFIC COMMENTS ON CHAPTER 6

1. Evacuation Model
The Fermi 2 analysis is an improvement over similar analyses recently issued for the reactors at the Susquehanna site (NUREG - 0564) [1] and the Virgil C. Summer site (NUREG - 0534) [2] by calculating the results using a realistic evacuation model. This evacuation model, which is described in Appendix H of the DES (Reference 3) and the use of evacuation time estimates prepared for the Applicant represents a

more realistic approach than that used in the Reactor Safety Study. [4]

In the Susquehanna analysis, for example, most of the calculated results were derived by assuming that people would not be relocated for seven days following a severe, Class 9 accident. This assumption led to a very conservative prediction of consequences and conveyed an incorrect impression of the magnitude of reactor accidents.

2. <u>Use of the Computer Code CRAC</u>
It is appropriate to comment on the use of the computer code CRAC (Calculation of Reactor Accident Consequences) since many of the results presented in the analysis depend on its use. The assessment methodology employed is that described in the Reactor Safety Study. The major modifications of the RSS methods are the use of site specific meteorological and population data, the use of release categories appropriate to the "rebaselined" BWR and, as has already been mentioned, the incorporation of a realistic evacuation model. There are, however, other easily incorporated modifications to CRAC which have been described in recent studies such as that of the Limerick BWR [5]. The omission of these modifications is a significant source of conservatism. Examples of these conservatisms include:

(a) Plume Width

The width of the plume in the dispersion model used in the RSS is strictly applicable to releases of radioactive material of duration 3 minutes; that is, the formulae used in the RSS for calculating the plume width are phenomenological fits to data taken in experiments in which the duration of release was about 3 minutes. In practice, the smallest duration of release considered in the RSS was 30 minutes. It is a well-known characteristic of dispersing plumes that, roughly speaking, their average width is an increasing function of the duration of cloud passage.[4] If plume widths appropriate to a 30 minute release are used, the effect is to reduce predicted plume center line concentrations by a factor of about two. Radiation doses are then reduced by the same factor. The predicted effect on the number of acute fatalities depends on the population distribution around the reactor and could also be reduced by at least a factor of two.

(b) Shielding Factors

The CRAC analysis incorporates shielding factors for people assumed to be sheltered from gamma-rays emitted by deposited fission products. In the RSS a shielding factor of 0.3 was used. In the Limerick Study[5], the shielding factor was estimated by considering the shielding provided

by typical houses to be found in Pennsylvania. Since brick houses with basements are common there, with excellent shielding characteristics, a shielding factor of 0.15 was deduced. The accumulated ground dose is the dominant contributor to the radiation dose that is used in calculations of early fatalities [6], thus the shielding factor can lead to a substantial reduction in that dose.

According to the RSS, the percentage of brick houses in Michigan is slightly lower than that in Pennsylvania, and slight modification would have to be made for applicability to the Fermi site. Since the analysis is intended to be as site-specific as possible, it would be appropriate to include shielding factors that are characteristic of the region.

(c) Conclusions

By including a site-specific shielding factor and a factor of two due to the change from a 3-minute to a 30-minute plume width, a reduction by a factor of three to four in predicted doses is possible. The corresponding reduction in the predicted number of early deaths may be even greater because of the threshold in the early fatality dose-risk relationships.

3. Miscellaneous Comments

a. The captions on Figures 6.2 and 6.3 have been inadvertently switched.

b. Figure 6.7, Individual Risk of Dose as a Function of Distance, is hard to interpret since there are only two cryptic sentences devoted to it, at the bottom of page 6-29. It does not appear to add any useful information to that presented in other tables and figures in the analysis and there are no conclusions that depend on it. It would be better if it were omitted.

c. The Applicant has reservations about the use of numbers as low as 10^{-12} per year for the isopleths of the risk of acute fatality per year to an individual as shown on Figure 6.8; 10^{-12} per year means once in a thousand billion years, that is, once in a period that exceeds a hundred times the age of the earth. Numbers of this nature can have no meaning.

d. The fraction of the core inventory of iodine that is given in Table 6-3 for the atmospheric release seems peculiar. For example, the DES gives release fractions of 0.2 for the TC-γ sequence. In the Reactor Safety Study, the TC-γ sequence is assigned to the BWR3 category, for which the

inorganic iodine release fraction is given as 0.1 and the organic release fraction as $7X10^{-3}$ (in Table VI 2-1). Similarly, in Table 6-3 of the DES, sequences $S_1E\gamma$ and $S_2E\gamma$ are assigned an iodine release fraction of 0.1 whereas, in the RSS, these sequences belong to category BWR4, for which the corresponding release fraction is given an $8X10^{-4}$ for the inorganic and $7X10^{-4}$ for the organic iodine. In themselves, these discrepancies are probably not particularly important but they do raise a question. The reasons for the choice of the release fractions for the rebaselined PWR's and BWR's that are used in the analysis have never been published. Since it appears that they will be frequently used in studies of this type, it would be useful to publish a complete description of the accident sequences that make up the rebaselined PWR and BWR.

REFERENCES

1. NUREG - 0564, Supplement No. 2; Supplement to the Draft Environmental Statement Related to the Operation of the Susquehanna Steam Electric Station, Units 1 and 2 (March, 1981)

2. NUREG - 0534, Supplement; Draft Environmental Statement Related to the Operation of Virgil C. Summer Nuclear Station Unit No. 1, (November, 1980)

3. Aldrich, D. C., Blond, R. M. and Jones, R. B., "A Model of Public Evacuation for Atmospheric Radiological Releases", Sandia Laboratories Report SAND 78-0092 (1978).

4. Reactor Safety Study, WASH-1400 (NUREG 75/014), 1975

5. Probabilistic Risk Assessment, Limerick Generating Station, Philadelphia Electric Company, Docket Numbers 50-352 and 50-353, (March, 1981)

6. Wall, I. B., Yaniv, S. S., Blond, R. M., et al, "Overview of the Reactor Safety Study", Paper presented at the International Conference of Nuclear Systems Reliability Engineering and Risk Assessment, Gatlinburg, Tennessee, June 19-25, 1977.

CHAPTER 7 ALTERNATIVES TO THE PROPOSED ACTION

Section 7.1 Resume
(p. 7-1)

The Staff's statement that "It is in this context that the Applicant has delayed the commercial availability of the Fermi unit" should be further amplified.

This statement implies that the Applicant intentionally delayed the construction of Fermi 2 due only to the decline in expected load growth. Design modifications, made necessary to meet new NRC regulations, increased the scope of the project which caused further delays.

Section 7.2.1.1 Production Costs
(p. 7-3)

Reference is made to Table 7.1, Page 7-3, where the Applicant's production cost is 0.8 million dollars higher with Fermi 2 than without Fermi 2. Perhaps the Staff was misled with the Applicant's response to their request. The Detroit Edison Company (DECO) and Michigan Electric Coordinated System (MECS) production costs have not been modified to reflect purchased power; they contain only the self-generated fuel costs. Therefore, attached are revised Tables 1, 2, and 3 that reflect the total energy costs and should replace the data submitted originally.

(Table 7.2 p. 7-3) Average cost of replacement energy from external sources, year 1985, should be 48.87 $/MWh instead of 48.81 $/MWh.

Section 7.2.1.3 Reliability Analysis

(Table 7.4 p.7-5) For 1984, DECO Purchases (Sales) should be (15) instead of 15. For DECO, under the Reserves column, in 1988 the 3678 should be 3078; the 36.4 is correct; the 2804 should be 2145; and the 33.1 should be 25.4; the title of the table should be 1984 - 1988 not 1985.

TABLE 1

DETROIT EDISON (DE) AND MICHIGAN ELECTRIC COORDINATED SYSTEM (MECS) NET COST FOR SYSTEM LOAD FORECASTS WITH FORECASTED GROWTH RATE

	With Fermi 2		Without Fermi 2	
	DE NEt Fuel Cost $\$ \times 10^6$	MECS NET Fuel Cost $\$ \times 10^6$	DE NET Fuel Cost $\$ \times 10^6$	MECS NET Fuel Cost $\$ \times 10^6$
1984	1170.4	2129.9	1285.9	2245.2
1985	1156.3	2312.0	1354.0	2471.5
1986	1418.9	2743.8	1634.7	2945.7
1987	1599.3	3149.0	1887.5	3477.2
1988	2020.5	3927.6	2387.7	4355.7

June 1, 1981

TABLE 2

DETROIT EDISON (DE) AND MICHIGAN ELECTRIC COORDINATED SYSTEM (MECS) NET COSTS FOR SYSTEM LOAD FORECASTS WITH LOAD GROWTH RATE AT HALF THE FORECASTED GROWTH RATE

	With Fermi 2		Without Fermi 2	
	DE NET Fuel $\$ \times 10^6$	MECS NET Fuel $\$ \times 10^6$	DE NET Fuel $\$ \times 10^6$	MECS NET Fuel $\$ \times 10^6$
1984	1043.4	1917.4	1143.9	2012.4
1985	1115.8	2097.1	1251.1	2228.4
1986	1270.3	2410.0	1446.9	2575.9
1987	1369.5	2692.0	1614.7	2948.4
1988	1644.9	3159.7	1902.6	3365.0

June 1, 1981

TABLE 3

DETROIT EDISON (DE) AND MICHIGAN ELECTRIC COORDINATED SYSTEM (MECS) NET COSTS FOR SYSTEM LOAD FORECASTS WITH ZERO LOAD GROWTH RATE (1980 BASE)

	With Fermi 2		Without Fermi 2	
	DE NET FUEL COST $\$ \times 10^6$	MECS NET FUEL COST $\$ \times 10^6$	DE NET FUEL COST $\$ \times 10^6$	MECS NET FUEL COST $\$ \times 10^6$
1984	943.2	1740.0	1023.1	1810.4
1985	1043.0	1917.9	1161.3	2019.8
1986	1151.5	2143.6	1300.0	2278.5
1987	1208.6	2339.9	1400.0	2532.0
1988	1378.3	2618.2	1583.0	2843.3

June 1, 1981

CHAPTER 9 BENEFIT - COST ANALYSIS

Section 9.4 (p. 9-1) Economic Costs

The Staff requested that the Applicant provide the latest estimate of the completed capital cost of the Fermi 2 unit, the estimate of the fixed charge rate on this investment, and the estimate of the first year fuel and O&M costs (in mills/KWhr). In addition, the levelized values over the assumed 30 years operating life of the plant was requested for these same cost elements (i.e., fuel and O&M). The most recent values for Fermi 2 are listed below:

o Capital Cost, ($ X 10^6)	2000
o Fixed Charge Rate, %	20.6
o Cost, first full year of operation	
Fuel, mills/KWhr	14.3
O&M, mills/KWhr	10.6
o Levelized Cost, 30 years	
Fuel, mills/KWhr	29.7
O&M, mills/KWhr	35.1

The fuel and O&M costs listed above are based on the information on the attached tables.

NUCLEAR OPERATIONS
Operating and Maintenance
7 Year NRC Budget Forecast
1984 - 1990
($,000)

(1981 dollars)

	1984/1990	1984		1985		1986		1987		1988		1989		1990	
NUCLEAR OPERATIONS	Projected Manpower	Oper	Maint	Oper	Maint	Oper	Maint	Oper	Maint	Oper	Maint	Oper	Maint	Oper	Maint
		$	$	$	$	$	$	$	$	$	$	$	$	$	$
Manager and Staff (See A&G Forecast)															
Nuclear Training	26	2,126		1,978		1,771		2,064		1,668		1,529		1,491	
Nuclear Engineering	66	3,202		3,202		3,202		3,202		3,202		3,202		3,202	
Administration	106	3,719		3,719		3,719		3,719		3,719		3,719		3,719	
Nuclear Quality Assurance	26	478	306	478	546	478	466	478	306	478	466	478	466	478.	306
Nuclear Plant Modifications	8		90		90		90		90		90		90		90
Outage Management	5		194		225		225		194		225		225		194
Total	237	9,525	590	9,377	861	9,170	781	9,463	590	9,067	781	8,928	781	8,890	590
NUCLEAR PRODUCTION															
Operations	71	5,689		5,689		5,689		5,689		5,689		5,689		5,689	
Technical	66	3,017	746	2,677	2,114	2,836	1,798	3,017	746	2,836	1,798	2,836	1,798	3,017	746
Maintenance	73	620	9,570	680	17,220	665	15,310	620	9,570	660	14,700	660	14,700	620	9,570
Radchem	46	5,027	198	6,394	198	6,126	198	5,027	198	6,036	198	6,036	198	5,027	198
Security	70	2,200		2,200		2,200		2,200		2,200		2,200		2,200	
Total	326	16,553	10,514	17,640	19,332	17,516	17,306	16,553	10,514	17,421	16,696	17,421	16,696	16,553	10,514
GRAND TOTAL	563	26,078	11,104	27,017	20,393	26,686	18,087	26,016	11,104	26,488	17,477	26,349	17,477	25,443	11,104
		37,182		47,410		44,773		37,120		43,965		43,826		36,547	

Revised 4-3-81

NUCLEAR OPERATIONS
ADMINISTRATIVE AND GENERAL
7 YEAR BUDGET FORECAST
1984 - 1990
1981 DOLLARS
(thousands of dollars)

	1984	1985	1986	1987	1988	1989	1990
Manager & Staff	780	780	780	780	780	780	780
Owners Group	75	75	75	75	75	75	75
Employee Benefits	4640	4640	4640	4640	4640	4640	4640
	5495	5495	5495	5495	5495	5495	5495

6/23/81

TABLE 1

The Base Case Parameters Related To Fuel Costs

Commercial Operation Date	November 15, 1983
Carrying Charges for Off-site Investment (Cycle One)	13.4%
Carrying Charges for Fuel Waiting On-site Prior to the Commencement of Operations (Cycle One)	13.4%
Carrying Charges for Off-site Investment (Back-end of the first Cycle and Front/Back-end of other Cycles)	11.0% (no taxes)
Carrying charges for On-site Investment (Other Cycles)	13.4%
Present Worth Factor	10%
Plant Capacity Factor	60%
Pre-Commercial Generation	660,000 MWh

The price escalations for the nuclear fuel estimates and services, are shown in Table 2.

TABLE 2

Base Prices and Escalation Rates

Fuel Cycle Step	1/1/81 Price	Escalation			
		From	Rate	From	Rate
Ore	$30.10/lb. U_3O_8	1/81	16%	1/83	12%
Conversion	4.62/KGU	1/81	5.5%	1/83	10%
Enrichment	105.37/SWU	1/81	13%	1/86	10%
Fabrication	32812/Assembly	1/81	9.34%	1/87	11%
Spent Fuel Shipping	36.04/KGU	1/81	11%		
Spent Fuel Disposal	341.57/KGU	1/81	11%	1/92	2%
Prime Rate		1/81	15%	1/84	11%

OMB: A-95 REVIEW

Monroe County, Michigan

1981

MEMORANDUM ATTACHMENT: F

TO: Monroe County Planning Commission

FROM: Staff

DATE: June 29, 1981

SUBJECT: Case No. 200.2 - 5-81-20
Draft Environmental Impact Statement
Regional Impact - Frenchtown Township
Monroe County, Michigan

Project Description

The United States Nuclear Regulatory Commission has submitted a Draft Environmental Statement for Areawide Clearinghouse review. The proposed action is for the issuance of an operating license to the Detroit Edison Company for the startup and operation of the Enrico Fermi Power Plant 2. The nuclear plant is located on Lake Erie in Monroe County, approximately eight miles northeast of Monroe, Michigan.

The facility will support a boiling-water reactor (BWR) to produce up to 3428 megawatts thermal. A steam turbine generator will use this heat to produce approximately 1150 net megawatts of electrical power capacity.

The information in this statement represents the second assessment of the environmental impact associated with Enrico Fermi 2 pursuant to the guidelines of the National Environmental Policy Act of 1969 and Title 10 of the Code of Federal Regulations/Part 51 (10 CFR 51) of the Commission's regulations. After an application to construct this plant was submitted to the Nuclear Regulatory Commission (NRC) in 1969, their staff reviewed impacts that would occur during the construction and operation of this plant. The staff evaluation was issued as a Final Environmental Statement (FES) in July 1972. As a result of that environmental review, a safety review, an evaluation by the Advisory Committee on Reactor Safeguards, and public hearings in Monroe, Michigan, and Washington, D.C., the NRC issued a permit in September 1972 for the construction of Enrico Fermi 2. As of March 1981, the construction of Enrico Fermi 2 was 80% complete. With a proposed fuel loading date of November 1982, Detroit Edison has applied for a license to operate the plant and submitted (in October 1974) the required safety and environmental reports to support this application. This Draft Environmental Statement (DES) presents the activities associated with the proposed operation of the plant, and potential impacts, as viewed by NRC staff.

Comments/Analysis

It must be noted that this DES was not produced by the Detroit Edison Company but by the Nuclear Regulatory Commission. After extensive in-house review, Monroe County Planning staff invited several other agencies to review the document and air their concerns in a meeting with Detroit Edison personnel. The other agencies include: the City of Monroe, Department of Community Development; the Monroe County Drain Commission; and the Monroe County Office of Civil Preparedness.

Planning staff developed an extensive list of concerns that were brought out at the meeting with Detroit Edison. Many of the concerns were the result of the highly technical nature of the document. Many of the questions were due to a lack of technical knowledge on staff's part in areas such as: aquatic biology, radiosensitivity of living organisms, meteorological dispersion of radioactive materials, etc., and were easily explained by Detroit Edison personnel. The following outline presents concerns that were not answered by Edison staff to the satisfaction of Planning staff.

In several instances, Edison personnel and staff members shared the same concerns over portions of the report.

1. In the portion of the document that summarizes Regional Water Use (pg 2-6) NRC staff suggested that "by State standards, the water (Lake Erie) is considered to be polluted to the extent that sports involving total body contact with the water should be avoided." Although this statement may have been true several years ago, staff feels it is erroneous at this time. This opinion has been verified by the Director of the Monroe County Environmental Health Division.

2. Under the title Environmental Impacts (4.4)(4.4.1.1) it is stated that three endangered or threatened species exist on the site, the American Lotus (endangered) the Swamp-Rose Hibiscus (threatened), the Eastern Fox-Snake (threatened), and further "because station operation will not involve destruction of habitat beyond that which has already occurred during construction, the staff believes that these species will not be effected." Planning staff feels that this is insufficient in terms of what <u>has</u> happened. NRC staff does not mention whether or not all, or a little, or a substantial amount of habitat has already been destroyed. In the following paragraph the same argument was used for acceptable levels of noise. They just state that noise levels after construction will be more acceptable than those during construction with no explanation of what the noise levels during construction affected.

3. Section 4.5.4 Radiological Impacts on Biota Other Than Humans; in the beginning of this section NRC staff reports that "terrestrial and aquatic biota will receive doses approximately the same or somewhat higher than humans receive", while in the last sentence of the section they state that "other living organisms (other than humans) are not much more radiosensitive than humans." This suggests to Planning staff that on one hand biota will receive the same or more radiation than humans and on the other that living organisms are more radiosensitive (however small) than humans. Staff interprets this to mean that other living organisms will be affected to a greater extent than humans while at the same time having less protection and resistance.

   It must be noted here that Edison personnel explained that very few studies have been completed in terms of radiosensitivity to living organisms other than humans, resulting in a situation that makes it very difficult to draw clear conclusions. Although staff acknowledges this fact we still feel uneasy with the aforementioned statements.

4. In section 6.1.2 Accident Experience and Observed Impacts NRC staff discusses the impacts of an accident on the public. They state that no significant impacts (due to accidents) are likely to occur over time periods of a few decades (Enrico Fermi 2 reactor life - 40 years). They further state that "This experience base is not large enough to permit a reliable quantitive statistical inference." Planning staff feels that if their experience base is not extensive enough to permit reliable quantitive statistical inference, they should not state that no significant impacts are likely to occur due to accidents.

5. Lastly, staff, in reviewing the document observed numerous statements and sets of data that were dated and no longer correct. Detroit Edison personnel concurred with staff's concerns in these areas and are forwarding their comments to the NRC.

Several other concerns were raised by other County agencies although they were not issues related to this specific document and will be brought up at the appropriate time.

Recommendation

Staff recommends that the Monroe County Planning Commission accept and place on file this review and forward the comments outlined herein to the Southeast Michigan Council of Governments and the U.S. Nuclear Regulatory Commission.

DEPARTMENT OF HEALTH & HUMAN SERVICES
Food and Drug Administration

Public Health Service

Food and Drug Administration
Rockville MD 20857

JUN 30 1981

Mr. B. J. Youngblood. Chief
Licensing Branch No. 1
Division of Licensing - NRR
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Youngblood:

Staff of the Bureau of Radiological Health of the Food and Drug Administration, have reviewed the health aspects of the Draft Environmental Statement (DES) for the Enrico Fermi Atomic Power Plant, Unit 2, NUREG-0769, April 1981.

In reviewing the DES for Fermi-2, it is recognized that a DES is an administrative action for the issuance of an operating license. We note that (1) the application for the construction of this plant was received by NRC in 1969, (2) the NRC staff evaluation was issued as a Final Environmental Statement (FES) - Construction Phase in July 1972, (3) the construction permit was issued on September 26, 1972, and (4) as of March 1981, the construction of Fermi-2 was 80 percent complete. The Bureau of Radiological Health staff have reevaluated the health aspects associated with proposed operations of the plant, and have the following comments to offer:

1. It appears the design objectives of 10 CFR 50, Appendix I, and the proposed operation plan of the Fermi-2 facility provide adequate assurance that the potential individual and population radiation doses meet current radiation protection standards.

2. The environmental pathways identified in Section 4.5.1 and in Figure 4.2, on page 4-16, as discussed in Appendix F of the FES - Construction Phase, cover all possible emission pathways that could impact on the population in the environs of the facility. The dose computational methodology and models used in the estimation of radiation doses to individuals near the plant and to populations within 80 km. of the plant have provided reasonable estimates of the doses resulting from normal operations and accident situations at the facility. Results of these calculations are shown in Tables 4.6, 4.7, 4.8, 4.9, and 4.12, and confirm our assessment.

3. The discussion in Section 6 on the environmental impact of postulated radiological accidents at Fermi-2 is considered to be an adequate assessment of the radiation exposure pathways and the dose and health impacts of atmospheric releases.

We believe, however, that the Emergency Preparedness Section (6.1.3.3) by itself is not adequate. We will forego further comment on this aspect, realizing that the process of granting an operating license to the facility will include an adequate review of emergency preparedness (FEMA-NRC Memorandum of Understanding, Regional RAC's, criteria in NUREG 0654). We have representation on the RAC's whose evaluation of the emergency planning relevant to Fermi-2 will speak for this agency.

In view of some of the monitoring problems during the Three Mile Island-2 accident, we suggest that the plan might be modified to address in particular the problems of monitoring radiohalogens (especially radioiodines) in the presence of radionoble gasses. This could be accomplished by reference to FEMA-REP-2, a document on instrumentation systems prepared with considerable input from NRC.

Considering the lessons learned from the accident at TMI-2, it would be helpful to expand the accident section of the DES to include a brief presentation of the critical public health and safety actions that the NRC has taken or plans to take to improve reactor safety and to mitigate the consequences of potential accidents. Such a discussion would provide an important amplification of this section of the DES, and would significantly increase public confidence and understanding of the implementation of the measures that the NRC has undertaken. The discussion in the first paragraph of page 6.9 is a possible introduction to the proposed modified section.

4. The operational monitoring program for each facility is planned to be a continuation of the preoperational program. It appears that the program will provide adequate sampling of environmental media and analysis for specific radionuclides that will be required to measure the extent of emissions from the plant, and to verify that such emissions meet applicable radiation protection standards.

5. The discussion of the uranium fuel cycle in Appendix C is a reasonable assessment of the population dose commitment and the potential health effects associated with releases of Radon-222 from facilty operations.

Thank you for the opportunity to review and comment on this draft document.

Sincerely yours,

John C. Villforth
Director
Bureau of Radiological Health

July 1, 1981

Director, Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

RECEIVED
JUL 07 1981
U.S. NUCLEAR REGULATORY COMMISSION

Sir:

I would like to offer the following comment regarding the "Draft Environmental Statement related to the operation of Enrico Fermi Atomic Power Plant, Unit No. 2" NUREG-0769.

I. Demonstrable Need

NEPA requires that alternatives to the proposed action be adequately considered. One such alternative to this plant has been neglected: not adding new production capacity is a prime candidate for recommendation in this DES.

Nearly a 400% error was made in the projected growth rate in peak demand in the Detroit Edison system, to wit a projected figure of 7.9% yearly growth versus the actual 2.1% figure during the years 1970-1980. NUREG-0769 at 7-1. This writer agrees with staff that this trend will likely continue.

For some reason, though, any further analysis of that trend and its concomitant results were omitted from the DES. Charting out more projections for the present decade would undoubtedly spell doom for Fermi 2. This writer expects such a table to reveal a negative growth, which would effectively vitiate the need for an additional 1150 net megawatts electrical.

Staff has circumvented this feature and what little there is to the showing of need rings quite hollow. The timely addition of this unit to Detroit Edison's system will result more probably in prompt consumer rate hikes.

II. Clam Biofouling

Staff has not accounted adequately for the presence of the Asiatic clam <u>Corbicula</u> <u>fluminensis</u>. It is present currently in Lake Erie and both its biofouling capacity and its tolerance to conventional biocides are superior to the organisms Staff did consider (fungal and bacterial growths, DES at 3-7). This writer suggests that both the 513 kg/day chlorine requirements and the dechlorination requirements are invalid.

In conclusion, this writer would request a copy of page 4-4 of the DES, which was incomplete in his copy of the DES. Thank you.

Sincerely,

Robert Alexander

Robert Alexander
4327 Alconbury #3
Houston, TX 77021

GENERAL COUNSEL OF THE
UNITED STATES DEPARTMENT OF COMMERCE
Washington, D.C. 20230

JUL 1 1981

RECEIVED
JUL 07 1981
U.S. NUCLEAR REGULATORY COMMISSION

Mr. B. J. Youngblood
Chief, Licensing Branch No. 1
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Youngblood:

This is in reference to your draft environmental impact statement entitled "Enrico Fermi Atomic Power Plant, Unit No. 2." The enclosed comments from the National Oceanic and Atmospheric Administration (NOAA) are forwarded for your consideration.

Thank you for giving us an opportunity to provide these comments, which we hope will be of assistance to you. We would appreciate receiving four copies of the final statement.

Sincerely,

Robert T. Miki
Director of Regulatory Policy

Enclosure Memos from: Mr. Eugene J. Aubert
Environmental Research Laboratories
NOAA

Mr. Robert B. Rollins
National Ocean Survey
NOAA

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SURVEY
Rockville, Md. 20852

MAY 29 1981

OA/C52x6:JVZ

TO: PP/EC - Joyce M. Wood

FROM: OA/C5 - Robert B. Rollins

SUBJECT: DEIS #8105.13 - Operation of Enrico Fermi Atomic Power Plant, Unit No. 2 (Docket No. 50-341), Monroe County, Michigan

The subject statement has been reviewed within the areas of the National Ocean Survey's (NOS) responsibility and expertise, and in terms of the impact of the proposed action on NOS activities and projects.

The National Ocean Survey operates a water level gage on the Fermi Power Plant site. Construction to date has not disturbed the gage or suite of bench marks. Future construction, as outlined in the Draft Environmental Statement would not affect the installation.

The Office of Oceanography would appreciate notification of any change in construction plans that would adversely impact gage operation or bench mark emplacement.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL RESEARCH LABORATORIES
Great Lakes Environmental Research Laboratory
2300 Washtenaw Avenue
Ann Arbor, MI 48104

June 9, 1981

TO: PP/EC - Joyce Wood

FROM: RD/RF24 - Eugene J. Aubert

SUBJECT: DEIS 8105.13 - Operation of Enrico Fermi Atomic Power Plant, Unit No. 2 (Docket No. 50-341), Monroe County, Michigan

The subject DEIS prepared by the U.S. Nuclear Regulatory Commission on the operation of Enrico Fermi Atomic Power Plant on Lake Erie has been reviewed and comments herewith submitted.

Our review of the operation of Enrico Fermi Atomic Power Plant, Unit No. 2, was limited to the effects on Lake Erie. We found them to be minimal. There are no objections against the issuance of an operating license.

104 Davey Laboratory
The Penn. State University
University Park
Pa., 16802
13 July 1981

Director, Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C.
20555

Dear Director:

Attached are my comments on the Draft Environmental Statement on the operation of the Enrico Fermi Unit 2, (NUREG-0769). Please note that the opinions and calculations are my own, and not necessarily those of The Pennsylvania State University, which affiliation si given for identification purposes only.

I should note that I requested a copy of the draft from Document Control on 23 June, but did not receive it until 10 July. It is particularly distressing to see the "Rebaselining" that is done in this Draft without the kind of Peer Review that the NRC recognized was necessary for WASH-1400 in its January 18, 1979 "NRC Statement on Risk Assessment and the Reactor Safety Study Report in light of the Risk Assessment Review Group Report". (P. 3).

I hope these comments are useful in developing the Final EIS required by NEPA.

Sincerely,

William A. Lochstet

W.A. Lochstet, Ph.D.

The Long Term Health Consequences of Enrico Fermi, Unit 2

by

William A. Lochstet

The Pennsylvania State University*

July 1981

The Nuclear Regulatory Commission(NRC) has attempted to evaluate the health consequences of the operation of the Enrico Fermi Atomic Power Plant, Unit 2, in its draft Environmental Statement NUREG-0769. The health consequences of the radon-222 released from the mill tailings and the open pit mines are evaluated for the first 1000 years from now in Appendix C. This evaluation suggests (Page C-8) that the radon emissions increase after the first 500 years have elapsed. There is no suggestion that there is any reason to believe that these emissions will stop at that time, or after 1000 years.

The fact is that these radon emissions are governed by the 80,000 year half life of thorium-230 and the 4.5 billion year half life of uranium-238. The thorium situation had been adequately discussed by Pohl (Search, 7(5),345-350, August 1976). The impact of the uranium-238 as a source of radon was recognized in GESMO (NUREG-0002)(1976) and is discussed in the Final Environmental Statement for the Split Rock Mill (NUREG- 0639 Pages A-57 to A-60). The result is that the uranium in the mill tailings is estimated to cause 200,000 deaths, for the amount of activity to generate the fuel for one 1000 Mwe plant operating at 80 % capacity factor. This is the generic case taken in the Draft, NUREG-0769.

* The opinions and calculations presented here are my own. and not necessarily those of the Pennsylvania State University. My affiliation is given here for identification purposes only.

Southeast Michigan Council of Governments
800 Book Building · Detroit, Michigan · 48226 · (313) 961-4266

July 17, 1981

B. J. Youngblood, Chief
Licensing Branch No. 1
U. S. Nuclear Regulatory Commission
Washington, DC 20555

RE: Draft Environmental Impact Statement from the U. S. Nuclear Regulatory Commission for project entitled "Operation of Enrico Fermi Atomic Power Plant, Unit No. 2."
Areawide Clearinghouse Code: LU 810205

Dear Mr. Youngblood:

The Council of Governments has processed a review for the above Draft Environmental Impact Statement according to the guidelines established in federal Office of Management and Budget Circular No. A-95.

The following agencies were asked to comment on your project:

(See attached list.)

As of this date the Wayne County Planning Commission, the Wayne County Intermediate School District, the Oakland County Division of Planning, the Monroe County Planning Department and Commission, Frenchtown Township, Jefferson Schools, the Macomb County Planning Commission, the Washtenaw County Metropolitan Planning Commission, SEMTA, and the Detroit Area Agency on Aging 1-A have submitted written comments which are attached.

The other public agencies notified have not responded to our solicitation for comments during the A-95 review period. We will forward late comments to you, for your information and attention.

The Wayne County Planning Commission's response had an attached letter from the Wayne County Department of Health, Air Pollution Control Division which stated that the Michigan-Ontario Transboundary Air Pollution Committee of the International Joint Commission should be informed of this Draft EIS. SEMCOG has not notified Canadian authorities but the 10 Mile Plume Exposure Pathway and 50 Mile Ingestion Exposure Pathway directly impact the Province of Ontario, Canada. We assume that the NRC has initiated comments from Canadian authorities, since international relations falls outside the scope of A-95 review.

The Wayne County Intermediate School District has recommended that the Final Environmental Impact Statement include an emergency response plan in case of a nuclear emergency at Enrico Fermi. Reference to the Michigan-Detroit Edison-Monroe County Radiological Emergency Response Plan may satisfy this concern. SEMCOG is not aware at this time whether or not this Emergency Response Plan is completed, nor are we aware of the extent of the intergovernmental communications network involved. This Plan should be completed before the Fermi plant begins operation. All major governmental units within the 10 and 50 mile exposure areas should be familiar with this Plan. The Oakland County Division of Planning and the Oakland County Emergency Medical Service/Disaster Control Division have also forwarded comments concerning communications with Enrico Fermi Power Plant officials concerning an emergency response to accidents or sabotage.

The Monroe County Planning Department and Commission asked for an extension in the review period for the Draft EIS. The NRC graciously extended the time period to allow the Planning Commission an opportunity to further investigate the impacts of the operation of Enrico Fermi on Monroe County. The Planning Commission invited representatives from Detroit Edison to a meeting and the resulting comments are contained in the attached letter. They do not directly object to the operation of this facility, but would like their concerns addressed.

The Council's staff and AWQB staff have reviewed the Draft Environmental Impact Statement document for consistency with areawide plans and programs. Although the Southeast Michigan Council of Governments is currently developing a comprehensive regional energy management plan, this document has not yet been presented for adoption by the Council's policy body. The Fermi II Draft Environmental Impact Statement has, however, been reviewed for consistency with SEMCOG's adopted policies concerning environmental protection and land use. There are no apparent conflicts between the Draft EIS and these plans and policies. We look forward to the Final EIS for the Enrico Fermi facility.

Sincerely,

Edward J. Hustoles, AICP, PCP
Director, Planning Division

EJH/RWP/lh
Attachments

cc: Please see attached list.

<u>10 Mile Plume Exposure Pathway</u>

Michigan Department of Civil Rights-Eastern Division
Monroe County Intermediate School District
Monroe County Cooperative Extension Service
Monroe County Planning Commission
Berlin Township
Village of Estral Beach
Village of South Rockwood
Village of Carleton
City of Monroe
Frenchtown Township
Monroe Township
LaSalle Township
Exeter Township
Ash Township
Raisinville Township
Jefferson School District
Wayne County Intermediate School District
Wayne County Planning Commission
Wayne County Cooperation Extension Service
Huron Township
City of Flat Rock
City of Rockwood
Brownstown Township
City of Gibraltar
City of Woodhaven
City of Trenton
Grosse Ile Township

<u>50 Mile Ingestion Exposure Pathway</u>

Michigan Department of Civil Rights-Western Division
Washtenaw County Metropolitan Planning Commission
Livingston County Department of Internal Services
Oakland County Division of Planning
Macomb County Planning Commission
City of Detroit Planning Department
Region II Planning Commission
Clinton River Watershed Council
Rouge River Watershed Council
St. Clair County Metropolitan Planning Commission
Southeastern Michigan Transportation Authority (SEMTA)
Areawide Water Quality Board
Toledo Metropolitan Area Council of Governments (TMACOG)
Huron-Clinton Metropolitan Authority
Downriver Community Conference
Huron River Watershed Council
Comprehensive Health Planning Council of Southeastern Michigan (CHPC-SEM)
Southeastern Michigan Council on Emergency Medical Services
Area Agency on Aging 1-A
Area Agency on Aging 1-B
Area Agency on Aging 1-C

cc: Berlin Township
Village of South Rockwood
Frenchtown Township
Jefferson School District
Wayne County Intermediate School District
Huron Township
City of Flat Rock
City of Rockwood
Brownstown Township
City of Gibraltar
City of Woodhaven
City of Trenton
Grosse Ile Township
Detroit Planning Department
Detroit Area Agency on Aging 1-A
Southeastern Michigan Transportation Authority (SEMTA)
County Planning Offices of Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw and Wayne
City of Monroe

ROBERT J. NORWOOD
Supervisor — 242-5904
BERNARD J. FELDER
Clerk — 242-5800
JACQUELINE K. ROUSSELO
Treasurer — 242-5902

FRENCHTOWN CHARTER TOWNSHIP

2744 VIVIAN ROAD — MONROE, MICHIGAN 48161

May 27, 1981

RECEIVED
MAY 29 1981
SEMCOG

Southeast Michigan Council of Governments
Regional Review Office
800 Book Building
Detroit, Michigan 48226

Attn: Daniel R. Snyder, Manager
Land Use and Energy Programs

Dear Mr. Snyder:

There are no objections to the draft supplement of the environmental statement in regards to the issuance of an operating license for the Enrico Fermi Atomic Power Plant Unit Two; subject to all the conditions recommended by the Staff for the Protection of the Environment, namely, "License Conditions: and "Significant Environmental Protection Requirements."

Respectfully,

Robert J. Norwood

Robert J. Norwood
Supervisor
Frenchtown Charter Township

RJN/se

cc: file

Jefferson Schools

5102 North Stoney Creek Road • Monroe, Michigan 48161 Telephone (313) 289 - 4200

James Egan
Superintendent of Schools

Ermil Jones
Assistant Superintendent

Athletic Department
Telephone 289-4215. Ext. 9

Velma LaBeau
Director Compensatory Education
Elementary Curriculum Coordinator

HIGH SCHOOL
[illegible] Williams Road
[illegible]
Raymond Kessler, *Principal*
Fredrick Sakel, *Asst. Principal*

SODT ELEMENTARY SCHOOL
2888 Nadeau Road
289 - 4210
Allen Pearsall, *Principal*

HURD RD. ELEMENTARY SCHOOL
1960 E. Hurd Road
289 - [illegible]
John Mueller, *Principal*

MIDDLE SCHOOL
5102 N. Stoney Creek Rd
289 - 4204
Jon Rhoades, *Principal*
Charles Kennon, *Asst. Principal*

June 1, 1981

RECEIVED
JUN 3 - 1981
SEMCOG

Mr. D. Snyder, Mgr.
Southeast Michigan Council of Governments
800 Book Building
Detroit, Michigan 48226

Dear Mr. Snyder,

We agree 100% with the draft of the Environmental Impact statement. In fact, the school district is extremely pleased and honored and feels very positive of having the Enrico Fermi Plant in our area.

One of the many reasons why we feel positive about the Fermi Plant is because they have been approved and in the process of building a large building that will house a number of research scientists and engineering employees. These professional individuals moving into our area, we feel, will be an asset to this community.

In summary, our feeling is that the impact of the Enrico Fermi Plant will be a very positive influence on our community.

Sincerely,

James Egan,
Superintendent

JE/cl

WASHTENAW COUNTY

METROPOLITAN PLANNING COMMISSION

305 COUNTY BUILDING MAIN AND HURON STREETS
P.O. BOX 8645 ANN ARBOR, MICHIGAN 48107 (313) 994-2435

DIRECTOR
Thomas J. Fegan

RECEIVED
JUN 8 - 1981
SEMCOG

June 4, 1981

Daniel R. Snyder, Manager
Land Use Program
Southeast Michigan Council of Governments
1249 Washington Blvd.
800 Book Bldg.
Detroit, MI 48226

County Ref. No. 204-39-81
SEMCOG Ref. No. LU 810205

Dear Mr. Snyder:

In accordance with Federal OMB Circular A-95 and review procedures established by the Southeast Michigan Council of Governments (SEMCOG), the Washtenaw County Metropolitan Planning Commission (WCMPC) has reviewed the Draft Environmental Impact Statement from the United States Nuclear Regulatory Commission for a project titled "Operation of the Enrico Fermi Atomic Power Plant, Unit II".

According to the information provided by the applicant, the proposed action is the issuance of an operating license to the Detroit Edison Company for the start up and operation of the Enrico Fermi Atomic Power Plant, Unit II, located on Lake Erie in Monroe County, approximately eight miles northeast of Monroe, Michigan.

In reviewing this proposal, staff contacted Dr. John Atwater, Director of the Washtenaw County Health Department. Dr. Atwater indicated his agency was aware of, and had no conflict with, the Fermi II proposal. Staff found no conflict with this proposal and any County or local land use plan or policy and therefore recommends approval of the request.

Sincerely,

Robert L. Tetens
Associate Planner

RLT:wps

MORTON STERLING
Director
Air Pollution Control Division

WAYNE COUNTY DEPARTMENT OF HEALTH

AIR POLLUTION CONTROL DIVISION

1311 EAST JEFFERSON
DETROIT, MICHIGAN 48207
Telephone: (313) 224-4650

June 5, 1981

Mr. Maurice W. Roach, Director
Wayne County Planning Commission
730 City-County Building
2 Woodward Avenue
Detroit, MI 48226

Dear Mr. Roach:

Subject: Response to Your Letter of June 1, 1981 Relative to the Draft Environmental Impact Statement Concerning Proposed Operation of the Enrico Fermi Atomic Power Plant, Unit No. 2.

We have reviewed the summary and conclusion in the Draft Environmental Impact Statement described above. Since this facility may impact the communities along the Detroit River, the MOTAP (Michigan-Ontario Trans-boundary Air Pollution) Committee of the International Joint Commission is involved in preparing a comprehensive contingency plan which will be followed to ensure that the appropriate authorities on the state side as well as the Canadian side are informed in the event of accidental releases into the atmosphere of material having significant environmental impact. I would suggest that you advise Mr. L. Shenfeld, Chief - Air Quality & Meteorology, Ontario Ministry of the Environment, 880 Bay Street, 4th Floor, Toronto, Ontario, Ontario N5S IZ8 of this particular Draft Environmental Impact Statement so that appropriate action could follow. Mr. Shenfeld is currently the chairman of the MOTAP Committee of the International Joint Commission.

Thank you very much for this opportunity of reviewing this material.

Very truly yours,

Benjamin Baskin

Benjamin Baskin, P.E.
Engineering Supervisor

BB:ls

cc: Mr. L. Shenfeld

Branch: DOWNRIVER OFFICE
152 ELM STREET
WYANDOTTE, MICHIGAN 48192
Telephone: (313) 284-0664

COUNTY OF OAKLAND
6-2
DANIEL T. MURPHY, COUNTY EXECUTIVE

June 8, 1981

Ms. Debbie Schutt
Oakland County Planning Div.
County Service Center
Pontiac, Mich. 48053

Re: Operation of Enrico Fermi Atomic Power Plant, Unit No. 2

Dear Ms. Schutt:

I have reviewed the summary and conclusions of the draft environmental impact statement which was prepared by the U.S. Nuclear Regulatory Commission in regards to the operation of the Enrico Fermi Atomic Power Plant, Unit No. 2, located in Monroe County.

As far as I can determine from the information reviewed, the operation of the Power Plant Unit 2 will not effect any of the Oakland County Public Works' activities.

Best regards,

Milton W. Handorf, P.E.
Director
Dept. of Public Works

MWH/mah

Department of Public Works
1200 NORTH TELEGRAPH ROAD, PONTIAC, MICHIGAN 48053
(313) 858-1208

Monroe County Planning Department & Commission

1410 EAST FIRST STREET, MONROE, MICHIGAN 48161
Telephone: (313) 243-7093

ROYCE R. MANIKO,
Planning Director

BERNARD J. FELDER,
Commission Chairman

RECEIVED

JUN 15 1981

SEMCOG

June 11, 1981

Daniel R. Snyder, Manager
Land Use & Energy Programs
Southeast Michigan Council of Gov'ts
8th Floor, Book Building
1249 Washington Boulevard
Detroit, Michigan 48226

Dear Mr. ~~Snyder~~ Dan:

RE: LU 810205 Operation of Enrico Fermi II
Draft Environmental Impact Statement

We have been unable to undertake an adequate review of the above prefaced matter due to lack of sufficient time. At the June 10, 1981 meeting the Monroe County Planning Commission considered the matter and authorized me to request a thirty (30) day extension of the review period.

Your attention to this request would be greatly appreciated.

Sincerely,

Royce

Royce R. Maniko, AICP
Planning Director

RRM/kt

Southeastern Michigan Transportation Authority

First National Building
660 Woodward Avenue
Detroit, Michigan 48226
313 256-8600

SEMTA

June 12, 1981

Mr. Daniel Snyder, Manager
Land Use & Energy Programs
Southeast Michigan Council
of Governments
800 Book Building
Detroit, Michigan 48226

RE: LU 810205, Operation of Enrico Fermi Atomic Power Plant, Unit No. 2 Draft Environmental Impact Statement

Dear Mr. Snyder:

The staff of the Southeastern Michigan Transportation Authority (SEMTA) has reviewed the above-referenced DEIS. Based on that review, we have no comments.

Sincerely yours,

Harry L. Rogers
Harry L. Rogers
Manager
Project Control and Programming

/sg

COUNTY OF OAKLAND
DANIEL T. MURPHY, COUNTY EXECUTIVE

June 16, 1981

RECEIVED
JUN 19 1981
SEMCOG

Mr. Daniel Snyder
Southeast Michigan Council
of Governments
800 Book Building
1249 Washington Blvd.
Detroit, MI 48226

Re: Operation of Enrico Fermi Atomic Power Plant, Unit No. 2
County Control No.: 81-61
SEMCOG Code No.: LU 810205

Dear Mr. Snyder:

Our office has received and reviewed the above project as submitted by the U.S. Nuclear Regulatory Commission.

As a part of our review process, our office sent information on this project to the Oakland County Department of Public Works, Emergency Medical Services/Disaster Control, Human Services and the Health Department. Attached is the response of Public Works and the EMS/Disaster Control Division.

This project does not conflict with the plans and/or policies of the County Planning Division and we recommend approval contigent upon Enrico Fermi Atomic Power Plant officials addressing the recommendations requested by the EMS/Disaster Control Unit of the county.

Sincerely,

Philip W. Dondero
Manager

PWD:hk

cc: Deborah Schutt
Paul Phelps

Division of Planning, Administrative Annex II
1200 NORTH TELEGRAPH ROAD, PONTIAC, MICHIGAN 48053
(313) 858-0720

OAKLAND COUNTY

Inter-Departmental Memo

Date June 16, 1981

From: Paul R. Phelps, E.M.S./Disaster Control Division

To: Debbie Schutt, Planning Division

Subject: Operation of Enrico Fermi Atomic Power Plant, ~~Unit No. 2 Draft Environmental Impact Statement~~

In response to your correspondence dated May 26, 1981, relative to the above, I would like to provide the following comments for inclusion in your report to the Southeast Michigan Council of Governments.

I am extremely concerned about two matters, both of which would have a direct impact on Oakland County's environment.

First, even though the environmental risk from accidental radiation exposure or other accident is very low according to the reports, the possibility still exists that one could occur. This possibility results in the need to properly prepare plans to act accordingly in the event of a mass evacuation declaration.

I would, however, like to point out that we presently are not thoroughly prepared to effectively implement our plans to evacuate a large number of persons.

Secondly, the transportation of nuclear waste materials through Oakland County would pose another risk to the environment. Again, the risks would result in the preparation of plans to effectively respond to accidents or sabotage.

Because of these two identified environmental risks, I would ask the Enrico Fermi Atomic Power Plant officials to act favorably on the following recommendations.

1. To establish and maintain a close liaison relationship with this Division.

2. To provide information relative to the potential risks associated with the plant's operations.

3. To assist in the preparation of plans to respond to accidental radiation exposure or other accident situations.

4. To report forthwith to this Division any occurrence of an unusual or important event that indicates or could result in significant environmental impact.

5. To conduct or participate in continuing education classes or seminars on providing information to respond to accidents.

If you have any questions, or desire any additional information, please call me at 858-1283.

PRP:mr.
cc: Robert E. Chisholm

Wayne County Intermediate School District

June 18, 1981

RECEIVED
JUN 19 1981
SEMCOG

Mr. Richard Pfaff
Regional Review Office
Southeast Michigan Council of Governments
800 Book Building
Detroit, Michigan 48226

Re: A-95 Review of Draft Environmental Impact Statement

Applicant: U.S. Nuclear Regulatory Commission

Area Clearinghouse Code: LU 810205

Dear Mr. Pfaff:

The above-referenced project has been reviewed by our Office of State and Federal Programs. The only expected significant impact that the Enrico Fermi Atomic Power Plant, Unit No. 2, could have on the Wayne County Intermediate School District and its constituents would be that of radiation released in the event that emergency conditions occur. It is realized that if Detroit Edison follows all safe operation procedures and if the Nuclear Regulatory Commission enforces all the regulations applicable to this facility, the chances of emergency conditions occurring are very low.

It is recommended that the plan advising the public what to do in the event of a nuclear emergency at this facility be included in the final Environment Impact Statement.

Sincerely,

Susan M. Sommer, Consultant
State/Federal Programs

SMS/ml

cc: Othello Colecchia
Wayne County Planning Commission

33500 Van Born Road, Wayne, Michigan 48184 (313) 326-9300 (From Detroit, 274-5000)

Wayne County Planning Commission

730 CITY-COUNTY BUILDING
2 WOODWARD AVENUE
DETROIT, MICHIGAN 48226
PHONE 313/224-5018

MAURICE W. ROACH
DIRECTOR

RECEIVED
JUN 26 1981
SEMCOG

June 25, 1981

Mr. Richard Pfaff
Southeast Michigan Council of Governments
800 Book Building
1249 Washington Boulevard
Detroit, Michigan 48226

Dear Mr. Pfaff:

Please be advised that the Wayne County Planning Commission is in receipt of the Draft Environmental Statement related to the operation of Enrico Fermi Atomic Power Plant Unit No. 2 in Monroe County, Michigan.

The document was referred to the Public Works Committee of the Wayne County Board of Commissioners on June 23, 1981, at which time the Statement was received and filed with no comment.

The Wayne County Planning Commission did receive comments submitted by other Wayne County agencies, which are attached.

Respectfully submitted,

Maurice W. Roach, Director
Wayne County Planning Commission

MWR/pf

cc: Clarence Young

Encl.

Macomb County Planning Commission

115 S. Groesbeck Highway, Mount Clemens, Michigan, 48043
(313) 469-5285

July 1, 1981

RECEIVED
JUL 6 - 1981
SEMCOG

Mr. Michael M. Glusac
Executive Director
Southeast Michigan Council
of Governments
800 Book Building
Detroit, MI 48226

Re: Notice of Draft Environmental Statement
Related to Operation of Enrico Fermi
Atomic Power Plant, Unit No. 2
U.S. Nuclear Regulatory Commission
Detroit Edison Company

Dear Mr. Glusac:

In accordance with established A-95 Clearinghouse procedures, we have reviewed the Draft Environmental Statement related to the operation of Enrico Fermi Atomic Power Plant, Unit No. 2, submitted by the U.S. Nuclear Regulatory Commission.

The Offices of Macomb County Health Services and Emergency Services were contacted with regard to this document. Enclosed is a copy of the response from the Macomb County Health Services office. The Office of Emergency Services has indicated that they had no objection to the proposed operation of the power plant as long as all safety regulations are complied with.

The staff of the Macomb County Planning Commission has reviewed the general planning data contained in the document such as, land use, population characteristics, recreational activities and other urban services and finds no conflict with our programs or information. This review has been conducted with the assumption that the appropriate federal, state and local requirements will be met.

Sincerely,

Bernard E. Giampetroni

Bernard E. Giampetroni
Director

BEG:JWB:bas

Enclosure

cc: Robert A. VerKuilen, Chairman
Macomb County Board of Commissioners

Norman Hill, Administrator
Macomb County Health Services

John Perry, Coordinator
Emergency Services

RECEIVED
JUL 6 - 1981
SEMCOG

MACOMB COUNTY HEALTH DEPARTMENT

43525 ELIZABETH
MOUNT CLEMENS, MICHIGAN 48043

DANIEL C. LAFFERTY
Health Officer

LELAND C. BROWN
Medical Director

June 25, 1981

Bernard E. Giampetroni, Director
Macomb County Planning Commission
115 South Groesbeck Highway
Mount Clemens, Michigan 48043

Re: Draft Environmental Statement Related to the Operation of Enrico Fermi Atomic Power Plant, Unit No. 2
U. S. Nuclear Regulatory Commission
Detroit Edison Company

Dear Mr. Giampetroni:

We have given a cursory review of the material forwarded to us relative to the above mentioned project. We shall interpose no objection to the proposed operation - providing the plant emergency plan is approved by the Michigan Department of Public Health and all other applicable, Federal, State and local requirements are adhered to.

If we can be of further assistance, please feel free to call upon us.

Sincerely,

MACOMB COUNTY HEALTH DEPARTMENT

Daniel C. Lafferty
Director/Health Officer

RECEIVED
JUN 29 1981
MACOMB
PLANNING COMMISSION

DCL/MED/ml

ENVIRONMENTAL HEALTH 469-5236 | CLINIC SERVICES 469-5372 | PERSONAL HEALTH SERVICES 469-5520 | INFORMATION 469-

DETROIT AREA AGENCY ON AGING
3110 Book Building
1249 Washington Boulevard
Detroit, Michigan 48226
(313) 961-6680

Shelton Tappes
Chairperson
Board of Directors

Virginia Crowthers
Executive Director

July 2, 1981

Mr. Daniel R. Synder, Manager
Land Use & Energy Programs
Southeast Michigan Council of Governments
800 Book Building
Detroit, Michigan 48226

RECEIVED
JUL 6 - 1981
SEMCOG

RE: LU 810205

Dear Mr. Synder:

Please be advised the goals and objectives of this project do not fall within the persual of the Detroit Area Agency on Aging.

Sincerely,

Frances F. Mosley

FM:bj
7/2/81

Monroe County Planning Department and Commission

1410 EAST FIRST STREET MONROE, MICHIGAN 48161
Telephone: (313) 243-6900 Ext. 277

July 9, 1981

ROYCE R. MANIKO,
Planning Director

BERNARD J. FELDER,
Commission Chairman

RECEIVED
DATE JUL 13 1981
A-95 REVIEW CENTER
SOUTHEAST MICHIGAN
COUNCIL OF GOVERNMENTS

Southeast Michigan
Council of Governments
8th Fl. Book Bldg., 1249 Washington
Detroit, Michigan 48226

Attn.: Daniel Snyder

Subject: Draft Environmental Impact Statement OMB A-95 200.2-5-81-30
Regional Impact - Frenchtown Township, Monroe County, Michigan
Areawide Clearinghouse Code: LU 810205

Dear Mr. Snyder:

We have completed our review of the above prefaced subject matter and advise as follows:

> "Moved by Mr. White and seconded by Mr. Swick that the Monroe County Planning Commission accept and place on file this review and forward the comments outlined herein to the Southeast Michigan Council of Governments and the U.S. Nuclear Regulatory Commission.
> Motion Carried."

We further enclose a copy of staff memorandum in this regard to indicate the considerations which went into the resolution of this issue.

Thank you for allowing us this opportunity to respond to the subject matter as it affects areawide plans adopted by our Planning Commission.

Sincerely,

Royce R. Maniko

Royce R. Maniko, Director

Enclosure

Editor's Note: The enclosure referenced appears as pages A-38 to A-40.

RRM:mm

Southeast Michigan Council of Governments
800 Book Building · Detroit, Michigan · 48226 · (313) 961-4266

July 24, 1981

RECEIVED
JUL 28 1981
U.S. NUCLEAR REGULATORY COMMISSION

B. J. Youngblood, Chief
Licensing Branch No. 1
U. S. Nuclear Regulatory Commission
Washington, DC 20555

RE: Operation of Enrico Fermi Atomic Power Plant, No. 2
Areawide Clearinghouse Code: LU 810205

Dear Mr. Youngblood:

We are hereby forwarding the attached late comments which were solicited during the Council's A-95 review of the above captioned project(s).

Should you need additional information or consultation, please contact Daniel Snyder, Manager, Land Use & Energy Programs.

Sincerely,

Linda Hamilton
Regional Review Clerk

Attachment(s)

CITY OF MONROE
MICHIGAN

Community Development
JOHN R. IACOANGELI, AICP
Director

120 EAST FIRST STREET
LORANGER SQUARE
48161

(313) 243-0700
Extension 234

July 22, 1981

Mr. Daniel Snyder
S.E.M.C.O.G.
800 Book Building
1249 Washington Boulevard
Detroit, MI 48226

SUBJECT: Draft Environmental Impact Statement Review for Operation of Enrico Fermi Atomic Power Plant, Unit 2. SEMCOG Code No: LU 810205

Dear Mr. Snyder:

The City of Monroe has received and reviewed the above project as submitted by the U.S. Nuclear Regulatory Commission. There are two concerns that the City has about the draft E.I.S. and requests that they be addressed in the final E.I.S.

1. The City, in its pursuit to provide public safety to its residents, expects that Detroit Edison will provide and maintain the monitoring devices on the City's drinking water system as they did when Atomic Power Plant Fermi I was in operation. In addition, the City requests that a monitoring device to detect radioactivity be placed at the point of water intake, located one mile off-shore, two miles southeast of the Fermi II power plant, or that a discharge pipe be constructed as a modification to the water treatment system.

   Current plans would have a radioactivity monitoring device monitoring water after it has been drawn one mile up the intake pipe. There is a design problem with that location. If the water did become radioactively contaminated, the present water plant design does not have the capability to reverse the flow of water. This would result in the City shutting down the water system without a method to discharge the radioactive water trapped in the water intake pipe.

   Detroit Edison officials have been in contact with the City of Monroe's water supervisor to have a solution worked out for this problem. So far, the City is unaware of anything that has been done to eliminate that problem.

2. The City of Monroe is also concerned about the transportation of radioactive materials through the City. In the draft E.I.S., primary concern is with possible accidents occuring on site, with only a brief statement that the transportation dose "is small and is not considered significant in comparison with the natural-background dose." This statement obviously does not take into consideration the possibility of an accident enroute to the site. Although the City is aware that a license to transport radioactive materials to the Power Plant will be issued only after review with concerned governmental bodies, the City finds it appropriate to include impacts of transportation accidents in the final E.I.S., and what routes are proposed.

Thank you for allowing us this opportunity to respond to this Draft E.I.S. on the Fermi II Atomic Power Plant as it is an important concern to the City of Monroe.

Sincerely,

John R. Iacoangeli, AICP
Director of Community Development

JRI:RAS:dmh

cc: Mr. John M. Wisniewski, Detroit Edison
Monroe County Planning Department

APPENDIX B

NEPA POPULATION DOSE ASSESSMENT

Population dose commitments are calculated for all individuals living within 80 km (50 mi) of the Fermi-2 facility, employing the same models used for individual doses (see Regulatory Guide 1.109, Rev. 1). In addition, population doses associated with the export of food crops produced within the 80-km region and the atmospheric and hydrospheric transport of the more mobile effluent species, such as noble gases, tritium, and carbon-14, have been considered.

Noble Gas Effluents

For locations within 80 km of the reactor facility, exposures to these effluents are calculated using the atmosphere dispersion models in Regulatory Guide 1.111, Rev. 1, and the dose models described in Section 4.5 and Regulatory Guide 1.109, Rev. 1. Beyond 80 km, and until the effluent reaches the northeastern corner of the United States, it is assumed that all the noble gases are dispersed uniformly in the lowest 1000 m (3300 ft) of the atmosphere; decay in transit is considered. Beyond this point, noble gases having a half-life greater than one year (for example, Kr-85) were assumed to mix completely in the troposphere with no removal mechanisms operating.

Transfer of tropospheric air between the northern and southern hemispheres, although inhibited by wind patterns in the equatorial region, is considered to yield a hemisphere average tropospheric residence time of about two years with respect to hemispheric mixing. Since this time constant is quite short with respect to the expected midpoint of plant life (15th year), mixing in both hemispheres can be assumed for evaluations over the life of the nuclear facility. This additional population dose commitment to the U.S. population was also evaluated.

Iodines and Particulates Released to the Atmosphere

Effluent nuclides in this category deposit onto the ground as the effluent moves downwind, which continuously reduces the concentration remaining in the plume. Within 80 km of the facility, the deposition model in Regulatory Guide 1.111, Rev. 1, was used in conjunction with the dose models in Regulatory Guide 1.109, Rev. 1. Site-specific data concerning production and consumption of foods within 80 km of the reactor were used. For estimates of population doses beyond 80 km it was assumed that excess food not consumed within the 80 km distance would be consumed in the population beyond 80 km. It was further assumed that all the particulates released from the facility would deposit onto the ground plane within the 80 km region and thus would make no contribution to the population dose outside the 80 km region.

Carbon-14 and Tritium Released to the Atmosphere

Carbon-14 and tritium were assumed to disperse over land without deposition, in the same manner as krypton-85. These nuclides do, however, interact with the oceans. This causes the carbon-14 to be removed with an atmospheric residence time of from four to six years, with the oceans being the major sink. From this, the equilibrium ratio of the carbon-14 to natural carbon in the atmosphere was determined. The same ratio was then assumed to exist in humans so that the dose received by the entire population of the United States could be estimated. Tritium was assumed to mix uniformly in the hydrosphere, which was assumed to include all the water in the atmosphere and in the upper 70 m (230 ft) of the oceans. With this model, the equilibrium ratio of tritium to hydrogen in the environment can be calculated. The same ratio was assumed to exist in humans and was used to calculate the population dose in the same manner as for carbon-14. Doses obtained in this manner were then assumed to be received by the number of individuals living within the direction sector and distance described above for noble gas effluents. The population density in this sector was taken conservatively to be representative of the Eastern United States, which is about 62 persons per square km.

Liquid Effluents

Concentrations of effluents in the receiving water within 80 km of the facility were calculated in the same manner as described for the Appendix I calculations. It was assumed that there was no depletion of the nuclides present in the receiving water by deposition on the bottom of Lake Erie. It was also assumed that aquatic biota concentrate radioactivity in the same manner as was assumed for the Appendix I evaluation. However, food consumption values appropriate for the average, rather than the maximum, individual were used. It was further assumed that all the sport and commercial fish and shellfish caught within the 80-km area were eaten by the U.S. population.

Beyond 80 km, it was assumed that all liquid-effluent nuclides except tritium have deposited on the sediments so that they make no further contribution to population exposures. The tritium was assumed to mix uniformly in the hydrosphere and to result in an exposure to the U.S. population in the same manner as discussed for tritium in gaseous effluents.

APPENDIX C

ENVIRONMENTAL EFFECTS OF THE URANIUM FUEL CYCLE

On March 14, 1977, the Commission presented in the Federal Register (42 FR 13803) an interim rule regarding the environmental considerations of the uranium fuel cycle. It revises Table S-3 of Paragraph (e) of 10 CFR Part 51.20. In a subsequent announcement on April 14, 1978 (43 FR 15613), the Commission further amended Table S-3 to delete the numerical entry for the estimate of radon releases and to explain that the table does not cover health effects. The period of effectiveness of the interim rule has been extended several times.

On July 27, 1979, the Commission approved a final rule setting out revised environmental-impact values for the uranium fuel cycle to be included in environmental reports and environmental statements for reactors (44 FR 45362). The final rule reflects the latest information relative to reprocessing of spent fuel and radioactive waste management as discussed in NUREG-0116, "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle,"[1] and NUREG-0216,[2] which presents staff responses to comments on NUREG-0116. The rule also considers other environmental factors of the uranium fuel cycle, including aspects of mining and milling, isotopic enrichment, fuel fabrication, and management of low- and high-level wastes. These are described in the Atomic Energy Commission report WASH-1248, "Environmental Survey of the Uranium Fuel Cycle."[3]

Specific categories of natural-resource use are included in Table S-3 of the final rule and are reproduced here as Table A.* These categories relate to land use, water consumption, thermal effluents, radioactive releases, burial of transuranic and high- and low-level wastes, and radiation doses from transportation and occupational exposures. The contributions in Table S-3 for reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no recycle); that is, the cycle that results in the greater impact is used.

The following assessment of the environmental impacts of the fuel cycle as related to the operation of the proposed project is based on the values given in Table S-3 and the staff's analysis of the radiological impact from radon releases. For the sake of consistency, the analysis of fuel-cycle impacts has been cast in terms of a model 1000-MWe light-water-cooled reactor (LWR) operating at an annual capacity factor of 80%. In the following review and evaluation of the environmental impacts of the fuel cycle, the staff's analysis and conclusions would not be altered if the analysis were to be based on the net electrical power output of the proposed project.

*A narrative explanation of Table S-3 was published on March 4, 1981 in the Federal Register (46 FR 15154-15175).

Table A. (Table S-3) Summary of environmental considerations for the uranium fuel cycle[a]

Normalized to model LWR annual fuel requirement (WASH-1248) or reference reactor year (NUREG-0116)

Natural resource use	Total	Maximum effect per annual fuel requirement reactor year of model 1000-MWe LWR
Land, acres		
Temporarily committed[b]	100	
Undisturbed area	79	
Disturbed area	22	Equivalent to 110-MWe coal-fired power plant
Permanently committed	13	
Overburden moved, millions of metric tons	2.8	Equivalent to 95-MWe coal-fired power plant
Water, millions of gallons		
Discharged to air	160	Equals 2% of model 1000-MWe LWR with cooling
Discharged to water bodies	11,090	
Discharged to ground	127	
Total	11,377	Less than 4% of model 1000-MWe LWR with once-through cooling
Fossil fuel		
Electrical energy, thousands of megawatt hours	323	Less than 5% of model 1000-MWe LWR output
Equivalent coal, thousands of metric tons	118	Equivalent to the consumption of a 45-MWe coal-fired power plant
Natural gas, millions of standard cubic feet	135	Less than 0.3% of model 1000-MWe energy output
Effluents - chemical, metric tons		
Gases (including entrainment)[c]		
SO_x[4]	4,400	
NO_x	1,190	Equivalent to emissions from 45-MWe coal-fired power plant for a year
Hydrocarbons	14	
CO	29.6	
Particulates	1,154	
Other gases		
F	0.067	Principally from UF_6 production, enrichment, and reprocessing. Concentration within range of state standards - below level that has effects on human health
HCl	0.014	
Liquids		
SO_4^{2-}	9.9	From enrichment, fuel fabrication, and reprocessing steps.
NO_3^-	25.8	Components that constitute a potential for adverse environmental effect are present in dilute concentrations and receive additional dilution by receiving bodies of water to levels below permissible standards. The constituents that require dilution and the flow of dilution water are: NH_3 - 600 cfs; NO_3 - 20 cfs; Fluoride - 70 cfs
Fluoride	12.9	
Ca^{2+}	5.4	
Cl^-	8.5	
Na^-	12.1	
NH_3	10.0	
Fe	0.4	
Tailings solutions, thousands of metric tons	240	From mills only - no significant effluents to environment
Solids	91,000	Principally from mills - no significant effluents to environment

Table A. (Continued)

Natural resource use	Total	Maximum effect per annual fuel requirement reactor year of model 1000-MWe LWR
Effluents - radiological, curies		
Gases (including entrainment)		
Rn-222		Presently under reconsideration by the Commission
Ra-226	0.02	
Th-230	0.02	
Uranium	0.034	
Tritium, thousands	18.1	
C-14	24	
Kr-85, thousands	409	
Ru-106	0.14	Principally from fuel reprocessing plants
I-129	1.3	
I-131	0.83	
Tc-99		Presently under consideration by the Commission
Fission products and transuranics	0.203	
Liquids		
Uranium and daughters	2.1	Principally from milling - included in tailings liquor and returned to ground - no effluents, therefore, no effect on environment
Ra-226	0.0034	From UF_6 production
Th-230	0.0015	
Th-234	0.01	From fuel fabrication plants - concentration 10% of 10 CFR Part 20 for total processing 26 annual fuel requirements for model LWR
Fission and activation products	5.9×10^{-6}	
Solids (buried on site)		
Other than high level (shallow)	11,300	9100 Ci come from low-level reactor wastes and 1500 Ci come from reactor decontamination and decommissioning - buried at land burial facilities. Mills produce 600 Ci - included in tailings returned to ground, about 60 Ci come from conversion and spent-fuel storage. No significant effluent to the environment
TRU and HLW (deep)	1.1×10^7	Buried at Federal repository
Effluents - thermal, billions of British thermal units	4,063	Less than 4% of model 1000-MWe LWR
Transportation, person-rems Exposure of workers and general public	2.5	
Occupational exposure, person-rems	22.6	From reprocessing and waste management

[a]In some cases where no entry appears, it is clear from the background documents that the matter was addressed and that, in effect, this table should be read as if a specific zero entry has been made. However, there are other areas that are not addressed at all in this table. Table S-3 of WASH-1248 does not include heatlh effects from the effluents described in this table or estimates of releases of Radon-222 from the uranium fuel cycle. These issues which are not addressed at all by this table may be the subject of litigation in individual licensing proceedings. Data supporting this table are given in the "Environmental Survey of the Uranium Fuel Cycle," WASH-1248, April 1974; the "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," NUREG-0116 (Suppl. 1 to WASH-1248), and the "Discussion of Comments Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," NUREG-0216 (Suppl. 2 to WASH-1248). The contributions from reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no-recycle). The contribution from transportation excludes transportation of cold fuel to a reactor and or irradiated fuel and radioactive wastes from a reactor which are considered in Table S-4 of Sect. 51.20(g). The contributions from the other steps of the fuel cycle are given in columns A - E of Table S-3A of WASH-1248.

[b]The contributions to temporarily committed land from reprocessing are not prorated over 30 years because the complete temporary impact accrues regardless of whether the plant services 1 reactor for 1 year or 57 reactors for 30 years.

[c]Estimated effluents based on combustion of equivalent coal for power generation.

[d]1.2% from natural gas use and process.

Land Use

The total annual land requirement for the fuel cycle supporting a model 1000-MWe LWR is about 46 ha. About 5 ha/yr are permanently committed land and 41 ha/yr are temporarily committed. (A "temporary" land commitment is a commitment for the life of the specific fuel-cycle plant; for example, mill, enrichment plant, or succeeding plants. On abandonment or decommissioning, such land can be used for any purpose. "Permanent" commitments represent land that may not be released for use after plant shutdown and/or decommissioning.) Of the 41 ha/yr of temporarily committed land, 32 ha/yr are undisturbed and 9 ha/yr are disturbed. Considering common classes of land use in the United States,* fuel-cycle land-use requirements to support the model 1000-MWe LWR do not represent a significant impact.

Water Use

The principal water-use requirement for the fuel cycle supporting a model 1000-MWe LWR is that required for removal of waste heat from the power stations supplying electrical energy to the enrichment step of this cycle. Of the total annual requirement of 43 x 10^6 m^3, about 42 x 10^6 m^3 are required for this purpose, assuming that these plants use once-through cooling. Other water uses involve the discharge to air (for example, evaportation losses in process cooling) of about 0.6 x 10^6 m^3/yr and water discharged to ground (for example, mine drainage) of about 0.5 x 10^6 m^3/yr.

On a thermal-effluent basis, annual discharges from the nuclear fuel cycle are about 4% of those from the model 1000-MWe LWR using once-through cooling. The consumptive water use of 0.6 x 10^6 m^3/yr is about 2% of that from the model 1000-MWe LWR using cooling towers. The maximum consumptive water use (assuming that all plants supplying electrical energy to the nuclear fuel cycle use cooling towers) would be about 6% of that of the model 1000-MWe LWR using cooling towers. Under this condition, thermal effluents would be negligible. The staff finds that these combinations of thermal loadings and water consumption are acceptable relative to the water use and thermal discharges of the proposed project.

Fossil-Fuel Consumption

Electrical energy and process heat are required during various phases of the fuel-cycle process. The electrical energy is usually produced by the combustion of fossil fuel at conventional power plants. Electrical energy associated with the fuel cycle represents about 5% of the annual electrical power production of the model 1000-MWe LWR. Process heat is generated primarily by the combustion of natural gas. This gas consumption, if used to generate electricity, would be less than 0.3% of the electrical output from the model plant. The staff finds that the direct and indirect consumptions of electrical energy for fuel-cycle operations are small and acceptable relative to the net power production of the proposed project.

---

*A coal-fired power plant of 1000-MWe capacity using strip-mined coal requires the disturbance of about 81 ha/yr for fuel alone.

Chemical Effluents

The quantities of chemical, gaseous, and particulate effluents associated with fuel-cycle processes are given in Table S-3. The principal species are sulfur oxides, nitrogen oxides, and particulates. Judging from data in a Council on Environmental Quality report,[4] the staff finds that these emissions constitute an extremely small additional atmospheric loading in comparison with those from the stationary fuel-combustion and -transportation sectors in the United States; that is, about 0.02% of the annual national releases for each of these species. The staff believes that such small increases in releases of these pollutants are acceptable.

Liquid chemical effluents produced in fuel-cycle processes are related to fuel-enrichment, -fabrication, and -reprocessing operations and may be released to receiving waters. These effluents are usually present in dilute concentrations such that only small amounts of dilution water are required to reach levels of concentration that are within established standards. The flow of dilution water required for specific constitutents is specified in Table S-3. Additionally, all liquid discharges into the navigable waters of the United States from plants associated with the fuel-cycle operations will be subject to requirements and limitations set forth in the NPDES permit.

Tailings solutions and solids are generated during the milling process. These solutions and solids are not released in quantities sufficient to have a significant impact on the environment.

Radioactive Effluents

Radioactive effluents estimated to be released to the environment from reprocessing and waste-management activities and certain other phases of the fuel-cycle process are listed in Table S-3. Using these data, the staff has calculated the 100-yr involuntary environmental dose commitment* to the U.S. population. It is estimated from these calculations that the overall involuntary total-body gaseous dose commitment to the U.S. population from the fuel cycle (excluding reactor releases and the dose commitment due to radon-222) would be about 400 person-rem for each year of operation of the model 1000-MWe LWR (reference reactor year, or, RRY). Based on Table S-3 values, the additional involuntary total-body dose commitment to the U.S. population from radioactive liquid effluents due to all fuel-cycle operations other than reactor operation would be about 100 person-rem for each year of operation. Thus, the estimated involuntary 100-yr environmental dose commitment to the U.S. population from radioactive gaseous and liquid releases due to these portions of the fuel cycle is about 500 person-rem (whole body) per RRY.

At this time, the radiological impacts associated with radon-222 releases are not addressed in Table S-3. Principal radon releases occur during mining and

*The environmental dose commitment (EDC) is the integrated population dose for 100 years; that is, it represents the sum of the annual population doses for a total of 100 years. The population dose varies with time, and it is not practical to calculate this dose for every year.

milling operations and as emissions from mill tailings. The staff has determined that releases per RRY from these operations are as given in Table B. The staff has calculated population-dose commitments for these sources of radon-222 using the RABGAD computer code described in NUREG-0002, Appendix A, Section IV.J.[5] The results of these calculations for mining and milling activities prior to reclamation of open-pit uranium mines and tailings stabilization are given in Table C.

Table B Radon releases from mining and milling operations and mill tailings for each year of operation of the model 1000-MWe LWR

Source	Radon-222 Release
Mining*	4060 Ci
Milling and tailings** (during active milling)	780 Ci
Inactive tailings** (prior to stabilization)	350 Ci
Stabilized tailings** (for several hundred years)	1 to 10 Ci/yr
Stabilized tailings** (after several hundred years)	110 Ci/yr

*Testimony of R. Wilde from: "In the Matter of Duke Power Company (Perkins Nuclear Station)," U.S. Nuclear Regulatory Commission, Docket No. 50-488, filed April 17, 1978.

**Testimony of P. Magno from: "In the Matter of Duke Power Company (Perkins Nuclear Station)," U.S. Nuclear Regulatory Commission, Docket No. 50-488, filed April 17, 1978.

Table C Estimated 100-yr environmental dose commitment for each year of operation of the model 1000-MWe LWR

		Population-Dose Commitment (person-rem)		
Source	Radon-222 Release (Ci)	Total Body	Bone	Lung (bronchial epithelium)
Mining	4100	110	2800	2300
Milling and active tailings	1100	29	750	620
Total		140	3600	2900

When added to the 500 person-rem total-body dose commitment for the balance of the fuel cycle, the overall estimated total-body involuntary 100-yr environmental dose commitment to the U.S. population from the fuel cycle for the model 1000-MWe LWR is about 640 person-rem. Over this period of time, this dose is equivalent to 0.00002% of the natural-background total-body dose of about three billion person-rem to the U.S. population.*

The staff has considered health effects associated with the releases of radon-222, including both the short-term effects of mining, milling, and active tailings, and the potential long-term effects from unreclaimed open-pit mines and stabilized tailings. The staff has assumed that underground mines will be sealed after completion of active mining, with the result that releases of radon-222 from them will return to background levels. For purposes of providing an upper bound impact assessment, the staff has assumed that open-pit mines will be unreclaimed and has calculated that if all ore were produced from open-pit mines, releases from them would be 110 Ci/yr per RRY. However, because the distribution of uranium-ore reserves available using conventional mining methods is 66.8% underground and 33.2% open-pit,[6] the staff has further assumed that uranium to fuel LWRs will be produced by conventional mining methods in these proportions. This means that long-term releases from unreclaimed open-pit mines will be 37 Ci/yr (0.332 x 110) per RRY.

Based on these assumptions, the radon released from unreclaimed open-pit mines over 100- and 1000-yr periods would be about 3700 Ci and 37,000 Ci per RRY, respectively. The total dose commitments for periods of 100, 500, and 1000 yr would be as shown in Table D. These commitments represent a worst-case situation because no mitigating circumstances are assumed. However, state and Federal laws currently require reclamation of strip and open-pit coal mines, and it is very probable that similar reclamation will be required for open-pit uranium mines. If so, long-term releases from such mines should approach background levels.

Table D Population-dose commitments from unreclaimed open-pit mines for each year of operation of the model 1000-MWe LWR

Time Period (yr)	Radon-222 Release (Ci)	Population-Dose Commitment (person-rem)		
		Total Body	Bone	Lung (bronchial epithelium)
100	3,700	96	2,500	2,000
500	19,000	480	13,000	11,000
1,000	37,000	960	25,000	20,000

*Based on an annual average natural-background individual dose commitment of 100 mrem and a stabilized U.S. population of 300 million.

For long-term radon releases from stabilized-tailings piles, the staff has assumed that the tailings would emit, per RRY, 1 Ci/yr for 100 yr, 10 Ci/yr for the next 400 yr and 100 Ci/yr for periods beyond 500 yr. With these assumptions, the cumulative radon-222 release per RRY from stabilized-tailings piles would be 100 Ci in 100 yr, 4090 Ci in 500 yr, and 53,800 Ci in 1000 yr.[7] The total-body, bone, and bronchial-epithelium dose commitments for these periods are as shown in Table E.

Table E Population-dose commitments from stabilized-tailings piles for each year of operation of the model 1000-MWe LWR

Time Period (yr)	Radon-222 Release (Ci)	Population-Dose Commitment (person-rem)		
		Total Body	Bone	Lung (bronchial epithelium)
100	100	2.6	68	56
500	4,090	110	2,800	2,300
1,000	53,800	1,400	37,000	30,000

Using risk estimators of 135, 6.9, and 22.2 cancer deaths per million person-rem for total-body, bone, and lung exposures, respectively, the estimated risk of cancer mortality due to mining, milling, and active-tailings emissions of radon-222 is about 0.11 cancer fatality per RRY. When the risk due to radon-222 emissions from stabilized tailings over a 100-yr release period is added, the estimated risk of cancer mortality over a 100-yr period is unchanged. Similarly, a risk of about 1.2 cancer fatalities per RRY over a 1000-yr release period is estimated. When potential radon releases from reclaimed and unreclaimed open-pit mines are included, the overall risks of radon-induced cancer fatalities per RRY range as follows:

0.11 - 0.19 fatality for a 100-yr period
0.19 - 0.57 fatality for a 500-yr period
1.2 - 2.0 fatalities for a 1000-yr period

To illustrate: A single model 1000-MWe LWR operating at an 80% capacity factor for 30 yrs would be predicted to induce between 3.3 and 5.7 cancer fatalities in 100 yr, 5.7 and 17 in 500 yr, and 36 and 60 in 1000 yr as a result of releases of radon-222.

These doses and predicted health effects have been compared with those that can be expected from natural-background emissions of radon-222. Using data from the National Council on Radiation Protection (NCRP),[8] the average radon-222 concentration in air in the contiguous United States is about 150 pCi/m^3 which the NCRP estimates will result in an annual dose to the bronchial epithelium of 450 mrem. For a stabilized future U.S. population of 300 million, this represents a total lung-dose commitment of 135 million person-rem/yr. Using the same risk estimator of 22.2 lung-cancer fatalities per million person-rem

(lung) used to predict cancer fatalities for the model 1000-MWe LWR, lung-cancer fatalities alone from background radon-222 in the air can be calculated to be about 3000/yr, or 300,000 to 3,000,000 lung-cancer deaths over periods of 100 and 1000 yr, respectively.

In addition to the radon-related potential health effects from the fuel cycle, other nuclides produced in the cycle, such as carbon-14, will contribute to population exposures. It is estimated that an additional 0.08 to 0.12 cancer death per RRY may occur (assuming that no cure for or prevention of cancer is ever developed) over the next 100 to 1000 yrs, respectively, from exposures to these other nuclides.

These exposures also can be compared with those from naturally occurring terrestrial and cosmic-ray sources, which average about 100 mrem. Therefore, for a stable future population of 300 million persons, the whole-body dose commitment would be about 30 million person-rem/yr, or three billion person-rem and 30 billion person-rem for periods of 100 and 1000 yr, respectively. These dose commitments could produce about 400,000 and 4,000,000 cancer deaths during the same time periods. From the above analysis, the staff concludes that both the dose commitments and health effects of the uranium fuel cycle are insignificant when compared with dose commitments and potential health effects to the U.S. population resulting from all natural-background sources.

Radioactive Wastes

The quantities of buried radioactive waste material (low-level, high-level, and transuranic wastes) are specified in Table S-3. For low-level waste disposal at land-burial facilities, the Commission notes in Table S-3 that there will be no significant radioactive releases to the environment. For high-level and transuranic wastes, the Commission notes that these are to be buried at a Federal repository and that no release to the environment is associated with such disposal. It is indicated in NUREG-0116[1] (in which background and context are provided for the high-level and transuranic Table S-3 values established by the Commission) that these high-level and transuranic wastes will be buried and will not be released to the biosphere. No radiological environmental impact is expected from such disposal.

Occupational Dose

The annual occupational dose attributable to all phases of the fuel cycle for the model 1000-MWe LWR is about 200 person-rem. The staff concludes that this occupational dose will not have a significant environmental impact.

Transportation

The transportation dose to workers and the public is specified in Table S-3. This dose is small and is not considered significant in comparison with the natural-background dose.

Fuel Cycle

The staff analysis of the uranium fuel cycle does not depend on the selected fuel cycle (no recycle or uranium-only recycle), because the data provided in

Table S-3 include maximum recycle-option impact for each element of the fuel cycle. Thus, the staff's conclusions as to acceptability of the environmental impacts of the fuel cycle are not affected by the specific fuel cycle selected.

References

1. "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle." U.S. Nuclear Regulatory Commission, NUREG-0116 (Supplement 1 to WASH-1248), October 1976.*

2. "Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle." U.S. Nuclear Regulatory Commission, NUREG-0216 (Supplement 2 to WASH-1248), March 1977.*

3. "Environmental Survey of the Uranium Fuel Cycle." U.S. Atomic Energy Commission, WASH-1248, April 1974.*

4. "Seventh Annual Report of the Council on Environmental Quality." Figures 11-27 and 11-28, pp. 238-239, September 1976.**

5. "Final Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light-Water-Cooled Reactors." U.S. Nuclear Regulatory Commission, NUREG-0002, August 1976.*

6. "Statistical Data of the Uranium Industry." U.S. Department of Energy, GJO-100(78), January 1978.**

7. Testimony of R. Gotchy from: "In the Matter of Duke Power Company (Perkins Nuclear Station)." U.S. Nuclear Regulatory Commission, Docket No. 50-488, filed April 17, 1978. (Available for inspection and copying for a fee in the NRC Public Document Room, 1717 H Street, NW., Washington, D.C. 20555.)

8. "Natural Background Radiation in the United States," National Council on Radiation Protection and Measurements, Publication 45, 1975. (Available from NCRP, P.O. Box 30175, Washington, D.C. 20014.)

*Available from the NRC/GPO Sales Program, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, and from the National Technical Information Service (NTIS), Springfield, Va. 22161

**Available from NTIS only.

APPENDIX D

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

STATE OF MICHIGAN

WILLIAM G. MILLIKEN, Governor

DEPARTMENT OF NATURAL RESOURCES

STEVENS T. MASON BUILDING, BOX 30028, LANSING, MICHIGAN 48909
HOWARD A. TANNER, Director

January 23, 1979

CERTIFIED MAIL

Detroit Edison Company
2000 Second Avenue
Detroit, Michigan 48226

Attn: Mr. Art Heidrich
Environmental Activities

Re: Enrico Fermi Atomic Power Plant
Unit 2
MI 0037028

Gentlemen:

Your application for a National Pollutant Discharge Elimination System (NPDES) Permit has been processed in accordance with appropriate State and Federal regulations.

Your NPDES Permit contains: 1) limitations which require you to monitor your effluent in accordance with Part I, Section A and 2) a schedule of compliance which requires you to meet deadlines concerning the construction of waste control facilities in accordance with Part I, Section C.

REVIEW THE PERMIT EFFLUENT LIMITS AND PERFORMANCE SCHEDULES CAREFULLY. These are subject to the criminal and civil enforcement provisions of both state and federal law. All permit violations are audited by the United States Environmental Protection Agency and will appear in a published quarterly non-compliance report made available to agencies and the public.

Your monthly operating report forms will be transmitted to you in the near future. These reports are to be submitted monthly as required by your NPDES permit.

Very truly yours,

WATER QUALITY DIVISION

Karl Zollner, Jr. /bl

Karl Zollner, Jr., P.E., Chief
Engineering & Technical Services Section

KJZ:bl
Enclosure: Permit
cc: A. H. Manzardo (2)
R. J. Courchaine
Data Center
Files
T. K. Wu
C. Odin
A. Howard
F. Baldwin
R. Schrameck
Southeast Michigan Council of Governments

R1025 10/75

Permit No. MI 0037028

MICHIGAN WATER RESOURCES COMMISSION

AUTHORIZATION TO DISCHARGE UNDER THE

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

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

The Detroit Edison Company, as sole operator and principal owner of a facility known as Enrico Fermi Atomic Power Plant, Unit 2, located at 6400 Dixie Highway, Newport, Michigan, is authorized to discharge from said facility to receiving waters named Lake Erie and Swan Creek in accordance with effluent limitations, monitoring requirements and other conditions set forth in Parts I and II hereof.

This permit shall become effective upon the commencement of discharge.

This permit and the authorization to discharge shall expire at midnight, November 30, 1982. In order to receive authorization to discharge beyond the date of expiration, the permittee shall submit such information and forms as are required by the Michigan Water Resources Commission no later than 180 days prior to the date of expiration.

This permit is based on the company's application numbered MI 0037028, dated May 5, 1975 as amended, and shall supersede any and all Orders of Determination, Stipulation, or Final Orders of Determination previously adopted by the Michigan Water Resources Commission.

Issued this 28th day of November, 1977, and modified this 19th day of January, 1979, for the Michigan Water Resources Commission.

Robert J. Courchaine

Robert J. Courchaine
Executive Secretary

PART I

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. Final Effluent Limitations

During the period beginning with the commencement of the discharge and lasting until the expiration date of this permit, the permittee is authorized to discharge cooling tower blowdown and low volume wastes, including but not limited to, demineralizer regeneration wastes and rad wastes treatment system effluent from outfall 001. Such discharge shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations: kg/day (lbs/day) Daily Average	kg/day (lbs/day) Daily Maximum	Other Limitations Daily Average	Other Limitations Daily Maximum	Monitoring Requirements: Measurement Frequency	Sample Type
Flow, M^3/Day					Daily	
Temperature (^{o}F)						
Intake					Daily	Continuous
Discharge					Daily	Continuous
				Report monthly avg. & daily max.		

The permittee shall demonstrate, within one year after start of commercial operation the extent of the mixing zone required, but in no case shall that zone exceed 72 acres (a defined area equivalent to that of a circle with a radius of 1000 feet). The required mixing zone shall not increase the temperature of Lake Erie at the edge of the mixing zone more than $3^{o}F$ above the existing natural temperature or above the following monthly maximum temperature; provided, however, the permittee may exceed the monthly maximum temperatures when natural temperatures exceed the monthly maximum temperatures, but any such increase at the edge of the mixing zone shall not exceed the natural water temperature plus $3^{o}F$.

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
45	45	45	60	70	75	80	85	80	70	60	50

Above maximum monthly temperatures are based upon Water Resources Commission Rules, Part 4, Rule 1069(2).

Effluent Characteristic	Daily Average	Daily Maximum	Measurement Frequency	Sample Type
Oil & Grease	No Visible Film		Daily	Visual Observation
Total Residual Chlorine* (TRC)	0.2 mg/l	0.3 mg/l	5 x Weekly	Three grab samples equally spaced during each treatment
Chlorine discharge time**		160 min/day	5 x Weekly	report application time

* to be measured by the amperometric titration technique

**the permittee may elect to exceed the 160 min/day maximum discharge time. If the permittee elects to exceed the 160 min/day maximum discharge time, the average concentration of TRC shall not exceed the concentrations described as "The Acute Toxicity Threshold Value from the Freshwater Criteria Curve by J.S. Mattice and H.E. Zittle", illustrated on page 6 of 9 for the period of discharge. The maximum concentration of TRC shall be limited to 1.5 times the average concentration of TRC.

1. Final Effluent Limitations (continued)

The permittee may use dechlorination techniques to achieve the applicable limitations, using sodium thiosulfate or sodium sulfite or other dechlorinating agents approved by the Chief of the Water Quality Division as dechlorination reagents. The quantity of reagent used shall be limited to 1.5 times the stoichiometric amount needed for dechlorination of the chlorine applied. The permittee shall report monthly the quantity of each dechlorination reagent used per day.

The permittee may demonstrate to the Commission that higher concentrations of chlorine are acceptable.

a. The pH shall not be less than 6.0 nor greater than 9.0. The pH shall be monitored as follows: Weekly; grab

b. The discharge shall not cause excessive foam in the receiving waters. The discharge shall be essentially free of floating and settleable solids.

c. Samples taken in compliance with the monitoring requirements above shall be taken intake - prior to entering the plant; discharge - prior to discharging to Lake Erie except for chlorine, samples for which shall be taken from the discharge of the decant pump.

2. Final Limitations

During the period beginning with the commencement of discharge and lasting until the termination of this permit, the permittee is authorized to discharge demineralizer regeneration wastes, a low volume waste source, through outfall 001. Such discharge shall be limited and monitoried by the permittee prior to mixing with cooling tower blowdown as specified below:

Effluent Characteristic	Discharge Limitations kg/day (lbs/day) Daily Average	Daily Maximum	Other Limitations Daily Average	Daily Maximum	Monitoring Requirements Measurement Frequency	Sample Type
Flow, M^3/Day (MGD)					Per Occurrence	
Total Suspended Solids			30 mg/l	100 mg/l	Per Occurrence	Grab
Oil and Grease*			15 mg/l	20 mg/l	Monthly	Grab

* Company may demonstrate that a requirement of "No Visible Film" is more stringent than the above concentration limitations.

a. The discharge shall not cause excessive foam in the receiving waters. The discharge shall be essentially free of floating and settleable solids.

b. Samples taken in compliance with the monitoring requirements above shall be taken prior to discharge to outfall 001.

3. Final Limitations

Effective upon the date of issuance of this permit, the company shall not discharge any polychlorinated biphenyls to receiving waters of the State of Michigan.

4. Final Limitations

Beginning on the date of issuance of this permit and lasting until the expiration date, the permittee shall collect and remove debris accumulated on intake trash bars and dispose of such material on land in an appropriate manner. Intake screen backwash may be discharged pending future review.

5. Final Limitations

During the period beginning with the commencement of discharge and lasting until the expiration of this permit, the permittee is authorized to discharge radwaste treatment system effluent from outfall 001. Such discharge shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations kg/day (lbs/day) Daily Average	Daily Maximum	Other Limitations Daily Average	Daily Maximum	Monitoring Requirements Measurement Frequency	Sample Type
Flow M^3/Day (MGD)					Weekly per occurrence	
Total Suspended Solids			30 mg/l	100 mg/l	Weekly per occurrence	Grab
Oil & Grease			No visible film		Daily per occurrence	Vis. ob:
Oil and Grease *			15 mg/l	20 mg/l	Monthly per occurrence	Grab

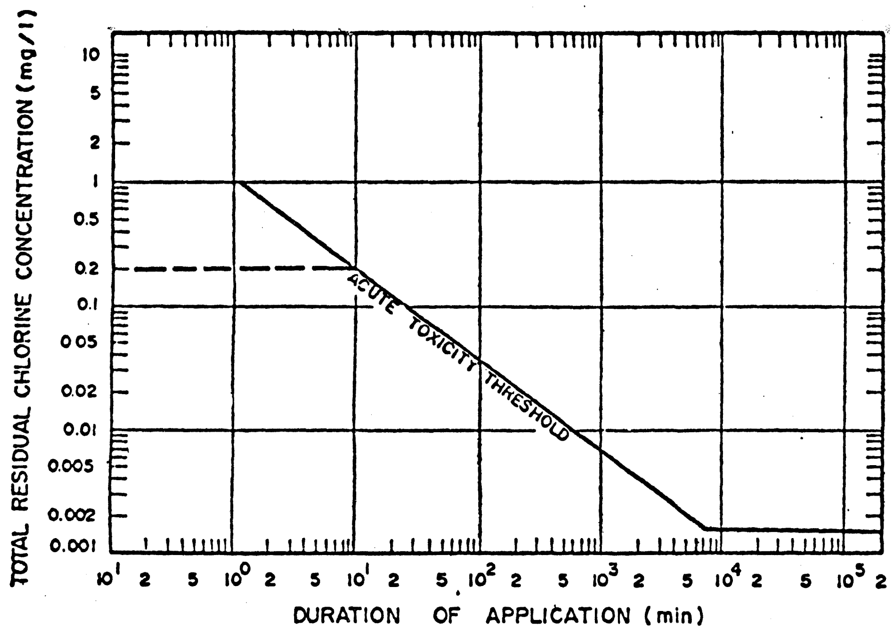
*Company may demonstrate that a requirement of "No Visible Film" is more stringent than the above concentration limitations.

Samples taken in compliance with the monitoring requirements above shall be taken prior to mixing with any other process or cooling waters.

6. Chlorine Limitation Condition

Following approval of the study plan, the permittee shall conduct a 12 month study to determine the magnitude of the free-chlorine component of the total residual chlorine (TRC) which occurs during each of the four seasons of the year. Such study shall be conducted in accordance with a study plan submitted to and approved by the Chief of the Water Quality Division of the Michigan Department of Natural Resources. A final report of findings shall be submitted within 90 days of the completion of the study. If the results of the studies reveal that the magnitude of the average free-chlorine component cannot be reduced to 25 percent or less of the TRC during any particular season, the permit may be modified in accordance with Part IIB4 of this permit. Such modification will require that during those particular seasons when the magnitude of the average free-chlorine component cannot be reduced to 25 percent of the TRC, the average concentration of TRC shall be limited to the concentration described as "The Acute Toxicity Threshold Value from the Freshwater Criteria Curve of J.S. Mattice and H.E. Zittle" illustrated on page 6 of 9 , for the period of application, with the maximum concentration limited to 1.5 times the allowable average concentration of the TRC during the same period of application.

FRESHWATER CRITERIA CURVE
by
J.S. MATTICE and H.E. ZITTLE



Log Concentration = -0.7407 (log time) + 0.0296

Time = minutes
Concentration = mg/l

Chronic Mortality Threshold = 0.0015 mg/l

PART I

B. MONITORING AND REPORTING

1. Representative Sampling

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

2. Reporting

The permittee shall submit monitoring reports containing results obtained during the previous month and shall be postmarked no later than the 10th day of the month following each completed report period. The first report shall be submitted within 90 days of the effective date of this permit.

3. Definitions

a. The daily average discharge is defined as the total discharge by weight, or concentration if specified, during a calendar month divided by the number of days in the month that the production or commercial facility was operating. When less than daily sampling is required, the daily average discharge shall be determined by the summation of the measured daily discharges by weight divided by the number of days during the calendar month when the measurements were made.

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

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

d. The Michigan Water Resources Commission is located in the Stevens T. Mason Building. The mailing address is Box 30028, Lansing, Michigan 48909.

4. Test Procedures

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

5. Recording of Results

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

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

b. The dates the analyses were performed;

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

d. the analytical techniques or methods used; and

e. The results of all required analyses.

6. Additional Monitoring by Permittee

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

7. Records Retention

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

8. Cooling Water Intake

The Michigan Water Resources Commission has determined that the location, design, construction and capacity of the Enrico Fermi Atomic Power Plant, Unit 2, intake structure reflects the best technology available for minimizing adverse environmental impact in accordance with Section 316(b) of the Act. The permittee shall submit to the Chief of the Water Quality Division, a detailed study plan and time schedule for conducting environmental monitoring to determine the loss of aquatic organisms in the cooling water intake and obtain his approval thereof within 18 months after the facility becomes fully operational.

C. SCHEDULE OF COMPLIANCE

1. The permittee shall achieve compliance with the effluent limitations specified in this permit upon commencement of discharge.

2. The permittee shall comply with the requirements of Section 10, Part II-A in accordance with the following:

a. Submit plans for approval to the Chief of the Water Quality Division necessary to comply with the primary power provision of Section 10 in Part II on or before N/A.

b. The permittee shall comply with the requirements of items 10a or 10b contained in Part II on or before N/A.
Not withstanding the preceding sentence the permittee shall at all times halt, reduce, or otherwise control production in order to protect the waters of the State of Michigan upon the reduction or loss of the primary source of power.

3. If the Company elects to demonstrate to the Michigan Water Resources Commission that higher concentrations of chlorine are acceptable, it shall, submit a study plan for determining safe levels of total residual chlorine in its discharges and obtain approval thereof by the Chief of the Water Quality Division. Said plan shall be implemented upon approval and shall be completed within a period not to exceed 15 months from the date of approval. A progress report shall be submitted 7 months after implementation.

Following completion of the study, a report thereon shall be made to the Chief of the Water Quality Division not later than 3 months following completion of the study along with a time schedule for designing and completing the control facilities needed to meet safe total residual chlorine levels determined by the approved study.

4. The permittee shall conduct a study, during the four seasons of the year, to determine the average percentage of the Total Residual Chlorine which is represented by the Free Chlorine component referenced in Part I A 6 of this permit. All submittals shall be to the Chief of the Water Quality Division of the Department of Natural Resources.

a. Submit a study plan and receive approval on or before N/A.

b. Submit a report of findings 90 days following completion of the study.

5. No later than 14 calendar days following a date identified in the above schedule of compliance, the permittee shall submit either a report of progress or, in the case of specific actions being required by identified dates, a written notice of compliance or noncompliance. In the latter case, the notice shall include the cause of noncompliance, any remedial actions taken, and the probability of meeting the next scheduled requirement.

PART II

A. MANAGEMENT REQUIREMENTS

1. Change in Discharge

All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant identified in this permit more frequently than or at a level in excess of that authorized shall constitute a violation of the permit. Any anticipated facility expansions, production increases, or process modifications which will result in new, different, or increased discharges of pollutants must be reported by submission of a new NPDES application or, if such changes will not violate the effluent limitations specified in this permit, by notice to the permit issuing authority of such changes. Following such notice, the permit may be modified to specify and limit any pollutants not previously limited.

2. Containment Facilities

The permittee shall provide approved facilities for containment of any accidental losses of concentrated solutions, acids, alkalies, salts, oils, or other polluting materials in accordance with the requirements of the Michigan Water Resources Commission Rules, Part 5.

3. Operator Certification

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

4. Noncompliance Notification

If, for any reason, the permittee does not comply with or will be unable to comply with any daily maximum effluent limitation specified in this permit, the permittee shall provide the Regional Administrator and the State with the following information, in writing, within five (5) days of becoming aware of such condition:

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

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

5. Spill Notification

The permittee shall immediately report any spill or loss of any product, by-product, intermediate product, oils, solvents, waste material, or any other polluting substance which occurs to the surface or groundwaters of the state by calling the Department of Natural Resources 24 hour Emergency Response telephone number (517) 373-7660; and, the permittee shall within ten (10) days of the spill or loss provide the State with a full written explanation as to the cause and discovery of the spill or loss, clean up and recovery measures taken, preventative measures to be taken, and schedule of implementation.

6. Facilities Operation

The permittee shall at all times maintain in good working order and operate as efficiently as possible, all treatment or control facilities or systems installed or used by the permittee to achieve compliance with the terms and conditions of this permit.

7. Adverse Impact

The permittee shall take all reasonable steps to minimize any adverse impact to navigable waters resulting from noncompliance with any effluent limitations specified in this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge.

8. By-passing

Any diversion from or by-pass of facilities necessary to maintain compliance with the terms and conditions of this permit is prohibited, except (i) where unavoidable to prevent loss of life or severe property damage, or (ii) where excessive storm drainage or runoff would damage any facilities necessary for compliance with the effluent limitations and prohibitions of this permit. The permittee shall promptly notify the Michigan Water Resources Commission and the Regional Administrator, in writing, of such diversion or by-pass.

9. Removed Substances

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

10. Power Failures

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

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

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

B. RESPONSIBILITIES

1. Right of Entry

The permittee shall allow the Executive Secretary of the Michigan Water Resources Commission, the Regional Administrator an/or their authorized representatives, upon the presentation of the credentials and subject to applicable requirements of federal and state law:

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

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

2. Transfer of Ownership or Control

In the event of any change in control or ownership of facilities from which the authorized discharge emanate, the permittee shall notify the succeeding owner or controller of the existence of this permit by letter, a copy of which shall be forwarded to the Michigan Water Resources Commission and the Regional Administrator.

3. Availability of Reports

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

4. Permit Modification

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

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

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

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

5. Toxic Pollutants

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

6. Civil and Criminal Liability

Except as provided in permit conditions on "By-passing" (Part II, A-8) and Power Failures" (Part II, A-10), nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance, whether or not such noncompliance is due to factors beyond his control, such as accidents, equipment breakdowns, or labor disputes.

7. Oil and Hazardous Substance Liability

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

8. State Laws

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

9. Property Rights

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

10. Severability

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

11. Corps of Engineers

The U.S. Corps of Engineers has the authority to assess the permittee for the Corps' reasonable cost incurred in dredging materials attributable to the permittee's discharge.

Permit No. MI 0039110

MICHIGAN WATER RESOURCES COMMISSION

AUTHORIZATION TO DISCHARGE UNDER THE

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

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

THE DETROIT EDISON COMPANY

(Sole operator and principal owner) is authorized to discharge from the Enrico Fermi Atomic Power Plant, Unit 2, construction site located at

6400 Dixie Highway
Newport, Michigan 48166

to receiving waters named Swan Creek and Lake Erie in accordance with effluent limitations, monitoring requirements, and other conditions set forth in Parts I and II hereof.

This permit shall become effective on the date of commencement of any discharge authorized herein.

This permit and the authorization to discharge shall expire five years from the effective date. In order to receive authorization to discharge beyond the date of expiration, the permittee shall submit such information and forms as are required by the Michigan Water Resources Commission no later than 180 days prior to the date of expiration of this permit.

This permit is based on the company's application numbered MI 0039110 dated July 7, 1977, as amended, and shall supersede any and all Orders of Determination, Stipulation, or Final Orders of Determination previously adopted by the Michigan Water Resources Commission.

Issued this 4th day of April, 1978, for the Michigan Water Resources Commission.

Robert J. Courchaine

Robert J. Courchaine
Executive Secretary

PART I

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. Effluent Limitations (Demineralizer Regeneration Wastes)

During the period beginning on the effective date of this permit and lasting until the expiration date of this permit, the permittee is authorized to discharge demineralizer regeneration wastes, a low volume waste source, through outfall (see Footnote a.). Such discharge shall be limited and monitored by the permittee prior to discharge as specified below:

Effluent Characteristic	Discharge Limitations kg/day (lbs/day) Daily Average	Daily Maximum	Concentrations Daily Average	Daily Maximum	Monitoring Requirements Measurement Frequency	Sample Type
Flow, M^3/Day (MGD)					Per Occurrence	
Total Suspended Solids			30 mg/l	100 mg/l	Weekly per Occurrence	Grab
Oil and Grease			15 mg/l	20 mg/l	Monthly per Occurrence	Grab

a. The permittee shall notify the Executive Secretary of the Michigan Water Resources Commission of the exact location of the outfall, in writing, at least 30 days prior to the commencement of discharges therefrom.

b. The pH shall not be less than 6.0 nor greater than 9.0. The pH shall be monitored as follows: Weekly per Occurrence; grab.

c. The discharge shall not cause excessive foam in the receiving waters. The discharge shall be essentially free of floating and settleable solids.

d. The discharge shall not contain oil or other substances in amounts sufficient to create a visible film or sheen on the receiving waters.

e. Samples taken in compliance with the monitoring requirements above shall be taken prior to discharge to the waters of the State.

2. Final Limitations (Leak/Hydrostatic Testing)

During the period beginning on the effective date of this permit and lasting until the expiration date of this permit, the permittee is authorized to discharge waters from leak testing; hydrostatic testing; and preoperational testing as required for nuclear power plant systems and equipment through outfall (see Footnote a). Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day (lbs/day)		Concentrations			
	Daily Average	Daily Maximum	Daily Average	Daily Maximum	Measurement Frequency	Sample Type
Flow, M^3/Day (MGD)					Per occurrence	

a. The permittee shall notify the Executive Secretary of the Michigan Water Resources Commission of the exact location of the outfall and the nature of the discharge, in writing, at least 30 days prior to the commencement of discharge therefrom.

b. The discharge shall not cause excessive foam in the receiving waters. The discharge shall be essentially free of floating and settleable solids.

c. The discharge shall not contain oil or other substances in amounts sufficient to create a visible film or sheen on the receiving waters.

d. Samples taken in compliance with the monitoring requirements above shall be taken prior to discharge to the water of the State.

3. Final Limitations (Flushing and Passivation)

During the period beginning on the effective date of this permit and lasting until the expiration date of this permit, the permittee is authorized to discharge wastewater from flushing and passivation operations as required for nuclear power plans systems and equipment through outfall (see Footnote a). Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations kg/day (lbs/day) Daily Average	Daily Maximum	Other Limitations Daily Average	Daily Maximum	Monitoring Requirements Measurement Frequency	Sample Type
Flow, M^3/Day (MGD)					Per Occurrence	
Ammonia (as N)					Per Occurrence	Gra
Hydrazine (NH_2NH_2)					Per Occurrence	Gr
Oil and Grease			15 mg/l	20 mg/l	Monthly per Occurrence	Gra
Total Suspended Solids			30 mg/l	100 mg/l	Per Occurrence	Gr
Total Iron				1 mg/l	Per Occurrence	Gr.
Total Copper				1 mg/l	Per Occurrence	Gr.
Total Phosphorus (as P)				1 mg/l	Per Occurrence	Gr.

a. The permittee shall notify the Executive Secretary of the Michigan Water Resources Commission of the exact location of the outfall and the nature of the discharge, in writing, at least 30 days prior to the commencement of discharge therefrom.

b. The pH shall not be less than 6.5 nor greater than 9.5. The pH shall be monitored as follows: per occurrence; grab.

c. The discharge shall not cause excessive foam in the receiving waters. discharge shall be essentially free of floating and settleable solids.

d. The discharge shall not contain oil or other substances in amounts suff[illegible] to create a visible film or sheen on the receiving waters.

e. Samples taken in compliance with the monitoring requirements above shall taken prior to discharge to Fermi I Cooling Water Canal with exception of [illegible] shall be monitored at the Overflow Canal prior to discharge to the Swan Creek.

4. Final Limitations (Chemical Rinse Water)

During the period beginning on the effective date of this permit and lasting until the expiration date of this permit, the permittee is authorized to discharge waste water from chemical rinsing operations as required for nuclear power plant systems and equipment through outfall (see Footnote a). Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations kg/day (lbs/day) Daily Average	Daily Maximum	Concentrations Daily Average	Daily Maximum	Monitoring Requirements Measurement Frequency	Sample Type
Flow, M^3/Day (MGD)					Per Occurrence	
Oil and Grease			15 mg/l	20 mg/l	Monthly per Occurrence	Grab
Total Suspended Solids			30 mg/l	100 mg/l	Per Occurrence	Grab
Total Iron				1 mg/l	Per Occurrence	Grab
Total Copper				1 mg/l	Per Occurrence	Grab

a. The permittee shall notify the Executive Secretary of the Michigan Water Resources Commission of the exact location of the outfall and the nature of the discharge, in writing, at least 30 days prior to the commencement of discharge therefrom.

b. The pH shall not be less than 6.5 nor greater than 9.5. The pH shall be monitored as follows: per occurrence; grab.

c. The discharge shall not cause excessive foam in the receiving waters. The discharge shall be essentially free of floating and settleable solids.

d. The discharge shall not contain oil or other substances in amounts sufficient to create a visible film or sheen on the receiving waters.

e. Samples taken in compliance with the monitoring requirements above shall be taken prior to discharge to Fermi I Cooling Water Canal WITH exception of pH which shall be monitored at the Overflow Canal prior to discharge to the Swan Creek.

5. Final Limitations (Stormwater)

During the period beginning on the effective date of this permit and lasting until the expiration date of this permit, the permittee is authorized to discharge point source storm water runoff through outfall C01C. Such discharge shall be limited and monitored by the permittee as specified.

Effluent Characteristic	Discharge Limitations kg/day (lbs/day) Daily Average	Daily Maximum	Concentrations Daily Average	Daily Maximum	Monitoring Requirements Measurement Frequency	Sample Type

The discharge is limited to stormwater runoff only.

6. Final Limitations (construction site dewatering)

During the period beginning on the effective date of this permit and lasting until the expiration date of this permit, the permittee is authorized to discharge point source construction site dewatering through outfall (see Footnote a). Such discharge shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations kg/day (lbs/day) Daily Average	Daily Maximum	Concentrations Daily Average	Daily Maximum	Monitoring Requirements Measurement Frequency	Sample Type
Oil and Grease			15mg/l	20mg/l	monthly	Grab

a. The permittee shall notify the Executive Secretary of the Michigan Water Resources Commission of the exact location of the outfall, in writing, at least 30 days prior to the commencement of discharge therefrom.

b. The discharge shall not cause excessive foam in the receiving waters. The discharge shall be essentially free of floating add settleable solids.

c. The discharge shall not contain oil or other substances in amounts sufficient to create a visible film or sheen on the receiving waters.

PART I

B. MONITORING AND REPORTING

1. Representative Sampling

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

2. Reporting

The permittee shall submit monitoring reports containing results obtained during the previous month and shall be postmarked no later than the 10th day of the month following each completed report period. The first report shall be submitted within 90 days of the date of issuance of this permit.

3. Definitions

a. The daily average discharge is defined as the total discharge by weight, or concentration if specified, during a calendar month divided by the number of days in the month that the production or commercial facility was operating. When less than daily sampling is required, the daily average discharge shall be determined by the summation of the measured daily discharges by weight divided by the number of days during the calendar month when the measurements were made.

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

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

d. The Michigan Water Resources Commission is located in the Stevens T. Mason Building. The mailing address is Box 30028, Lansing, Michigan 48909.

4. Test Procedures

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

5. Recording of Results

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

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

b. The dates the analyses were performed;

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

d. the analytical techniques or methods used; and

e. The results of all required analyses.

6. Additional Monitoring by Permittee

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

7. Records Retention

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

C. SCHEDULE OF COMPLIANCE

1. The permittee shall achieve compliance with the effluent limitations specified herein upon the effective date of this permit.

2. The permittee shall comply with the requirements of Section 10, Part II-A in accordance with the following:

a. Submit plans for approval to the Chief of the Water Quality Division necessary to comply with the primary power provision of Section 10 in Part II on or before N/A.

b. The permittee shall comply with the requirements of items 10a or 10b contained in Part II on or before N/A. Not withstanding the preceding sentence the permittee shall at all times halt, reduce, or otherwise control production in order to protect the waters of the State of Michigan upon the reduction or loss of the primary source of power.

3. No later than 14 calendar days following a date identified in the above schedule of compliance, the permittee shall submit either a report of progress or, in the case of specific actions being required by identified dates, a written notice of compliance or noncompliance. In the latter case, the notice shall include the cause of noncompliance, any remedial actions taken, and the probability of meeting the next scheduled requirement.

PART II

A. MANAGEMENT REQUIREMENTS

1. Change in Discharge

All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant identified in this permit more frequently than or at a level in excess of that authorized shall constitute a violation of the permit. Any anticipated facility expansions, production increases, or process modifications which will result in new, different, or increased discharges of pollutants must be reported by submission of a new NPDES application or, if such changes will not violate the effluent limitations specified in this permit, by notice to the permit issuing authority of such changes. Following such notice, the permit may be modified to specify and limit any pollutants not previously limited.

2. Containment Facilities

The permittee shall provide approved facilities for containment of any accidental losses of concentrated solutions, acids, alkalies, salts, oils, or other polluting materials in accordance with the requirements of the Michigan Water Resources Commission Rules, Part 5.

3. Operator Certification

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

4. Noncompliance Notification

If, for any reason, the permittee does not comply with or will be unable to comply with any daily maximum effluent limitation specified in this permit, the permittee shall provide the Regional Administrator and the State with the following information, in writing, within five (5) days of becoming aware of such condition:

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

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

5. Spill Notification

The permittee shall immediately report any spill or loss of any product, by-product, intermediate product, oils, solvents, waste material, or any other polluting substance which occurs to the surface or groundwaters of the state by calling the Department of Natural Resources 24 hour Emergency Response telephone number (517) 373-7660; and, the permittee shall within ten (10) days of the spill or loss provide the State with a full written explanation as to the cause and discovery of the spill or loss, clean up and recovery measures taken, preventative measures to be taken, and schedule of implementation.

6. Facilities Operation

The permittee shall at all times maintain in good working order and operate as efficiently as possible, all treatment or control facilities or systems installed or used by the permittee to achieve compliance with the terms and conditions of this permit.

7. Adverse Impact

The permittee shall take all reasonable steps to minimize any adverse impact to navigable waters resulting from noncompliance with any effluent limitations specified in this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge.

8. By-passing

Any diversion from or by-pass of facilities necessary to maintain compliance with the terms and conditions of this permit is prohibited, except (i) where unavoidable to prevent loss of life or severe property damage; or (ii) where excessive storm drainage or runoff would damage any facilities necessary for compliance with the effluent limitations and prohibitions of this permit. The permittee shall promptly notify the Michigan Water Resources Commission and the Regional Administrator, in writing, of such diversion or by-pass.

9. Removed Sub tances

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

10. Power Failures

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

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

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

B. RESPONSIBILITIES

1. Right of Entry

The permittee shall allow the Executive Secretary of the Michigan Water Resources Commission, the Regional Administrator an/or their authorized representatives, upon the presentation of the credentials and subject to applicable requirements of federal and state law:

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

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

2. Transfer of Ownership or Control

In the event of any change in control or ownership of facilities from which the authorized discharge emanate, the permittee shall notify the succeeding owner or controller of the existence of this permit by letter, a copy of which shall be forwarded to the Michigan Water Resources Commission and the Regional Administrator.

3. Availability of Reports

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

4. Permit Modification

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

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

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

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

5. Toxic Pollutants

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

6. Civil and Criminal Liability

Except as provided in permit conditions on "By-passing" (Part II, A-8) and Power Failures" (Part II, A-10), nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance, whether or not such noncompliance is due to factors beyond his control, such as accidents, equipment breakdowns, or labor disputes.

7. Oil and Hazardous Substance Liability

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

8. State Laws

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

9. Property Rights

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

10. Severability

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

Permit No. MI 0039365

MICHIGAN WATER RESOURCES COMMISSION

AUTHORIZATION TO DISCHARGE UNDER THE

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

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

Detroit Edison Company
2000 Second Avenue
Detroit, Michigan 48226

is authorized to discharge from a facility located at

6400 Dixie Highway
Newport, Michigan 48166

to receiving waters named Lake Erie via the South Lagoon

in accordance with effluent limitations, monitoring requirements, and other conditions set forth in Parts I and II hereof.

This permit shall become effective on the date of issuance.

This permit and the authorization to discharge shall expire at midnight, October 31, 1983. In order to receive authorization to discharge beyond the date of expiration, the permittee shall submit such information and forms as are required by the Michigan Water Resources Commission no later than 180 days prior to the date of expiration.

This permit is based on the company's application numbered MI 0039365, dated August 25th, 1978, and shall supersede any and all Orders of Determination, Stipulation, or Final Orders of Determination previously adopted by the Michigan Water Resources Commission.

Issued this 14th day of November 1978, for the Michigan Water Resources Commission.

Robert J. Courchaine

Robert J. Courchaine
Executive Secretary

PART I

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. Effluent Limitations

During the period beginning with the commencement of the discharge and lasting until the date of expiration of this permit, the permittee is authorized to discharge water from material dredged from Lake Erie and placed in a diked disposal basin thru outfall 001. Such discharge shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day (lbs/day)		Other Limitations			
	Daily Average	Daily Maximum	Daily Average	Daily Maximum	Measurement Frequency	Sample Type
Flow M^3/Day (MGD)					Daily when discharging	
Total Suspended Solids -			30 mg/ l	100 mg/l	Daily when discharging	Grab
Oil & Grease			NO VISIBLE FILM		Daily when discharging	Visual Observation

a. The pH shall not be less than 6.0 nor greater than 9.0. The pH shall be monitored as follows: Daily when discharging: Grab.

b. The discharge shall not cause excessive foam in the receiving waters. The discharge shall be essentially free of floating and settleable solids.

c. The discharge shall not contain oil or other substances in amounts sufficient to create a visible film or sheen on the receiving waters.

d. Samples taken in compliance with the monitoring requirements above shall be taken prior to discharge to the South Lagoon.

PART I

B. MONITORING AND REPORTING

1. Representative Sampling

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

2. Reporting

The permittee shall submit monitoring reports containing results obtained during the previous month and shall be postmarked no later than the 10th day of the month following each completed report period. The first report shall be submitted within 90 days of the date of issuance of this permit.

3. Definitions

a. The daily average discharge is defined as the total discharge by weight, or concentration if specified, during a calendar month divided by the number of days in the month that the production or commercial facility was operating. When less than daily sampling is required, the daily average discharge shall be determined by the summation of the measured daily discharges by weight divided by the number of days during the calendar month when the measurements were made.

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

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

d. The Michigan Water Resources Commission is located in the Stevens T. Mason Building. The mailing address is Box 30028, Lansing, Michigan 48909.

4. Test Procedures

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

5. Recording of Results

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

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

b. The dates the analyses were performed;

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

d. the analytical techniques or methods used; and

e. The results of all required analyses.

6. Additional Monitoring by Permittee

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

7. Records Retention

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

C. SCHEDULE OF COMPLIANCE

1. The permittee shall achieve compliance with the effluent limitations specified for outfall 001 in accordance with the following schedule:

a. Submit progress report to the Chief of the Water Quality Division on or before N/A.

b. Submit a preliminary engineering report and basis of design for said facilities to the Chief of the Water Quality Division and obtain his approval thereof on or before N/A.

c. Submit progress report to the Chief of the Water Quality Division on or before N/A.

d. Submit final plans and specifications for said facilities to the Chief of the Water Quality Division and obtain his approval thereof on or before N/A.

e. Commence construction of said facilities on or before N/A.

f. Submit progress report to the Chief of the Water Quality Division on or before N/A.

g. Complete construction of said facilities on or before N/A.

h. Attain operational level necessary to meet the limitations specified herein on or before the commencement of the discharge.

2. The permittee shall comply with the requirements of Section 10, Part II-A in accordance with the following:

a. Submit plans for approval to the Chief of the Water Quality Division necessary to comply with the primary power provision of Section 10 in Part II on or before N/A.

b. The permittee shall comply with the requirements of items 10a or 10b contained in Part II on or before N/A.
Not withstanding the preceding sentence the permittee shall at all times halt, reduce, or otherwise control production in order to protect the waters of the State of Michigan upon the reduction or loss of the primary source of power.

3. No later than 14 calendar days following a date identified in the above schedule of compliance, the permittee shall submit either a report of progress or, in the case of specific actions being required by identified dates, a written notice of compliance or noncompliance. In the latter case, the notice shall include the cause of noncompliance, any remedial actions taken, and the probability of meeting the next scheduled requirement.

PART II

A. MANAGEMENT REQUIREMENTS

1. Change in Discharge

All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant identified in this permit more frequently than or at a level in excess of that authorized shall constitute a violation of the permit. Any anticipated facility expansions, production increases, or process modifications which will result in new, different, or increased discharges of pollutants must be reported by submission of a new NPDES application or, if such changes will not violate the effluent limitations specified in this permit, by notice to the permit issuing authority of such changes. Following such notice, the permit may be modified to specify and limit any pollutants not previously limited.

2. Containment Facilities

The permittee shall provide approved facilities for containment of any accidental losses of concentrated solutions, acids, alkalies, salts, oils, or other polluting materials in accordance with the requirements of the Michigan Water Resources Commission Rules, Part 5.

3. Operator Certification

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

4. Noncompliance Notification

If, for any reason, the permittee does not comply with or will be unable to comply with any daily maximum effluent limitation specified in this permit, the permittee shall provide the Regional Administrator and the State with the following information, in writing, within five (5) days of becoming aware of such condition:

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

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

5. Spill Notification

The permittee shall immediately report any spill or loss of any product, by-product, intermediate product, oils, solvents, waste material, or any other polluting substance which occurs to the surface or groundwaters of the state by calling the Department of Natural Resources 24 hour Emergency Response telephone number (517) 373-7660; and, the permittee shall within ten (10) days of the spill or loss provide the State with a full written explanation as to the cause and discovery of the spill or loss, clean up and recovery measures taken, preventative measures to be taken, and schedule of implementation.

6. Facilities Operation

The permittee shall at all times maintain in good working order and operate as efficiently as possible, all treatment or control facilities or systems installed or used by the permittee to achieve compliance with the terms and conditions of this permit.

7. Adverse Impact

The permittee shall take all reasonable steps to minimize any adverse impact to navigable waters resulting from noncompliance with any effluent limitations specified in this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge.

8. By-passing

Any diversion from or by-pass of facilities necessary to maintain compliance with the terms and conditions of this permit is prohibited, except (i) where unavoidable to prevent loss of life or severe property damage, or (ii) where excessive storm drainage or runoff would damage any facilities necessary for compliance with the effluent limitations and prohibitions of this permit. The permittee shall promptly notify the Michigan Water Resources Commission and the Regional Administrator, in writing, of such diversion or by-pass.

9. Removed Substances

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

10. Power Failures

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

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

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

B. RESPONSIBILITIES

1. Right of Entry

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

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

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

2. Transfer of Ownership or Control

In the event of any change in control or ownership of facilities from which the authorized discharge emanate, the permittee shall notify the succeeding owner or controller of the existence of this permit by letter, a copy of which shall be forwarded to the Michigan Water Resources Commission and the Regional Administrator.

3. Availability of Reports

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

4. Permit Modification

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

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

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

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

5. Toxic Pollutants

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

6. Civil and Criminal Liability

Except as provided in permit conditions on "By-passing" (Part II, A-8) and Power Failures" (Part II, A-10), nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance, whether or not such noncompliance is due to factors beyond his control, such as accidents, equipment breakdowns, or labor disputes.

7. Oil and Hazardous Substance Liability

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

8. State Laws

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

9. Property Rights

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

10. Severability

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

11. Notice to Public Utilities

It is further made a condition of this permit that the applicant give notice to public utilities in accordance with Act 53 of the Public Acts of 1974, being sections 460.701 to 460.718 of the Michigan Compiled Laws, and comply with each of the requirements of that Act.

The mixing zone for the purpose of evaluating compliance with the state water quality standards is defined as

A zone of mixing in a receiving stream has not been designated. The discharge is directly to the South Lagoon and mixing will take place in that Lagoon.

APPENDIX E

LETTER FROM MICHIGAN STATE HISTORIC PRESERVATION OFFICER

MICHIGAN DEPARTMENT OF STATE
RICHARD H. AUSTIN SECRETARY OF STATE

LANSING
MICHIGAN 48918

MICHIGAN HISTORY DIVISION
ADMINISTRATION, ARCHIVES, HISTORIC SITES, AND PUBLICATIONS
3423 N. Logan Street
517-373-0510
STATE MUSEUM
505 N. Washington Avenue
517-373-0515

March 18, 1981

RECEIVED
MAR 23 1981
U.S. NUCLEAR REGULATORY COMMISSION

Mr. Albert Schwencer, Chief
Licensing Branch No. 2
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555 Re: ER-2621

Dear Mr. Schwencer:

Our staff has reviewed the following project and concludes that it will have no effect on any cultural resources either eligible for or listed on the National Register of Historic Places.

Operating License, Fermi-2 Nuclear Power Plant,

Monroe County, Michigan

If you have further questions, please contact Donald E. Weston, Environmental Review Coordinator for the Michigan History Division at 517/373-0510. (Please refer to the reference number above.) Thank you for giving us the opportunity to comment.

Sincerely,

Martha M. Bigelow
Director, Michigan History Division
and
State Historic Preservation Officer

MMB/DEW/

APPENDIX F

FINAL ENVIRONMENTAL STATEMENT, CONSTRUCTION STAGE, ENRICO FERMI ATOMIC POWER PLANT, UNIT 2

A copy of the CP-FES was printed as Appendix F of the Draft Environmental Statement related to the operation of Enrico Fermi Atomic Power Plant, Unit 2 as a convenience to the commentors; it has not been reprinted in this final statement. Copies of the draft statement, including the CP-FES, are available for inspection at the NRC Public Document Room, 1717 H Street, NW, Washington, DC, and the local public document room, the Monroe County Library, 3700 S. Custer Road, Monroe, MI. Copies of the draft statement may be obtained by writing to

Director, Technical Information and Document Control
U.S. Nuclear Regulatory Commission
Washington, DC 20555

APPENDIX G

REBASELINING OF THE RSS RESULTS FOR BWRs

The results of the Reactor Safety Study (RSS) have been updated. The update was done largely to incorporate results of research and development conducted after the October 1975 publication of the RSS and to provide a baseline against which the risk associated with various LWRs could be consistently compared.

Primarily, the rebaselined RSS results reflect use of advanced modeling of the processes involved in meltdown accidents, that is, the MARCH computer code modeling for transient and LOCA initiated sequences and the CORRAL code used for calculating magnitudes of release accompanying various accident sequences. These codes* have led to a capability to predict the transient and small LOCA-initiated sequences that is considerably advanced beyond what existed at the time the Reactor Safety Study was completed. The advanced accident process models (MARCH and CORRAL) produced some changes in the staff estimates of the release magnitudes from various accident sequences in WASH-1400. These changes primarily involved release magnitudes for the iodine, cesium, and tellurium families of isotopes. In general, a decrease in the iodines was predicted for many of the dominant accident sequences, while some increases in the release magnitudes for the cesium and tellurium isotopes were predicted.

Entailed in this rebaselining effort was the evaluation of individual dominant accident sequences as we understand them to evolve rather than the technique of grouping large numbers of accident sequences into encompassing, but synthetic, release categories as was done in WASH-1400. The rebaselining of the RSS also eliminated the "smoothing technique" that was criticized in the report by the Risk Assessment Review Group (sometimes known as the Lewis Report, NUREG/CR-0400)

In both of the RSS designs (PWR and BWR), the likelihood of an accident sequence leading to the occurrence of a steam explosion (α) in the reactor vessel was decreased. This was done to reflect both experimental and calculational indications that such explosions are unlikely to occur in those sequences involving small size LOCAs and transients because of the high pressures and temperatures expected to exist within the reactor coolant system during these scenarios. Furthermore, if such an explosion were to occur, there are indications that it would be unlikely to produce as much energy and the massive missile-caused breach of containment as was postulated in WASH-1400.

For rebaselining of the RSS BWR design, the sequence $TC\gamma'$ (described later) was explicitly included into the rebaselining results. The accident processes associated with the TC sequence had been erroneously calculated in WASH-1400. In general, the rebaselined results led to slightly increased health impacts being predicted for the RSS BWR design. This is believed to be largely attributable to the inclusion of $TC\gamma'$.

---

*It should be noted that the MARCH code was used on a number of scenarios in connection with the TMI-2 recovery efforts and for post-TMI-2 investigations to explore possible alternative scenarios that TMI-2 could have experienced.

In summary, the rebaselining of the RSS results led to small overall differences from the predictions in WASH-1400. It should be recognized that these small differences due to the rebaselining efforts are likely to be far outweighed by the uncertainties associated with such analyses.

The accident sequences identified in the rebaselining effort which are expected to dominate risk of the RSS-BWR design are briefly described below. These sequences are assumed to represent the approximate accident risks from the Fermi-2 BWR design.

Each of the accident sequences is designated by a string of identification characters in the same manner as in the RSS. (See page G-4 for Table showing these symbols.) Each character represents a failure in one or more of the important plant systems or features. For example, in sequences having a γ' at the end of the string, it means a particular failure mode (overpressure) of the containment structure (and a rupture location) where a release of radioactivity takes place directly to the atmosphere from the primary containment. In the sequence having a γ at the end of the string, the containment failure mode is again by overpressure but this time, the rupture location is such that the release takes place into the reactor building (secondary containment) before discharging to the environment. In this latter (γ) case, the overall magnitude of radioactivity release is somewhat diminished by the deposition and plateout processes that take place within the reactor building.

<u>TCγ' and TCγ</u>

These sequences involve a transient event requiring shutdown of the reactor while at full power, followed by a failure to make the reactor subcritical (i.e., terminate power generation by the core). The containment is assumed to be isolated by these events; then, one or the other of the following chain of events is assumed to happen:

(a) High pressure coolant injection system would succeed for some time in providing makeup water to the core in sufficient quantity to cope with the rate of coolant loss through relief and safety valves to the suppression pool of the containment. During this time, the core power level varies, but causes substantial energy to be directed into the suppression pool; this energy is in excess of what the containment and containment heat removal systems are designed to cope with. Ultimately, in about 1-1/3 hours, the containment is estimated to fail by overpressure and it is assumed that this rather severe structural failure of the containment would disable the high pressure coolant makeup system. Over a period of roughly 1-1/2 hours after breach of containment, it is assumed the core would melt. This has been estimated to be one of the more dominant sequences in terms of accident risks to the public.

(b) A variant to the above sequence is one where the high pressure coolant injection system fails somewhat earlier and prior to containment overpressure failure. In this case, the earlier melt could result in a reduced magnitude of release because some of the fission products discharged to the suppression pool, via the safety and relief valves, could be more effectively retained if the pool remained subcooled. The overall accident consequences would be somewhat reduced in this earlier

melt sequence but ultimately, the processes accompanying melt (for example, noncondensibles, steam, and steam pressure pulses during reactor vessel melt-through) could cause overpressure failure (γ or γ') of the containment.

TWγ' and TWγ

The TW sequence involves a transient where the reactor has been shut down and containment has been isolated from its normal heat sink (that is, the power conversion system). In this sequence, the failure to transfer decay heat from the core and containment to an ultimate sink could ultimately cause overpressure failure of containment. Overpressure failure of containment would take many, many hours, allowing for repair or other emergency actions to be accomplished; but, should this sequence occur, it is assumed that the rather severe structural failure of containment would disable the systems (for example, HPI, RCIC) providing coolant makeup to the reactor core. (In the RSS design, the service water system which conveys heat from the containment via RHR system to the ultimate sink was found to be the dominant failure contribution in the TW sequence.) After breach of containment, the core is assumed to melt.

[TQUVγ', AEγ', S_1Eγ', S_2Eγ'] and [TQUVγ, AEγ, S_1Eγ, S_2Eγ]

Each of the accident sequences shown grouped into the two bracketed categories above are estimated to have quite similar consequence outcomes and these would be somewhat smaller than the TCγ',γ and TWγ' sequences described above. In essence, these sequences, which are characterized as in the RSS, involve failure to deliver makeup coolant to the core after a LOCA or a shutdown transient event requiring such coolant makeup. The core is assumed to melt down and the melt processes ultimately cause overpressure failure of containment (either γ' or γ). The overall risk from these sequences is expected to be dominated by the higher frequency initiating events (that is, the small LOCA (S_2) and shutdown transients (T)).

Key to SWR Accident Sequence Symbols

A - Rupture of reactor coolant boundary with an equivalent diameter of greater than 6 in.

B - Failure of electric power to ESFs.

C - Failure of the reactor protection system.

D - Failure of vapor suppression.

E - Failure of emergency core cooling injection.

F - Failure of emergency core cooling functionability.

G - Failure of containment isolation to limit leakage to less than 100 volume per cent per day.

H - Failure of core spray recirculation system.

I - Failure of low pressure recirculation system.

Key to BWR Accident Sequence Symbols (Continued)

J - Failure of high pressure service water system.

M - Failure of safety/relief valves to open.

P - Failure of safety/relief valves to reclose after opening.

Q - Failure of normal feedwater system to provide core make-up water.

S_1 - Small pipe break with an equivalent diameter about 2 to 6 in.

S_2 - Small pipe break with an equivalent diameter of about 1/2 to 2 in.

T - Transient event.

U - Failure of HPCI or RCIC to provide core make-up water.

V - Failure of low pressure ECCS to provide core make-up water.

W - Failure to remove residual core heat.

α - Containment failure due to steam explosion in vessel.

β - Containment failure due to steam explosion in containment.

γ - Containment failure due to overpressure - release through reactor building.

γ' - Containment failure due to overpressure - release direct to atmosphere.

δ - Containment isolation failure in drywell.

ε - Containment isolation failure in wetwell.

ζ - Containment leakage greater than 2400 volume percent per day.

η - Reactor building isolation failure.

θ - Standby gas treatment system failure.

APPENDIX H

EVACUATION MODEL

"Evacuation," used in the context of offsite emergency response in the event of substantial amount of radioactivity release to the atmosphere in a reactor accident, denotes an early and expeditious movement of people to avoid exposure to the passing radioactive cloud and/or to acute ground contamination in the wake of the cloud passage. It should be distinguished from "relocation" which denotes a post-accident response to reduce exposure from long term ground contamination. The Reactor Safety Study[1] (RSS) consequence model contains provision for incorporating radiological consequence reduction benefits of public evacuation. Benefits of a properly planned and expeditiously carried out public evacuation would be well manifested in reduction of acute health effects health effects associated with early exposure, namely, in a number of cases acute associated with early exposure; namely, in number of cases of acute fatality and acute radiation sickness which would require hospitalization. The evacuation model originally used in the RSS consequence model is described in WASH-1400[1] as well as in NUREG-0340.[2] However, the evacuation model incorporated in the RSS consequence model which has been used herein is a modified version[3] of the RSS model and is, to a certain extent, site emergency planning oriented. The modified version is briefly outlined below:

The model utilizes a circular area with a specified radius (such as a 16-km (10-mile) plume exposure pathway Emergency Planning Zone (EPZ), with the reactor at the center. It is assumed that people living within portions of this area would evacuate if an accident should occur involving imminent or actual release of significant quantities of radioactivity to the atmosphere.

Significant atmospheric releases of radioactivity would in general be preceded by one or more hours of warning time (postulated as the time-interval between the awareness of impending core-melt and the beginning of the release of radioactivity from the containment building). For the purpose of calculation of radiological exposure, the model assumes that all people who live in a fan-shaped area (fanning out from the reactor), within the circular zone with the downwind direction as its median; that is, those people who would potentially be under the radioactive cloud that would develop following the release would leave their residences after lapse of a specified amount of delay time* and then evacuate. The delay time is reckoned from the beginning of the warning time and is recognized as the sum of the time required by the reactor operators to notify the responsible authorities, time required by the authorities to interpret the data, decide to evacuate, and direct the people to evacuate, and time required for the people to mobilize and get underway.

*Assumed to be a constant value which would be the same for all evacuees.

The model assumes that while leaving the area, each evacuee would move radially out and in the downwind direction with an average effective speed* (obtained by dividing the zone radius by the average time taken to clear the zone after the delay time) over a fixed distance* from the evacuee's starting point. This distance is selected to be 24 km (15 mi) (which is 8 km (5 mi) more than the 16 km (10 mi) plume exposure pathway EPZ radius). After reaching the end of the travel distance the evacuee is assumed to receive no further radiation exposure. (An important assumption incorporated in the RSS consequence model is that if the calculated ground dose to the total marrow over a 7-day period would exceed 200 rems in the regions beyond the evacuation zone, then this high dose rate would be detected by actual field measurements following the accident and people from those regions would be relocated immediately. Therefore, the model limits the period for ground-dose calculation to only 24 hr for those regions. When no evacuation at all is assumed, this manner of ground-dose calculations applies to all regions, beginning from the reactor's location. The CRAC code implements this feature irrespective of the evacuation model used.)

This distance is selected to be 16 km (10 mi) (which is 8 km (5 mi) more than the 16 km (10 mi) plume exposure pathway EPZ radius). After reaching the end of the travel distance the evacuee is assumed to receive no further radiation exposure. (An important assumption incorporated in the RSS consequence model is that if the calculated ground dose to the total marrow over a 7-day period would exceed 200 rems in the region beyond the evacuation zone, then this high dose rate would be detected by actual field measurements following the accident and people from those regions would be relocated immediately. Therefore, the model limits the period for ground-dose calculation to only 24 hr for those regions. When no evacuation at all is assumed, this manner of ground-dose calculation applies to all regions beginning from the reactor's location. CRAC code implements this feature irrespective of the evacuation model used.

The model incorporates a finite length of the radioactive cloud in the downwind direction which would be determined by the product for the duration over which the atmospheric release would take place and the average windspeed during the release. It is assumed that the front and the back of the cloud formed would move with an equal speed which would be the same as the prevailing windspeed; therefore, its length would remain constant as its initial value. At any time after the release, the concentration of radioactivity is assumed to be uniform over the length of the cloud. If the delay time would be less than the warning time, then all evacuees would have a head-start; that is, the cloud would be trailing behind the evacuees initially. On the other hand, if the delay time would be more than the warning time, then depending on initial locations of the evacuees there are possibilities that (a) an evacuee will still have a head-start, or (b) the cloud would be already overhead when an evacuee starts out to leave, or (c) an evacuee would be initially trailing behind the cloud. However, this initial picture of cloud/people disposition would change as the evacuees travel depending on the relative speed and positions between the cloud and people. It may become possible that the cloud and an evacuee would overtake one another one or more number of times before the evacuee would reach his or her destination. In the model, the radial position of an evacuating person, while stationary or in transit, is compared to the front and the back of the cloud as a function of time to determine a realistic period of exposure

*Assumed to be of a constant value which would be the same for all evacuees.

to airborne radionuclides. The model calculates the time periods during which people are exposed to radionuclides on the ground while they are stationary and while they are evacuating. Because radionuclide would be deposited continually from the cloud as it passed a given location, a person while under the cloud would be exposed to ground contamination less concentrated than if the cloud had completely passed. To account for this, at least in part, the revised model assumes that persons are exposed to the total ground contamination concentration, calculated to exist after complete passage of the cloud, when completely passed by the cloud; to one half the calculated concentration when anywhere under the cloud; and to no concentration when in front of the cloud. The model provides for use of different values of the shielding protection factors for exposure from airborne radioactivity and contaminated ground, and the breathing rates for stationary and moving evacuees during delay and transit periods.

It is realistic to expect that authorities would evacuate persons at distances from the site where exposures above the threshold for causing acute fatalities could occur regardless of the plume exposure pathway EPZ distance. Figure H-1 illustrates the reduction in acute fatalities that can occur by extending evacuation to a larger distance such as 32 km (20 mi) from the Fermi-2 site. Also illustrated in Figure H-1 is a pessimistic case for which no early evacuation is assumed and all persons are assumed to be exposed for the first 24 hr following an accident and are then relocated.

The model has the same provision for calculation of the economic cost associated with implementation of evacuation as in the original RSS model. For this purpose the model assumes that for atmospheric releases of durations 3 hours or less, all people living within a circular area of 8-km (5-mi) radius centered at the reactor plus all people within a 45-degree angular sector within the plume exposure pathway EPZ and centered on the downwind direction will be evacuated and temporarily relocated. However, if the duration of release would exceed three hours, the cost of evacuation is based on the assumption that all people within the entire plume exposure pathway EPZ would be evacuated and temporarily relocated. For either of these situations, the cost of evacuation and relocation is assumed to be $125 (1980 dollars) per person, which includes cost of food, and temporary sheltering for a period of one week.

REFERENCES

1. U.S. Nuclear Regulatory Commission, "Reactor Safety Study," WASH-1400, USNRC Report NUREG-75/014, October 1975 (available from NTIS, Springfield, VA 22161).

2. "Overview of the Reactor Safety Study Consequences Model," USNRC Report NUREG-0340, October 1977 (available from NRC/GPO Sales Program, Washington, DC, 20555 and from NTIS).

3. "A Model of Public Evacuation for Atmospheric Radiological Releases," SAND 78-0092, June 1978 (available for inspection and copying for a fee in the NRC Public Document Room, 1717 H St. NW, Washington, DC 20555).

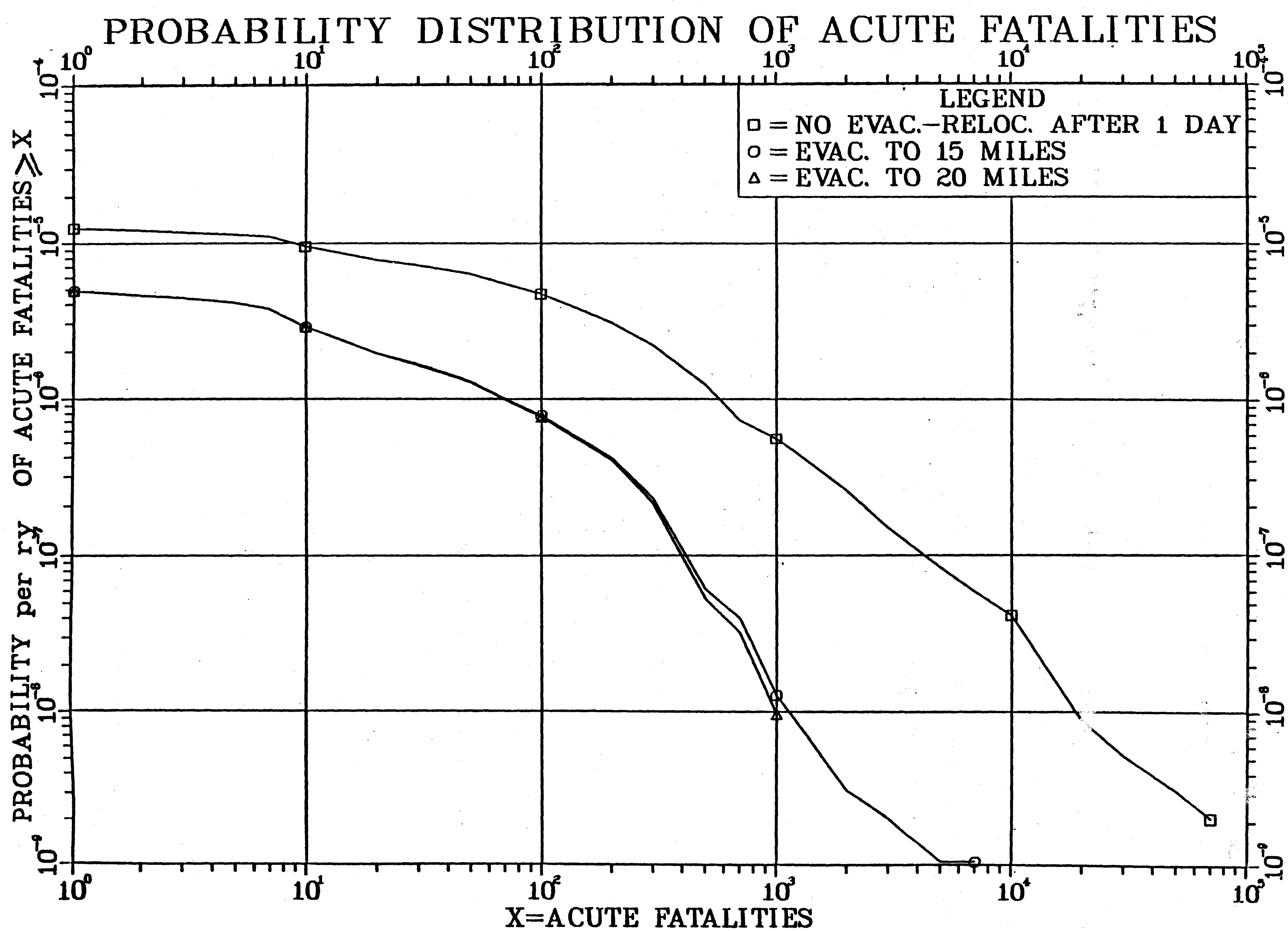


Figure H-1

Note: Please see Section 6.4.4.7 for discussion of uncertainties in risk estimates

*U.S. GOVERNMENT PRINTING OFFICE: 1981 341-742/1265 1-3

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Docket No. 50-341

16. ABSTRACT (200 words or less)

The information in this Final Environmental Statement is the second assessment of the environmental impact associated with the construction and operation of the Fermi 2 Nuclear Power Plant, located on Lake Erie in Monroe County, Michigan. The Draft Environmental Statement was issued in April 1981. The first assessment was the Final Environmental Statement related to construction issued in July 1972 prior to issuance of the Fermi 2 construction permit. The Fermi 2 plant construction is now 80% complete, and startup is scheduled for November 1982. The present assessment is the result of the NRC staff review of the activities associated with the proposed operation of the plant, and includes the staff response to comments on the Draft Environmental Statement.

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