DOCKET-50289--20
DOCKET-50320--38

Final

environmental statement

related to operation of

THREE MILE ISLAND NUCLEAR STATION UNITS 1 and 2

METROPOLITAN EDISON COMPANY
PENNSYLVANIA ELECTRIC COMPANY
JERSEY CENTRAL POWER AND LIGHT COMPANY

DOCKET NOS. 50-289 and 50-320

December 1972

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UNITED STATES ATOMIC ENERGY COMMISSION

DIRECTORATE OF LICENSING

MASTER

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Summary and Conclusions

This Final Detailed En[illegible]ironmental Statement was prepared by the U. S. Atomic Energy Commission, Di[illegible]ctorate of Licensing.

1. This action is [illegible]nistrative.

2. The proposed actions are the continuation of construction permits CPPR-40 and CPPR-66 and the issuance of operating licenses to Metropolitan Edison Company, Jersey Central Power and Light Company, and the Pennsylvania Electric Company (the Applicants) for the operation of the Three Mile Island Nuclear Station Units 1 and 2 near Harrisburg in Dauphin County, Pennsylvania.

The Three Mile Island Nuclear Station is comprised of two pressurized water reactor units. Unit Number 1 has a designed thermal rating of 2535 megawatts with a maximum electrical output of 871 megawatts. Unit Number 2 has a designed thermal rating of 2772 megawatts with a maximum electrical output of 959 megawatts. Four natural draft cooling towers, two per unit, are utilized for dissipating the waste heat from the closed cycle cooling water system.

3. Summary of environmental impact and adverse effects:

a. Construction and site development has and will cause some temporary disturbance of land onsite and of adjacent waters.

b. About 36,000 gpm of auxiliary services cooling water and blowdown from the cooling towers will be discharged to the Susquehanna River. This liquid effluent from the Station is approximately 5% of the minimum river flow. The effluent will average 3°F or less above ambient river temperature depending upon the season of the year. Following relatively infrequent reactor shutdowns during unusual weather conditions (high air and low water temperatures) the effluent could be as much as 19°F above river ambient for periods not exceeding a few hours.

c. About 20,800 gpm of river water will be evaporated from the cooling towers.

d. About 7555 curies of radionuclides in gaseous effluents and 2008 curies of radionuclides in liquid effluents (including 2000 curies of tritium) will be released to the environment annually.

e. Increased local fog and occasional augmentation of natural fog at Harrisburg International Airport from operation of cooling towers.

f. A very low likelihood of accidental radiation exposure to nearby residents will be created.

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g. Small amounts of chemicals will be released in the liquid effluents and cooling tower drift from the Station; but, aside from residual chlorine which will place organisms in the near vicinity of the outfall at significant risk if not carefully controlled, expected maximum concentrations to be discharged will be sufficiently low as not to pose a hazard to aquatic or human life.

h. Operation of intake and discharge systems will cause some localized destruction of minute aquatic organisms, and some local alteration of fish populations.

i. There will be some visual impact from the cooling towers and transmission lines.

4. Principal alternatives considered were:

- Alternative power sources
- Construction of the Station at an alternate site
- Alternative land uses
- Use of alternate cooling methods

5. Comments on "Environmental Report-Operating License Stage, Three Mile Island Nuclear Station Unit 1 and Unit 2" dated October 1, 1970, have been received from the following agencies and used in the preparation of this Final Environmental Statement:

Department of Agriculture
Department of Defense
Department of Health, Education and Welfare
Department of the Interior
Federal Power Commission
Pennsylvania Department of Health

6. The following Federal, State and local agencies were requested to comment on the Draft Detailed Environmental Statement:

Advisory Council on Historical Preservation
Department of Agriculture
Department of Army, Corps of Engineers
Department of Commerce
Department of Health, Education, and Welfare
Department of Housing and Urban Development
Department of the Interior
Department of Transportation
Federal Power Commission
Environmental Protection Agency
Pennsylvania Department of Health
Board of Commissioners - Dauphin County, Pennsylvania
Pennsylvania Historical and Museum Commission

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Comments received on the Draft Detailed Environmental Statement are incorporated in this Final Statement in Appendix C. Comments received were forwarded to the Applicants. Their replies are incorporated in this Final Statement in Appendix D.

7. This Final Detailed Environmental Statement is being made available to the public, to the Council on Environmental Quality, and to the other agencies, as noted above, in December, 1972.

8. On the basis of the evaluation and analysis set forth in this statement, and after weighing the environmental, economic, technical, and other benefits of the Three Mile Island Nuclear Station Units 1 and 2 against environmental and other costs and considering available alternatives, it is concluded that the actions called for under NEPA and Appendix D to 10 CFR Part 50 are continuation of construction permits CPPR-40 and CPPR-66 and the issuance of operating licenses for Unit 1 and Unit 2, subject to the following conditions for the protection of the environment:

a. The Applicants will perform preoperational measurements of the distributions of aquatic species to establish base-line data adequate for determining adverse effects the Station might have on the environment.

b. The Applic ts will define an environmental monitoring program for inclusion in the Environmental Technical Specifications considered by the Regulatory staff to be adequate to disclose any changes which may occur in land and water ecosystems as a result of plant operation.

c. The Applicants will monitor the total residual chlorine concentration in the Station effluent during and immediately following chlorination. If this concentration exceeds 0.1 ppm, the Applicants should take all practical measures to reduce it below this value. Should these efforts fail, the Applicants should determine the extent of the zone in the river within which the total residual chlorine concentration exceeds the EPA recommended criteria. The Environmental Technical Specifications for the Station will further describe the procedures to be followed in this situation.

d. The Applicants will take appropriate measures through monitoring, administrative measures and/or design changes to insure that the thyroid dose to critical segments of the general population through the grass-cow-milk chain does not exceed 5 mrem/year.

e. The Applicants will define a radiological monitoring program considered by the regulatory staff to be adequate to determine any radiological effects on the environment from op tion of the Three Mile Island Nuclear Station, Units 1 and 2.

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f. If harmful effects or evidence of irreversible damage are detected by the monitoring programs, the Applicants will provide an analysis of the problem and will develop a course of action to be taken to alleviate the problems. If the ecology of the river significantly changes at a future date as, for example, by major changes in water chemistry or reintroduction of shad, the Applicants will provide an analysis of expected impacts and a course of action to minimize the impacts.

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FOREWORD

This Final Detailed Statement of the environmental considerations applies to the Three Mile Island Nuclear Power Station (the Station). This Station is being built for Metropolitan Edison Company, Jersey Central Power and Light Company and Pennsylvania Electric Company (the Applicants). The Station is to consist of Unit 1 and Unit 2 (Docket Nos. 50-289 and 50-320). Construction Permits were issued May 18, 1968 and November 4, 1969 for Units 1 and 2, respectively. The next stage is a request for operating license with commercial operation scheduled for Unit 1 by November 1973 and for Unit 2 by May 1975.

This Statement has been prepared by the U. S. Atomic Energy Commission's Regulatory staff pursuant to the Commission's regulations, 10 CFR Part 50, Appendix D, implementing the National Environmental Policy Act of 1969 (NEPA). Section 102(2)(c) of the NEPA calls for a detailed statement on:

i. The environmental impact of the proposed action,

ii. Any adverse environmental effects, which cannot be avoided should the proposal be implemented,

iii. Alternatives to the proposed action,

iv. The relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and

v. Any irreversible and irretrievable commitments of resources which could be involved in the proposed action should it be implemented.

The Applicants submitted an "Environmental Report Operating License Stage" for Three Mile Island Nuclear Station Units 1 and 2 in October 1970. The Commission forwarded copies of this report to appropriate Federal and State agencies for review and comment. The Applicants responded to the comments of the agencies. A revised environmental report for Three Mile Island Nuclear Station Units 1 and 2 was submitted by the Applicants in December 1971 ~~to take~~ into account the provisions of the revised Appendix D regulations. In March 1972 Amendment No. 1 to the revised environmental report was submitted by the Applicants and Supplement No. 1 was submitted in August 1972.

This Draft Environmental Statement takes all of the above writings into account as well as the Preliminary and Final Safety Analysis Reports. These documents are available in the Commission's Public Document Room, 1717 H Street, N.W., Washington, D. C. and in the State Library of Pennsylvania Government Publication Section, Education Building, Harrisburg, Pennsylvania.

As part of the safety evaluation conducted by the Commission's staff prior to the issuance of construction permits and operating licenses, a

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detailed analysis is made of the Applicants' plans and facilities for minimizing and controlling the release of radioactive materials under normal operating and potential accident conditions. This includes an evaluation of the adequacy of proposed effluent and environmental monitoring programs and the potential radiation exposure that might be received by plant workers and members of the public. Inasmuch as these aspects are considered fully in other reports, only the salient features that bear directly on the environmental impact of the Station are discussed herein.

Dr. J. D. Jenkins is the AEC Environmental Project Manager (301-973-7263) for this statement.

I. Introduction

Metropolitan Edison Company (Met-Ed), Jersey Central Power and Light, and Pennsylvania Electric Company, the Applicants, are wholly-owned subsidiaries of General Public Utilities Corporation (GPU). GPU, a New York corporation, registered under the Public Utility Holding Company Act, is composed of four utilities and is operated as an integrated system -- the GPU Integrated System. The fourth GPU subsidiary corporation is the New Jersey Power and Light Company. A major fraction of the State of Pennsylvania and a portion of New Jersey are served by the GPU system, which has a peak generating capacity at the present time of about 5,900 MWe.

Capital costs for construction of the Three Mile Island Nuclear Power Station (the Station) are being shared by the Applicants: Met-Ed (50%), Jersey Central Power and Light (25%), and Pennsylvania Electric (25%). Met-Ed, however, has complete responsibility for the engineering, design, construction, operation, and maintenance of the Station. The three participating companies will share undivided ownership of the Station as tenants in common without right of partition.

The Station occupies part of an 814-acre site consisting of Three Mile Island (TMI) and adjacent islands in the Susquehanna River, approximately 10 miles southeast of Harrisburg, Pennsylvania. Location of the generating station with respect to regional features is shown in Figure 1, and in more detail in Fig. 2.

The two nuclear power units (Unit 1 and Unit 2), presently under construction, have gross capacities of 871 MWe and 959 MWe, respectively, and both employ pressurized water-type nuclear reactors supplied by Babcock and Wilcox Company. As of September 1972, construction of Unit 1 is approximately 90% complete, and construction of Unit 2 is about 31% complete.

The application for a construction permit for Unit 1 (Docket 50-289) was filed on May 3, 1967, and an AEC Exemption for limited construction below grade was granted on November 29, 1967. The Division of Reactor Licensing (DRL) safety evaluation was completed on February 5, 1968. A public hearing before the Atomic Safety and Licensing Board (ASLB) was held April 10 and 11, 1968. The public hearing was uncontested, and the construction permit (CPPR-40) was issued on May 18, 1968. The operating license application for Unit 1 was filed with the AEC on March 2, 1970.

The construction permit application for Unit 2 (Docket 50-320) was filed April 29, 1968, and amended, due to a site change for the Unit from Oyster Creek to the Station, on March 10, 1969. An AEC Exemption to construct the tendon access gallery was granted on June 27, 1969. The DRL safety evaluation was completed on September 5, 1969, and a public hearing before the ASLB was held October 6 and 7, 1969. This hearing was also uncontested, and the construction permit (CPPR-66) for Unit 2 was granted on November 4, 1969.

Figure 1 – COUNTIES AND MUNICIPALITIES IN THE THREE MILE ISLAND AREA

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CONTOUR INTERVAL 20 FEET

1 ½ 0 1 MILE

0 4000 8000 FEET
2000 6000

APPROX. SCALE

SITE TOPOGRAPHY – 5 MILE RADIUS
THREE MILE ISLAND NUCLEAR STATION

Figure 2

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A. Site Selection

The Station site was purchased by a predecessor company of Met-Ed in the early 1900's. In the course of selecting a site for installation of one or more large generating units, the Applicants initially considered twenty different locations; this list was narrowed to six for more intensive study. Three Mile Island was finally selected because of a combination of favorable factors, including:

1. Availability of cooling water from the Susquehanna River.

2. Close proximity to existing high voltage transmission facilities (1.5 miles to Middletown junction substation) and central location in the GPU service area.

3. Close to existing highway and rail transportation.

4. A suitably large and readily controllable exclusion area.

5. The absence of nearby regions of high population density. The area is predominantly rural.

6. Availability of the land since the company already owned it.

The decision to build a nuclear plant rather than a fossil fuel plant was primarily economic; the estimates of overall costs of power generation were lower for nuclear fuel than for fossil. Since 1967, when the decision was taken, revised estimates of cost for the two types of power generation favor nuclear power even more. For example, typical fuel costs today for the region in which the plant is located are:

Oil (used for peak load demand) - 74¢/million BTU
Coal - 30¢/million BTU
Gas - Unavailable in sufficient quantities
Nuclear - 17¢/million BTU.

In addition the sulfur dioxide discharge standards of the Commonwealth of Pennsylvania require coal containing the equivalent of 0.7% sulfur or less for new plants. Since such low-sulfur coal is not readily available locally, the additional transportation cost further worsens the economic picture for coal.

There are a number of other power-generating facilities in the immediate vicinity of the Station which uses the Susquehanna River for cooling water. The Met-Ed Crawford Station at Middletown (about three miles upstream) is an older 115 MWe fossil plant, recently converted from coal to oil, which uses river water for direct condenser cooling. The Brunner Island coal-fired plant of the Pennsylvania Power and Light Co. is located several miles downstream from the Station. The Brunner Island Station, consisting of three

units that produce a total of 1,500 MWe, uses river water for direct cooling of the condensers. In addition to the two fossil plants, there is the Met-Ed York Haven Hydro Power Station, located at the dam that extends across the river from the southern end of TMI. This small, 20 MWe, station is presently used to help meet peak load demand in the GPU system.

Other major industrial activities in the immediate vicinity of the Station are a Bethelem Steel pipe fabrication plant at Steeltown, a Bethlehem Steel plant at Lebanon and the Hershey Chocolate Company at Hershey, Pa. In addition, there is some small diversified industry in the area, although none of this is in the immediate vicinity of the Station.

As part of the general development of recreational area in the vicinity of the plant, the Applicants are proposing to locate a recreational facility at the southern end of Three Mile Island. In the course of planning the development of the recreation resources of this project, a number of individuals in the State and local governments were consulted.

There have been contacts between the Applicants and persons in the Pennsylvania Fish Commission and the Department of Environmental Resources regarding the pre- and postoperational biological and radiological monitoring programs for the Station.

There are no special populations such as hospitals or schools in the immediate vicinity of the site. The nearest public facility is a school located approximately 4 miles north of the site in Middletown.

B. Applications and Approvals

A list of the Federal, State, and local applications and permits for the Station is given in Table 1.

Three public hearings have been held concerning the Station, two before the Atomic Safety and Licensing Board as part of the construction permit approval, noted above, and an FAA-Pennsylvania Aeronautics Commission hearing (April, 1968) on matters relating to the effect of the large cooling towers on operations at Harrisburg International Airport.

The Federal Aviation Administration (FAA) and the Pennsylvania Aeronautics Commission were consulted with regard to construction of the cooling towers, and the FAA has given a permit for construction of the cooling towers at the site. In addition, design changes were made in the plant buildings so that all critical structures have been "hardened" to withstand direct impact of a large commercial jet aircraft.

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TABLE 1

LIST OF LICENSES, PERMITS AND APPROVALS OF CONSTRUCTION AND OPERATION OF THREE MILE ISLAND NUCLEAR STATION REQUIRED BY FEDERAL, STATE AND LOCAL AUTHORITIES

A. Federal

Permit No.	Purpose	Authority	Status
Docket No. 50-289	Licensing of Plant	U. S. Atomic Energy Commission	FSAR submitted
Docket No. 50-320	Construction Permit Unit 1	U. S. Atomic Energy Commission	PSAR submitted, Issued May 18, 1968
	Construction Permit Unit 2	U. S. Atomic Energy Commission	Issued November 4, 1969
	Special Nuclear Material License	U. S. Atomic Energy Commission	Application submitted June 8, 1972
	Byproduct Material License	U. S. Atomic Energy Commission	Application issued November 30, 1971
NYC-OE-68-61	Determination of No Hazard to Air Navigation - Unit 1 Cooling Towers	Federal Aviation Administration	Issued April 23, 1968
70-EA-150-OE	Determination of No Hazard to Air Navigation - Unit 2 Cooling Towers	Federal Aviation Administration	Issued July 29, 1970
Project No. 1888	Amendment to York Haven Power Project License to Permit Joint Use of Project Waters	Federal Power Commission	Unit 1 approved October 8, 1969 - Unit 2 application submitted July 1970
NABOP-P (Met-Ed Co.) 13	Intake, Screen, and Pump House and Temporary Earth-fill Cofferdam- Unit 1 (Section 10, Refuse Act of 1899)	U. S. Army Corps of Engineers	Issued May 22, 1969

LIST OF LICENSES, PERMITS AND APPROVALS OF CONSTRUCTION AND OPERATION
OF THREE MILE ISLAND NUCLEAR STATION REQUIRED BY FEDERAL, STATE AND LOCAL AUTHORITIES

A. FEDERAL

Permit No.	Purpose	Authority	Status
NABOP-P (Met-Ed Co.) 21	Intake, Screen and Pump House and Temporary Earthfill Cofferdam - Unit 2 and Intake Channel - Units 1 & 2 (Section 10, Refuse Act of 1899)	U. S. Army Corps of Engineers	Issued March 10, 1971
2SD OXU 3 000719	Discharge of Plant Effluent Units 1 & 2 (Section 13, Refuse Act of 1899)	U. S. Army Corps of Engineers	Section I and Section II Part A submitted August 25, 1971. Section B submitted November 10, 1971

B. COMMONWEALTH OF PENNSYLVANIA

Permit No.	Purpose	Authority	Status
17145	Temporary Access Bridge Extension for use of bridge thru 1973	Department of Environmental Resources	Issued July 11, 1967 Issued April 30, 1969
17259	Temporary Pump Intake Facility	Department of Environmental Resources	Issued October 10, 1967
17421	Temporary Cofferdam and Causeway to construct the Permanent Access Bridge Extension of six months	Department of Environmental Resources	Issued March 13, 1968
17291	Construct and Maintain a Permanent Railroad and Highway Access Bridge	Department of Environmental Resources	Issued October 10, 1967
17948	Construct an Intake, Screen House, and Pump House for Unit 1 Extension to December 1971	Department of Environmental Resources	Issued April 8, 1969 Issued December 11, 1970

LIST OF LICENSES, PERMITS AND APPROVALS OF CONSTRUCTION AND OPERATION
OF THREE MILE ISLAND NUCLEAR STATION REQUIRED BY FEDERAL, STATE AND LOCAL AUTHORITIES

B. COMMONWEALTH OF PENNSYLVANIA

Permit No.	Purpose	Authority	Status
18875	Construct an Intake, Screen House, and Pump House for Unit 2 and Intake Channel for Units 1 & 2	Department of Environmental Resources	Issued July 14, 1970
2270204	Industrial Wastes Permit Units 1 and 2	Department of Environmental Resources	Issued August 17, 1971
2270408	Sanitary Wastes - Units 1 and 2	Department of Environmental Resources	Issued January 5, 1971
22-302-015	Two Auxiliary Boilers Unit 1 Plan Approval Operating Permit	Department of Environmental Resources	Issued May 14, 1970 Has not been inspected
22-301-037	Incinerator Plan Approval Operating Permit	Department of Environmental Resources	Issued January 14, 1971 Has not been inspected
22-301-137	Unit 2 - Radioactive Gaseous Wastes Plan Approval	Department of Environmental Resources	Application dated 1971
No. 67	Scientific Collecters Permit	Pennsylvania Fish Commission	Issued February 3, 1971
No. 85	Underwater Blasting for Intake Channel - Units 1 and 2	Pennsylvania Department of	
162,562	3 - 4,000 gallon underground gas and diesel fuel oil tanks	Pennsylvania State Police Fire Marshall Division.	Issued October 17, 1968
166,468	2,000 and 3,000 gallon fuel oil tanks - underground	Pennsylvania State Police Fire Marshall Division	Issued August 4, 1969

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LIST OF LICENSES, PERMITS AND APPROVALS OF CONSTRUCTION AND OPERATION OF THREE MILE ISLAND NUCLEAR STATION REQUIRED BY FEDERAL, STATE AND LOCAL AUTHORITIES

B. COMMONWEALTH OF PENNSYLVANIA

Permit No.	Purpose	Authority	Status
165,220	Cancelled by 166,468	Pennsylvania State Police Fire Marshal Division	Issued January 17, 1969
165,822	4 - 4,000 gallon diesel fuel underground tanks	Pennsylvania State Police Fire Marshal Division	Issued May 5, 1969
166,246	Cancelled by 165,822	Pennsylvania State Police Fire Marshal Division	Issued June 27, 1969
168,465	30,000 gallon underground diesel fuel tank - Unit 1	Pennsylvania State Police Fire Marshal Division	Issued June 12, 1970
168,466	50,000 gallon above ground fuel oil tank	Pennsylvania State Police Fire Marshal Division	Issued June 12, 1970
166,622	3 - 4,000 gallon and 2 - 4,000 gallon underground diesel fuel tanks	Pennsylvania State Police Fire Marshal Division	Issued August 26, 1969
HA 133193	Occupancy of Service Building	Pennsylvania Department of Labor and Industry	Issued September 15, 1971
P-33401	Temporary Access Bridge Highway Occupancy Permit	Pennsylvania Department of Highways	Issued July 13, 1967
P-84381	Permanent Private Access Road Highway Occupancy Permit	Pennsylvania Department of Highways	Issued October 13, 1967
S-16013	Extension of Permit		Issued January 30, 1968
132403	Permanent Access Road	Pennsylvania Department of Highways	Issued January 16, 1970

C. LOCAL

Permit No.	Purpose	Authority	Status
278	Building Permit	Londonderry Township	Issued July 10, 1967.

II. THE SITE

A. GENERAL

The Station will occupy about 200 acres of the 472-acre Three Mile Island (TMI). The tract owned by the Applicants, a total of 814 acres, includes several adjacent islands in the Susquehanna River as well as the whole of Three Mile Island (Figure 3). The islands were purchased as part of a regional power development plan. TMI is about 11,000 ft. long and 1,700 ft. wide. Its long axis is oriented approximately north-south, paralleling the flow of the river. It lies about 900 ft. from the east bank of the river and about 6,500 ft. from the west bank. South and east of the island the river is transected by the York Haven Dam, the is nd itself serving as part of the dam. There are no locks.

On the east bank of the river is a single track line of the Penn-Central Railroad and State Highway 441, a two-lane, blacktop, medium-duty road. A multitrack Penn-Central line and a two-lane blacktop road parallel the river's edge of the west bank.

A bridge connecting the north end of the island with State Highway 441 near the junction of Highway 441 and Geyers Church Road, is used by Station personnel. A one-track railroad spur across the bridge provides for transportation of heavy equipment. Other Station personnel, visitors, and construction equipment have acces to the island from the south by a temporary bridge connecting the island with Highway 441 near Falmouth in Lancaster County.

B. LOCATION

TMI is located in Londonderry Township of Dauphin County about three miles south of Middletown, Dauphin County, and about 1.25 miles east of the small community of Goldsboro, York County at latitude 40° 9'10", longitude 76° 43'25" (Figure 2).

Between 1957 and the start of construction, 270 acres on TMI were leased for farming. The flat, rich, sandy silt soil was used to grow corn and tomatoes. Since there was no access to the island by bridge, the farmer transported his equipment and produce by barge.

Seventy cabins on the island were also leased; 53 on the west side and 17 on the east side. There was also a picnic area with five tables, two fireplaces, two toilets, a boat dock, and a well for drinking water. The periphery of the island and a tract of the southeast part of the island, about 200 acres in all, were wooded.

No electricity was supplied to TMI.

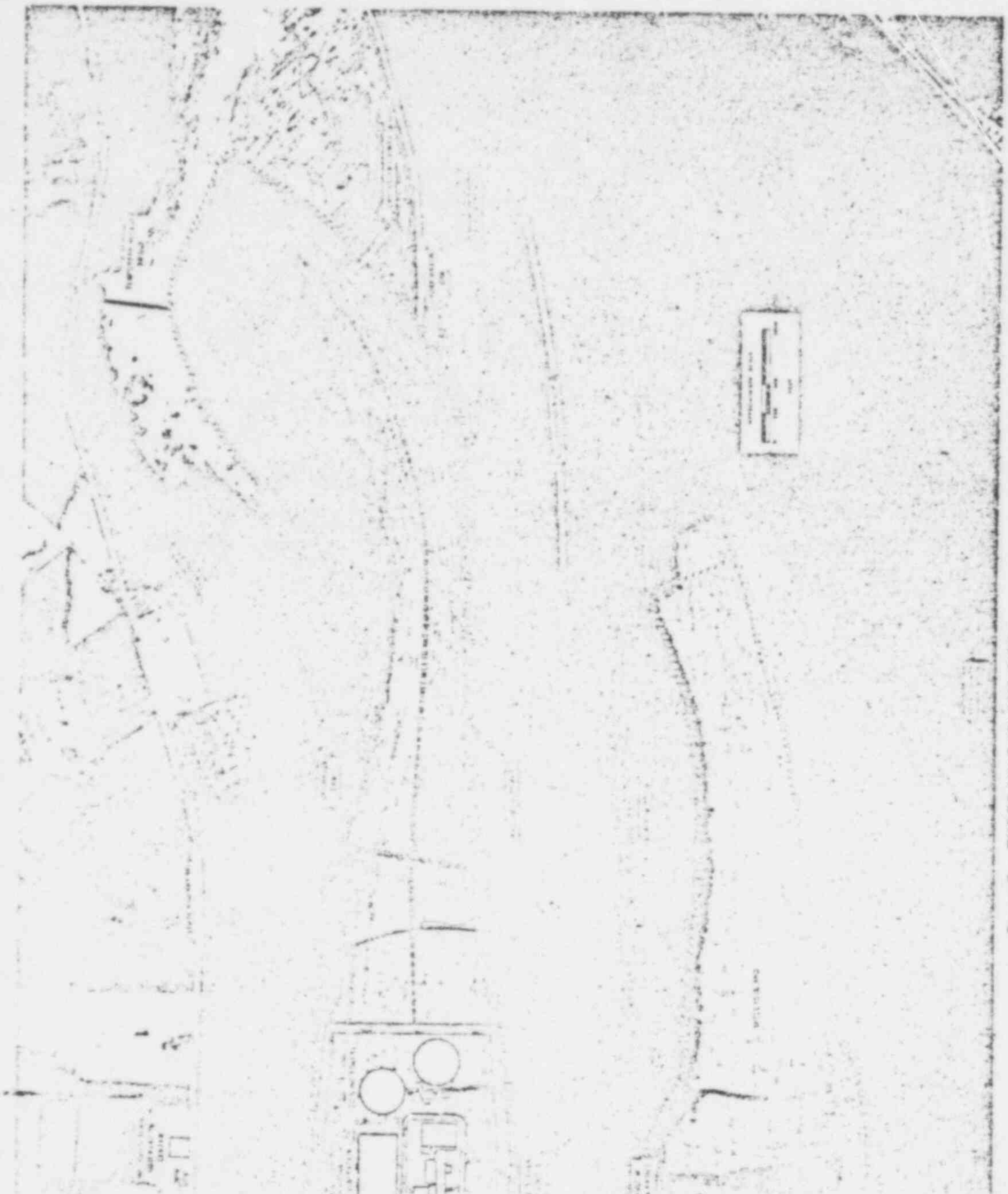

Figure 3 – THREE MILE ISLAND SITE

C. REGIONAL DEMOGRAPHY AND LAND USE

The location of the Station with respect to nearby counties and municipalities is shown in the map of Figure 1. The highest density of population in Dauphin County, where the Station is situated, is northwest of TMI and includes Harrisburg and the adjacent municipalities along the east bank of the Susquehanna River, i.e., Steelton, Highspire, Middletown and Royalton (Table 2).

Goldsboro, with 576 people, is the municipality closest to the Station (about 1 mile) and is located directly opposite TMI on the west shore of the Susquehanna. In 1970 the total population within 20 miles of the Station was about 621,000.

Land throughout the area is used primarily for dairy farming, poultry farming, and for growing tobacco, vegetables, fruit, alfalfa, corn and wheat. About 75% of Dauphin, York, and Lancaster counties is either farmland or forest and woodland, with the major forest and woodland areas located in the mountain range in the north region of Dauphin County. About 50% of the land in the three-county area is used for crops and about 8% for dairy farming.

The largest employer in the area is the Commonwealth of Pennsylvania. Harrisburg is the State capital and is thus the location of the legislature and executive branches of State government. Most of the administrative and regulatory agencies have their main offices within the City of Harrisburg. Industrial employers in the area manufacture a wide range of products consisting of leather goods, clothing, food products and candy, shoes, and chemicals. Other major industrial activities nearby are a Bethlehem Steel pipe fabrication plant at Steelton and a Bethlehem Steel plant at Lebanon, Pennsylvania.

There are two airports in the immediate vicinity of the Station; Harrisburg International (formerly Olmsted State Airport) and Harrisburg-York Airport. The former handles primarily commercial and the latter primarily light aircraft. In terms of passengers served, Harrisburg International is the third largest airport in Pennsylvania, and the area it serves extends beyond the six-county region centered around the Station. The average scheduled departures for 1971 are about 33 per day, or about 66 je airplane landings and takeoffs per day. Present indications are that this airport's operations will grow rapidly within the next 5 to 10 years. Lancaster Airport also serves scheduled airlines, but its primary function is to provide connections to Harrisburg and Baltimore. The stimuli for growth of Harrisburg International are (1 the proposed introduction of international flight operations and (2) the limitations on scheduled operations at Lancaster Airport.

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Table 2

1970 Populations and Growth Since 1960

of Municipalities Within 10-Mile Radius of the Station

Municipality	County	1970 Population	1960-1970, % Change	Distance from TMI (Miles)
Goldsboro	York	576	+6.3	1
Royalton	Dauphin	1,040	-7.8	2
Middletown	"	9,080	-18.8	2-1/2
Highspire	"	2,947	-1.7	4
Yorkhaven	York	671	-8.8	4
Elizabethtown	Lancaster	8,072	+19.1	6
Manchester	York	2,391	+64.4	6-1/2
Steelton	Dauphin	8,555	-24.1	7
New Cumberland	Cumberland	9,803	+5.9	9
Harrisburg	Dauphin	68,061	-14.6	9
Hummelstown	"	4,723	+5.6	9
Hershey	"	7,407	+8.1	10

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Under grants from the Federal Housing and Urban Development Agency (HUD) the counties in the area surrounding the Station have recently developed comprehensive land use plans that are intended as guides for the establishment of local zoning codes.

D. HISTORICAL SIGNIFICANCE

There are no historic structures on the site. The National Register of Historic Places[8] was consulted and the nearest one listed was the Walnut Street Bridge in Harrisburg, about 11 miles from the Station. Also listed was the Cornwall Iron Furnace in Lebanon County, 17 miles from the site and Billmeyer House in York, about 14 miles from the site. St. Peter's Evangelical Lutheran Church in Middletown about 3 miles north of the site and a cemetery slightly further away bear historic markers and are candidates for inclusion in the National Register. A representative of the Pennsylvania Historical and Museum Commission, with concern for historic sites not listed in the National Register, indicated no knowledge of other sites.

Since the island was formed by deposition of materials washed down the river over many years, it is not a unique source of fossil deposits, but it does have some archaeological interest. Susquehannock Indians once lived nearby in a large town, Sasquesahanaugh, on the east side of the Susquehanna River at Washington Boro, downstream from TMI. Their influence extended over a large area.

Construction of the plant provided both the incentive and the means to carry out limited archaeological excavations that might not have been undertaken otherwise. The Applicants provided a $2,500 grant to help finance the work which was carried out by scientists of the Pennsylvania Historical and Museum Commission during the latter part of 1967. As many as possible of the known areas of prehistoric occupation on TMI were excavated. Over a thousand artifacts, projectile points, knives, drills, scrapers, and pieces of broken pottery were found. From these artifacts it was deduced that the site had an Archaic Period component, dating about 4000 B.C. to 1500 B.C., Early and Middle Woodland cultures of about 1000 B.C. to 1000 A.D., and a minor Late Woodland period of occupation (post 1000 A.D.). The most important artifacts were from the Early and Middle Woodland cultures, because these are poorly known eras of Pennsylvania prehistory.

Although the finds were important additions to understanding the way of life of an early people, they were not as useful as they might have been if the site had not been disturbed in the past by flooding and cultivation, which mixes artifacts of one culture with another.

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E. ENVIRONMENTAL FEATURES

TMI was formed by deposition of materials carried by the river. Boulders, probably the nucleus for formation of the island, are present in the soil at the north end of the island.

1. River Characteristics

The drainage area of the Susquehanna River above the Station is estimated to be 25,000 square miles. The Susquehanna collects surface runoff and ground water seepage, as well as their respective contaminants, from a total watershed of approximately 27,400 square miles of which 21,000 lie within Pennsylvania. A summary of the characteristics of the main tributaries in the vicinity of the Station is given in Table 3.

Table 3. Characteristics of Streams in the Vicinity of the Station

Stream	Drainage Area	Average Rate of Flow (cfs)
Conoduguinet Creek	483 sq. mi.	580
Yellow Breeches Creek	227 sq. mi.	285
Swatara Creek	567 sq. mi.	940
West Conewago	510 sq. mi.	560

The Juniata River enters the Susquehanna River about 25 miles upstream from the site. Its drainage area is about 3,426 sq. mi. and its average flow rate is 4,320 cfs.

The Susquehanna River is rather extreme in the variability of its flow characteristics as shown by the following summary of data recorded at Harrisburg over the period 1891-1965:

Minimum flow (Sept. 28, 1964)	1,700 cfs
Median annual flow	20,000 cfs
Average flow	34,000 cfs
Mean annual flood	300,000 cfs
Maximum flood (March 19, 1936)	740,000 cfs

Additional data on the seasonal flow variation of the river are given in Figure 4. The data show mean monthly flows for recurrence intervals of 2, 5, 10, 20 and 50 years. It will be noted that characteristically the low flows occur in the late summer and fall and that the minimum monthly flow of record, in general, follows the 50-year curve.

On June 24, 1972 rains from tropical storm Agnes resulted in a flood volume of 1,000,000 cfs, considerably in excess of the maximum recorded in the 1891-1965 period but below the probable maximum flood for the TMI location.

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The average river level of 278 ft.* is about 25 ft. below the highest point on the island. Because of the danger of flooding, therefore, dikes have been constructed around the perimeter of the north end of the island.

The Station is to be protected from floods up to those with flow rates of 1,100,000 cfs by an extensive dike system around the northern part of the island. The northern or upstream portion of the dike was completed prior to the June 24, 1972 flood, but had not been completed on the downstream or southern portion of the island. The June 1972 flood, as a result of the presence of only a partial dike around the plant, flooded the westerly portion of the Station construction area around the four cooling towers by backing in through downstream uncompleted dike areas. For floods greater than the dike design flood and up to the probable maximum flood (1,645,000 cfs), the Station is designed to be shut down, waterproofed, and the dike is designed to allow water to back into the plant area from the downstream southern end of the island. The PMF (probable maximum flood) is based on the maximization of numerous hydro-meteorological parameters, of which storm precipitation and its time and space distribution are only a few. Comparison of the Agnes precipitation with similar data used in the PMF determination indicates no need for modification of extreme precipitation estimates and, therefore, no need to modify PMF runoff estimates accordingly.

Preliminary high water data from the June 1972 flood in the site vicinity have been reviewed to determine the adequacy of coefficients used to determine both the dike design water surface profile, and the PMF water surf :e used to assure that water will back into the plant area (rather than overtop the dike upstream). In both cases, it is concluded that conservative coefficients have been selected and the flood design bases for the plant are conservative. For instance, the Agnes water level at the intake structure was approximately elevation 300.0 ft. MSL, while the computed level is about elevation 302 ft. MSL.

During FSAR review of the plant the adequacy of riprap protection for the levee, and general maintenance of flood protection, was reviewed extensively. Inspection of the levee after the June 1972 flood indicated that although the riprap in place at the time appeared generally adequate, periodic maintenance of both the rock and the earth levee should indeed be undertaken at the intervals proposed by the Applicants (annually and after every major flood). It was noted that removal of riprap fines by floods, and extensive vegetative growth in the levee as now exists, could reduce flood control effectiveness.

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*Elevations are above mean sea level (MSL).

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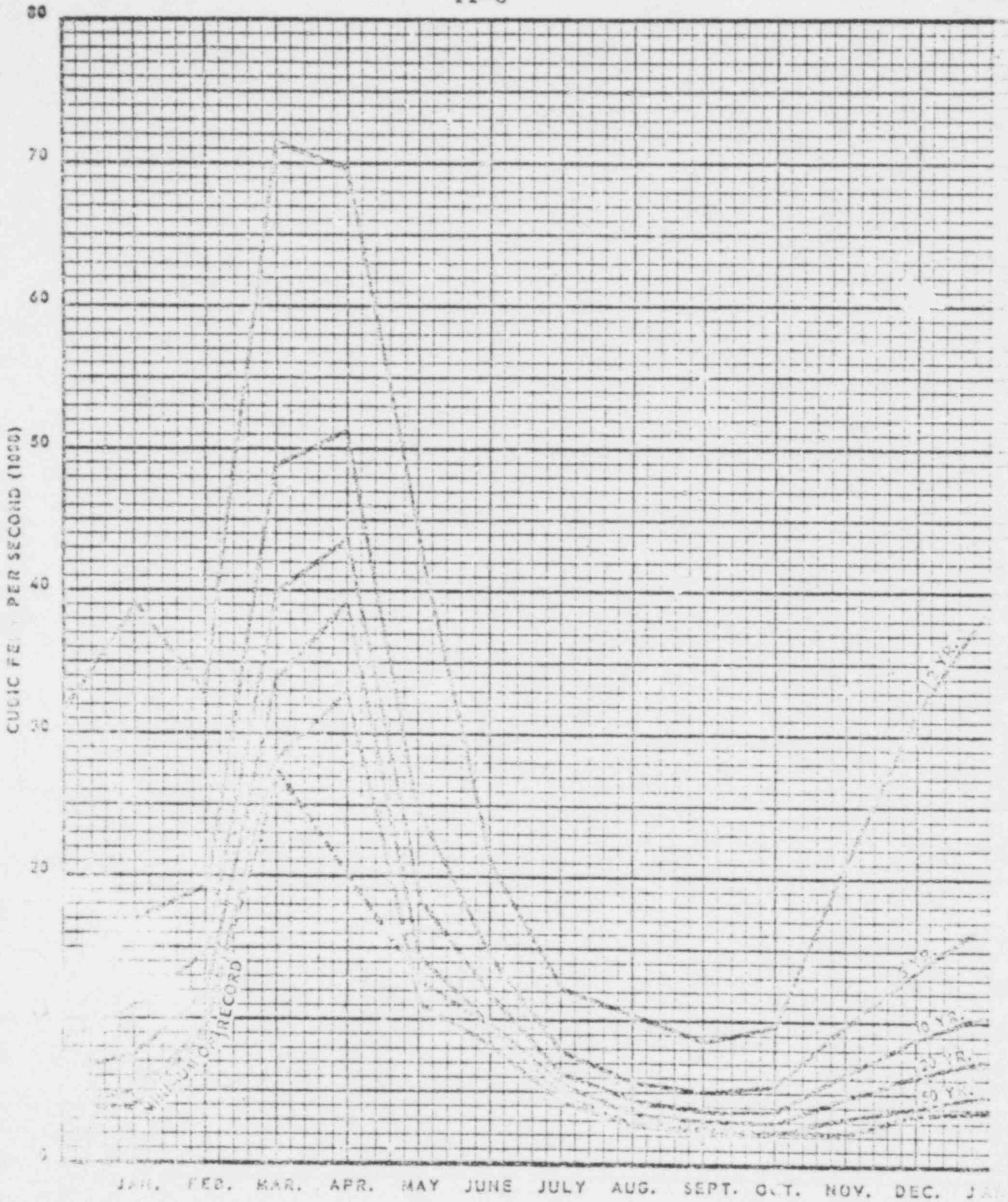

Figure 4 - SUSQUEHANNA RIVER AT HARRISBURG MEAN MONTHLY LOW FLOW SUMMARY

The hypothetical PMF is considered the upper limit of potential flooding at a particular site. The staff does not consider larger floods credible and, therefore, does not require the design of nuclear facilities for more severe events. It is concluded that the flood design bases for TMI have been conservatively estimated as a result of a review of the record June 1972 floods on the Susquehanna River.

A pumped storage facility consisting of two reservoirs and dams is proposed for completion in 1983-84 on Stony Creek, approximately 13 miles northeast of Harrisburg and upstream of TMI. Detailed design data are not yet available for the project. Since the Federal Power Commission has the responsibility to insure the safety of all facilities downstream of the pumped storage project, it should not affect TMI.

The river and the streams in the vicinity are presently used for water supplies, both public and industrial, power generation, boating, fishing, and recreation. Sport fishing is done in all streams in the general area of the site; however, there is no commercial fishing.

2. Groundwater

Groundwater occurs at TMI under water table conditions. The water table reaches its maximum elevation at the highest topographic point in the center of the island and falls off toward both shores. A variation of about 5 ft. occurs from either side to the center, producing a gradient of approximately 0.6 percent toward the river. At observation points in and surrounding the plant area, water levels occurred generally at a depth in excess of 15 ft. and ranged from 14 to 19 ft. The groundwater level occurred at a maximum of 6.2 ft. above the top of rocks with less than 1 foot of head existing above the soil-rock interface at one point of observation. The water level of the Susquehanna River, normally flowing at elevation 278 ft., controls TMI groundwater levels. Since a positive head exists on the island, any movement of groundwater from the Station site would be toward the river, and would eventually enter the stream. The river would act as a natural boundary; the dispersal of island groundwater would be limited to the river.

The bedrock underlying the general area, Gettysburg shale of Triassic Age, is composed of shales, sandstones, and siltstones. The sandstones are normally the best aquifers, although relatively high yields may also be obtained in jointed or fractured shale. Alluvial deposits are not believed to be a major source of groundwater in the region. Infiltration of contaminated groundwater from the Station into the underlying Gettysburg shale and transmission to onshore water supplies is unlikely, since a maximum head of six feet exists above the impervious (relative to soils) Gettysburg formation, and groundwater levels are higher on either river shore than on the island, with hydraulic gradients sloping toward the river. Surface and aerial examinations have revealed no geologic faults in the area that might facilitate infiltration of groundwater into an aquifer.

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3. Meteorology

General climatic conditions in the site region are characterized by a continental type climate, modified and protected somewhat from more severe weather by the Appalachian Mountain Range to the north. Summers tend to be warm and humid, and winters are cool, with frequent periods of precipitation.

An on-site meteorological data collection program has been in operation at the Station since May 1967. Wind speed and direction have been continuously recorded 100 ft. above grade on TMI and 2-1/2 miles north 25 ft. above grade at Crawford Station. A two-year period of record has been analyzed, ending in May 1969, to provide a basis for evaluation of routine radioactive gas release limits.

In more than seventy-five years of record at the U. S. Weather Bureau in Harrisburg, the highest and lowest temperatures recorded were 104° and -14°F. Maximum monthly rainfall was 18.55 in.; maximum 24-hour rainfall 12.55 in., and maximum 24-hour snowfall 21.0 in. Maximum snow accumulation was 81.3 in. Average annual rainfall is 40 in.

During the 92-year period 1871 through 1963, thirty-three hurricane or tropical storm center paths passed within about 100 miles of the site. Most of these were in dissipation stages. The most severe was "Hazel", the center of which passed just west of Harrisburg on October 15, 1954. A peak gust of 80 miles per hour was recorded at the Harrisburg-York Airport during the passage of "Hazel". Winds from hurricane Agnes in 1972 did not exceed these values.

4. Geology

The TMI site lies within the Gettysburg Basin section of the physiographic division known as the Piedmont Province. The topography of the area immediately surrounding TMI is of slightly undulating nature with maximum relief of about 200 ft. and highest elevation seldom above 500 ft. From the east, drainage is largely represented by the southwesterly flowing Swatara Creek, which has its mouth near Middletown, and by the more westerly flowing Conewago Creek, which empties into the Susquehanna River at the south end of TMI. Fishing Creek flows into the Susquehanna west of the site, and the northwesterly flowing Conewago Creek terminates at York Haven. TMI has very little relief, with elevations ranging from about 280 ft. at the water's edge to slightly more than 300 ft. in the north-central portion.

The site is located in the Triassic lowland of Pennsylvania, one of a series of long narrow basins of Triassic deposits which extend in broken patches from Connecticut to North Carolina. The Triassic lowland in the vicinity of the site is referred to as the Gettysburg Basin. North and west of the Triassic lowland are the folded and thrust faulted Paleozoic rocks which comprise the Appalachian Mountains. Southeast of the Triassic lowland is the Piedmont, of Pre-Cambrian and Early Paleozic Age, composed of granites, gneisses, and schists.

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The site is underlaid by the sedimentary rocks of the Gettysburg shale. The bedrock surface, at the site, is essentially flat and lies at approximately elevation 277 ft. One to three feet of weathered rock occurs at the overburden-bedrock interface. No evidence of faulting transects the island as seen in the field from available rock exposures along the east bank of the river, or along the western periphery of the island. Aerial photographs as well give no suggestion of faulting through the island. A comprehensive evaluation of major tectonic elements in south central Pennsylvania has been prepared. It is concluded that the site is not deleteriously affected by faulting, and further, that regional tectonic elements are inactive and present no threat to the structural integrity of the local geology.

The island, as a whole, is composed of fluvially stratified sand and gravel containing varying amounts of silt, clay, and clean sand. Density values range from loose to very dense, as established by Standard Penetration Tests. Boulders are present at depth and are mainly confined to the lower portions of the soil zone on the north end of the island. Soil depths vary from approximately 6 feet at the south end of the island to a maximum of 30.0 feet near the axial intersection of the island. Depth of soil is relatively constant at about 20 feet in the vicinity of the plant site. From one-half to one foot of topsoil, composed of sandy silt with much organic material, covers the island.

F. <u>ECOLOGY OF THE SITE AND ENVIRONS</u>

Terrestrial communities are essentially those of the flood plain sere; aquatic habitats are those of a warm water stream - falls, riffles, ponds, or mud-bottom pools. Somewhat less than half of the area within a 1.5 mile radius of the Station is aquatic, the rest terrestrial. Of the terrestrial habitat, about two-thirds is farm land devoted to the production of dairy or poultry products, vegetables, fruits, alfalfa, corn, wheat or tobacco. The combination of wooded and farmed area forms a forest edge community.

1. <u>Terrestrial</u>

a. <u>Flora</u> - Dominant vegetation on the east shore of the river near the Visitors Center consists of the following species:

Ash (white)
Ailanthus (some 24" diameter)
Basswood
Black locust (common)
Black oak
Black walnut (18" diameter few)
Box elder
Cherry (black)
Elm (American)
Hackberry
Mulberry
Poison ivy (luxuriant)
Poplar (cottonwood)
Pokeberry
Silver maple
Sugar maple
Sumac
Sycamore
Wild grape

The composition of the forest indicates a stage in succession of a flood plain sere between the cottonwood-willow and oak-hickory stages. Estimated age for a plant community of this type is somewhat less than 80 years.[2] The Applicants have provided a floristic analysis of Three Mile Island.[1]

b. Fauna - Most game animals of interest to the sportsman belong to the forest edge. Species found on the island were the cottontail rabbit, fox squirrel, deer, bobwhite, pheasant, and dove. Pheasant were especially abundant. They feed upon waste grains, weed seeds, insects (including grasshoppers, Japanese beetles, and corn borers), fruits of shrubs and vines, various greens derived from native plants, and farm crops such as clover.

The Applicants have provided a faunistic list of the terrestrial fauna of Three Mile Island.[1] This list includes several bird species which are endangered,[2] namely the peregrine falcon and the bald eagle. However, the Pennsylvania Game Commission[3] has indicated that the peregrine probably no longer occurs in the state and that the bald eagle is occasionally seen, but probably does not breed along the Susquehanna. The osprey, another species causing some concern, is described as unusual, but not rare in the state; a single individual was recently seen in the Harrisburg area. Because the latter two species are only rare transients in the area, plant construction and operation should not further endanger them.

2. Aquatic

The aquatic habitat in the vicinity of TMI is primarily of interest as a fishery. The area may be subdivided into three areas on the basis of their importance as fisheries.

Area 1: The reservoir above York Haven dam between the island and the east bank of the river is not fished very much, except in the fall when smallmouth bass may be caught. As a stream habitat it is a mud-bottom pool.

Area 2: The area southwest of TMI just above the dam, also a mud-bottom pool, is most popular, with muskellunge, smallmouth, and largemouth bass, redbreast sunfish, and rock bass being taken. Rock bass and redbreast sunfish predominate.

Area 3: The area below the falls on the east shore near Falmouth is popular for muskellunge during the winter. It is a pool at the end of a rifle habitat.

The area below the TMI impoundment is more popular as a fishery than the TMI impoundment because of easier access. Downstream, the area below the Brunner Island fossil fuel power station provides good year-around fishing.

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The quantity, quality, and variety of fish in a stream are indicators of the ecological balance of the stream and the quality of the water. The Applicants have contracted for fish population studies to be carried out: 1) to describe the present fish population of the river in the vicinity of TMI, 2) to detect any changes in this population after the Station goes into operation, and 3) if such changes do occur, to determine whether they were caused by the Station. The species composition of fish in the local waters as reported by the Applicants (Appendix A) suggests a healthy warm water river community containing several game species, as well as coarse fish such as carp.

Analysis of benthic invertebrates by C. B. Wurtz,[4] consultant to the Applicants, indicates a diverse and stable community. The number of species varied between 79 and 145 in the study years from 1967 to 1970, and were distributed among the major taxonomic groups expected in such a habitat. A species list with distribution by sampling station is available in the cited literature. A decline in species abundance occurred during these studies, which apparently reached maximum in 1969 although later analysis indicates recovery is taking place. Wurtz suggests[4] that: "There are strong indications that a toxicant has been introduced into the river from above the study area." Since the Susquehanna at this point lies below areas of intensive agricultural, urban, and industrial development, such degradation is not surprising. The maintenance of an aquatic community which is capable of recovering after stress provides additional evidence of the basic health of the community. The observation of such a substantial change in the benthos over a several year period will be important in interpreting Station operating effects on the stream biota.

The Applicants have provided[1] a list of aquatic plant species; they are what one would expect in this environment.

No information has been provided about diatoms, protozoa, or other physically small organisms in the areas likely to be affected by Station operations. However, because of the interrelated nature of natural community dynamics, observation of some portions of that ecosystem will provide information on the functioning and organization of the entire community.[5]

Reptile and amphibia species known to be in the area are also provided by the Applicants.[1] The only species of note is the bog turtle, Clemmys muhlenbergii, which is described as "known to be in the area." Its habitat requirements are described[6] as "partial to sphagnum bogs and clear meadow streams." It is doubtful that any suitable habitat was disturbed by transmission line routing does not appear to have been investigated by the Applicants. While this species is not formally listed as endangered at this time, its status is of some concern to the U.S. Department of Interior.[7]

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REFERENCES FOR SECTION II

1. Environmental Report, Operating License Stage, Three Mile Island Nuclear Station Unit 1 and 2, Metropolitan Edison Company, Jersey Central Power and Light Company, October 1971.

2. Endangered Species of the United States, U. S. Department of the Interior, 1970.

3. Personal Communication, Ronald Sutherland, October 19, 1972.

4. Wurtz, C. B., Progress Reports on a Biological Survey of the Susquehanna River in the Vicinity of York Haven, Pennsylvania, 1967, 1969, 1970.

5. Kaesler, R. L. and Cairns, J., "Cluster Analysis of Data from Limnological Surveys of the Upper Potomac River," American Midland Naturalist, 88, 1, (1972).

6. Netting and Richmond, Pennsylvania Reptiles and Amphibians, Pennsylvania Fish Commission Booklet, (1950).

7. Personal Communication, Earl Baysinger, U. S. Department of Interior, October 19, 1972.

8. U. S. Department of Interior, National Register of Historic Places, Federal Register 37(51), as amended, Federal Register 37(129), 1972.

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III. THE PLANT

A. EXTERNAL APPEARANCE

An indication of the functional design and external appearance of the finished Station is given by the architectural rendering presented in Fig. 5. A detailed plant layout is presented in Fig. 6. Certain buildings for each unit are designed to withstand direct impact of a jet aircraft (class I structures). They are the reactor building, auxiliary building, fuel handling building, control building, diesel generator building, intake screen and pump house, heat exchanger vault and the air intake structure. The turbine buildings, cooling towers, and service building are not designed to withstand aircraft impact (class III structures).

The most conspicuous structures on the site are the four 370 ft. high, hyperbolic, natural draft cooling towers. The towers are made of reinforced concrete and are left with a natural concrete finish. They are shown in Fig. 7, a photograph of the site taken during construction in August 1971. The two finished towers for Unit 1 are to the left. The nighttime lighting of the towers consists of four flashing red lights at the top and four steady red lights at the midpoint. The Unit 1 containment building and partially completed fuel handling and control buildings are in front of the turbine building at the left center. The partially completed containment building for Unit 2 is to the right of Unit 1 and the partially constructed forced draft cooling towers for Unit 2 are located to the right. Highway 441 is visible in the background.

Also shown in the photograph is the flood protection dike which is being built between the main plant area and the river at the upstream end of the island. The dike is an earth embankment constructed of clay and silt that has been compacted to produce a stable and relatively impervious wall. The dike exterior is protected from erosion by a layer of stone riprap on top of a laye f gravel and sand that is embedded in the clay.

Altho   all the major Station structures can be seen from the balcony of the V s ors Center, the dense foliage along the river screens all but the cooling towers from the view of the observer on the highway. From the river bank the tops of the major structures are visible, but most of the structures at and slightly above grade level are not.

The Applicants have plans for landscaping upon completion of construction. Because most of the site at grade level cann t be seen from the surrounding areas, this will probably not have an appreciable effect on the appearance of the Station to its neighbors.

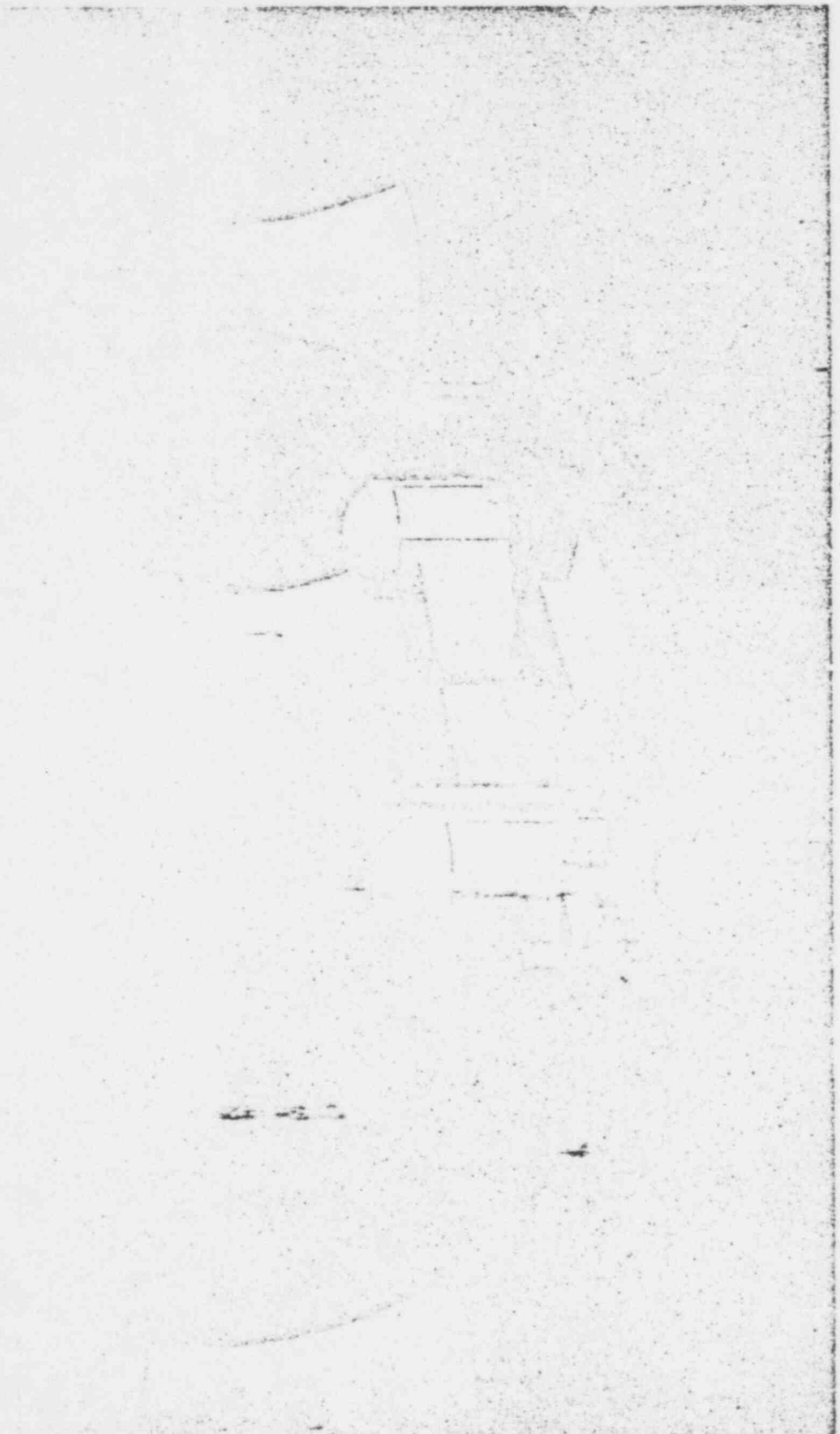

Figure 5 – ARCHITECTURAL RENDERING – THREE MILE ISLAND NUCLEAR STATION

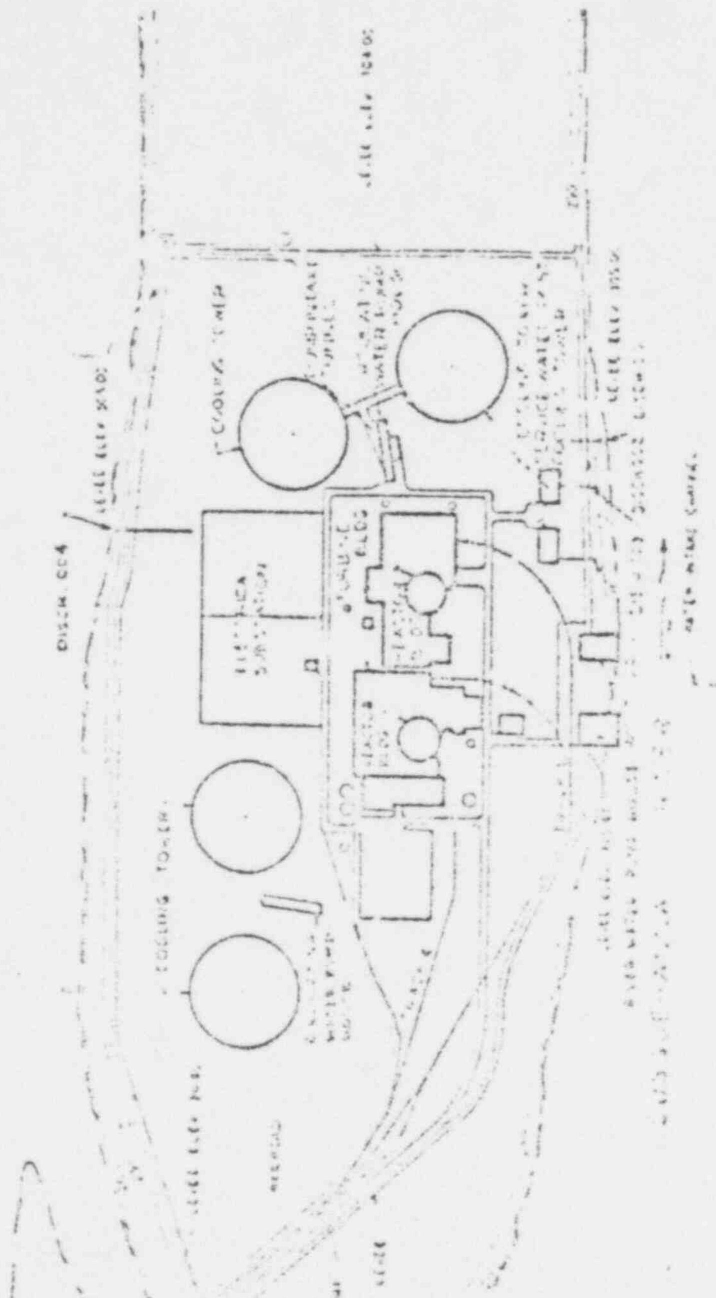

Figure 6 - THREE MILE ISLAND NUCLEAR STATION - PLOT PLAN

Figure 7 – VIEW OF STATION DURING CONSTRUCTION

B. TRANSMISSION LINES

Unit 1 generates electric power, at 19 kilovolts, which is fed through an isolated bus phase to the unit main transformer bank where it is stepped up to 230 kV transmission voltage and delivered to the substation. In the case of Unit 2, the power is to be fed through the main transformer bank, where it is stepped up to 500 kV transmission voltage and delivered to the substation. Unit 1 is connected to the Met-Ed 230 kV transmission network by two lines, each 1.4 miles long, from the site to Middletown junction, and a 4.1 mile line, which connects to an existing line to Cly. In summary, for Unit 1 approximately 7 miles of 230 kV line have been constructed. All of the new circuits are installed on double circuit 230 kV lattice-type combination steel/aluminum towers except for two structures which are modified Dreyfus designed steel pole-type structures. The towers range in height from 66 ft. to 175 ft. and are approximately 35 ft. square at the base. There are about six structures per mile and the right of way for all the 230 kV line construction is 150 ft. wide.

Unit 2 will be tied into the existing Met-Ed 500 kV transmission network by a 0.7 mile line to the new TMI substation located east of the visitors center. From the substation, two 500 kV lines will extend on diverging paths to the existing Peach Bottom-Juniata 500 kV line. One connection is 7.1 miles long and the second is 11.1 miles long. This second line is to be constructed, owned, and operated by Pennsylvania Power and Light Company, which is not a GPU Company and which is not involved in the construction or operation of the Three Mile Island Nuclear Generating Station. When these lines are installed, the 500 kV tie between Peach Bottom and Juniata will be made at the TMI substation. In addition to this, clearing has been completed and construction is underway on a 67.3 mile, 500 kV line from the new substation east to Bechtelsville. Thus, for Unit 2, a total of 74.4 miles of new 500 kV line will be constructed. These circuits will be installed on single circuit 500 kV lattice-type all steel or combination steel/aluminum towers. The towers range in height from 87 to 177 ft. and the base dimensions vary from 10 ft. 7 in. x 24 ft. 9 in. to 64 ft. square. There are about 4.5 towers per mile and the right of way for all the 500 kV line construction is 200 ft. wide.

The original plans for Unit 2 called for a 230 KV transmission system. However, studies carried out by the Mid-Atlantic Area Coordination Committee (MAAC) on the transmission facilities of the Pennsylvania - New Jersey - Maryland (PJM) interconnection, indicated the need for a third west to east 500 KV transmission line east of the Susquehanna irrespective of the TMI project. There are already two west to east 500 KV lines west of the Susquehanna. As a result, the transmission lines for Unit 2 were designed at 500 KV for a dual purpose: to transmit energy from Unit 2 and to serve as part of the third west-east link.

The 500 KV line from TMI 500 KV Substation to Bechtelsville, together with the extension of that line by other PJM companies to Souderton, Pennsylvania (a point on the Whitpain - Branchburg 500 KV line) and the looping of the Juniata - Peach Bottom 500 KV line to the TMI 500 KV Substation would provide the third west-east line. All these segments are necessary for the third west-east line to exist.

Routing and clearing for the transmission lines has, wherever practicable, followed the recommendations incorporated in the U. S. Departments of Agriculture and Interior's booklet, "Environmental Criteria for Electric Transmission Systems".

Permits have been obtained from the U.S. Army Corps of Engineers and the Pennsylvania Department of Environmental Resources for the Susquehanna River crossings where necessary. The Pennsylvania Department of Transportation and the Pennsylvania Turnpike Commission will be requested to grant permits for road crossings. The Federal Aviation Administration has approved an application to construct the lines in the vicinity of the Harrisburg International Airport.

C. REACTOR AND STEAM ELECTRIC SYSTEM

The two reactors for the TMI Station are pressurized-water type supplied by the Babcock and Wilcox Company. Unit 1 has a thermal rating of 2535 megawatts corresponding to a gross output of 871 MWe, while Unit 2 has a thermal rating of 2772 MW corresponding to a gross output of 959 MWe. Since the details of the two cores are essentially the same, the following description applies to both Units 1 and 2. The nominal operating pressure for the reactor is 2155 psig with an average coolant temperature of 579°F. The reactor coolant system is designed for a pressure of 2500 psig at a temperature of 650°F.

The core reactivity is controlled by a combination of 69 movable control rod assemblies and a neutron absorber (boric acid) dissolved in the coolant. The control rods are silver-indium-cadmium alloy encapsulated in stainless steel. The control rods are used for short-term reactivity control associated with the changes in power level and also with changes in fuel burnup between periodic adjustments of dissolved boron concentrations. The reactor can be shut down by the movable control rods from any power level at any time. Each movable control rod assembly contains 16 control pins and is actuated by a separate control rod drive mechanism mounted above the reactor vessel. On receiving a trip signal the 69 control rod assemblies fall into the core by gravity.

Two outlet coolant loops are connected to the reactor vessel by nozzles located near the top of the vessel. Each loop contains one steam generator, two coolant pumps, and the interconnecting piping. Reactor coolant is pumped

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from the reactor through each steam generator and back to the reactor inlet via two parallel loops by two centrifugal pumps located at the outlet of each steam generator.

The steam generator is a vertical straight tube and shell heat exchanger which produces superheated steam at constant pressure over the reactor operating power range. Reactor coolant flows downward through the tubes and steam is generated on the shell side.

For Unit 1 the steam flows from the steam generator to an 1800 rpm, tandem compound, six-flow steam turbine generator manufactured by General Electric. The turbine generator for Unit 2 is a tandem compound machine, 1800 rpm, with reheat and four-flow exhaust manufactured by Westinghouse.

The following organizations have been engaged by the Applicants as principal contractors for construction of the Station:

Gilbert Associates, Inc., Architect-Engineer, Unit 1 and Burns and Roe, Inc., Architect-Engineer, Unit 2 -- authorized to design and engineer the entire nuclear power generating station, excluding the nuclear steam supply system, which will be designed by Babcock and Wilcox for the Applicants.

Babcock and Wilcox, Reactor Vendor -- authorized to design, build, and deliver the necessary components for the nuclear steam supply system.

United Engineers and Constructors, Inc., Construction Contractor-- authorized to manage the construction of the Station to the specifications established by the Applicants, Gilbert Associates, Inc., Burns and Roe, Inc., and Babcock and Wilcox. Authorized to procure material and engage subcontractors for construction.

Pickard and Lowe, Consultants-- consult on general nuclear and environmental engineering matters.

The Applicants' project manager is responsible for coordination of the activities of the foregoing named principal contractors.

D. EFFLUENT SYSTEMS

1. Heat

The Station utilizes four hyperbolic natural draft cooling towers for dissipating the heat rejected from the plant steam cycle. Virtually all the heat from the turbine exhaust condensers is dissipated to the atmosphere through these towers. In addition to this major heat load there are several other cooling systems which dissipate heat from other portions of the plant. These include

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the secondary services cooling system, the nuclear services cooling system, and the decay-heat cooling system. A flow diagram of the Station cooling system showing the flow balance for both units is shown in Fig. 8.

Makeup for cooling tower evaporation, drift, and blowdown is obtained from the secondary services river water pumping system. After passing through the secondary services heat exchangers, water is mixed with circulating water in the cooling tower open flume. The maximum makeup flow is approximately 27,000 gal/min. which includes the approximately 20,000 gal/min. (44 cfs) evaporated by the four cooling towers and a minimum of 4,000 gal/min. blowdown from the cooling tower basins. The cooling tower water pump building is located between the condensers (in turbine building) and the cooling towers; it contains six circulating water pumps arranged so that three pump through each of two 103 in. diameter mains. The secondary services heat exchangers, located in the turbine buildings, cool equipment such as air compressors, lube oil coolers, sample coolers, heater drain pumps, hydrogen coolers, etc.

A flow of river water is also provided for the nuclear services heat exchangers, located in an underground vault next to the auxiliary building. These heat exchangers are used for decay heat removal from Unit 2 and for cooling nuclear equipment, such as reactor coolant pump motors, reactor building cooling units, fan motors, the spent fuel pool cooler, evaporator distillate cooler, waste gas compressors, etc. The river water used for cooling the nuclear services heat exchangers, along with the excess secondary system heat exchanger water and the condenser cooling circuit blowdown, is passed through a forced draft cooling tower before being returned to the Susquehanna River.

The Unit 1 decay heat removal system removes decay heat from the core and sensible heat from the reactor cooling system during the latter stages of a cooldown. The system also provides an auxiliary spray to the pressurizer for complete depressurization, maintains the reactor coolant temperature during refueling, and provides a means for filling and draining the fuel transport canal In the event that the forced draft tower freezes up, the decay heat services cooling for both Units can be maintained by passing cooling water directly through the tower basin.

The river water, upon entering the intake structures, passes under a skimmer wall, through automated trash racks with 1 inch vertical bar spacings, through traveling screens with 3/8 inch mesh, through the river water pumps, and finally through strainers of 1/8 inch mesh, before passing to the heat exchangers. The intake river-water structure is provided with a deicing water line. Under normal operation in sub-freezing weather, condenser circulating water discharge will be the source of deicing water. The flow velocity at the intake structure under normal and low river flows and normal operating conditions is 0.2 ft/sec.

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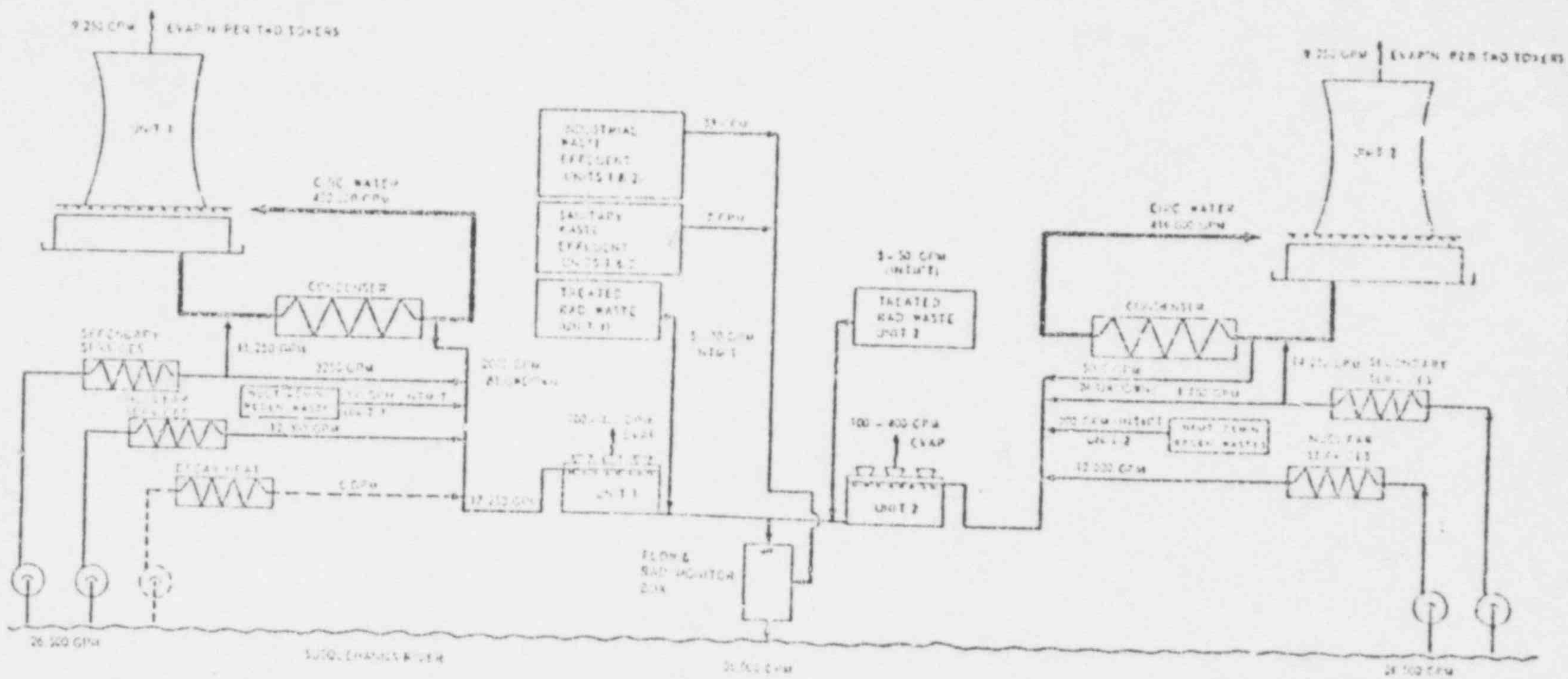

Figure 8 – WATER USE DIAGRAM, THREE MILE ISLAND NUCLEAR STATION

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The river pumping systems are designed to pump from a minimum river level ("loss of York Haven Dam") of 271 ft., from the normal level of 278 ft., and also from flood levels. They pump to a high point in the plant and drain by gravity through a double-ended 48-inch diameter discharge line through the forced draft cooling tower. The discharge flow rate from the tower basin is measured by a propeller meter. Flow rate and radiation level of the Station radioactive waste are measured and the effluent is then mixed with this discharge. The mixture passes 100 ft. to a weir box where the radiation level is monitored as it is discharged to the river. The cooling water is finally released through a 72 inch diameter pipe line that discharges directly into the river behind the natural shore line. Under normal conditions the pipe is half submerged and the nominal discharge velocity is 2.7 ft./sec. with a maximum value of 5.2 ft./sec.

The river water temperature at the intake structure varies from a minimum of 33°F in the winter to a maximum of 85°F in the summer. As stated, all of the cooling water effluent from the plant is passed through a forced draft cooling tower (one for each unit) prior to discharge to the river. tThe temperature rise (over river ambient) of the effluent from the forced draft cooling towers varies daily and seasonally because of changes in cooling tower operation dictated by varying ambient air and river water temperatures. In the summer the forced draft towers will be operated so that the discharge is at essentially the ambient river temperature during normal Station operation. During a reactor cooldown* in summer, the discharge could be 2°F higher than river ambient, but would never exceed 87°F.

In the winter, because of the necessity for operating the cooling towers in the "deicing mode" (wherein a curtain of hot water is passed around the outside of the cooling tower fill to prevent freeze up), the effluent will average 3°F above river ambient during normal plant operation, although this could be as high as 10°F during an extreme river/air temperature mismatch. During a reactor cooldown in winter the initial discharge will, on the average, be 12°F above ambient, but under extreme river/air temperature mismatch conditions it could be as high as 19°F. A typical cooldown transient is such that the initial 12°F temperature difference would decrease to about 2°F within 12 hours (~ 1°F/hr). Under the extreme temperature conditions, effluent temperatures would decrease at a rate of approximately 1.5°F/hr. Furthermore, the usual operational mode will be to shut down only one unit at a time and, therefore, the initial effluent temperature difference will be the average of 3°F and 12°F or about 8°F.

The transit time from the intake to the discharge through the secondary and nuclear service heat exchanger circuits is about 13 minutes and the temperature rise is 10 to 15°F. The residence time of the coolant in the large basins

*Cooling down of the reactor primary coolant loop by the nuclear decay heat system following a reactor shutdown.

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under the natural draft cooling towers (capacity 8×10^6 gallons) is approximately 70 minutes and the temperature rise in the condenser cooling circuits is 28°F.

The maximum consumption of river water when the two units are operating at full power is 20,800 gal/minute. This is evaporated from the four natural draft cooling towers, and the two small forced draft towers.

2. Radioactive Waste

In the operation of nuclear power reactors, radioactive material is produced by fission and by neutron activation reactions of metals and material in the reactor coolant system. Small amounts of gaseous and liquid radioactive wastes enter the effluent streams, which are monitored and processed within the Station to minimize the radioactive nuclides that will ultimately be released to the atmosphere and into the Susquehanna River at low concentrations under controlled conditions. The Limitations of 10 CFR Part 20 and the "As Low As Practicable" requirements of 10 CFR Part 50 with respect to radioactive releases will be met during the operation of the Station at full power.

The waste treatment systems for the Station, described in the following paragraphs, are designed to collect and process the gaseous, liquid, and solid waste which may contain radioactive materials. These waste handling and treatment systems are discussed in detail in the Final Safety Analysis Report for Unit 1 (March 2, 1970), in the Preliminary Safety Analysis Report for Unit 2 (March 1969), and in the Applicant's Revised Environmental Report dated December 1971.

a. Gaseous Waste. During power operation of the facilities, radioactive materials released to the atmosphere in gaseous effluents include low concentrations of fission product noble gases (krypton and xenon), halogens (mostly iodines), tritium contained in water vapor and particulate material including both fission products and activated corrosion products. The systems for the processing of radioactive gaseous waste and ventilation paths are shown schematically in Figures 9-11.

Concentrations of various solutes, such as hydrogen and boron, in the primary coolant are maintained at specified values, and the buildup of fission and activation products is limited by withdrawing coolant at a normal rate of 45 gpm (the letdown stream). A side stream from this coolant is cooled, depressurized, and diverted to the makeup and purification system and, as necessary, to the boron management system or the liquid waste disposal system, Figure 12. Normally, the vent valves on the makeup and purification system equipment are closed and the system is operated at positive pressure. By this procedure the inventories of noble gases in the coolant increase to steady-state values except in the case of long-lived krypton-85. Only the coolant that is diverted to the boron control system is normally degassed.

91 192

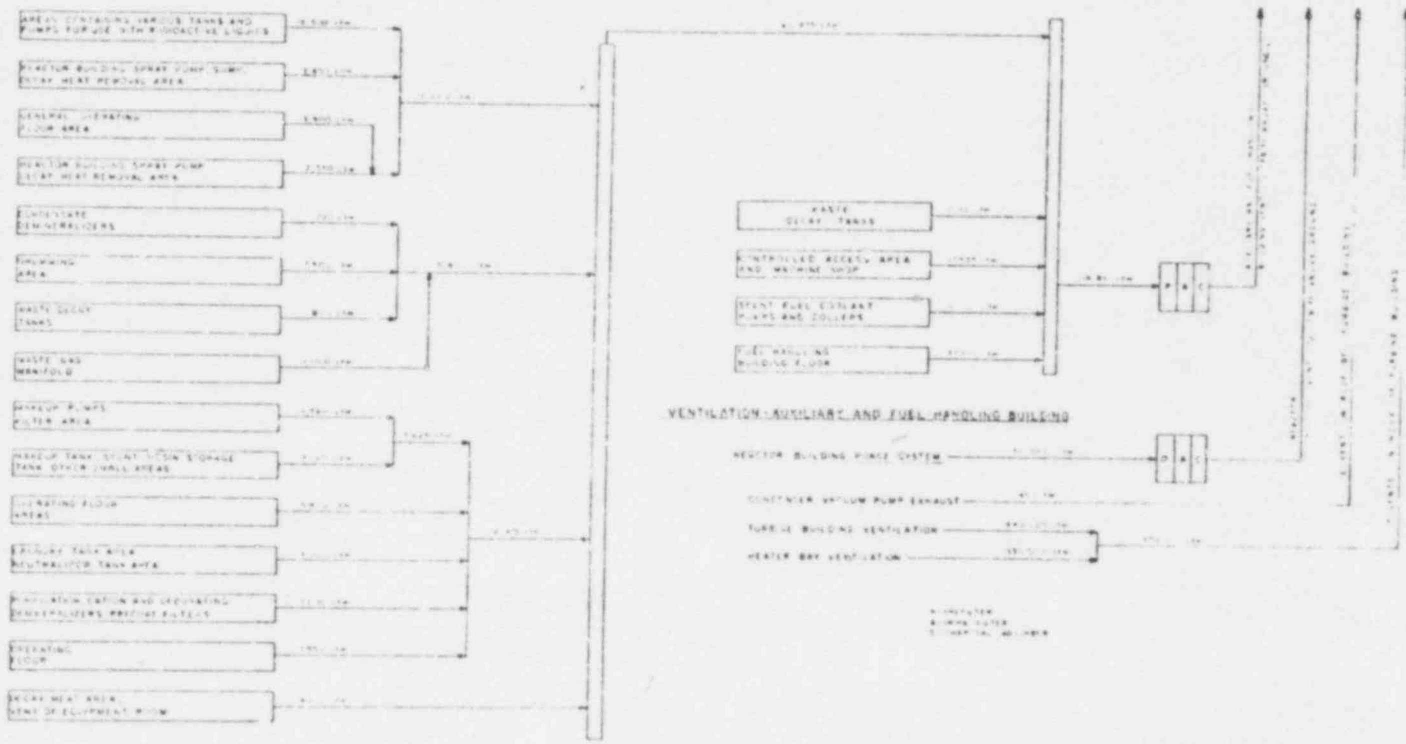

Figure 9 – VENTILATION SYSTEMS, THREE MILE ISLAND NUCLEAR STATION UNIT 1

91 193

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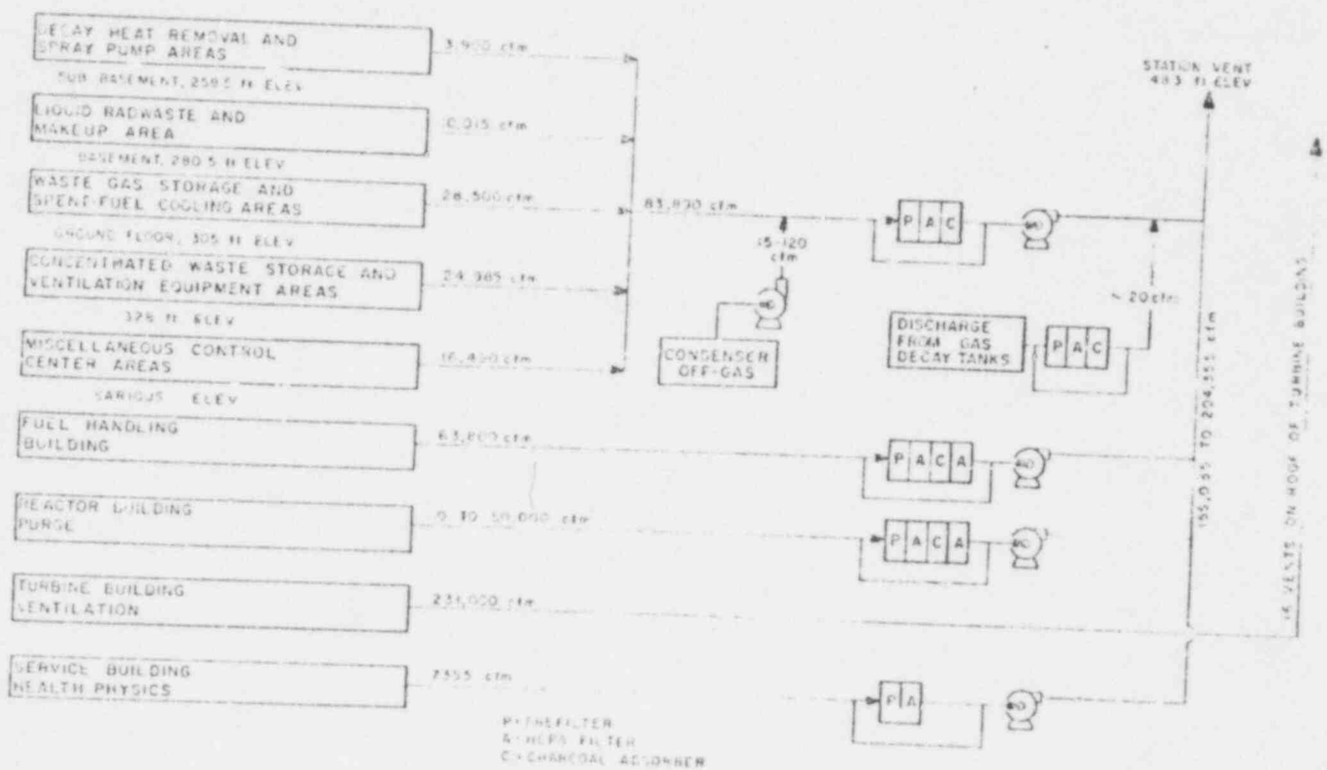

Figure 10 - VENTILATION SYSTEM, THREE MILE ISLAND NUCLEAR STATION - UNIT 2

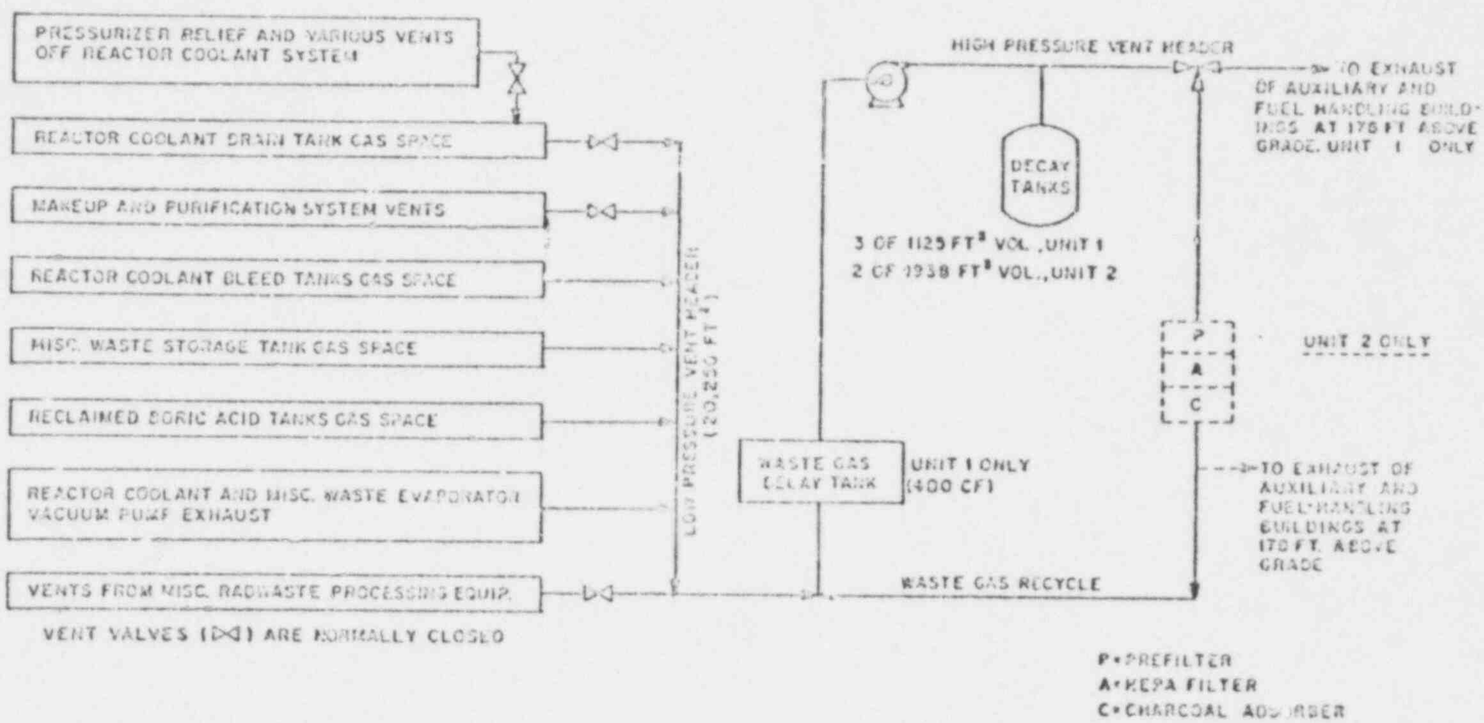

Figure 11 – GASEOUS RADIOACTIVE WASTE COLLECTION SYSTEMS, THREE MILE ISLAND UNITS 1 AND 2

91 195

000051

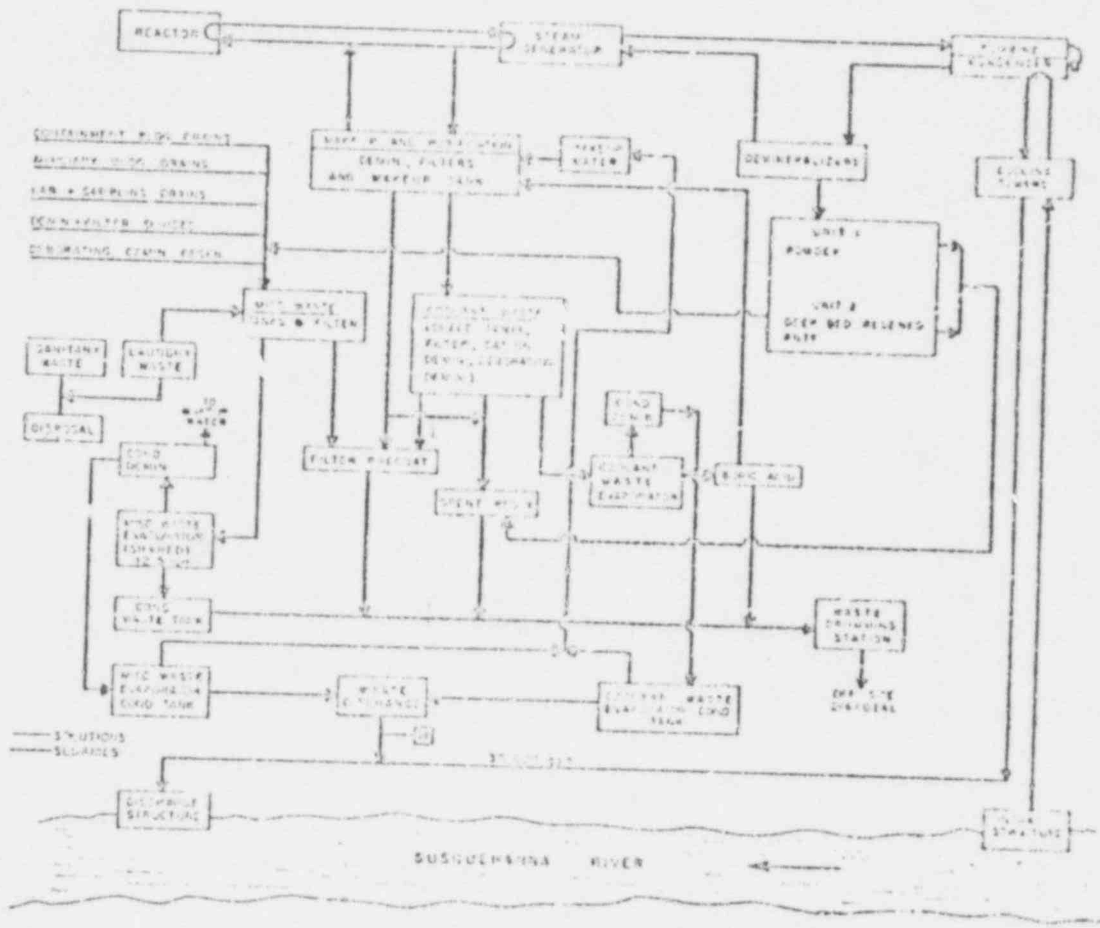

Figure 12 - LIQUID RADIOACTIVE WASTE TREATMENT SYSTEM, THREE MILE ISLAND, UNITS 1 AND 2

Gases stripped from the recycled reactor coolant together with cover gases are collected, compressed, and stored in pressurized tanks for radioactive decay. With the exception of long-lived krypton-85, the gases will decay to a small fraction of the original amount prior to being released. The gas is filtered through high efficiency particulate filters and charcoal adsorbers and released to the atmosphere through the auxiliary building vent stack. The holdup system was evaluated based on the Applicants' statement that a minimum holdup of 30 days will be used.

Additional sources of radioactive gases which are not concentrated enough to permit collection and storage include the auxiliary building exhaust, the turbine building exhaust, the reactor building containment air, and the main condenser air ejectors, which remove radioactive gases which have collected in the condenser as a result of primary to secondary system leakage. The air ejector exhaust from the main condenser of Unit 1 is discharged through the turbine building exhaust without treatment. The ejector exhaust from Unit 2 is routed through demisters to the auxiliary building filter train and released to the station vent.

The auxiliary building is maintained at a slightly negative pressure with respect to ambient pressure. All the exhaust air is filtered through high efficiency particulate filters (HEPA) prior to being discharged through the auxiliary building vent stack. Areas within the auxiliary building which have possible contamination have the capability to be exhausted through charcoal adsorbers in addition to HEPA filters.

The steam generators are once-through units with no blowdown and with full flow demineralizers on the condensate return. Turbine building ventilation is discharged to atmosphere without treatment through roof-mounted exhaust fans.

Calculations of expected normal discharges of noble gases and iodines are summarized in Tables 4 and 5. The bases for these calculations are presented in Table 8.

b. <u>Liquid Wastes</u>. All equipment relevant to the liquid waste processing system is duplicated in the two units except the miscellaneous waste evaporator which is located in Unit 1 and shared by Unit 2. A notable difference between the two units is the method of condensate demineralization. Unit 1 uses Powdex; whereas, Unit 2 uses deep-bed demineralizers. Due to the constraints on waste processing in the miscellaneous waste subsystem, we assumed in our evaluation that 10% of the deep-bed regenerant solution and 100% of the Powdex sluice water will be released to the environment without treatment.

In both units a make-up and purification system maintains the quality and boron concentration of the primary coolant. A stream is continuously "letdown," cooled, demineralized in a mixed bed ion exchanger,

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Table 4
ANTICIPATED ANNUAL RELEASE OF RADIOACTIVE NUCLIDES IN GASEOUS EFFLUENT FROM THREE MILE ISLAND UNIT 1

Discharge Rate (Ci/yr)

Isotope	Containment Purge	Gas Processing System	Steam Generator Leak	Auxiliary Building Leak	Total
Kr-83m	-	-	1	1	2
Kr-85m	-	-	5	5	10
Kr-85	20	665	10	10	705
Kr-87	-	-	2	3	5
Kr-88	-	-	9	9	18
Xe-131m	2	53	6	5	66
Xe-133m	-	-	10	10	20
Xe-133	140	890	860	850	2740
Xe-135	-	-	15	15	30
Xe-138	-	-	20	20	40
I-131	.04	-	.01	.08	.13
I-133	-	-	.01	.08	.09

Table 5
ANTICIPATED ANNUAL RELEASE OF RADIOACTIVE NUCLIDES IN
GASEOUS EFFLUENT FROM THREE MILE ISLAND UNIT 2

Discharge Rate (Ci/yr)

Isotope	Containment Purge	Gas Processing System	Steam Generator Leak	Auxiliary Building Leak	Total
Kr-83m	-	-	1	1	2
Kr-85m	-	-	5	5	10
Kr-85	20	725	10	10	770
Kr-87	-	-	3	3	6
Kr-88	-	-	9	10	19
Xe-131m	2	60	6	6	74
Xe-133m	-	-	1	1	2
Xe-133	160	970	940	930	3000
Xe-135	-	-	16	16	32
Xe-138	-	-	2	2	4
I-131	.04	-	-	.08	.12
I-133	-	-	-	.09	.09

filtered, and fed to the make-up tank from which it is returned to the reactor. When the boron concentration is being lowered, a "bleed" stream from the "letdown' stream is directed to the coolant waste system. This stream is processed through a demineralizer, filter and evaporator. The condensate from the evaporator passes through a mixed bed demineralizer to a storage tank from which it may be recycled or discharged. The concentrated boric acid (evaporator bottoms) is stored for re-use in a subsequent core cycle or sent to the radioactive waste drumming station for off-site disposal.

During the last portion of the core cycle, when the boron concentration is the lowest, the entire "letdown" stream is also passed through a deborating demineralizer to effect reduction of boron content, rather than by use of a "bleed" stream. This mode of operation does not produce a waste stream directly; however, this deborating bed is regenerated, and the neutralized regenerants and rinses are processed through the miscellaneous waste system. No other demineralizers processing radioactive streams are regenerated except the main condensate demineralizers in Unit 2, mentioned above. Other waste-water containing boric acid from reactor shutdowns, startups, and refueling operations is also processed through the coolant waste disposal system equipment.

Wastes collected in the containment and auxiliary building drains, lab and sampling drains, demineralizer resin and filter precoat sluice water, deborating bed regenerants, and decontamination and other miscellaneous wastes are processed in the miscellaneous waste system. These wastes are collected, filtered, and evaporated. The condensate from this evaporator is passed through a polishing demineralizer and then routed to recycle or to hold-up for discharge. Bottoms from this evaporator are stored in the concentrated waste tank until they can be processed through the waste drumming station.

Laundry wastes will be collected, filtered, monitored, and normally routed with the sanitary wastes. The turbine building drains are monitored and discharged to the cooling tower effluent stream. From an accumulative leak rate of 5 gpm from all systems in the turbine building that contain secondary coolant we expect less than .05 Ci/yr.

Controlled discharges will be made from the radwaste systems into the cooling tower effluent stream. This flow is 36,000 gpm on an annual average basis for the combined units. Unit 1 can discharge waste at up to 30 gpm while Unit 2 can achieve a maximum of 50 gpm. Activity monitors and flow controllers will maintain approximate activity levels. Discharges cannot be made from both units simultaneously. No discharge will be made unless the cooling tower effluent flow is at least 5000 gpm.

Based on the assum tions noted above and shown on Table 8, the releases from the primary sources for normal operation were calculated to be less than 5 Ci/year per unit. To compensate for treatment equipment

91 200

Table 6

ANTICIPATED ANNUAL RELEASE OF RADIOACTIVE MATERIAL IN THE LIQUID EFFLUENT FROM THREE MILE ISLAND UNIT 1

Nuclide	Curies/yr
Rb-86	0.00055
Sr-89	0.00044
Y-90	0.00005
Y-91	0.0099
Zr-95	0.00007
Nb-95	0.00007
Mo-99	0.037
Tc-99m	0.037
Ru-103	0.00005
Rh-103m	0.00005
Sb-124	0.00005
Te-125m	0.00003
Te-127m	0.00032
Te-127	0.00035
Te-129m	0.0016
Te-129	0.0010
Te-131m	0.00074
Te-131	0.00014
Te-132	0.019
I-130	0.0013
I-131	1.3
I-132	0.020
I-133	0.21
I-135	0.025
Cs-134	0.21
Cs-136	0.083
Cs-137	0.17
Ba-137m	0.16
Ba-140	0.00048
La-140	0.00042
Ce-141	0.00007
Ce-144	0.00005
Pr-143	0.00007
Pr-144	0.00005
Nd-147	0.00002
Na-24	0.00007
P-32	0.00007
Cr-51	0.0011
Fe-55	0.0010
Fe-59	0.0006
Co-58	0.0097
Co-60	0.0012
Ni-63	0.00009
W-185	0.00005
W-187	0.00058
Np-239	0.00035

TOTAL ~ 3.0   91 201   Tritium-1,000 Ci/yr

Table 7

ANTICIPATED ANNUAL RELEASE OF RADIOACTIVE MATERIAL IN LIQUID EFFLUENTS FROM THREE MILE ISLAND UNIT 2

Nuclide	Ci/yr
Rb-86	.0012
Sr-89	.0041
Sr-90	.00012
Sr-91	.000018
Y-90	.000072
Y-91	.0082
Zr-95	.00072
Nb-95	.00080
Mo-99	.032
Tc-99m	.030
Ru-103	.00048
Ru-106	.00014
Rh-103m	.00048
Rh-106	.00014
Sb-124	.00036
Sb-125	.000036
Te-125m	.00034
Te-127m	.0036
Te-127	.0034
Te-129m	.014
Te-129	.0088
Te-131m	.0012
Te-131	.00021
Te-132	.050
I-130	.0013
I-131	2.7
I-132	.052
I-133	.20
I-135	.021
Cs-134	.54
Cs-136	.15
Cs-137	.41
Ba-137m	.39
Ba-140	.0030
La-140	.0032
Ce-141	.00066
Ce-143	.00002
Ce-144	.00045
Pr-143	.00039
Pr-144	.00045
Nd-147	.00014

Nuclide	Ci/yr
Pm-147	.000054
Na-24	.000089
P-32	.00048
Cr-51	.0088
Mn-54	.000036
Fe-55	.011
Fe-59	.0054
Co-58	.095
Co-60	.013
Ni-63	.011
Zn-65	.000054
W-185	.00045
W-187	.00082
Np-239	.00075

TOTAL ∿ 5.0

Tritium 1,000 Ci/yr

91 202

Table 8

ASSUMPTIONS USED IN DETERMINING RELEASES OF RADIOACTIVE EFFLUENTS AT THREE MILE ISLAND

	Unit 1	Unit 2
Reactor Power, MWt	2533	2772
Plant Capacity Factor	0.8	0.8
Fuel with Defective Cladding, %	0.25	0.25
Leak of Primary Coolant into Steam Generators, gpd	20	20
Leak of Primary Coolant to the Auxiliary Building, gpd	40	40
Frequency of Containment Purge, times/yr	4	4
Waste Gas Holdup for Decay, days	30	30
Cold Shutdowns, times/year	2	2
Coolant Volumes Degassed and Processed During Cold Shutdowns and Normal Operations	5	5
Miscellaneous Waste Processed, gallons/year	600,000	600,000

91 203

downtime and expected operational occurrences, the values shown in Tables 6 and 7 for the waste systems have been normalized to 3 curies per year for Unit 1 and 5 curies per year for Unit 2.

c. Solid Wastes. The following types of solid wastes will be treated in Unit 1 (Unit 2 wastes that require solidification will be transferred to Unit 1):

(1) Compressible wastes - paper, rags, clothing, and charcoal filters.

(2) Incompressible wastes - metal parts from inside the reactor, wires, cables, and spent filter cartridges.

(3) Evaporator concentrates.

(4) Spent resins and used filter precoat.

All solid waste will be packaged and shipped to a licensed burial ground in accordance with AEC and DOT regulations. Based on plants presently in operation, it is expected that approximately 300 to 600 drums of solid waste will be transported off-site each year.

3. Chemical and Sanitary Wastes

The chemicals used in significant quantities at the Station are listed in Table 9.

a. Demineralizer Regeneration Solutions. Sulfuric acid and sodium hydroxide solutions are used for regenerating resins in the two-stage feed water demineralizers used for both Units 1 and 2. These materials are disposed of on a batch basis; each batch, for a given unit, consists of 2,000 pounds of sulfuric acid and 1,300 pounds of sodium hydroxide diluted in 70,000 gallons of water. The resulting solution of sodium sulfate, with a pH between 6 and 9, is released every three days at a controlled rate over a 4-hour period (about 300 gpm flow rate). The waste solution is diluted with the 36,000 gpm cooling water effluent of the forced-draft cooling towers prior to discharge to the river. The amounts listed in Table 9 are the total quantities of acid and base used annually for the two units at the Station. The concentrations in the second column of the Table, however, occur in the 36,000 gpm cooling water effluent only during the batch discharge from a single unit, since the two units discharge their batches at different times.

b. Condensate Polisher Regeneration Solutions. The condensate polishers for Unit 1 are the wound element filter type precoated with powdered resin. The spent resin is washed out and discharged to the sludge treatment house rather than being regenerated, hence no regeneration

91 204

Table 9. Major Chemicals Used at the Station **

	Average quantity released (lbs./yr.)	Incremental concentration in water released to environment during batch discharge (mg/l)
Regeneration of water treatment demineralizers (units 1 &2):		
H_2SO_4	485,000	29 (as SO_4)
NaOH	312,000	11 (as Na)
Condensate polishers (unit 2 only):		
H_2SO_4	210,000	30 (as SO_4)
NaOH	173,000	14 (as Na)
Sulfuric acid added to cooling tower circuit for pH control (units 1 & 2)	4,450,000	28* (as SO_4)
Concentration of river water solids in cooling tower blowdown (Units 1 and 2)	----	107*
Chlorine gas used as biocide (units 1 & 2):		
Service water chlorination	73,000	0.3 ppm†
Cooling tower circuits chlorination	365,000	

*Continuous discharge at this level, see text.

†Total residual chlorine.

**See Appendix B for Susquehanna Water Quality Data at TMI.

chemicals are used. The condensate polishers for Unit 2, however, are deep bed demineralizers and produce dilute waste solutions of sulfuric acid and sodium hydroxide from the regeneration of the demineralizers. The quantities used are 2300 pounds of sulfuric acid and 1,900 pounds of sodium hydroxide per regeneration cycle, which occurs every fourth day. These chemicals, dissolved in 60,000 gallons of water, comprise a batch which is released over a period of four hours every four days (about 250 gpm flow rate). This batch is neutralized and diluted in the effluent of the forced draft cooling tower prior to being released to the river. The quantities of materials listed in Table 8 are the total quantities of sulfuric acid and sodium hydroxide used for Unit 2 and the concentrations in the last column of the Table are the values in the 36,000 gpm of cooling water during the time of the batch release.

c. Sulfuric Acid for Cooling Tower Circuits. Sulfuric acid is added to the circulating water in the condenser cooling water circuits, for pH control, at an average rate of 12,200 pounds/day for both units, and the Applicants have stated that this quantity could increase to a maximum 2.5 times greater under some circumstances. This acid, which forms sulfates with the various cations in the cooling tower water, is eventually released with the 4,000 gpm blowdown from the two units and mixed with the Station cooling water before it is returned to the river. The total quantity of sulfuric acid listed in Table 8 is based upon the average addition and the concentration in the last column of the Table is the resulting sulfate in the cooling water effluent due to the continuous addition of acid.

In addition to the acid added to the blowdown there is a concentration of the naturally occurring salts in the river water by about a factor of 5 in the cooling tower basin. This also leads to an increase in dissolved solids in the blowdown water which, in turn, increases the dissolved solids content of the 36,000 gpm cooling water effluent returning to the river. The average concentration of dissolved salts in the river is 238 mg/1. This is concentrated to about 1200 mg/1 in the blowdown, which, after dilution with the cooling water, results in a final concentration of about 345 mg/1 in the effluent from the station.

d. Chlorination. The water taken from the river (54,500 gpm total for both units) is treated with approximately 200 pounds/day of chlorine to prevent the growth of biological slimes in the service water heat exchangers. Although a program for these chlorine additions has not yet been established, experience with other plants indicates that it will be added over several one-half hour periods during a 24 hour day. An average of 1,000 pounds/day per unit of chlorine will also be injected into the cooling tower circulating water system for control of biological slimes and plant growth. The chlorine will be injected one to four times a day for periods of 15 to 30 minutes each. The Applicants have also stated that the 1,000 pounds/day average value could increase to a maximum of 2,000 pounds/day.

In the recirculating water (natural draft cooling tower) system it is unlikely that chlorine released in the blowdown will exist at a level such as to cause violation of the EPA recommended criteria* for the river. The chloramines produced in the recirculating water system and in the makeup water before addition to the system will largely be lost by volatilization in the cooling towers. The free chlorine present at the position immediately downstream of the condensers will at least partly be destroyed by reaction with organic slimes in the piping, in the cooling towers, and in the collecting basins beneath the cooling towers.

However, some of the effluent from the secondary services and all of the nuclear services effluent are discharged after only one pass through the forced draft cooling towers (i.e. does not pass through the natural draft cooling tower circuit) and the flow and radiation monitor-box. The chlorine level in the service waters (during periods of chlorination) will be high because of the necessity to defoul a series of heat exchangers, and the degree to which the chloramines will be removed by evaporation and the free chlorine removed by reaction with slimes and other substances in the forced draft cooling towers cannot be predicted accurately. The Applicant states that the total residual chlorine at the point of discharge to the river cannot be guaranteed to be below 0.3 ppm. The Staff believes that by careful control of the levels and duration of chlorine additions the residual total chlorine in the discharge can be kept to a level of 0.1 ppm that would be required to assure conformity to the EPA recommended criteria for the river.* If in fact experience indicates that it will not be possible so to maintain the residual chlorine in the discharge, alternative methods of operation can be considered, including the passage of all service water into the recirculating condenser cooling water circuits. This would lead to the large residence time in those circuits (prior to blowdown) that will be required for evaporation and decomposition of the chlorine species. This would lead to greater blowdown rates and more dilute solutions in the recirculating water systems.

e. Sanitary Wastes. The sanitary waste system is designed to handle about 10,000 gal/day (sized to handle a normal population at the site of about 120 persons). The treatment plant is an activated-sludge system with tertiary treatment. The system consists of two aeration tanks and an aerobic digester which produce an odor-free sludge that will be used for land fill. With proper operation it is expected that 93% of the biological oxygen demand (BOD) in the intake will be removed. The remaining BOD is further reduced by the addition of sodium hypochlorite. The chlorine applied to the sewage varies from 0 to 8 ppm, but the Applicants state that the residual chlorine is always less than 1 ppm. The treated sanitary waste is mixed with the service water and blowdown before discharge to the river as shown in Figure 8.

Since the nonradioactive laundry waste water passes into this system, the control of phosphate discharges is also of interest. The tertiary stage of the system includes a lime process removal of the phosphate ions, and it is expected to remove 80% of the input phosphate. The discharge from the treatment plant contains about 6 ppm of phosphate ion.

*See Section V-C-2.

91 207

4. Other Wastes

The chemicals and additives used in the makeup water pretreatment system generate a sludge consisting mainly of fine silt, and suspended matter from the river along with clay added to assist in coagulation. The sludge is separated from the carrier water by filtration at a 95% removal efficiency, resulting in compressed dewatered blocks. The blocks, approximately 2,000 pounds/day, will be collected and trucked off site to an approved sanitary land fill. An additional 66 pounds/day of solid sludge cake from the sanitary waste system is also disposed of in an approved off site sanitary land fill.

There is a small oil fire incinerator at the site for disposing of nonradioactive combustible trash; the ashes from the burning of 400 pounds per day of wastes are hauled off site for disposal in a licensed land fill. The solid waste and trash from the river water removed from the plant intake screens is also hauled off site and disposed of in a land fill.

IV. ENVIRONMENTAL IMPACT OF SITE PREPARATION AND PLANT CONSTRUCTION

A. SUMMARY OF PLANS AND SCHEDULES

1. Plant Construction

Construction started in the fall of 1967. The original plan was for Unit 1 only, but GPU decided to move Oyster Creek Unit 2 to TMI. Construction of Unit 1 should be completed by early 1973, but Unit 2 construction will continue well into 1974. Manpower for construction has increased to a current peak of about 2,200 workers, and this level should remain fairly constant through December 1972. Throughout 1973 the level of employment is expected to decrease, and by early 1974 will be half of the current requirements.

2. Bridges and Highways

Two bridges provide access to the Station. Both span the east channel of the river and lead to State Highway 441. The bridge at the north end of the island is the permanent private access road. The permit was issued on October 13, 1967. This bridge provides access for a one-track Penn. Central R.R. spur, as well as an asphalt surface two-lane road, and has evidently been in service from the date at which construction began. It is of all concrete construction with some of the columns supported at Sandy Beach Island, which is spanned by the bridge. Excavation on this island and on the east shore was exposed at the time of the aerial photograph (Fig. 13) but no evidence of construction effects or erosion was observed at the time of the site visit by members of the staff.

The south bridge is wood and provides auxiliary access during construction. It is less than two years old and it is intended to use this bridge for access to the recreational site that will be developed subsequent to plant construction (see Section V). This bridge is the property of the York Haven Power Company, a wholly owned subsidiary of Met-Ed.

3. Transmission Line Construction

The towers and 230-kV lines to the Middletown and Cly junctions from Unit 1, a distance of 6.9 miles, are completed. From Unit 2, there will be one 500-kV and one 230-kV line, both taken to a 500 kV substation 0.7 miles east, on Applicant's property on the east side of State Highway 441. The area containing the transmission line substation, about 20 acres, has been cleared and closed in with cyclone fence. Selective clearing of 393 acres of right-of-way for the 500 kV line extending from this substation 67.3 miles to the Bechtelsville junction has been completed, and construction of the line is well underway. The major impact of the construction of the Bechtelsville transmission line has already taken place, that is, the clearing of the right-of-way. The incremental impact of the remaining construction is not considered to be substantial or unduly adverse. No clearing or construction has taken place for the 500 kV line running between the TMI Unit 2 substation and the

91 209

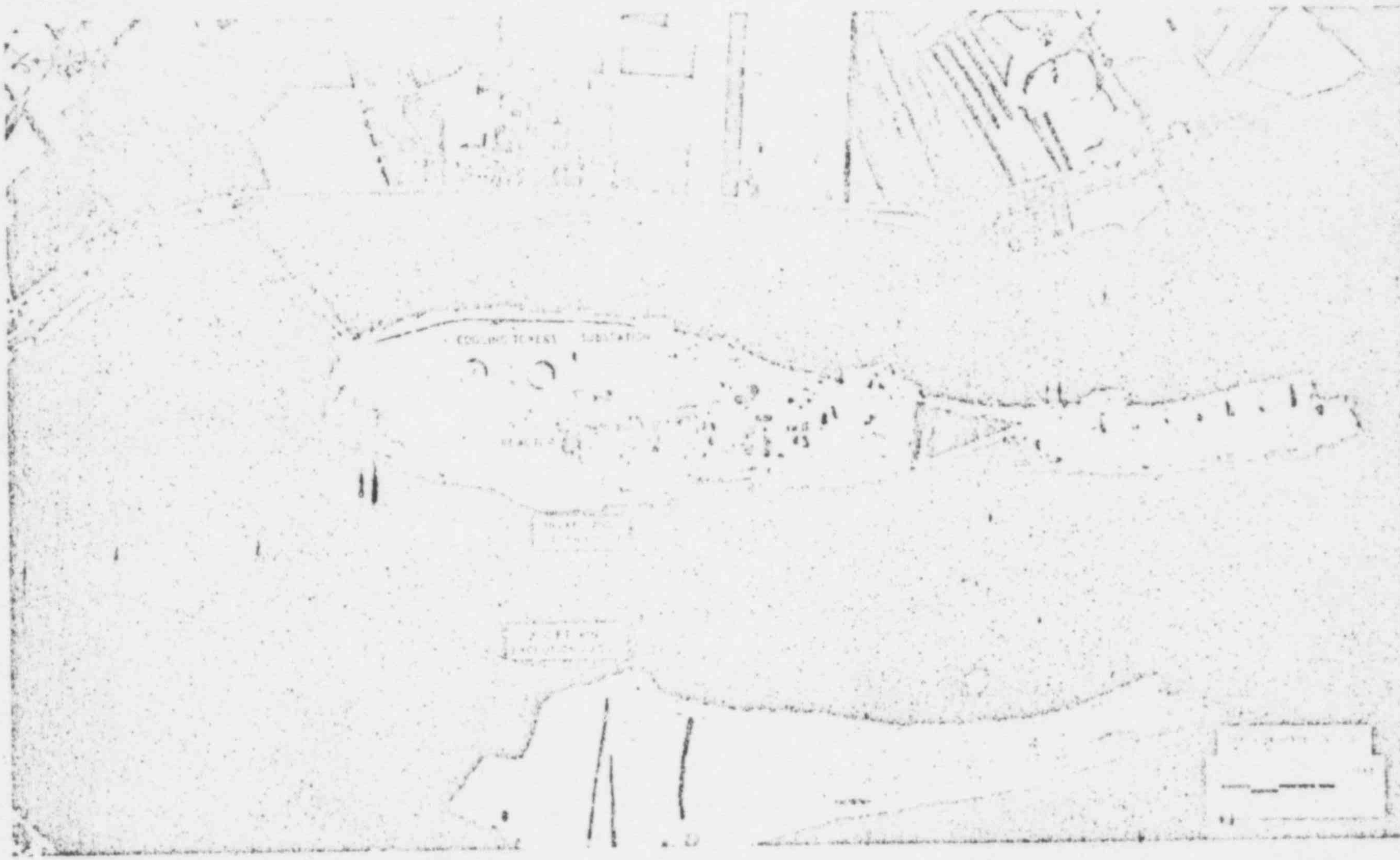

Figure 13 – APPEARANCE OF THREE MILE ISLAND DURING EARLY CONSTRUCTION STAGE

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Juniata-Peach Bottom line. All of the transmission line construction is scheduled for completion by the winter of 1973. The ground under existing towers shows no effects of excavation during construction.

4. Visitors Center

The Applicants own approximately eight acres of property, including three farm buildings, along the east side of Highway 441, directly east of the Station. The visitors center and observation platform is in a newly constructed building about 80' wide x 100' deep with sloping roof. This building, along with landscaping and asphalt parking lot for about 75 cars, was completed during 1971 and is in use. The farm buildings purchased with the property appear to be newly painted and are being used for housing the quality control group. There is a gravel road that leads to the rear of the property, for access from the highway to the 500-kV substation area at the rear of the property. Some heavy equipment for construction of the Station was on the premises during the fall of 1971, but because this part of the property is at lower elevation than the highway, the construction cannot be seen from the highway.

B. IMPACTS ON LAND, WATER, AND HUMAN RESOURCES

1. Land

a. Impact on TMI

Site preparation and plant construction have affected only the 472 acres on TMI with no evident effect on Shelley or the other islands in the 814 acre site. A small (200' x 800') section of the State-owned Sandy Beach island, northeast of TMI, has been affected by construction of piers for the concrete bridge. Major impact has fallen on the north half of TMI, approximately 200 acres. Most of the land occupied by the Station was formerly farmed. The extent of the farm land is shown in the aerial photograph of the island, taken before the start of construction (Fig. 3). The part of the farm area that was excavated during the construction is shown in Figure 13. In addition to the 200 acres that surround the plant facilities, the remainder of the farm land, about 100 acres, is being used during construction for automobile parking, construction shacks, road to the south bridge, and for fill needed during site preparation.

Most of the forest land, about 172 acres, (Fig. 3) remains untouched. Tree damage has occurred mainly on the east and west shores of the island that abut the Station site, where trees were removed for railroad track and bridge construction, for construction of the water intake and pump houses and for effluent trench facilities. The shore to the west of the reactor locations is almost completely stripped of tree cover. The trees on the east shore have been thinned out and the existing trees provide very little landscape screening. In total, about 28 acres of wooded land were disturbed by construction.

A factor that both adds to prevention of wind and rain erosion and indicates considerable moisture at the surface is the rapid growth of vegetation. The flood control dike system that was constructed from the fill and that surrounds the facility area on three sides is completely covered over. The older borrow pit areas are also covered by a variety of weeds. The measures that were instituted to control dust, mud silt runoff, and flood waters are described in Section IV-C.

Construction rubbish - large rocks and pieces of wood and metal scrap - is widely dispersed in the borrow pit area and can be seen from the road that leads from the construction area to the south bridge.

Another major effect on land use was the removal of 70 recreational cabins on the island, that were built and in use by a lease arrangement. All but two of the cabins were moved to nearby islands at the Applicants expense. A small picnic area, consisting of five tables, two fireplaces, two toilets, one boat dock, and a drinking-water well, was destroyed by the construction.

The area of construction activity must be presumed to be totally lost as a wildlife habitat for the lifetime of the Station. Other parts of the island will be less suitable than formerly because of the large numbers of people and machinery traversing the island. The effect is similar to any large scale construction in a rural area. It is difficult to assess the influence of noise, but since jet flights to and from Harrisburg fly near the island, and since there is a railroad and well-traveled highway nearby, noise sensitive species would already have been affected.

b. Impact on Shore (Mainland) Property

The shore property disturbed by construction includes 8 acres of farmland purchased by the Applicants for the Visitors Center, and about 2 acres of woodland west of Highway 441 on the river east bank. About one-half acre of farmland was used for the Visitors Center building, the adjacent paved parking lot and the grass landscape. The impact of this construction was relatively minor. The land relief change was evidently insignificant. Similarly, the Unit 2 substation will not require a significant degree of cut or fill. On the west side of the highway, the trees were removed to provide a view of the Station from the Visitors Center.

2. Water

The impact of construction on silting of the river water and changes in topography of the island shore line and river bottom arise primarily from dredging the intake channel and installation of the intake water pump houses located at the west shore of the island, opposite the reactor buildings. Some

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temporary damage was also caused by the bridge pier construction in the east channel of the river. Some silting can, and probably does, result from the storm wa er drainage system that empties into the east channel. Pollution of the river by uncontrolled disposal of solid or liquid wastes may also occur but there is no evidence that the precautionary measures described below in Section IV-C have been violated.

The impact of the water intake building construction comes from several sources. The formation of water intake channels required blasting that caused temporary turbidity of the water, disturbance of the natural riverbed silt and some fish kill. There was some disturbance of the river banks caused by the blasting and dredging operations. The cofferdams that were constructed before foundations and housing buildings could be poured caused temporary silting of the river and changes in the shoreline. The material used for cofferdam construction and the rock formed by the blasting created forei[illegible] matter in the river.

3. Human Resources

The impact on human resources in the area arises primarily from the need for skilled labor for the construction of the Station. About 65% of the 2,000 or so construction employees had to be brought in from outside the area. Staff members of the Tri-County Planning Commission in Harrisburg have stated that the rate of residential construction in the Harrisburg area has been significantly reduced through the absorption of skilled labor by the Station construction and the highway construction in the Harrisburg area.

The migration of construction workers to this area has affected the supply and cost of housing relatively little. Workers without families who are looking for rental rooms or apartments in the immediate area, primarily Middletown and Royalton, report that such accommodations are in short supply and quite expensive. There are, however, a large number of trailer units in the area that were formerly occupied by service personnel and civilian employees at Olmsted Air Force Base. The closing of this base has made reasonable cost housing available for the families of Station construction workers. There are no reports or evidence that the families of Station construction workers have concentrated sufficiently in any one area to cause overcrowding of school or hospital facilities. Again, the lack of pressure may be partly due to the coincidence of the closing of the Air Force base.

C. CONTROLS TO LIMIT IMPACT OF PLANT CONSTRUCTION

Several provisions have been taken to minimize dust formation due to exposure of soil and to control storm water drainage so as to minimize river silting caused by storm water drainage. Excess surface water is collected by an underground piping system in the main plant area and drained into ditches at the periphery of the main site. The collecting ditch drains through a 60-inch diameter culvert into the east channel of the river. The culvert is

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so designed that at heavy runoff the flow from the trench is impeded, causing heavy silt to settle to the bottom of the trench instead of being carried into the river. The borrow pits, sources of construction fill, and their surrounds were shaped to that eroded soil is carried toward the pit rather than into the river.

The flood protection dikes, constructed from the fill excavation to the south of the main site, were carefully finished to minimize erosion by storm water and wind. The exterior slopes have a heavy stone riprap finish on an embedded layer of gravel and sand, and they are already partially covered by natural vegetation. The interior slopes were planted with crown vetch.

The exposed surfaces in the main plant area intended for automobile parking are paved with an asphalt surface, as are the main roads. Heavily travelled paths between buildings are covered with crushed stone, and much of the lesser travelled surface is covered with weeds that seem to grow readily in the whole area.

Damage to the river bottom from the intake channel blasting was minimized by removing the shot rock to the borrow pits from which the land fill was excavated. Erosion of the river banks adjacent to the intake water facilities was minimized by a covering of stone riprap. The two cofferdams that were constructed on the west bank of TMI before intake water facility housing could be erected were made from packed truckloads of earth and finished with a layer of riprap to prevent river silting.

The construction crews are ordered not to dispose of waste soil or solids into the river. Liquid and solid wastes from the latrines in the temporary and permanent facilities are stored and carried off the island pending completion of the permanent sanitary sewage treatment facility.

Heavy truck traffic to and from the Station has been minimized by use of the railroad spur onto the site for hauling in the large components and construction materials. A major factor in diminishing heavy truck traffic and highway damage has been the location of a concrete plant on the site.

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V. ENVIRONMENTAL IMPACTS OF PLANT OPERATION

A. LAND USE

1. Access and Recreation

Since the Station is on an island wholly owned by the Applicants, and since the exclusion radius for each of the two reactors extends over land owned by the Applicants, the operation of the Station will deprive no one of access to land that he would otherwise have been free to enter. The major impact on TMI and adjacent Shelley Island is that about 400 acres of farmland will be lost to further production and about 70 summer homes have been relocated to Beshore Island, also owned by the Applicants. The Applicants have proposed to begin development of an extensive "recreational resource" on TMI and other islands in the vicinity that will expand the summer-home land lease program and replace the lost forest and farmland on the south end of TMI with a multi-use recreational area that will benefit the whole Harrisburg area. The pool, or reservoir, created by the York Haven Dam, raises the level of the river about 22 ft. To exploit the recreational potential of the river in this area, new facilities such as boat launchways, docks, and car parking facilities are needed. The Pennsylvania Fish Commission has recognized this need by acquiring shore land adjacent to Goldsboro, on the west shore, that will be used as a start for providing the above mentioned facilities. The recreational facilities on TMI that are proposed by the Applicants are shown in Fig. 14. Initially, these will include all circulatory roads, a marina (excavation), 80 boat slips and docks, parking for 50 cars and boat trailers or 275 cars, 125 picnic sites, 2 comfort stations, 2 group picnic areas, 2 picnic shelters with comfort stations, a shoreline trail, general landscape development around use areas, drinking water distribution, and a sewage disposal system (septic tanks).

The Applicants plan to spend about $750,000[3] on development in addition to that already completed.

A longer range, more extensive recreational resource development project has been proposed by the Applicants after consultation with several state agencies and county planning commissions (Tri-County, York and Lancaster). Most of the acreage to be used in the new development will be Applicants' property, but the cost of the future developments will be only partially covered by Applicants' contribution. Some local and federal tax money will be necessary to complete the project. Formal agreements between the Applicants and interested agencies have not been completed at this time.

2. Transmission Lines

The 6.9 miles of 230 kV transmission lines associated with TMI Unit 1, which are completely built and ready for service, have little impact other than aesthetic since they traverse open farmland and no significant change in land use is involved.

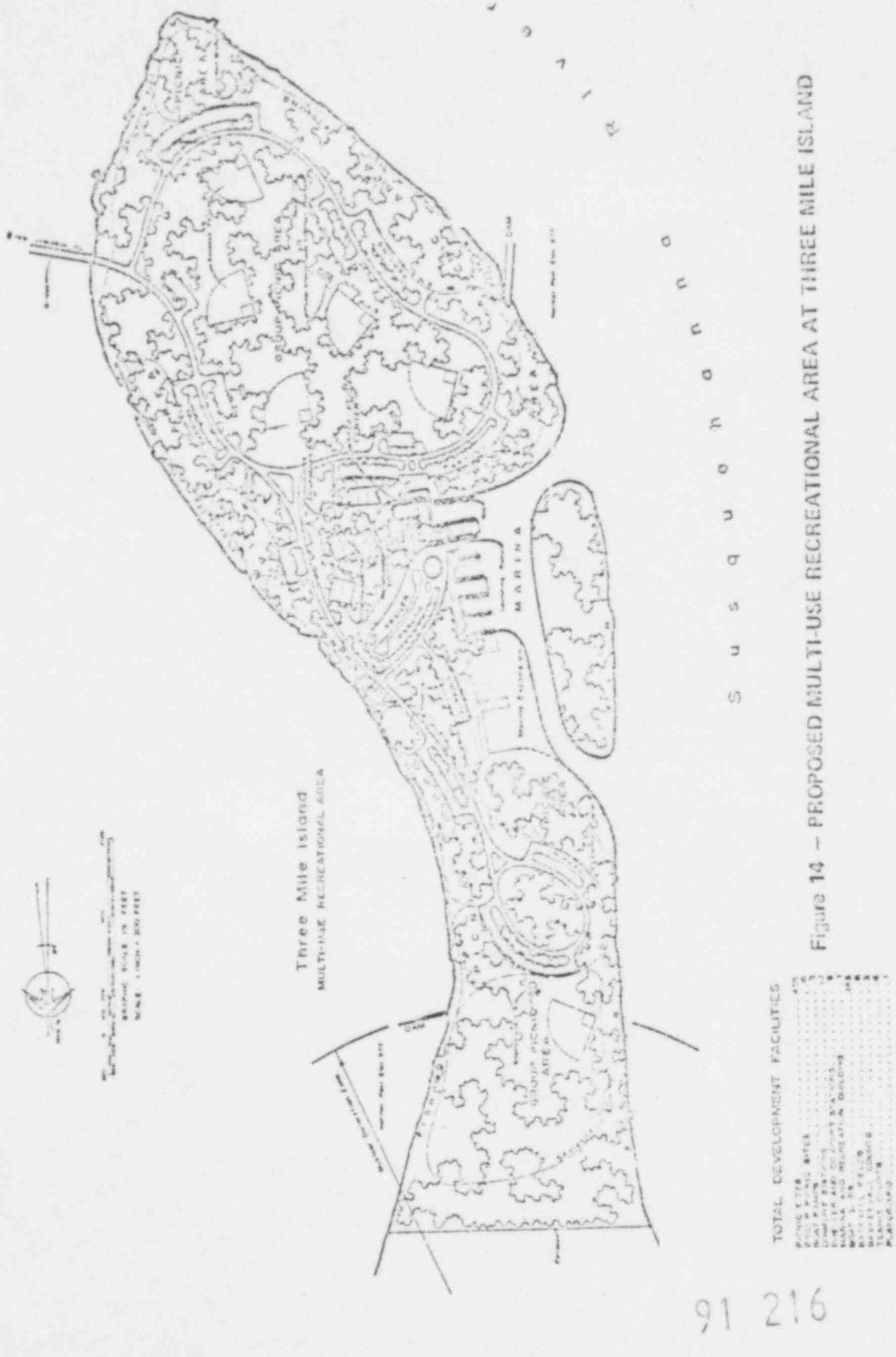

Figure 14 – PROPOSED MULTI-USE RECREATIONAL AREA AT THREE MILE ISLAND

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The right-of-way for the 67.3 mile 500 kV TMI Unit 2-Bechtelsville line occupies about 1620 acres. The Applicants have stated that route selection was carried out using techniques and procedures which factored in the need to minimize relocation of property owners, to maximize use of existing rights-of-way, to avoid high points and long paralleling of highways, and to minimize environmental impact. Although existing rights-of-way could have been paralleled or utilized for most of the line, this approach was rejected because it would have required the removal of a large number of homes. The route which was finally chosen parallels or uses existing transmission corridors for 15 miles, and traverses primarily rolling farmland with some scattered woodland. The purchase of one home and the selective clearing of 393 acres of right-of-way were required. Of this 393 acres, 233 acres were second, third, fourth, or fifth growth forests, and the remainder abandoned pasture or agricultural land, brush and scrub field growth, overgrown meadows, fencerows, and the like.

Clearing was carried out in accordance with "Specifications for Right-of-way Clearing", developed in 1969 by one of the Applicants, which are fully consistant with the U. S. Departments of Agriculture and Interior's guidelines entitled "Environmental Criteria for Electric Transmission Systems". These procedures, largely prepared by professional company foresters, call for selective clearing by the preservation of desirable species, screening at all road crossings, steep slope cutting, and preservation and care for streams, paths, and trails.

The route does not cross public lands, and does not pass through areas of historic or recreational value. For 64.6 miles of the 67.3 mile route, easements have been obtained which permit the owners of the right-of-way to use the land for growing crops, grazing cattle, or growing trees to a limited height. Accordingly, little change in land use should result, in view of the predominantly agricultural nature of the land through which the right-of-way passes.

The TMI Unit 2-Juniata 500 kV transmission line extends 7.16 miles from the TMI 500 kV line, west of the Susquehanna River, between Juniata and Peach Bottom. The proposed right-of-way will occupy about 170 acres, half of which is farmland and the remainder woodland and river crossing. Six homes must be acquired, and condemnation proceedings undertaken for the 1.26 miles of right-of-way not already owned or covered by easements.

From TMI the proposed route would run southeast and south for about 1-3/4 miles, paralleling or utilizing existing right-of-way for most of this distance, and then cross the Susquehanna River. The point chosen for the river crossing is adjacent to crossings by four other transmission lines, the furthest 1/2 mile away, so visual impact will not be significantly altered.

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West of the river the route traverses 1/2 mile of wooded property owned by the Applicant to a point opposite an existing substation, where it begins a parallel run with an existing 230 kV line for about 3 miles. Near the substation, crossing of a state highway is required, and since there is considerable strip development along the road, impact on homes and/or commercial property is unavoidable. The route chosen, paralleling the existing right-of-way, will necessitate the purchase of four homes located on that road. The final mile of the line diverts from the 230 kV parallel in order to avoid a juncture with the Juniata-Peach Bottom line at a point which would have required acquisition of a number of homes. This section traverses open farmland.

According to the Applicants, route selection has followed, to the extent possible, the recommendations of the U. S. Departments of Agriculture and Interior cited above, and selective clearing procedures will be in accordance with these guidelines and the Applicants' "Specifications for Right-of-way Clearing", also discussed above.

After reviewing the route chosen by the Applicants and comparing it with the available alternatives, and after balancing the factors relating to environmental impact, the staff has concluded that the proposed route for the TMI-Juniata transmission line represents the preferable approach and will not have a significant adverse impact on the environment.

Since a large proportion of the land traversed by the Station transmission lines is open farmland, and selective clearing procedures which largely retain low growing trees and shrubs have been used in the woodland sections, the impact on wildlife is expected to be minimal.

3. Effect of Cooling Tower Operation

Four large natural draft cooling towers, two for each unit, will be used to dissipate most of the condenser heat from the Station. In addition, two three-cell wet mechanical draft cooling towers (one for each unit) will be used to cool the combined service water effluent and the blowdown from the natural draft units so that there will be small thermal discharges to the Susquehanna River. At full load, 11.5×10^9 BTU/hr will be discharged to the atmosphere. Each tower will discharge a maximum 5000 gallons/minute of water in vapor form per minute.

Because of the large quantities of water vapor they discharge, concern has been expressed about the possibilities of weather modification, such as fogging, precipitation and humidity increase, icing, etc., which might be produced by the towers. Since the total operating experience with such towers in the U. S. is small, techniques for predicting weather modifications are still relatively primitive. Natural draft cooling towers have been used for at least two decades in Europe, expecially in England. Decker[6] has made a survey of European operating experience and has uncovered little evidence of

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adverse weather modifications attributable to natural draft cooling towers. Experience in the USA to date has revealed no significant problems.[5,7,8,9,10,11] Operational experience both in the USA and in Europe has shown that, of the various alternate cooling procedures, natural draft cooling towers have the lowest adverse meteorological impact.[4,5]

a. Cooling Tower Plume Model

The Applicant has developed a numerical model to predict the length and other dimensions of the visible plume generated by the cooling towers;[12] a summary of the model was published earlier.[7] This formulation is similar to other models, such the EG&G model,[13] in that plume motion is divided into two phases; (1) a plume rise portion describing the plume behavior in the immediate vicinity of the tower, followed by (2) an atmospheric diffusion calculation, describing the lateral dispersion of the plume once it has reached its point of maximum rise (zero upward velocity).

The plume rise section of the Applicant's model (within two km of the tower) is basically the isolated cumulus cloud model developed by Weinstein and Davis.[14] Further from the tower, where dispersion of the tower effluent is controlled by ambient wind and turbulence conditions, calculations of diffusion are made using the standard dispersion procedures.[15] The dispersion model predicts the change in absolute humidity (mass of water vapor per unit volume) as a result of the tower effluent. If this increment is more than the ambient saturation deficit,* some of the excess moisture will condense and a visible plume will form. Since the water vapor content of saturated air varies from 2.1 g/m^3 at -10°C to 17.3 g/m^3 at +20°C, it is clear that the potential for a visible plume is much greater during the conditions of low temperature and high humidity which typically occur during winter months. These meteorological conditions also contribute to the production of natural fog.

Typical results of cumulus cloud model calculations[13] give plume heights of 1,000 to 3,000 ft, even for stable lapse rates. Because of this high penetration altitude, the calculated subsequent lateral dispersion of the plume rarely results in a visible plume at an altitude lower than the top of the cooling tower. The calculations predict that meteorological conditions of moderate winds, stable lapse rates, and low saturation deficits favor the generation of visible plumes which, if they reach the ground, become fog.

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*The saturation deficit is the water vapor content of saturated air minus the actual content or (W_s -W) g/m^3.

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Comparisons between the results of calculations using the cumulus cloud model and actual observations have rarely been published. Hosler[7] reports one observation of plume penetration to 1500 ft at the Keystone Plant, in agreement with calculated plume height based on atmospheric soundings (temperature and humidity measurements vs. altitude) taken at the Pittsburgh airport 50 miles away.

b. Fogging

The question of production of fog by cooling towers is of paramount interest, particularly with regard to possible effects on nearby population centers, roads and, in the case of the TMI Station, airports. Large natural draft towers have some inherent advantages over smaller mechanical draft towers in this respect. A natural draft tower releases a relatively large diameter plume at a high altitude from a single source, and the resulting plume, having a low surface-to-volume ratio, maintains its buoyancy and upward travel (because of a lower rate of mixing and resulting buoyancy loss due to turbulent interchange) to a higher altitude. The result is that the plume from a natural draft tower is able to penetrate very stable atmospheric conditions (inversions) and send plumes hundreds of meters into the air before leveling off. The plume then travels downwind from the tower, sometimes oscillating vertically about the lateral direction of motion, and because of its height, touches the ground infrequently. This behavior is in contrast to the forced-draft towers, which typically release plumes at lower elevations with higher velocities. This leads to turbulence and mixing at low altitudes so that plumes often contact the ground. Hosler[7] gives the only reported instance where the plume from a natural draft cooling tower was seen returning to the ground.

Using the cumulus cloud model, the Applicant has calculated the potential fogging effects at nearby Harrisburg International Airport from cooling tower operation to be 29 hours per year for the operation of one unit and 39 hours for the operation of two units. They further state that on any given day the effects persist for 6 to 10 hours. This yields 3 to 5 days per year when there is fogging potential for operation of one tower, and 4-6 days per year for two towers. The atmospheric sounding data (radiosonde) used in these calculations was U.S. Weather Bureau data from Washington, D.C. (100 miles away) and Pittsburgh (170 miles away). Later, the Applicants obtained atmospheric sounding data at the Station with an instrumented light aircraft for three 30-day periods, starting October 1, 1969, January 1, 1970, and March 15, 1970. They state that the results of calculations using the new atmospheric data verify the earlier predictions of fogging potential at Harrisburg International Airport (29 and 39 hours/year for the operation of one and two units, respectively). This implies that the atmospheric soundings at the Station were not greatly different from those at Pittsburgh and Washington, D.C. The Applicants also state that the new calculations indicate that about half of the 39 hours are before sunrise.

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The Staff considers these estimates of surface fogging to be conservative, since experience at operational cooling towers shows that plumes rarely, if ever, reach the surface.[6,7,8,9,10,11,16] On those cold winter days when the plume is long enough to reach the airport, the base of the plume will usually be 300 to 500 feet above the runway.

Some indication of the impact of the cooling towers near the Station Plant. Bierman, et al.[11] report results of a study at Keystone based on observations of the cooling tower plumes for a 6-month period, February through July 1969. During this study, which included 144 individual observations, photographs of the towers were taken daily to explore the general characteristics of the plumes. The results showed that 81% of the time the plume evaporated to invisibility in the atmosphere; most of the remaining time it was absorbed in the overcast. The breakdown of the observations in the cases where it evaporated to invisibility (81%) was as follows:

a) Plume length less than five tower heights (1,625 ft) -- 87%;

b) Plume length five to fifteen tower heights — 10%;

c) Plume length greater than fifteen tower heights (> 1 mile) -- 3%.

Only one of the three winter months, when long plume formation is most likely, were included in the survey. However, if it can be assumed that the months of December and January are no worse than February and March, then the percentages given, on a yearly basis, would presumably still be valid or conservative.

Both the Keystone Plant and the Station are in geographic regions classified as having high fogging potential.[13] [A region of high fogging potential is defined in the study as one in which heavy fog is observed over 45 days/year, the maximum mixing depths are low (400 to 600 meters) from October through March, and the frequency of low-level inversions is at least 20 to 30%]. The topography of the two sites is similar; both are essentially wide valleys with hills about 200 ft. high on either side (but still well below the top of the cooling towers). Therefore, it is not unreasonable to expect that plume observations at Keystone would be useful in predicting results at the Station. According to the Bierman study, most of the time (70%) the plume would be well within the confines of the river banks and shadows would not be cast on the surrounding land. Approximately 10% of the time, or 36 days per year, when the plume evaporates to invisibility, the plumes would extend over the land, but they would be longer than one mile on only seven days. Of the total frequency of disappearance into the overcast (16.5%) given in the study, the plumes were greater than 1,625 ft long 87% of the time. This gives an incidence of 14% or 52 days/year under overcast conditions when the plumes will extend beyond the river to the land. Since

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the skies are already overcast there would probably be no additional shadow produced by the plumes under these circumstances. The total number of days when the plume length would be longer than one mile would be about 14 days; 7 each under overcast conditions and evaporation to invisibility.

The atmospheric conditions tending to produce long cooling tower plumes are the same as those favoring the formation of natural fog and clouds. In general, however, because of their height, the towers release heat and vapor above the surface inversion which contributes to fog, and the plumes tend to rise above fog. Consequently, the most probable effect at the Station from the cooling towers is some enhancement of natural fog at some distance from the plant, particularly during the winter months when the atmospheric saturation deficit is low. The smaller forced-draft cooling towers at the Station on the other hand, will produce some local fog since their plumes do not have the capability for penetrating to high altitudes. They are not expected to have an effect except at the Station itself, since the nearest land areas which could be affected are 2,000 ft away, and the heat load on these towers is very low.

c. Precipitation

Operating experience with natural-draft cooling towers indicates no measureable enhancement of precipitation attributable to the operation of the towers. A study by IIT Research Institute[16] showed a negative correlation between rainfall measured at a number of measuring stations within 20 miles of the Keystone Plant after the start of tower operation. Increases in humidity at upper altitude levels beyond the visible plume have been measured with aircraft, but increases in humidity at the surface have not been detected.[15]

d. Drift and Salt Fallout

Although most of the water leaving the cooling tower leaves as vapor (evaporation accounts for 60-70% of the cooling effect) a small percentage of the water circulated is carried out of the tower as entrained droplets. In the more recent cooling tower designs, by the installation of drift eliminators (baffles above the cooling tower fill) the windbreaks around the fill, manufacturers claim that drift has been reduced to 0.03% or less of the water circulated. Drift values as low as 0.005% have been measured in operational cooling towers. Thus, the Applicants' stated drift rate (0.03%) is conservative.

At the Station the cooling tower basin is operated with sufficient blowdown to maintain a dissolved salt concentration of five times the normal river water concentration. Water containing these dissolved salts is carried out as drift and produces some salt fallout from the plume as the water droplets evaporate. Using conservative values for the river water of 100 ppm of sulfate, 100 ppm of carbonate and 20 ppm of chloride, assuming a five-fold concentration in the cooling tower basin and 0.03% drift, the staff obtains a

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total salt fallout with both units operating of approximately 1.2×10^6 lbs/yr. Making the pessimistic assumption that all of this is deposited evenly within a one-mile radius of the Station, total salt fallout would be about 600 lbs/acre.

It is observed that, under most conditions, the drift particles evaporate completely before falling to the surface and that their salt is dispersed over a very large area before being swept from the atmosphere by rain or snow. Calculations of salt deposition from a salt water cooling tower show that there should be no significant problem at the Station.[17,18]

Discussions with personnel at the Paradise and Keystone Plants, both of which use river water for cooling tower makeup, indicate that there has been no noticeable salt fallout. It is concluded that the quantities likely to be deposited from the plumes at the Station would be undetectable visually.

4. Airport Use

In the following discussion, only the impact on the Harrisburg International Airport, 3 miles away, is considered since the Harrisburg-York Airport, 8 miles distant, is far enough so that it is essentially unaffected by the presence of the Station. While cooling tower plumes could occasionally extend aloft as far as this airport, it is well beyond the distance where ground effects from cooling towers have been observed.

a. Interference with Airport Traffic Patterns

The Station is well within the normal 5-mile radius which defines an airport traffic area. For light planes operating under VFR (Visual Flight Rules) conditions, the airport traffic pattern is normally 800 ft. above the surface. Thus the presence of the towers themselves does not constitute an inconvenience to air navigation, since VFR aircraft in the traffic area would be 400 ft. above the top of the towers when approaching or departing the airport. However, the plume rise would normally be higher than 800 ft. above the surface, and aircraft approaching from or departing to the south would have to fly around the plume. Since the towers are 3 miles south of the airport and the plume is likely to be less than 1 mile long most of the time, it does not appear that this would cause any particular problem to VFR traffic.

The position of the Station relative to the airport is well out of the existing instrument approach corridors as indicated by the following description of the current instrument approach procedures at the Harrisburg International Airport:

1. Runway 13 (the southeast runway) is a full Instrument Landing System runway (i.e., has electronic glide slope equipment). The approach minima applying to large jet aircraft are a decision height of 900 ft MSL (about 600 feet above the surrounding terrain) and a visibility of 1 mile. Aircraft using this instrument approach would not come near the Station during the approach and the point of closest approach to the Station would be upon landing at the airport.

2. Runway 31 (the northwest runway) is a localizer approach only (back course) without electronic glide slope information; however, the approach procedure stipulates that radar contact is required. The instrument minima for heavy jet aircraft are a minimum descent altitude of 860 ft MSL (about 560 ft above the surrounding terrain) and a visibility of 1-1/4 miles. The flight path of aircraft using this approach would be approximately 1.5 miles north of the site; however, the minimum descent altitude for the approach (the altitude below which aircraft are not permitted to go until visual sighting of the airport occurs) is 200 ft above the height of the cooling towers, which are at 670 ft MSL.

b. Effects on Instrument Flight Rules (IFR) Operations

The Applicants have calculated a probable fogging incidence of 39 hr/yr attributable to the operation of the Station cooling towers. Based on the cooling tower operating experience cited above, this is probably conservative. It is difficult to assess the impact of this on IFR operations at the airport in terms of delays that might be caused. On overcast days the plumes tend to merge into the overcast and, therefore, the effect at the airport on days with a low ceiling might be a slight lowering of the ceiling and/or slight reduction in visibility. Thus, the airport conditions would have to be borderline for the instrument approach minima in order for the cooling towers to affect the situation enough to prevent instrument approaches and departures. Since, at most airports, the number of days when conditions are exactly at instrument minima is relatively small, the impact is not expected to be large.

B. IMPACT ON RIVER WATER USAGE

All of the water used at the Station is drawn from the Susquehanna River.

1. Water Consumption

There is a net maximum consumption of river water by the Station of 20,800 gpm due to evaporation from the four natural draft and the two forced draft cooling towers. This amounts to 2.7% of the minimum river flow of 1,700 cfs (765,000 gpm) and 0.23% of the mean river flow of 20,000 cfs. Removal of water at this rate is not expected to have a significant effect on the water balance of the Susquehanna River in the vicinity of the Station since this is a small perturbation of the normal seasonal variation of the river flow (see Section II.E.).

2. Thermal Discharges

There is a nominal flow of 36,000 gallons per minute of cooling water returned to the river when both Units 1 and 2 are operating. Normally this effluent is cooled to river ambient temperature by the forced draft cooling

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towers. During winter operation, however, the effluent will average 3°F warmer than the river (see Section III-D), resulting in a heat load of 900,000 BTU/minute. This gives a mixed mean temperature increase for the minimum river flow condition (1,700 cfs) of 0.28°F and for the mean flow condition (20,000 cfs) of 0.024°F. Under unusual weather conditions, immediately after reactor shutdown the effluent could be as much as 19°F above river ambient for several hours. This could lead to an increase of approximately 1°F in the mixed river temperature at minimum flow conditions for a period of a few hours. In view of the small average temperature increases and relative infrequency of reactor shutdowns, and since the heat load will be added to the river during the winter, the staff concludes that the thermal discharges of the Station to the Susquehanna River will have a negligible effect in terms of the present use of the river for recreation, municipal water supplies, etc. The Commonwealth of Pennsylvania water quality criteria for this section of the Susquehanna River are given in Table 10. The staff concurs that these criteria should result in minimal impact on the environment.

3. Chemical Effluents

As discussed in Section III, the major chemical wastes discharged from the Station (exclusive of liquid radioactive wastes and treated sewage) are:

(1) Sodium sulfate from the demineralizer and condensate polisher regeneration steps,

(2) Sulfuric acid added to the cooling tower condenser circuit for pH control (discharged as soluble sulfates),

(3) Concentrated dissolved solids from normal river water in the cooling tower blowdown water, and

(4) Residual chlorine resulting from chlorine injections to the cooling tower-condenser circuit and the Station service water to prevent the growth of biological slimes.

Table 9 gives the total quantities of these chemicals released to the Susquehanna River annually and the concentrations in the Station cooling water effluent during discharge. Table 11 presents a summary of the total concentrations in the cooling water effluent and the resulting well mixed concentrations in the Susquehanna River for both the normal (20,000 cfs) and low flow (1,700 cfs) conditions. As shown, the total incremental dissolved solids in the river are 8.4 mg/l and 0.7 mg/l for the low and normal river flow conditions, respectively. This condition would prevail for the 15% fraction of time during which demineralizer or polisher wastes are being discharged. At other times the concentrations decrease to 6.3 mg/l and 0.5 mg/l, respectively. Considering that these concentrations will be diluted to values slightly above the natural levels of dissolved solids in the river, we conclude that the salt addition would not change the suitability of the Susquehanna River for the uses for which it is presently employed.

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Table 10. Water Quality Criteria for the Susquehanna River - Juniata River to the Pennsylvania-Maryland State Line

Item	Criteria
pH	Not less than 6.0 and not more than 8.5.
Dissolved Oxygen	Minimum daily average 5.0 mg/l; no value less than 4.0 mg/l in the epilimnion.
Iron	Total iron not more than 1.5 mg/l.
Temperature	Not more than 5°F rise above ambient temperature or a maximum of 87°F, whichever is less; not to be changed by more than 2°F in any one hour period.
Dissolved Solids	Not more than 500 mg/l as a monthly average value; not more than 750 mg/l at any time.

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The Pennsylvania Water Quality Criteria for this portion of the Susquehanna River (Table 9) give a specification for total dissolved solids but not for sulfate per se. Both the monthly average value of 500 mg/l and the maximum value of 750 mg/l specified for total dissolved solids are above the average and maximum values of 373 mg/l (238 natural river water +135 incremental) and 417 mg/l (238 natural river water + 179 incremental) in the Station effluent.*

Chlorine is added to the service water and cooling tower condenser circuit water to prevent the buildup of biological slimes in the cooling circuits. The total quantities of chlorine added are given in Table 9. As indicated, the chlorination systems will be operated intermittently for several 15 minute periods per day, and the Applicants indicate that these additions will result in a total residual chlorine in the effluent cooling water stream of 0.3 ppm or less. Normally, the residual chlorine reacts with other materials (chlorine demand) in the water, and persists for a relatively short period of time. While this level of chlorine is not detrimental to the use of the river water for the variety of human activities for which it is now employed, the impact on the biota of the river may be significant (see Section V-C).

The sewage treatment plant which is being constructed is a tertiary treatment activated sludge system and is the only known tertiary plant in the area. This plant has the capability of removing 93% of the biological oxygen demand (BOD). This is further reduced by the addition of sodium hypochlorite up to 8 ppm with a stated residual chlorine content of 1 ppm in the effluent. As in the case of the other wastes, the treated sewage is mixed with the cooling water prior to discharge to the river, and this results in a minimum 1000-fold dilution (for 5,000 gpm cooling water flow) prior to reaching the river. Under the minimum river flow conditions, further dilution by a factor of 150 is obtained upon complete mixing. Under nominal flow conditions for cooling water effluent and the river, a further dilution factor of about 15 would be obtained. The tertiary stage of the process will remove 80% of the input phosphate ion, resulting in an effluent containing 6 ppm of phosphate ion. In summary, it appears that the small quantity of treated sewage which the Station will return to the river will produce a negligible impact on the river. It is expected that there will be no effect on surrounding groundwater due to discharges from the Station to the Susquehanna River. This is because groundwater levels are higher on either shore of the river with hydraulic gradients sloping toward the river. In order for groundwater to move from TMI to the mainland it would be necessary to reverse the hydraulic gradient on the mainland.

* See Appendix B for Susquehanna River Water Quality Data at TMI.

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Table 11. Summary of Average Incremental Concentrations of Dissolved Salts in the Susquehanna River Due to Operation of the Station

		Concentrations (mg/1)	
		Well Mixed in River	
Continuous Discharges	In Cooling Water Effluent	Minimum River Flow	Normal River Flow
Sulfates due to H_2SO_4 additions to cooling tower circuit (as SO_4)	28	1.3	0.1
Concentrated river dissolved salts in cooling tower blowdown	107	5	0.4
Sub-total	135	6.3	0.5
Additional Intermittent Discharges			
Unit 2 condensate polisher*			
SO_4	30	1.4	0.13
Na	14	0.7	0.07
Total	179	8.4	0.7

*There are additional intermittent discharges from the unit 1 and 2 water treatment demineralizers; however, since the concentrations are less and the Applicants have indicated that only one batch of waste will be released at a time, the maximum values occur during the discharge of the condensate polisher wastes.

C. BIOLOGICAL IMPACT

1. Terrestrial Ecosystem

The plant community on the island is not unique. It is less than 80 years old and resembles many others in the region, so its removal or disturbance by construction of the Station has not destroyed anything of remarkable economic, aesthetic, or educational value.

The proposed conversion of the plant community into a recreation area with marina, playing fields, roads, parking areas, comfort stations, etc., and the accompanying people, could have a greater effect on the ecosystem than construction or operation of the Station. The impact of Station operation on the terrestrial ecosystem will not be ascertainable from studies on Three Mile Island itself because the proposed recreation area will itself cause extensive alteration of the natural vegetation resulting in what appears to be[19] a tree/meadow park development. For this reason, the suggested monitoring program should be located in the nearest possible forested area such as on one of the adjacent islands owned by the Applicant.

a. Cooling Tower Impacts

The physical size and presence of the towers have been of some concern as a possible source of harm to migrating birds. However, in the two years since two of the towers have been built, no bird fatalities have been noted. Tower collisions have most often occurred during migration in association with a complex of meteorological conditions leading to low overcast, fog, and greatly reduced visibility The greatest mortalities have occurred at night at lighted towers, brightly lit buildings (e.g., formerly at the Empire State Building), and airport ceilometers. One report[25] indicates that red navigation lights may cause confusion among migrating birds resulting in impact under conditions of poor visibility. Because this type of nighttime lighting is used on the cooling towers at TMI, the Applicants should monitor the base of the cooling towers during periods of peak migration under conditions of limited visibility to assess this impact.

During operation of the cooling towers, moisture is discharged into the atmosphere. Since drift is essentially equivalent to spraying five-fold concentrated river water over the surrounding countryside, it is considered in assessing impacts because:

1. High content of dissolved solids in the water tends to increase the osmotic pressure of the soil solution, thereby rendering water less available for plant growth.

2. The water may contain elements that are toxic to plants at certain concentrations.

3. The water may contain certain elements that impair soil quality, directly or indirectly (pollutants).

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Studies of natural salt fallout have been based on fallout from sea water and the application of salt to roads for snow melting.

Highway salting research has shown that applications of 500 to 1,000 lbs./acre/year can be detrimental to vegetation, depending on conditions of leaching. In Connecticut, leaching removes salt applied at the rate of 1000 lbs./acre/year by April 1.[11] Such comparisons are somewhat misleading, however, because highway application is concentrated in a several month period while drift occurs at a low rate over a longer period. Moreover, the chemical composition of the two differs, with highway salt consisting mostly of chlorides.

At the Station, with 0.03% drift, and with an extremely conservative assumption of fallout over an area within a one-mile radius of the Station, about 270 lbs./acre/year of sulfate and 54 lbs./acre/year of chloride from a total salt fallout of 600 lbs./acre/year would be expected to fall. Much of this would fall into the river. Actually, the value would be less because dispersal is over a greater area. Nearby farms could be affected. However, because of the buffering capacity of the soil, it is unlikely that soil pH would be affected by the sulfate.

Table 12 indicates total anion deposition on area soils using extremely conservative calculations. More realistic but less conservative assumptions would result in an increment from drift, several orders of magnitude lower. Even using these conservative estimates, the total increment from all sources is still well within accepted limits of no damage to vegetation, as is demonstrated in the last column of the table. Likewise copper addition to the soil will only be 1.08 lbs./acre over a 50-year period. This is less than 0.003 ppm when dissolved by precipitation, compared with a threshold irrigation water concentration[20] of 0.1 ppm.

The above cited concentrations should not cause damage to area soils or crops. Nevertheless, the Applicant should monitor both crop and natural vegetation for damage from salt drift in order to confirm the staff's appraisal.

2. Aquatic Ecosystem

A major concern of fishermen and fisheries specialists is the effect the water intake may have on fish. The design of the screened intake (Sect. III-D) is expected to minimize fish entrainment because of the low velocity (0.2 ft/sec) of the water entering the intake. All but the smallest fish should be able to avoid being trapped by the inflow. However, since there is more than a 30 foot distance from the intake orifice to the trash rack, a small number of fish may enter the structure and be unable to find their way out. Monitoring should investigate this effect. The skimmer wall, designed to prevent the entrance of material floating near the water surface, may be of some value in reducing the intake of floating eggs, larval fish, or other organisms favoring the water near the surface of the stream as a habitat. However, predominant species in the fishery from which the cooling water is drawn (and to which it is returned) lay eggs in sheltered bottom areas.

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Table 12. Estimated Maximum Yearly Anion Increments to Soil near Station

Anion	Naturally Occurring in Rainwater[21]	Increment Due to Cooling Towers	Total	Minimal Conc. for Irrigation Water Demonstrating Damage[20]
SO_4	2.37 (upper value)	32	35	192
Cl	0.30 (upper value)	7	8	62
	(all figures ppm)			

*Assuming all drift deposited within one mile radius, and dissolved in normal year's precipitation.

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The plankton, small fish, and other small floating or swimming organisms that enter the cooling system circuits will be killed by the sodium hypochlorite added to the water of the cooling system. Since less that 1% of the river's flow passes through the Station under average flow conditions, and even under record low flow conditions, only about 7% of the river's flow would be used, plankton loss of the same relative proportion can be expected. Since the dead organisms are returned to the river, they can still be used as nutrients for fish production. It seems unlikely that this will significantly affect the fish population. The Applicants' monitoring program should quantify the effects of such entrainment.

Under normal operating conditions, the discharge will be in the 2-3°F range over ambient and will meet the maximum temperature criterion of the commonwealth of Pennsylvania set forth in Table 9. The best information available, because it is based on a similar species complex from a nearby geographical area, was performed in the Delaware River.[22] Examination of these data suggest that there should be no mortality associated with Station operation due to high temperature effects, at least for the species tested. In local areas of the water where there is a prolonged temperature shift, even if only of a few degrees, there may be a shift in comparative abundance of species, with perhaps some species near the limit of their preferendum disappearing.[23] This effect, however, will only be local and minimal because of the small thermal increment, and because of the small size of the thermal plume relative to the river area. However, in light of the postulated presence of toxins in the water[33] as mentioned in II-F-2, if these toxins are affecting the fish population, it appears likely that increased environmental temperatures will augment their impact.[34]

Data from the Delaware River[37] lead one to expect that the effects of the heated discharge on benthic organisms will be minimal and local. There may be change in the periphyton community toward blue-green algae and diatoms of the family Fragillariaceae with, once again, no wide ranging consequences. These changes will only occur if the discharge plume touches bottom for an extended period.

The Applicants have provided information concerning a set of unusual circumstances which will result in a temperature differential of up to 19°F in winter (Section III-D). While specific information to make a definitive prediction is lacking, data on 45°F acclimated fish appear able to withstand temperature increments of more than 20°F.[22] It appears reasonable that fish acclimated to water ten or more degrees colder than this experimental temperature would have a similar absolute difference between acclimation and lethal temperatures. In any case, the time to lethality is never less than 19.5 hours which is ample time not only for the fish to leave the plume and return to their preferenda, but also for the Station to resume normal operation. Other observers agree that rapid temperature changes of 20°F can generally be tolerated by warm water fishes so long as the upper lethal limit is not exceeded.[36] Diseased fish, however, are somewhat susceptible to lethal effects under these conditions. Consequently, it is concluded that unusual operating conditions will not harm healthy fish, but might result in the death of some which are already diseased.

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deleterious effects result from such unusual Station operation, as determined from the monitoring program, corrective action should be taken. Similarly, corrective action should be taken to minimize the effects of winter shutdown. The increment of temperature by the discharge over river ambient should not cause mortality during shutdown, but if mortality occurs, the monitoring program should detect it.

Probably some fish will be attracted to the warmer discharge in all months.[22] Such concentration may result in increased predation, disease, and l... of condition. Such effects will be ascertainable from the fish monitoring program. If the monitoring program indicates deleterious effects on the fishery, corrective action should be taken.

Major chemical wastes are sodium sulfate and residual chlorine (Sect. V.B.). The sodium sulfate discharged would increase the sulfate in the river downstream from the Station by about 0.4 mg/l during normal river flow and up t... 5 mg/l under low flow conditions. Normal variations in the sulfate content of the water have been far greater than this. We do not have data on tolerances of sunfish and catfish, but ninety-six hour toxicity limits for fathead minnows are 13,500 ppm sodium sulfate in hard water and 9,000 ppm in soft water.[24] A change from 100 mg/l present in the river on the average to 100.4 or 105 mg/l does not appear significant.

The Applicants propose intermittent discharges of total residual chlorine of 0.3 ppm or less, to be produced by chlorination of 15 minutes, 3-4 time... per day. This figure exceeds EPA recommendations[25] of "A. 0.1 ppm <u>not to exceed</u> 30 minutes per day and B. 0.05 ppm <u>not to exceed</u> 2 hours per day." This recommendation is based upon an extensive review of the literature[27] which further notes: "However, there is a minimal, as yet, amount of data that indicate the possible necessity of lowering the intermittent concentration recommendations."

The Applicants, in their response to Agency comments, in part justify the residual chlorine release level on literature values for toxic effects on aquatic organisms. It must be noted that the fact that one or many organisms may not be singly affected by a toxin does not preclude ecosystem damage because of toxic effects on other of its members. Moreover, the observation has been made[27] that much of the older literature is based upon inadequate experimental design.

The National Water Quality Staff explicitly makes the point that:[25] "T... recommendations for discontinuous total residual chlorine in fresh water are on less firm ground due to the scarcity of data on toxic effects during a few minutes to a few hours of exposure". However, they continue: "Probably the mos...

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pertinent data were developed by the Michigan Water Resources Commission. They observed erratic swimming by fish of several species in a power plant discharge canal within 6 minutes of the initiation of chlorination by the plant. At this time the total residual chlorine was 0.09 (Truchan, 1971).[26] After 15 minutes there were dead fish at a total chlorine residual of 0.28 ppm." Some other adverse effects mentioned[27] at the levels predicted by the Applicants are gross reduction of fish species diversity and a reduction of plankton photosynthesis.

The fact that salmonids will avoid a chlorine discharge[28] is sometimes offered as a justification of excess chlorine level in discharge on the basis that the fish will avoid potentially toxic situations. This argument is inadequate because (1) Fish in the plume may be poiso..d at the onset of chlorination as mentioned above, (2) The sensory response of salmonids has not been demonstrated in other fish, and (3) Even in the salmonids, there are some toxic concentrations referred to as sensory traps which are attractive to the fish.

It is consequently anticipated that chlorination at the levels stated by the Applicants may result in notable mortality of fish, as well as more subtle effects such as changing the aquatic community's composition and productivity.

Accordingly, the staff recommends that chlorine levels be limited to 0.1 ppm at the point of discharge in order to meet the EPA water quality recommendations of 0.05 ppm (for discharges up to 2 hours per day) for receiving waters. If this concentration exceeds 0.1 ppm the Applicants should take all practical measures to reduce it below this value. Should these efforts fail, the Applicants should determine the extent of the zone in the river within which the total residual chlorine concentration exceeds the EPA recommended criteria. The Environmental Technical Specifications will define a monitoring program for chlorine to insure compliance with the staff's recommendations.

3. Biological Monitoring Program

a. Terrestrial

The Applicants have not made preoperational terrestrial surveys which will be useful in assessing effects of Station operation. Since no assessment of impact on the terrestrial ecosystem is possible in the absence of such study, the staff recommends that a study be initiated. A forested area typical of the region should be selected as close to the Station as possible, possibly on Shelley Island if this a pears suitable. This recommendation does not preclude the use of a re remote area to serve as a control.

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b. Aquatic

Annual biological surveys of the Susquehanna River in the vicinity of Three Mile Island were begun in 1967 for the Applicants by Dr. Charles B. Wurtz, Philadelphia, Pennsylvania, a consulting biologist with more than 20 years experience in the study of effects of discharges on aquatic ecosystems. The Applicants have planned to continue these studies into the post-operational period . Macroinvertebrate fauna (bottom organisms) are studied at a series of sampling stations extending from above Three Mile Island downstream to the Haldeman Riffle. Water quality characteristics are also monitored at the same stations. The variability in species diversity found from year to year during the pre-operational periods constitutes the pre-existing milieu in which interpretation of future effects of the Station must be made. This program appears adequate and should be continued.

In addition to the Wurtz survey, an expanded survey is being undertaken by Dr. G. Hoyt Whipple of the School of Public Health, University of Michigan, aided by personnel from Millersville State Teachers College.

The survey consists of the following:

1. A fish population study to determine population density, number of species, and condition factors.
2. A study of macro and microinvertebrate fauna in the water and sediments to determine composition, relative abundance, and general distribution.
3. An analysis of the area for some twenty chemical elements (stable isotopes) in conjunction with the biological phases of the survey. The objective of the stable isotope study is as follows:
   a. To "map" the area with respect to the distribution of the elements in the water sediments, suspended material, and living organisms.
   b. To develop a routine sampling program that will represent the area.
   c. To determine areas of high and low inputs of these elements and the concentration gradients in those locales relative to Three Mile Island.
   d. To determine the ratios of some of the elements in the water, sediments and indicator organisms.
   e. To attempt to correlate the data obtained in the stable isotope study with the biological population data from the the other phases of this survey.

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The Staff finds the Applicants' monitoring program deficient in several respects, especially sampling station locations, frequency of data collection and reporting, and methodology of sampling and analysis. Full details of a final biological monitoring program acceptable to the Staff will be specified in the Environmental Technical Specifications.

If significant changes in the ecology of the river are made at a future date, such as reintroduction of the shad or major changes in water chemistry, the Applicant should submit to the Staff an estimate of environmental impact of plant operations in the light of such changes, and propose a course of action to minimize such impact.

4. Radiation Dose to Species Other than Man

Terrestrial organisms in the environs of the plant would receive approximately the same radiation doses as those calculated for man. Aquatic organisms living in water containing released radionuclides will also be expected to receive radiation doses. Using the bioaccumulation factors given in Table 13, and assuming an additional dilution of 100 for the radioisotopes in the Susquehanna River, fish and aquatic invertebrates will each receive about 5 mrads/yr.

At this time, no guidelines for radiation exposure to biota have been established. Many investigations have been performed at higher dose rates than the above calculated values. However, no organisms have shown detectable sensitivity to radiation levels expected around the plant.[29]

Thus, it is concluded that no detectable adverse effects are expected on biota as a result of the radionuclide release from the Three Mile Island site.

D. RADIOLOGICAL IMPACT OF ROUTINE OPERATION

1. Introduction

In the operation of nuclear power reactors, radioactive material is produced by fission and by neutron-activation reactions of metals and material in the reactor system. Small amounts of gaseous and liquid radioactive wastes enter the waste streams which are monitored and processed within the plant to minimize the amount of radioactive nuclides that will ultimately be released. The gaseous and liquid wastes will be released to the atmosphere and to the Susquehanna River, respectively, at low concentrations under carefully controlled conditions. The quantity of radioactivity that is released to the environment will be a small fraction of the limits set forth in 10 CFR Part 20 of the Commission's Regulations, and the amounts will be kept as low as practicable in accordance with 10 CFR Part 50.36a. These regulations apply to the combined releases from all systems connected with both Units 1 and 2. The Staff has made calculations of the radiation dose using the estimated release rates of

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TABLE 13

BIOACCUMULATION FACTORS FOR RADIONUCLIDES
IN FRESH WATER SPECIES*

Radionuclides	Fish	Invertebrates
Rh	2,000	2,000
Sr	40	700
Y	100	1,000
Zr	100	1,000
Nb	30,000	100
Mo	100	100
Ru	100	2,000
Rh	100	2,000
Sb	40	16,000
Te	400	150
I	1	25
Cs	1,000	1,000
Ba	10	200
Ce	100	1,000
Pr	100	1,000
Nd	100	1,000
Pm	100	1,000
Sm	100	1,000
H	1	1
Cr	200	2,000
Mn	25	40,000
Fe	300	3,200
Co	500	1,500
Ni	40	100
Zn	1,000	40,000
Ag	3,000	3,000

* UCRL-50564, Lawrence Radiation Laboratory, "Concentration Factors of Chemical Elements in Edible Aquatic Organisms, Wm. H. Chapman, H. Leonard Fisher, Michael W. Pratt, Dec. 30, 1968.

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radionuclides listed in Tables 4, 5, 6 and 7 using stated assumptions relative to dilution, biological reconcentration in food chains, and use factors by people.

2. Radioactive Materials Released to the Atmosphere

The most significant radiation dose to the public will result from the radionuclides in the gaseous effluents from the plant. The radioactive materials released to the atmosphere are principally the fission-product noble gases, krypton and xenon. Nearly all of the dose received by persons living, working or using recreational facilities in the vicinity of the plant will result from radioactive krypton and xenon in the air surrounding the individual. The postulated gaseous effluents from the plant are listed in Tables 4 and 5. We have calculated the potential annual doses using averages for meteorological conditions and assuming releases of the listed isotopes at a constant rate.

During normal operation of the plant at full power, the maximum dose rate due to cloud immersion at the plant's exclusion boundary on the river bank (2170 ft. ESE) where the $X/Q = 9.1 \times 10^{-6}$ sec/m^3, is calculated to be about 0.72 mrem/yr while the dose at the nearest community (Goldsboro, 1-1 2 miles W) is less than 0.10 mrem/yr. The annual dose (outside) at the nearest home (2340 ft. E, $X/Q = 4.8 \times 10^{-6}$ sec/m^3) is estimated to be 0.38 mrem/yr. However, a higher dose of 0.58 mrem/yr will be received at another home located 2460 ft. ESE, where a higher X/Q of 7.4×10^{-6} sec/m^3 is calculated. Assuming an occupancy of 3 months annually, the total body dose to campers at Beach Island (2080 ft. SW) and Shelley Island (2000 ft. W), both normally uninhabited, would be about 0.52 mrem/yr and 0.14 mrem/yr, respectively. The dose also based upon three months per year occupancy, at the proposed recreational area at the southern end of Three Mile Island will range from about 0.10 mrem/yr at a point near York Haven Dam (3500 ft. S) to about 0.05 mrem/yr at the southern tip of the Island (8500 ft. S). A fisherman, pleasure boater or sunbather who spends 500 hours per year just outside the exclusion line at the nearest point on Shelley Island would receive less than 0.04 mrem/yr due to gaseous effluents. Higher doses, of course, would be received by a fisherman, swimmer, or boater who inadvertently violated the plant exclusion circle. For example, at a shore on Three Mile Island nearest the plant (inside the exclusion circle 830 ft. SW, where the X/Q is as high as 1.4×10^{-4} sec/m^3), a fisherman or boater spending 500 hours per year would receive about 0.63 mrem/yr from gaseous effluents.

Based on an annual release rate of 0.25 Ci/yr of iodine-131, the thyroid dose due to inhalation would be less than 1.1 mrem/yr at the exclusion line (2170 ft. ESE), less than 0.9 mrem/yr at the nearest home, 0.3 mrem/yr at the nearest town (Goldsboro) and 0.7 mrem/yr at the proposed recreation area (3500 ft. S).

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Radioactive iodine may be ingested by milk cows after deposition in grazing areas. Radiation exposure to the thyroid gland can result from drinking milk from these cows. A liter of milk consumed daily from a cow grazing five months per year at the nearest dairy farm (1-1/2 miles ESE, $X/Q = 1.6 \times 10^{-6}$ sec/m^3) would result in a calculated dose to an infant's thyroid of about 19 mrem/yr. Monitoring, administrative measures and/or design changes will be required to insure that the actual dose does not exceed 5 mrem/yr.

If in the future a cow is located closer to the plant than at present the Applicant will be required to evaluate the thyroid radiation doses likely to result from consumption of milk produced at the new location, and to take whatever steps are necessary to assure that these doses will be compatible with the then-existing limits for human exposure.

3. Radioactive Materials Released to Receiving Water

During normal operation of the plant, the liquid radwaste effluent will be combined with the forced draft cooling tower blowdown before release into the Susquehanna River. Calculation of radiation doses from radionuclides released into the liquid effluent requires estimating the concentrations of these radionuclides at the point of discharge. A nominal flow rate of 36,000 gallons per minute (80 cfs) for the cooling tower blowdown was used to calculate the liquid radwaste dilution in the discharge canal. The river flow ranges from a low of 1,600 cfs to a maximum flood level of 740,000 cfs with an average annual flow of 34,000 cfs. Thus, an additional factor of 100 was conservatively assumed in order to estimate the effluent dilution after mixing with the river water.

The principal pathways leading to exposure doses to man are drinking water from the river, consuming fish and invertebrates caught in the river, and swimming, boating, and picnicking in or on the shore of the river. Bioaccumulation factors used to calculate doses from fish and invertebrate consumption are listed in Table 11. The doses to individuals resulting from the previously mentioned pathways are calculated using the estimated annual nuclide liquid releases given in Table 6 and dilution factors described above. In addition, it was assumed that each person drinks 1,200 cc of water per day, consumes 20 grams of fish per day, 5 grams of invertebrates per day, swims 100 hours per year, and goes boating and picnicking on the shoreline for 500 hours per year. A delay of twenty-four hours is assumed between release and consumption. No delay factor is considered for recreational use. The results of the individual dose calculations are summarized in Table 14.

4. Radioactive Materials Stored on Site

The dose contribution at and beyond the site boundary due to radioactive storage areas on site is expected to be negligible.

5. Population Doses From All Sources

Values of the cumulative dose to the population from gaseous effluents based on 1970 census figures are listed in Table 15 for various distances from the Station. The combined dose to all individuals living within fifty miles of the Station (1,868,000) from exposure to radioactive gaseous effluents is

TABLE 14

ANNUAL DOSES AT EQUILIBRIUM CONDITIONS
TO INDIVIDUALS AT VARIOUS LOCATIONS

LOCATION	PATHWAY	DOSE (MREM/YR) GI TRACT	THYROID	TOTAL BODY
Exclusion Boundary (2170' ESE)	Cloud	—	1.1	0.72
Residence[1] (2340' E)	Cloud	--	0.62	0.38
Residence[1] (2460' ESE)	Cloud	--	0.83	0.58
Goldsboro (nearest town 1.5 miles W)	Cloud	—	0.15	0.10
Three Mile Island Recreation Area[2] (3500' S)	Cloud	—	0.15	0.10
Shelley Island (2000' W)	Cloud	--	0.21	0.14
Dairy Farm[3] (1.5 miles E)	Cloud, Ingestion of milk	--	18.5	0.13
Susquehanna River	Drinking water	0.009	0.50	0.025
	Fish Consumption	0.010	0.010	0.14
	Invertebrate Consumption	0.003	0.050	0.034
	Swimming	—	—	0.0001
	Picnicking and fishing on shoreline	--	—	0.041

[1]No shielding was assumed.
[2]Dose calculation assumes an occupancy of 3 months per year.
[3]Dose to a child's thyroid based on consuming one liter of milk daily from a cow grazing five months per year at that particular farm.

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TABLE 15

CUMULATIVE ANNUAL POPULATION DOSE AND AVERAGE DOSE FROM GASEOUS EFFLUENTS TO THE POPULATION UP TO 50 MILES FROM THE STATION

Radius (miles)	Cumulative Population*	Cumulative Dose (man-rem/yr)	Average Individual Dose (mrem/yr)
1	580	0.050	0.086
2	2,350	0.12	0.049
3	9,000	0.23	0.025
4	17,300	0.29	0.017
5	24,500	0.34	0.014
10	136,400	0.76	0.0056
20	621,300	1.43	0.0023
30	995,200	1.79	0.0018
40	1,235,000	1.85	0.0015
50	1,863,000	2.05	0.0011

*Based on 1970 Census Data given in Three Mile Island Environmental Report, Operating License Stage.

estimated to be 2.1 man-rem per year. It was assumed that 5 percent of this total population would be exposed while fishing, boating or picnicking in the immediate vicinity of the plant.

The dose from ingesting fish and invertebrates was estimated by assuming that 10 percent of the total population within a fifty mile radius of the Station obtained 25 percent of this intake from the Susquehanna River. Thus, the effective exposed population via this pathway is 47,000. The combined annual population dose via the drinking water, fish, invertebrate, recreation and transportation (of nuclear fuel and solid radioactive waste) pathways is calculated to be 31 man-rem.

The population dose from all of the above pathways is summarized in Table 16.

6. Radiological Environmental Monitoring

The Applicants' proposed radiological monitoring program is based on consideration of potential radiation sources from the Station and potential modes of radioactive material transport in air, water and food. The environmental radiation monitoring program is divided into three preparatory phases followed by an operational phase. The program is described in detail in pages 5.5-6 through 5.5-10 of the Applicants' 1971 Environmental Report (operating license stage). The tentative schedule for postoperational environmental monitoring is listed in Table 17.

Measurements are being made of the ratios of stable element concentrations in river fish compared to river water to determine biological concentration factors in the water-fish-man pathway. Studies have been made for the selection of sampling station locations and the type of samples to be taken. In addition, sediment, fish, soil, vegetation, airborne dust, airborne iodine precipitation, and external radiation will be measured as indicated in Table 15. Two terrestrial pathways are under consideration. They involve the air-pasture-cow-milk-child pathway and the river-irrigation-crop-human pathway for the liquid radioactive wastes.

The Commonwealth of Pennsylvania is also conducting an environmental monitoring program, under partial AEC sponsorship, at three plant sites: Three-Mile Island, Saxton, and Peach Bottom. This program is summarized in Table 18.

7. Evaluation of Radiological Impact

Using conservative estimates, the annual total man-rem dose from all pathways received by the approximately 1,868,000 people who live within a fifty-mile radius of the plant would be about 31 man-rem. By comparison, an annual total of about 233,000 man-rem to the same population results from an annual average natural background dose of 0.125 rem in the Commonwealth of Pennsylvania.

TABLE 16

ANNUAL DOSE TO THE GENERAL POPULATION
FROM THE OPERATION OF THE THREE MILE ISLAND PLANT

Pathway	Exposed Population	Cumulative Dose (man-rem/yr)
Cloud Immersion	1,868,000	2.1
Drinking Water	200,000	5.0
Ingestion of Fish	47,000	6.6
Ingestion of Invertebrates	47,000	1.6
Recreation:		
Swimming	93,000	>0.1
Fishing and Picnicking	93,000	3.8
Transportation of Nuclear Fuel and Solid Radioactive Waste	400,000	12.0
	TOTAL	~31

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TABLE 17. Tentative Schedule for Post-Operational Environmental Monitoring†

	NUMBER OF		REGIME		
	Indicator Stations	Background Stations	I	II	III
Air	6	6	C-1	C-1	C-1
Precipitation	6	6	C-13	C-4	C-4
Radiation	30	10	F-4	F-4	F-4
Milk	4	2	G-13	G-4	G-1
Crops**	2	1	G-13	G-13	G-4
River Water	2	1	C-13	C-4	C-1
Sediment*	2	1	P-13	P-13	P-4
Columbia Intake	1	-	C-13	C-4	C-1
Clams or Snails*	2	1	G-13	G-13	G-4
Fish	1	1	G-13	G-13	G-4
Aquatic Plants*	2	1	G-13	G-13	G-4

Key: C-1 (C-4, C-13): Collect continuously for 1 week (4 weeks, 13 weeks) and analyze.

F-4: Film badge or TLD exposed for 4 weeks and read.

G-1 (G-4): Grab sample taken at 1-week (4-week) intervals and analyzed.

P-4 (P-13): Underwater gamma scintillation scan at 4-week (13-week) interval.

G-13: A grab sample taken 3 times a year (spring, summer, and fall) at approximately 13-week intervals and analyzed.

* Still under investigation.

** Types of crops and related appropriate sampling times will be determined during phases 2 and 3 of the program.

† From TMI E.R. 1971.

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TABLE 18

SAMPLING AND ANALYTICAL REQUIREMENTS FOR THE INDEPENDENT MEASUREMENTS PROGRAM AT SELECTED SITES WITHIN THE COMMONWEALTH OF PENNSYLVANIA

	MEDIUM	OPERATIONAL REACTORS				NONOPERATIONAL REACTORS		
		SAMPLE LOCATION	SAMPLING FREQUENCY	FREQUENCY OF ANALYSES	ANALYSES	SAMPLING FREQUENCY	FREQUENCY OF ANALYSES	ANALYSES
ONSITE	LIQUIDS	WASTE TANK	QUARTERLY GRAB (BEFORE DISCHARGE)	QUARTERLY	GAMMA ISOTOPIC GROSS BETA STRONTIUM 90 TRITIUM	——	——	——
		DISCHARGE CANAL	QUARTERLY GRAB (DURING DISCHARGE)	QUARTERLY	GAMMA ISOTOPIC GROSS BETA TRITIUM	——	——	——
	AIR	GAS-STACK OR HOLDUP TANK	QUARTERLY GRAB	QUARTERLY	GAS ISOTOPIC TRITIUM(HTO,T_2)	——	——	——
		CHARCOAL FILTER-STACK	QUARTERLY GRAB	QUARTERLY	IODINE	——	——	——
		PARTICULATES	QUARTERLY	QUARTERLY	CESIUM 134,137 BA-LA 140 STRONTIUM 90	——	——	——
OFFSITE	LIQUIDS	1-UPSTREAM 2-DOWNSTREAM	MONTHLY GRAB	MONTHLY	GAMMA ISOTOPIC GROSS BETA TRITIUM	QUARTERLY	QUARTERLY	GAMMA ISOTOPIC GROSS BETA TRITIUM
	AIR PARTICULATE	1-AT OFFSITE MAX. CONC. 1-BACKGROUND	WEEKLY (FILTER CHANGE)	QUARTERLY (COMPOSITE)	CESIUM 134,137 BA-LA 140 STRONTIUM 90	WEEKLY (FILTER CHANGE)	QUARTERLY (COMPOSITE)	CESIUM 134-137 BA-LA 140 STRONTIUM 90
	TLD DOSE	6-STATIONS AT SITE 1-BACKGROUND	QUARTERLY EXPOSURE	QUARTERLY CHANGEOUT	READOUT	——	——	——
	FOOD MILK & FISH	LOCAL (FARMS & STREAMS)	QUARTERLY (SPRING, SUMMER, FALL)	QUARTERLY	CESIUM 134,137 STRONTIUM 90 I-131(MILK ONLY)	QUARTERLY (SPRING, SUMMER, FALL)	QUARTERLY	CESIUM 134-137 STRONTIUM 90 I-131(MILK ONLY)

Operation of the plant will contribute only an extremely small increment of the radiation dose that persons living in the area normally receive from natural background radiation. Normal fluctuation of the natural background dose is expected to exceed the small dose increment contributed by the plant. Thus, the incremental increase will be difficult if not impossible to measure and will constitute no meaningful risk.

E. TRANSPORTATION OF NUCLEAR FUEL AND SOLID RADIOACTIVE WASTE

The nuclear fuel for the two reactors at Three Mile Island near Harrisburg, Pennsylvania, is slightly enriched uranium in the form of sintered uranium oxide pellets encapsulated in zircaloy fuel rods. Each year in normal operation, about 60 fuel elements are replaced in each unit.

The Applicants have indicated that cold fuel for the reactors will be transported by truck from Lynchburg, Virginia. The Applicants have not indicated where the irradiated fuel or solid wastes will be shipped, but they did indicate irradiated fuel will be transported by rail and solid wastes by truck. The staff assumed a distance of 800 miles for shipping the irradiated fuel and 600 miles for shipping the solid radioactive wastes.

1. Transport of Cold Fuel

The Applicants have indicated that cold fuel will be shipped in AEC-DOT approved containers which hold two fuel elements per container. About 10 truckloads of 6 containers each will be required each year to meet the needs of both reactors for replacement fuel.

2. Transport of Irradiated Fuel

Fuel elements removed from the reactor will be unchanged in appearance and will contain some of the original U-235 (which is recoverable). As a result of the irradiation and fissioning of the uranium, the fuel element will contain large amounts of fission products and some plutonium. As the radioactivity decays, it produces radiation and "decay heat." The amount of radioactivity remaining in the fuel varies according to the length of time after discharge from the reactor. After discharge from a reactor, the fuel elements are placed underwater in a storage pool for radioactive decay and cooling prior to being loaded into a cask for transport.

Although the specific cask design has not been identified, the Applicants state that the irradiated fuel elements will be shipped after at least 4 months cooling period in approved casks designed for transport by rail. The cask will weigh perhaps 100 tons. To transport the irradiated fuel from both reactors, the Applicants estimate 15 rail carload shipments per year with 8 fuel elements per cask and 1 cask per carload. An equal number of shipments will be required to return the empty casks.

3. Transport of Solid Radioactive Wastes

The Applicants estimate that about 2740 cubic feet of solid radioactive wastes will be generated by the two reactors each year. Spent resins and evaporator bottoms will be solidified, and soft, solid wastes compacted in drums and 50 ft^3 containers for shipment and disposal. The Applicants estimate from 50 to 200 truckloads of wastes each year from the Station.

4. Principles of Safety in Transport

Protection of the public and transport workers from radiation during the shipment of nuclear fuel and waste is achieved by a combination of limitations on the contents (according to the quantities and types of radioactivity), the package design, and the external radiation levels. Shipments move in routine commerce and on conventional transportation equipment. Shipments are therefore subject to normal accident environments, just like other non-radioactive cargo. The shipper has essentially no control over the likelihood of an accident involving his shipment. Safety in transportation does not depend on special routing.

Packaging and transport of radioactive materials are regulated at the Federal level by both the Atomic Energy Commission (AEC) and the Department of Transportation (DOT). In addition, certain aspects, such as limitations on gross weight of trucks, are regulated by the States.

The probability of accidental releases of low level contaminated material is sufficiently small that, considering the form of the waste, the likelihood of significant exposure is extremely small. Packaging for these materials is designed to remain leakproof under normal transport conditions of temperature, pressure, vibration, rough handling, exposure to rain, etc. The packaging may release its contents in an accident.

For larger quantities of radioactive materials, the packaging design (Type B packaging) must be capable of withstanding, without loss of contents or shielding, the damage which might result from a severe accident. Test conditions for packaging are specified in the regulations and include tests for high-speed impact, puncture, fire, and immersion in water.[30]

In addition, the packaging must provide adequate radiation shielding to limit the exposure of transport workers and the general public. For irradiated fuel, the package must have heat-dissipation characteristics to protect against overheating from radioactive decay heat. For fresh and irradiated fuel, the design must also provide nuclear criticality safety under both normal and accident damage conditions.

Each package in transport is identified with a distinctive radiation label on two sides, and by warning signs on the transport vehicle.

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Based on recent accident statistics,[31] a shipment of fuel or waste may be expected to be involved in an accident about once in a total of 750,000 shipment-miles. The staff has estimated that only 1 in 10 of those accidents which involve Type A packages or 1 in 100 of these involving Type B packages might result in any leakage of radioactive material. In case of an accident, procedures which carriers are required[32] to follow will reduce the consequences of an accident in many cases. The procedures include segregation of damaged and leaking packages from people, and notification of the shipper and the Department of Transportation. Radiological assistance teams are available through an inter-Governmental program to provide equipped and trained personnel. These teams, dispatched in response to calls for emergency assistance, can mitigate the consequences of an accident.

5. Exposures During Normal (No Accident) Conditions

a. Cold Fuel

Since the nuclear radiations and heat emitted by cold fuel are small, there will be essentially no effect on the environment during transport under normal conditions. Exposure of individual transport workers is estimated to be less than 1 millirem (mrem) per shipment. For the 10 shipments, with two drivers for each vehicle, the total dose would be about 0.02 man-rem* per year. The radiation level associated with each truckload of cold fuel will be less than 0.1 mrem/hr at 6 feet from the truck. A member of the general public who spends 3 minutes at an average distance of 3 feet from the truck might receive a dose of about 0.005 mrem per shipment. The dose to other persons along the shipping route would be extremely small.

b. Irradiated Fuel

Based on actual radiation levels associated with shipments of irradiated fuel elements, we estimate the radiation level at 3 feet from the rail car will be about 25 mrem/hr.

Train brakemen might spend a few minutes in the vicinity of the car at an average distance of 3 feet, for an average exposure of about 0.5 millirem per shipment. With 10 different brakemen involved along the route, the cumulative dose for 15 shipments during the year is estimated to be about 0.03 man-rem.

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*Man-rem is an expression for the summation of whole body doses to individuals in a group. In some cases, the dose may be fairly uniform and received by only a few persons (e.g., drivers and brakemen) or, in other cases, the dose may vary and be received by a large number of people (e.g., 10^5 persons along the shipping route).

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A member of the general public who spends 3 minutes at an average distance of 3 feet from the rail car might receive a dose of as much as 1.3 mrem. If 10 persons were so exposed per shipment, the cumulative annual dose for the 15 shipments would be about 0.2 man-rem. Approximately 240,000 persons who reside along the 800-mile route over which the irradiated fuel is transported might receive an annual dose of about 0.3 man-rem. The regulatory radiation level limit of 10 mrem/hr at a distance of 6 feet from the vehicle was used to calculate the integrated dose to persons in an area between 100 feet and 1/2 mile on both sides of the shipping route. It was assumed that the shipment would travel 200 miles per day and the population density would average 330 persons per square mile along the route.

The amount of heat released to the air from each cask will be about 250,000 Btu's/hr. For comparison, 115,000 Btu's/hr is about equal to the heat output from the furnace in an average size home. Although the temperature of the air which contacts the loaded cask may be increased a few degrees, because the amount of heat is small and is being released over the entire transportation route, no appreciable thermal effects on the environment will result.

c. Solid Radioactive Wastes

The Applicants estimate that from 50 to 200 truckloads of solid radioactive wastes will be shipped to a disposal site per year from the two reactors. Under normal conditions, the individual truck driver might receive as much as 15 mrem per shipment. If the same driver were to drive 25 truckloads in a year, he could receive an estimated dose of about 400 mrem during the year. The cumulative dose to all drivers for the year, assuming 2 drivers per vehicle, might be from about 1.5 to 6 man-rem.

A member of the general public who spends 3 minutes at an average distance of 3 feet from the truck might receive a dose of as much as 1.3 mrem. If 10 persons were so exposed per shipment, the annual cumulative dose might be about 0.6 to 2.6 man-rem. Approximately 180,000 persons who reside along the 600-mile route over which the solid radioactive waste is transported might receive an annual cumulative dose of about 0.7 to 3 man-rem These doses were calculated for persons in an area between 100 feet and 1/2 mile on either side of the shipping route, assuming 330 persons per square mile, 10 mrem/hr at 6 feet from the vehicle, and the shipment traveling 200 miles per day.

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VI. ENVIRONMENTAL IMPACT OF POSTULATED ACCIDENTS

A. PLANT ACCIDENTS

A high degree of protection against the occurrence of postulated accidents in the Three Mile Island Nuclear Station, Unit 1 and Unit 2, is provided through correct design, manufacture, and operation, and the quality assurance program used to establish the necessary high integrity of the reactor system as will be considered in the Commission's Safety Evaluation for each unit. Deviations that may occur are handled by protective systems to place and hold the plant in a safe condition. Notwithstanding this, the conservative postulate is made that serious accidents might occur, in spite of the fact that they are extremely unlikely; and engineered safety features are installed to mitigate the consequences of these postulated events.

The probability of occurrence of accidents and the spectrum of their consequences to be considered from an environmental effects standpoint have been analyzed using best estimates of probabilities and realistic fission product release and transport assumptions. For site evaluation in the Staff safety review, extremely conservative assumptions were used for the purpose of comparing calculated doses resulting from a hypothetical release of fission products from the fuel against the 10 CFR Part 100 siting guidelines. The computed doses that would be received by the population and environment from actual accidents would be significantly less than those that will be presented in the Staff Safety Evaluations.

The Commission issued guidance to Applicants on September 1, 1971, requiring the consideration of a spectrum of accidents with assumptions as realistic as the state of knowledge permits. The Applicants' response is contained in "Environmental Report - Operating License Stage" for the Three Mile Island Nuclear Station, Unit 1 and Unit 2, dated December 10, 1971.

The Applicants' report has been evaluated using the standard accident assumptions and guidance issued as a proposed Annex to Appendix D of 10 CFR Part 50 by the Commission on December 1, 1971. Nine classes of postulated accidents and occurrences ranging in severity from trivial to very serious were identified by the Commission. In general, accidents in the high potential consequence end of the spectrum have a low occurrence rate, and those on the low potential consequence end have a higher occurrence rate. The examples selected by the Applicants for these classes are shown in Table 20. The examples selected are reasonably homogeneous in terms of probability with two exceptions. It was considered to be more appropriate to classify (1) the failure of the waste gas decay tank as an accident in Class 3 (Applicants use Class 8) and (2) the steam generator tube rupture as an accident in Class 5

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(Applicants use Class 8). The following assumptions made by the Applicants are questionable: (1) no steam generator tube leaks prior to the steam generator tube rupture are considered, (2) the primary coolant activity is based on 0.1% failed fuel, and (3) the consequences of various releases are evaluated based on release rates applicable for specified times. However, the use of alternative assumptions does not significantly affect overall environmental risks.

The postulated occurrences in Class 9 involve failures more severe than those required to be considered for the design basis of protection systems and engineered safety features. Their consequences could be severe. However, the probability of their occurrence is so small that their environmental risk is extremely low. Defense in depth (multiple physical barriers), quality assurance for design, manufacture, and operation, continued surveillance and testing, and conservative design are all applied to provide and maintain the required high degree of assurance that potential accidents in this class are, and will remain, sufficiently small in probability that the environmental risk is extremely low.

Staff estimates of the dose which might be received by an assumed individual standing at the site boundary in the downwind direction, using the assumptions in the proposed Annex to Appendix D, are presented in Table 20. Estimates of the integrated exposure that might be delivered to the population within 50 miles of the site are also presented in Table 20. The man-rem estimate was based on the projected population around the site for the year 2014. The estimates presented in Table 20 refer to a single unit.

To rigorously establish a realistic annual risk, the calculated doses in Table 20 would have to be multiplied by estimated probabilities. The events in Classes 1 and 2 represent occurrences which are anticipated during plant operation and their consequences, which are very small, are considered within the framework of routine effluents from the plant. Except for a limited amount of fuel failures and some steam generator leakage, the events in Classes 3 through 5 are not anticipated during plant operation; but events of this type could occur sometime during the 40-year plant lifetime. Accidents in Classes 6 and 7 and small accidents in Class 8 are of similar or lower probability than accidents in Classes 3 through 5 but are still possible. The probability of occurrence of large Class 8 accidents is very small. Therefore, when the consequences indicated in Table 20 are weighed by probabilities, the environmental risk is very low. The postulated occurrences in Class 9 involve sequences of successive failures more severe than those required to be considered in the design basis of protection systems and engineered safety features. Their consequences could be severe. However, the probability of their occurrence is so small that their environmental risk is extremely low. Defense in depth (multiple physical barriers), quality assurance for design, manufacture and operation,

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continued surveillance and testing, and conservative design all are applied to provide and maintain the required high degree of assurance that potential accidents in this class are, and will remain sufficiently small in probability that the environmental risk is extremely low.

Table 20 indicates that the realistically estimated radiological consequences of the postulated accidents would result in exposures of an assumed individual at the site boundary to concentrations of radioactive materials within or comparable to the Maximum Permissible Concentrations (MPC) of Table II of 10 CFR Part 20. The table also shows that the estimated integrated exposure of the population within 50 miles of the plant from each postulated accident would be orders of magnitude smaller than that from naturally occurring radioactivity, which corresponds to approximately 394,000 man-rem/yr based on a natural background level of 130 mrem/yr. When considered with the probability of occurrence, the annual potential radiation exposure of the population from all the postulated accidents is an even smaller fraction of the exposure from natural background radiation and, in fact, is well within naturally occurring variations in the natural background. It is concluded from the results of the realistic analysis that the environmental risks due to postulated radiological accidents are exceedingly small.

B. TRANSPORTATION ACCIDENTS

1. New Fuel

Under accident conditions other than accidental criticality, the pelletized form of the nuclear fuel, its encapsulation, and the low specific activity of the fuel limit the radiological impact on the environment to negligible levels.

The packaging is designed to prevent criticality under normal and severe accident conditions. To release a number of fuel assemblies under conditions that could lead to accidental criticality would require severe damage or destruction of more than one package, which is unlikely to happen in other than an extremely severe accident.

The probability that an accident could occur under conditions that could result in accidental criticality is extremely remote. If criticality were to occur in transport, persons within a radius of about 100 feet from the accident might receive a serious exposure but beyond that distance, no detectable radiation effects would be likely. Persons within a few feet of the accident could receive fatal or near-fatal exposures unless shielded by intervening material. Although there would be no nuclear explosion, heat

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TABLE 19

CLASSIFICATION OF POSTULATED ACCIDENTS AND OCCURRENCES

Class	AEC Description	Applicant's Example(s)
1	Trivial Incidents	None
2	Small Releases Outside Containment	Spill in Sample Hood
3	Radwaste System Failure	Inadvertent Release of Waste Gas De[illegible] Tank
4	Fission Products to Primary System (BWR)	Not applicable
5	Fission Products to Primary and Secondary Systems (PWR)	One day Operation with Primary Syst[illegible] Leak to Reactor Building Normal Operation with Steam Generat[illegible] Tube Leak and Release from Condens[illegible]
6	Refueling Accidents	Drop of Fuel Assembly or Drop of He[illegible] Object on Fuel Assembly
7	Spent Fuel Handling Accident	Drop of Fuel Assembly
8	Accident Initiation Events Considered in Design Basis Evaluation in the Safety Analysis Report	Uncompensated Operating Reactivity Changes Startup Accident Rod Withdrawal Accident Cold Water Accident Loss of Coolant Flow Accident Stuck-Out, Stuck-In, or Dropped Control Rod Accident Loss of Electric Load Accident Steam Line Failure Steam Line Leakage Steam Generator Tube Failure Rod Ejection Accident Loss of Coolant Accident Waste Gas Tank Rupture
9	Hypothetical Sequences of Failures More Severe Than Class 8	None

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TABLE 20

SUMMARY OF RADIOLOGICAL CONSEQUENCES OF POSTULATED ACCIDENTS

(Single Unit Only)

Class	Event	Estimated Fraction of 10 CFR Part 20 Limit at Site Boundary1/	Estimated Dose to Population in 50 Mile Radius, man-rem
1.0	Trivial incidents	2/	2/
2.0	Small releases outside containment	2/	2/
3.0	Radwaste system failures		
3.1	Equipment leakage or malfunction	0.073	10
3.2	Release of waste gas storage tank contents	0.29	40
3.3	Release of liquid waste storage tank contents	0.003	0.47
4.0	Fission products to primary system (BWR)	N.A.	N.A.
5.0	Fission products to primary and secondary systems (PWR)		
5.1	Fuel cladding defects and steam generator leaks	2/	2/
5.2	Off-design transients that induce fuel failure above those expected and steam generator leak	.002	0.23
5.3	Steam generator tube rupture	0.093	13

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TABLE 20 (cont'd)

Class	Event	Estimated Fraction of 10 CFR Part 20 Limit at Site Boundary[1/]	Estimated Dose to Population in 50 Mile Radius, man-rem
6.0	Refueling accidents		
6.1	Fuel bundle drop	0.015	2.1
6.2	Heavy object drop onto fuel in core	0.26	36
7.0	Spent fuel handling accident		
7.1	Fuel assembly drop in fuel storage pool	0.01	1.3
7.2	Heavy object drop onto fuel rack	0.038	5.3
7.3	Fuel cask drop	N.A.	N.A.
8.0	Accident initiation events considered in design basis evaluation in the safety analysis report		
8.1	Loss-of-coolant accidents		
	Small Break	0.16	40
	Large Break	1.2	1000
8.1(a)	Break in instrument line from primary system that penetrates the containment	N.A.	N.A.
8.2(a)	Rod ejection accident (PWR)	0.12	100
8.2(b)	Rod drop accident (BWR)	N.A.	N.A.
8.3(a)	Steamline breaks (PWR's-outside containment)		
	Small Break	<0.001	<0.1
	Large Break	<0.001	0.13

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TABLE 20 (cont'd)

Class	Event	Estimated Fraction of 10 CFR Part 20 Limit at Site Boundary[1/]	Estimated Dose to Population in 50 Mile Radius, man-rem
8.3(b)	Steamline breaks (BWR)	N.A.	N.A.

1/ Represents the calculated fraction of a whole body dose of 500 mrem or the equivalent dose to an organ.

2/ These releases will be comparable to the design objectives indicated in the proposed Appendix I to 10 CFR Part 50 for routine effluents (i.e., 5 mrem/yr to an individual from either liquid or gaseous effluents).

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generated in the reaction would probably separate the fuel elements so that the reaction would stop. The reaction would not be expected to continue for more than a few seconds and normally would not recur. Residual radiation levels due to induced radioactivity in the fuel elements might reach a few roentgens per hour at 3 feet. There would be very little dispersion of radioactive material.

2. Irradiated Fuel

Effects on the environment from accidental releases of radioactive materials during shipment of irradiated fuel have been estimated for the situation where contaminated coolant is released and the situation where gases and coolant are released.

(a) Leakage of contaminated coolant resulting from improper closing of the cask is possible as a result of human error, even though the shipper is required to follow specific procedures which include tests and examination of the closed container prior to each shipment. Such an accident is highly unlikely during the 40-year life of the plant.

Leakage of liquid at a rate of 0.001 cc per second or about 80 drops/hour is about the smallest amount of leakage that can be detected by visual observation of a large container. If undetected leakage of contaminated liquid coolant were to occur, the amount would be so small that the individual exposure would not exceed a few mrem and only a very few people would receive such exposures.

(b) Release of gases and coolant is an extremely remote possibility. In the improbable event that a cask is involved in an extremely severe accident such that the cask containment is breached and the cladding of the fuel assemblies penetrated, some of the coolant and some of the noble gases might be released from the cask.

In such an accident, the amount of radioactive material released would be limited to the available fraction of the noble gases in the void spaces in the fuel pins and some fraction of the low level contamination in the coolant. Persons would not be expected to remain near the accident due to the severe conditions which would be involved, including a major fire. If releases occurred, they would be expected to take place in a short period of time. Only a limited area would be affected. Persons in the downwind region and within 100 feet or so of the accident might receive doses as high as a few hundred millirem. Under average weather conditions, a few hundred square feet might be contaminated to the extent that it would require decontamination (that is, Range I contamination levels) according to the standards[1] of the Environmental Protection Agency.

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3. Solid Radioactive Wastes

It is highly unlikely that a shipment of solid radioactive waste will be involved in a severe accident during the 40-year life of the plant. If a shipment of low-level waste (in drums) becomes involved in a severe accident, some release of waste might occur but the specific activity of the waste will be so low that the exposure of personnel would not be expected to be significant. Other solid radioactive wastes will be shipped in Type B packages. The probability of release from a Type B package, in even a very severe accident, is sufficiently small that, considering the solid form of the waste and the very remote probability that a shipment of such waste would be involved in a very severe accident, the likelihood of significant exposure would be extremely small.

In either case, spread of the contamination beyond the immediate area is unlikely and, although local clean-up might be required, no significant exposure to the general public would be expected to result.

4. Severity of Postulated Transportation Accidents

The events postulated in this analysis are unlikely but possible. More severe accidents than those analyzed can be postulated and their consequences could be severe. Quality assurance for design, manufacture, and use of the packages, continued surveillance and testing of packages and transport conditions, and conservative design of packages ensure that the probability of accidents of this latter potential is sufficiently small that the environmental risk is extremely low. For these reasons, more severe accidents have not been included in the analysis.

5. Alternatives to Normal Transportation Procedures

Alternatives, such as special routing of shipments, providing escorts in separate vehicles, adding shielding to the containers, and constructing a fuel recovery and fabrication plant on the site rather than shipping fuel to and from the station, have been examined by the Staff on a generic basis. The impact on the environment of transportation under normal or postulated accident conditions is not considered to be sufficient to justify the additional effort required to implement any of the alternatives.

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References For Section VI

1. Federal Radiation Council Report No. 7 "Background Material for the Development of Radiation Protection Standards; Protective Action Guides for Strontium 89, Strontium 90 and Cesium 137." May 1965.

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VII. ADVERSE EFFECTS WHICH CANNOT BE AVOIDED

A. LAND USE

The prec se impact of the cooling towers on fogging and, hence, operations at the Harrisburg International Airport cannot be determined with certainty. As indicated, Applicants have estimated a maximum of 39 hours/year (involving 4 to 6 days/year) of potential fogging attributable to operation of the cooling towers. This is believed to be conservative, and that the actual effect will be less than this. The effect on commercial flight operations is minimized by the fact that the hours most likely to be affected by fogging (night and early morning) are a period of minimum activity at the airport. At the present time there is one commercial flight arriving daily after 10:00 p.m. and three arriving before 8:00 a.m. Although this picture could change in the future if commercial air traffic increases, it now appears that there would be at most 10 incoming flights per year that might be diverted to alternate airports as a direct result of cooling tower operation.

B. PHYSICAL APPEARANCE IN SURROUNDINGS

The question of the physical appearance of an industrial plant involves areas of judgment and opinion which are virtually impossible to quantify. The four large cooling towers at the station are imposing structures which significantly alter the appearance of the landscape. We can do no more at this time than suggest that some will judge this impact to be very adverse while others will consider it to be minimal. The number of persons now affected, however, is relatively small since the immediately surrounding area is predominantly rural. While this situation may change in the future, at least persons who do choose to take up residence near the Station will do so with full knowledge of the surroundings and environment they are choosing.

Likewise, the appearance of the transmission line towers is a subject which is likely to provoke a wide range of reaction among individuals. On the positive side, the Applicants have made attempts to minimize the impact by using special towers at visible points (such as highway crossings) which are more attractive than the ordinary towers. The impact of the transmission line towers lies primarily in their appearance, involving consideration of aesthetics, since land use in general is relatively unaffected by their installation.

C. SURFACE WATER

The aquatic ecosystem will be affected by passage of water through the cooling system and by chemical treatment. Viable plankton and larval forms of other organisms will be entrained in proportion to the amount of river flow used by the station. This will range from less than 1% under normal flow conditions to about 7% under low flow conditions. Most of the dead

organisms will be returned to the river as nutrients for the ecosystem. Downstream from the effluent discharge, species composition of benthic organisms may be altered because of the change in part of their energy source from living organisms to detritus. There may be local changes in fish populations due to direct temperature effects as well as from increased diseases and predation from indirect effects such as attraction to the discharge plume.

On an intermittent basis total residual chlorine concentrations in the Station effluent will be 0.3 ppm. Residual chlorine discharges at these levels will cause disturbances to the ecosystem in the immediate vicinity of the Station.

D. AIR

The presence of cooling tower plumes in the atmosphere is not considered to be detrimental to the general health and well being of surrounding inhabitants. Any effects, and they are believed to be minimal, would be in the nature of an occasional annoyance caused by shadows or a slight augmenting of natural fog. Since the prevailing winds at the Station are from the west and northwest, the plume would probably extend to the east of the site most frequently. Land in this direction is essentially rural with no population centers for a considerable distance; therefore the impact is expected to be minimal.

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VIII. SHORT TERM USES AND LONG TERM PRODUCTIVITY

The island property occupied by the Station, and the adjacent islands, are situated in a relatively picturesque part of the river valley that is bordered by forest land. This part of the river is classified by officials at the Commonwealth Fish Commission as a good sport fishing area. The best use of this land for the general population would be as recreational area, including cabin sites, boat docks, and picnic grounds. Neither the farm production nor the value of the land as a recreational site will necessarily be lost to future generations.

On a scale of time reaching into the future through several generations, the life span of the Station would be considered a short term use of the natural resources of land and water. The resource which will have been dedicated exclusively to the production of electrical power during the anticipated life span of the Station will be the land itself.

Approximately 200 acres of the site will be devoted to the production of electrical energy for the next 30 to 40 years.

At some future date, the TMI Station will become obsolete and be retired. Many of the disturbances of the environment will cease when the Station is shut down, and a rebalancing of the biota will occur. Thus, the "trade-off" between production of electricity and small changes in the local environment is reversible. Recent experience with other experimental and developmental nuclear plants has demonstrated the feasibility of decommissioning and dismantling such a plant sufficiently to restore its site to its former use. The degree of dismantlement, as with most abandoned industrial plants, will take into account the intended new use of the site and a balance among health and safety considerations, salvage values, and environmental impact.

No specific plan for the decommissioning of the TMI Station has been developed. This is consistent with the Commission's current regulations which contemplate detailed consideration of decommissioning near the end of a reactor's useful life. The licensee initiates such consideration by preparing a proposed decommissioning plan which is submitted to the AEC for review. The licensee will be required to comply with Commission regulations then in effect and decommissioning of the facility may not commence without authorization from the AEC.

To date, experience with decommissioning of civilian nuclear power reactors is limited to six facilities which have been shut down or dismantled: Hallam Nuclear Power Facility, Carolina Virginia Tube Reactor (CVTR), Boiling Nuclear Superheater (BONUS) Power Station, Pathfinder Reactor, Piqua Reactor, and the Elk River Reactor.

There are several alternatives which can be and have been used in the decommissioning of reactors: (1) Remove the fuel (possibly followed by decontamination procedures); seal the cap and pipes; and establish an exclusion area around the facility. The Piqua decommissioning operation was typical of this approach. (2) In addition to the steps outlined in (1), remove the superstructure and encase in concrete all radioactive portions which remain above ground. The Hallam decommissioning operation was of this type. (3) Remove the fuel, all superstructure, the reactor vessel and all contaminated equipment and facilities, and finally fill all cavities with clean rubble topped with earth to grade level. This last procedure is being applied in decommissioning the Elk River Reactor. Alternative decommissioning procedures (1) and (2) would require long-term surveillance of the reactor site. After a final check to assure that all reactor-produced radioactivity has been removed, alternative (3) would not require any subsequent surveillance. Possible effects of erosion or flooding will be included in these considerations.

Although the Applicants have not formulated plans for permanent shutdown of the Three Mile Island Station, they have estimated for Unit 1 that the cost of shutdown measures comparable to those for Hallam would not exceed $6,000,000 based on current dollar values, plus $50,000 per year to cover the cost of round-the-clock surveillance and periodic maintenance to fences and barriers. (Application for operating license as revised on May 26, 1971.)

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IX. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Numerous resources are involved in construction and operation of a major facility such as the TMI Station. These resources include the land upon which the facility is located, the materials and chemicals used to construct and maintain the Station, fuel used to operate the Station, and human talent, skill and labor.

Major resources to be committed irreversibly and irretrievably due to the operation of the Station is the uranium consumed by the reactor. Only that portion of the nuclear fuel which is burned up or not recovered in reprocessing is irretrievably lost to other uses. This will amount to approximately 48 metric tons of uranium-235 assuming a 30-year lifetime for the Station. Plutonium generated during the course of reactor operation will be recovered, and this plutonium could either be recycled in the plant and thus reduce the U-235 consumed or could be used elsewhere as nuclear fuel. Most other resources are either left undisturbed, or committed only temporarily as during construction or during the life of the Station and are not irreversibly or irretrievably lost.

Long-lived radioactive materials will be produced by fission of nuclear fuel in the core of the reactor and neutron activation of reactor parts near the core. The eventual disposal and storage of radioactive materials will require a certain amount of space, probably in an area remote from this Station for a very long period of time, and could for all practical purposes be considered as an irreversible commitment of resources.

Of the land used for Station buildings, it would appear that only a small portion beneath the reactor, control room, radwaste and the turbine-generator buildings would be irreversibly committed. Also, some components of the facility such as large underground concrete foundations and certain equipment are, in essence, irretrievable due to practical aspects of reclamation and/or radioactive decontamination. The degree of dismantlement of the Station, as previously noted, will be determined by the intended future use of the Site, which will involve a balance of health and safety considerations, salvage values, and environmental effects.

The use of the environment (air, water, land) by the Station does not represent significant irreversible or irretrievable resource commitments, but rather a relatively short-term investment. The use of chlorine at the levels anticipated by the Applicants will result in modification of the aquatic biota which will continue for the life of the Station. Accordingly, as discussed in Section V, the Staff recommends that the Applicants reduce the total residual chlorine in the Station's effluent to a maximum of 0.1 ppm during the chlorination periods. Other effects of Station operation will result in only minor and localized changes in the biota without anticipated long-term damage.

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Should an unanticipated significant detrimental effect to any of the biotic communities appear, the monitoring programs are designed to detect it, and corrective measures would then be taken by the Applicants.

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X. THE NEED FOR POWER

The Applicants are subsidiaries of GPU which is a holding company comprised of four utilities, operated as an integrated system. The GPU service area, shown in Fig. 15, extends from Lake Erie in Pennsylvania, at its western extremity, to the Atlantic Coast of New Jersey on the east, and includes more than half of the state of Pennsylvania. In the past decade or so, GPU has found it economically attractive to install modern mine-mouth, coal-fired plants in western Pennsylvania (Pennsylvania Electric area) and transmit sizable blocks of power to eastern load centers via high voltage transmission facilities. The more recent addition of new capacity at the eastern edge of the GPU service area in New Jersey close to eastern load centers, has produced a concentration of generating capacity at the eastern and western edges of the GPU service area. The location of the Station at Middletown (see Fig. 15) will tend to reduce the system dependence on this east-west transmission pattern and, therefore, will increase system reliability. The GPU system load demand is composed of: residential, 32.8; commercial, 19.7%; industrial, 41.9%; and miscellaneous, 5.6%.

The Applicants are members of the Pennsylvania, New Jersey, Maryland Interconnection (PJM) Power Pool which consists of the following companies:

- Atlantic City Electric Company,
- Baltimore Gas and Electric Company,
- Delmarva Power and Light Company,
- General Public Utilities System:
  - Jersey Central Power and Light
  - Metropolitan Edison Company
  - New Jersey Power and Light Company
  - Pennsylvania Electric Company,
- Pennsylvania Power and Light Company,
- Philadelphia Electric Company,
- Potomac Electric Power Company,
- Public Service Electric and Gas Company,
- UGI Corporation - Luzerne Electric Division.

The PJM Pool is operated from a central dispatch office at Valley Forge, Pennsylvania as a single system without regard to ownership of the facilities of member companies in meeting the overall load demand. There is frequent flow of interchange power between the member companies and they share in any required voltage reduction or curtailment of load. The PJM pool also maintains ties with neighboring power pools so that power may be interchanged on an emergency basis. The pool serves a population of about 20 million in a 48,000 sq mile area which includes 3/4 of Pennsylvania, most of New Jersey, more than half of Maryland, all of Delaware and the District of Columbia, plus a small part of Virginia. The total PJM capacity in 1971 was 31, 094 MWe.

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Figure 15 - GPU CORPORATION SYSTEM MAP

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The Applicants are also members of the Mid-Atlantic Area Coordinating Group (MAAC) which is one of nine regional groups of the National Electric Reliability Council. MAAC, composed of the same companies which comprise the PJM Pool, functions to set standards and to continually assess present and future plans which affect the reliability of the electric power service.

The projected GPU system load demand and generating capacity for the next decade is summarized in Table 21. The projected capacities required are based upon the system summer peak load plus a 20% reserve margin--this reserve margin having been adopted as the minimum desirable by the PJM Pool. As shown by the data in the Table, some purchase of power is planned for 1973, 1974, and 1975 to meet the peak summer load demand. The goal of 20% reserves (excluding the purchased power in 1974) is not met until the summer of 1975 when TMI-2 comes on line. The percentage reserve figures in the last two columns of Table 1 shows the effect of successive numbers of years delay for one or both TMI units. For example, if Unit 1 is delayed one year, the reserves drop to 7.5%; if Unit 1 is delayed two years and Unit 2 is delayed one year, reserves are 2%; if Unit 1 is delayed three years and Unit 2 is delayed two years, reserves are -0.5%; etc.

No utility in the power pool would be able to provide large blocks of firm power when it is needed by GPU. On a short term basis it appears that sizable amounts of power may be available, but this would not resolve the system's long term power problems.

The projected load demand and generating capacity for the PJM Pool for the next decade is presented in Table 22, which gives the same type of presentation as Table 21, for the PJM Pool instead of the GPU system. As shown by the data in the Tables, while the delay of TMI-1 and 2 causes a serious reduction in the reserve capacity of the GPU system, the effect on the PJM Pool is much less severe. For example, if one unit at TMI is not operating in 1976 as scheduled, the reserve capacity of the PJM Pool is reduced from 28.[illegible] to 26.2%. If both TMI-1 and 2 are not operating at that time, there is a further drop in reserves to 23.9%. This comparison, of course, does not consider the increased reliability resulting from location of generating capacity in a region where there is presently a shortage, nor does it consider the effect of delays in installation of new PJM generating capacity, 42% of which between the years 1972 and 1976 is comprised of nuclear units.

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The commercial service dates of this nuclear capacity are currently estimated to be as follows:

	MW	Date
Calvert Cliffs 1	845	Jan. 1973
Peach Bottom	1065	Mar. 1973
Three Mile Island 1	830	Nov. 1973
Calvert Cliffs 2	845	Jan. 1974
Calvert Cliffs rerating	20	Jan. 1974
Peach Bottom 3	1065	May 1974
Salem 1	1095	Oct. 1974
Calvert Cliffs rerating	20	Jan. 1975
Salem 2	1107	May 1975
Three Mile Island 2	830	May 1975
Limerick 1	1055	Mar. 1976
Three Mile Island 2 rerating	120	Mar. 1976
TOTAL	8897	

The effect of a one and two year delay in startup of these plants on PJM reserves would be as follows:

	Reserves with one year delay		Reserves with two year delay	
	MW	%	MW	%
1972	5972	20.7	5972	20.7
1973	4987	15.8	4987	15.8
1974	5574	16.3	3664	10.7
1975	8157	21.9	5397	14.5
1976	10298	25.5	7246	17.9

While a two year delay for all plants is unlikely, some delays are probable and it is clear from the above data that the PJM reserve capacity projected in Table 22 could be significantly altered by perturbations in construction and operation schedules of a relatively small number of plants.

TABLE 21 PROJECTED GPU SYSTEM LOAD AND GENERATING CAPACITY

Year	Projected Peak Summer Load (MWe)	Dependable Capacity (MWe)			Reserve Capacity (%)		
		GPU Internal	Purchases	Total	With TMI-1&2	Without TMI-1	Without TMI-1&2
1971	4326 (actual)	4945		4945	--	14.3	14.3
1972	4934	5625		5625	--	14.0	14.0
1973	5379	5873	350	6223	—	15.7	15.7
1974	5863	6935[1]	200	7135	21.7	7.5	7.5
1975	6377	7765[2]	400	8165	28.0	15.0	2.0
1976	6954	8696[3]		8696	24.9	13.1	-0.5
1977	7583	9090		9090	19.9	8.9	-6.0
1978	8269	10230		10230	23.4	13.7	2.2
1979	9022	10885		10885	20.6	11.4	1.0
1980	9851	11841		11841	20.2	11.8	2.1

[1]TMI-1 on line + 830 MWe.
[2]TMI-2 on line + 830 MWe.
[3]Rerate TMI-2 + 120 MWe.

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TABLE 22 PROJECTED PJM POOL LOAD AND GENERATING CAPACITY

Year	Projected Peak Summer Load (MWe)	Generating Capacity (MWe)	Reserve Capacity (%) With TMI-1&2	Without TMI-1	Without TMI-1&2
1971	25,529	31,094	--	21.8	21.8
1972	28,870	34,842	--	20.7	20.7
1973	31,470	38,367	--	21.9	21.9
1974	34,240	42,574[1]	24.3	21.9	21.9
1975	37,290	48,499[2]	30.1	27.9	25.6
1976	40,500	51,973[3]	28.3	26.2	23.9
1977	43,940	56,212	27.9	26.0	23.9
1978	47,630	60,736	27.5	25.7	23.8
1979	51,470	66,231	28.7	27.0	25.2
1980	55,660	70,357	26.4	24.9	23.2

[1]TMI-1 on line.
[2]TMI-2 on line.
[3]Rerate TMI-2.

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XI. ALTERNATIVES TO THE PROPOSED ACTION AND COST-BENEFIT ANALYSIS OF THEIR ENVIRONMENTAL EFFECTS

The Applicants have provided a discussion of alternatives and a cost benefit analysis in their Environmental Report.[1] The Staff's independent review is summarized below. In many cases the staff found the Applicants' estimates adequate and these were used in the discussion. In other cases the estimates were made independently.

A. SUMMARY OF ALTERNATIVES

1. Abandonment of the Project

Abandonment of the project is an alternative to be considered in evaluating the impact of both plant construction and subsequent plant operation. In the case of Three Mile Island Station we have concluded that abandonment of the project is not a practicable alternative for the following reasons:

- Construction of the Station has progressed to the point where environmental impact associated with this phase has already been absorbed.
- The identifiable environmental costs of plant operation are insignificant when compared with the unsalvageable cost of $350 million involved in abandonment (see B.1. below).

2. Alternative Power Sources

a. Purchase of Power

The applicants state that there was and is no possibility of a power purchase in an amount equivalent to the capacity and energy of the TMI project. The staff notes that while PJM pool reserves appear substantial (table 22), such pool reserves do not generally include provisions for long term firm power transactions. In addition, projected PJM reserves are uncertain, because of the possibility of delay in new generating capacity now under construction. The uncertainties of maintaining construction schedules and the steady extension of demand in this area make dependence on this external base-load power source highly questionable. In addition, the Applicants state that no nearby public or private utilities outside of the PJM pool have large amounts of power for sale on a long term continuing basis.

b. Alternative Methods of Generating Power

Coal Fired, Base Load Generation

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Economic studies performed by the Applicants in 1965 indicated that mine mouth coal fired generation in western Pennsylvania provided short term economic advantages over an equivalent nuclear unit located in the eastern portion of the state. Based on these studies a decision was made to proceed with construction of the Homer City unit, a coal-fired mine mouth generating plant in western Pennsylvania.

In 1966 the Applicants re-examined the economics of additional nuclear generation, but this time in comparison with a coal-fired unit at the same site as would be selected for the nuclear unit. The Applicants state that there were two reasons for this shift in the basis of comparison:

(1) The particularly attractive conditions applicable to the Homer City plant were no longer available as an alternative, and

(2) Coal suppliers had suggested that fuel might be delivered to the GPU site for 20 cents per million Btu, although this was not a firm offer of such a supply.

Even on the basis of this low delivered fuel price, a nuclear unit installation was found to be advantageous. In November 1966, the decision was made to proceed with a nuclear installation for service in 1971; in December 1966, the TMI site was selected for this installation.

A comparison of a coal fired plant with the Three Mile Island Nuclear Plant is given in part B of this section.

Oil-Fired, Base Load Generation

The Applicants did not consider this alternative in the 1965-66 economic studies, because of the relatively high cost of oil fuel as compared to coal delivered in the area for which the unit was then planned.

A comparison of an oil burning plant with the Three Mile Island Nuclear Plant is given in part B of this section.

Hydroelectric Generation

The geography and flow of the Susquehanna River are such that it is impossible to find the combination of head and water quantity that can produce the capacity and energy equivalent of TMI.

Gas-Fired Generation

The Applicants state and the staff agrees that this fuel can be dismissed from further consideration, since gas fuel is not available for boiler use within the company's service territory.

Thermal Peaking Capacity

The Applicants state that peaking capacity is not considered as an alternative because of the high cost and inefficient use of fuel, if such units are used for

long hours of generation, comparable to those expected of a nuclear plant. Combustion turbines, combined cycle units and oil-fired cycling units are intended for a different type of service and GPU is planning on a long-term basis for limited use of such capacity to provide for a balanced development of its system. Currently, however, very large combustion turbine installations are being made because of delays in installations of [illegible] capacity.

The environmental cost of such peaking units are quite similar to those for an oil-fired base load unit.

The staff concurs with this evaluation and notes that it is essential to add to base load generating capacity at the present time if the applicant is to be capable of meeting its projected loads.

Other Sources

The production of energy by MHD, solar heat, fuel cells, wind power or tidal power must be dismissed as not feasible in the time period and in the area that will be served by TMI. Pumped storage is not a viable alternative since such facilities are net consumers of electrical energy.

3. Alternate Sites

Five sites were considered by the Applicants during the initial planning (1965-66) for Unit 1, the nuclear station that was to provide the 1973-74 power need for GPU. These sites were:

(1) Three Mile Island,
(2) Gilbert Station site on the Delaware River in New Jersey,
(3) Portland Station site on the Delaware River in Pennsylvania,
(4) Monocacy site on the Schuylkill River, south of Reading, Pennsylvania, and
(5) Berne site on the Schuylkill River, north of Reading.

A major consideration in the selection of a nuclear plant site is its relation to centers of population. There was not much choice among the available sites in this respect. All possible sites were sufficiently far from major cities, out not very far removed from one or more small communities that cover most of Met Ed's area. From this point of view, one site was just about as good as any other that could be given serious consideration, and no difference in cost was assumed to arise from nuclear safety considerations.

Foundation conditions, including exposure to seismic disturbances, likewise vary in no important respects at the sites investigated.

Conditions which varied among the sites considered and on which selection of the Three Mile Island site was based included:

(1) Availability and cost of cooling water,
(2) Transmission investment and transmission losses,
(3) Cost of site and site preparation, and
(4) Construction labor rates and productivity.

The discussion of these several criteria in the following sections is based on information provided by the Applicants.

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a. Cooling Water

Cooling towers for Unit 1 will require approximately 22 cfs as make-up for evaporation and other losses. Water can be obtained at this rate not only from the Susquehanna and Delaware, but also from the Schuylkill and even smaller streams. The smaller the drainage area considered, the more likely it would be that a reservoir is needed for flow augmentation. The Applicants state that one of the sites considered required such a reservoir in addition to cooling towers.

b. Transmission

A study was made by the Applicant of GPU system transmission losses with the nuclear plant in various locations. Because of the pattern of west to east flow of energy in the GPU and PJM systems, the losses are progressively higher as the nuclear plant is moved farther west, thus adding more to this energy flow.

In addition, there was a need for a third east-west 500 Kv line to meet the MAAC reliability criteria. The location of the TMI site was advantageous in that it allowed the line then to fulfill a dual function: to transport TMI-2 output and to provide additional system reliability.

c. Cost of Site Preparation

Several of the possible locations for the nuclear plant involved existing sites, where all or nearly all of the necessary land area was already owned by the Applicants (or an affiliate) and little if any additional capital expenditure for land would be necessary. These differences in land cost (as well as other site differences) are reflected in the comparison of sites.

There were also differences among the sites in road and railroad access, flood protection, grading, etc., which the Applicants evaluated in the estimate of plant cost.

d. Construction

A most important difference considered by the Applicants between the several sites was the influence of labor rates and productivity on plant construction costs. This is a difference which is evident from comparison of union wage scales and is one which has affected the construction costs of existing plants of the Applicants and their affiliates in GPU. A fairly reliable background was, therefore, available upon which an estimate could be based for relative construction costs in New Jersey, eastern Pennsylvania, and in the Susquehanna River region. The lowest construction labor costs were expected to be available at Three Mile Island.

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e. Other Differences

Other differences that might be significant were related only to the Gilbert site, and these were unfavorable to its use by the Applicants. This site is in New Jersey and is owned by an affiliate company. Use of this site by the Applicants would involve some reduction in the Pennsylvania taxes paid (income tax), but a more than offsetting increase in New Jersey taxes. It is also likely that this location would involve higher expenses for operation and maintenance because of differences in wage rates. An evaluation of these differences is not necessary to the selection of the Three Mile Island site.

f. Summary

The evaluation of each of the above criteria by the Applicants indicated the relative cost of the several sites to be:

SITE	ADDITIONAL COST ($1,000,000)
Three Mile Island	Base
Gilbert	1.2
Monocacy	2.5
Portland	2.5
Berne	8.9

The decision to locate the second unit at TMI, then scheduled for service in 1973, was made in December 1968. Studies of the site for this unit were begun by the Applicants in 1967 with comparisons being made among the following locations:

Oyster Creek, N. J. (existing site)
Union Beach, N. J. (on Raritan Bay)
Gilbert, N. J. (existing plant on Delaware River)
Portland, Pa. (existing plant on Delaware River)
Scottsville, Pa. (on upper Susquehanna River)
TMI, Pa.

The Applicants state that these studies showed a very small advantage (less than the error inherent in such estimates) for TMI as compared to Oyster Creek, assuming that discharge temperature requirements for the second unit at Oyster Creek would be somewhat more severe than for the first unit. Nevertheless tentative selection was made of the Oyster Creek location, based largely on the local need for additional generation and the associated transmission.

Compared with a nuclear plant at various sites, the addition of a third unit to the mine-mouth plant then under construction at Homer City showed the lowest overall cost; but the advantage of this site could be further enhanced if use of this site were delayed several years until load growth in the western Pennsylvania area of GPU could absorb this capacity, making it

again unnecessary to construct long transmission lines to eastern load centers. Consequently, it was desirable to delay the Homer City installation (and in fact it was delayed, this third unit now being scheduled for service in 1976) and to remove it from further consideration in connection with the 1973 unit.

During 1968, further studies were carried out by the Applicants with respect to:

(1) The cooling water problem at Oyster Creek,
(2) The need for extensive 500 Kv transmission additions, and
(3) Possible delays in both plant and transmission construction.

The Applicants state that the results of these studies pointed up certain disadvantages in the Oyster Creek site for 1973 capacity and added to the earlier marginal advantage of TMI. Finally, in December 1968, decision was made to shift the location of this 1973 unit to TMI.

In the series of site studies, extending from 1965 through 1968, it was apparent that there were relatively small cost differences among many of the sites that were investigated, and several of those sites that were not then selected for immediate use were considered as likely locations for the next nuclear unit. The small differences among sites is to be expected from the nature of the areas in which the plants were to be located; and these small differences have been confirmed by more recent studies by the Applicants of additional sites.

No comparisons were made by the Applicants in 1965-68 with off-shore sites, for such locations for large nuclear units did not then appear to be feasible, either for plant construction or transmission connection. However, as is evident from the above discussion, TMI was compared with coastal sites at Oyster Creek and Union Beach and was found to be economically advantageous in comparison with either one.

4. Alternative Land Uses

Three Mile Island is in a relatively picturesque landscape and it is quite probable that the land would be used for residential and/or recreational facilities, if it had not been owned and reserved for its present use. There are then several uses of this land that should be considered in a cost-benefit analysis:

(1) nuclear power station,
(2) fossil-fueled power station,
(3) other industrial uses,
(4) commercial uses, i.e., restaurants, boat clubs, etc.,
(5) residential uses,
(6) public park and recreational uses,
(7) farm land.

Among the more important benefits to be considered in land use, the economic benefits would include the productivity in terms of the gross dollar income from sales, wages brought to the local area, and the increased dollar activity in the local business community from sales to the industries or persons occupying the land in question. Other benefits that can be qualitatively evaluated on the basis of needed services provided are electrical power, food, living area, recreational area and commercial establishments. Table 21 presents a summary of comparative benefits and environmental costs from the alternative land uses. For purposes of comparison it is presumed that other industry would be attracted to this area and that the total sales would be comparable to that from the sale of electricity. Similar presumptions are made with regard to the attraction to TMI of commercial and residential developers. Without a great increase in population near the site, it is in fact doubtful that any large economic benefits could be extracted from a shopping center or other commercial enterprises on TMI. In view of the large amount of undeveloped land to the east and west of TMI, it is also doubtful that TMI would be in demand as a site for a large housing development. It is, however, quite possible that TMI could be developed as a site for vacation homes or for a one-acre lot development. The estimate of $10 million from sales and development of residential homes is based on 270 lots of one acre, with an average cost of $40,000.

The principal conclusion of this comparison is that, whereas the 1660 Mw nuclear station will produce a relatively large economic benefit, the environmental costs compared to the use of TMI for other industry or for commercial or residential uses will be relatively small, except for the aesthetic impact. The recreational and farm uses are to be preferred from the environmental cost basis, but their economic benefits ar negligible. The recreational use would, however, satisfy what is perhaps the greatest need for the area.

5. Alternatives to Natural Draft Cooling Towers

The probable fog impact from the four natural draft cooling towers, based on experience with comparable facilities and model calculations, is considered slight. However, because of the proximity of the Station to Harrisburg International Airport, the possibility of cooling by other methods should be considered as a means for correcting any serious problems that may arise. Given present technology, the following methods of heat dissipation are possible substitutes for the natural-draft wet cooling tower method:

(1) Once-through cooling,
(2) Cooling pond,
(3) Spray-canal,
(4) Mechanical-draft towers, wet,
(5) Dry cooling towers.

Table 23: COST-BENEFIT ANALYSIS OF ALTERNATIVE LAND USES

Benefits	1660 Mw Nuclear Power Station	Other Industry	Commercial	Residential	Recreational	Farm
Sales (10^6 dollars)	250/yr	~250/yr	<250/yr	~10	Neg.	<0.2
Wages (10^6 dollars)	1.2/yr	>1.2/yr	>1.2/yr	Included above	Small	Neg.
Local Business (10^6 dollars)	.050/yr	Probably much greater	Greater	~2/yr	1/yr	Neg.
Electricity	X	—	—	—	—	—
Other Products	—	X	X	—	—	X
Living Area	—	?	?	X	X	Neg.
Recreational Area	X	?	?	?	X	—
Commercial Services	—	?	X	?	X	—
Need, for this Area	-X	X	—	—	X	—
Costs						
Aesthetic Impact	High	High	Medium	Medium	Neg.	Neg.
Aquatic Life Cost	Medium to Small	High to Neg.	Small	Medium	Neg.	Small
Bird and Animal Life Cost	Small	High to Neg.	Small	Medium	Neg.	Small
Noise Cost	Neg.	High to Neg.	Medium	Medium	Small	Neg.
Shoreline Erosion Cost	Neg.	High to Neg.	Neg.	Small	Neg.	Neg.
Atmospheric Cost	Medium	High to Small	Medium	Medium	small	Neg.
Population Increase	Neg.	High to	High	High	Small	Neg.

Among these five alternatives, the spray-canal and wet mechanical draft towers have greater potential for ground fog than the present system. The cooling pond system is impractical at the present site because of the large land area that would be necessary. It is estimated that a 3400-acre pond would be necessary for both TMI-1 and 2. Once-through cooling would put an excessive thermal load on the Susquehanna River and would not comply with Pennsylvania thermal discharge standards for the River.

The alternative that would probably least affect the environment is the dry cooling tower. The dry heat that is emitted from such towers should produce no adverse fogging impact, although it is possible that a change may occur in local precipitation or storm frequency from the large volumes of rising dry air. Dry cooling systems are not included in the following cost-benefit analysis, since the designs are not at the stage where they can be considered as practical alternatives.

6. Alternative Transmission Lines

The route originally considered for the transmission line from the TMI Plant to Bechtelsville paralleled existing lines of lower voltage and would have required additions to the width of the right-of-way. For the portion of that route west of Reading, at least ten homes would have had to be purchased and removed and thirty homes were within 300 feet of the existing line. The portion of the route east of Reading would have passed fairly close to the towns of Seyfert, Gibraltar, Lorane, and Stonetown, and many homes would have had to be removed. For the transmission line from the TMI Plant to Juniata, following existing rights-of-way would have interfered with a farmhouse, a rendering plant, several houses in the village of Falmouth and a road and numerous homes near the junction with the Juniata - Peach Bottom line. These impacts necessitated changes in the routing of the transmission lines to put them through less developed areas.

The alternative of putting the transmission lines underground has problems of technology and of economics. The use of underground cable for high-voltage transmission of bulk power has generally been limited to the short lengths required in extremely congested areas and to voltages of less than 500 kv. The cost of underground lines can range from ten to forty times that of overhead lines of equal capacity. The Federal Power Commission in "The 1970 National Power Survey" (Part IV, Chapter 7) states that the prospects for major reductions in this cost ratio are not encouraging.

B. SUMMARY OF COST-BENEFIT ANALYSIS

The generating costs and the environmental effects of the TMI nuclear plant are compared with those for a coal-burning plant and for an oil-burning plant in the discussion below and in Table 24. The benefits of the TMI plant are then discussed and balanced against its costs.

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Table 24

COMPARISON OF THE TMI NUCLEAR PLANT WITH ALTERNATIVE FOSSIL-FUEL PLANTS

	TMI Nuclear Plant	Coal-Burning Plant	Oil-Burning Plant
Generating Costs a/ ($ million)			
Capital	645	561 b/	374
Operating c/	234	526	953
Total	879	1,087	1,327
Use of Natural Resources			
Land (acres)	200	More than 200.	More than 200.
Water (gal/min consumed)	20,800	14,000	14,000
Fuel (t is tons)	U_3O_8: 1,200 t + 330 t/yr	4,500,000 t/yr.	17,000,000 bbl/yr.
Impact on Air and Land			
Fogging	Possibly 39 hr/yr at Harrisburg Airport.	Depends on location	Depends on location.
Chemicals in drift	Insignificant	Insignificant	Insignificant
Noise	Acceptable on-site, negligible off-site.	Somewhat less than for nuclear plant.	Somewhat less than for nuclear plant.
Gaseous radwaste	2.1 man-rem/yr to population within 50 miles.	Comparable with nuclear plant.	None.
Combustion products (tons per year)	None	SO_2: 50,000 NO_x: 34,000 Particulates: 5,400	SO_2: 43,000 NO_x: 16,000 Particulates: 5,400
Impact on Water			
Intake from river	Intake velocity of 0.2 ft/sec and volume equal to 0.4% of average yearly river flow should have insignificant effect on river aquatic life.	Similar to nuclear.	Similar to nuclear.

a/The fact that construction of the TMI plant is in progress is not considered here but is discussed at the end of subsection B.1 below.

b/Includes the cost of equipment to reduce SO_2 emission and additional transmission costs associated with mine-mouth plant in western Pennsylvania.

c/Present worth computed for 30 years of operation at a discount rate of 8.75%/yr.

Table 24 (cont'd)

COMPARISON OF THE TMI NUCLEAR PLANT WITH ALTERNATIVE FOSSIL-FUEL PLANTS

	TMI Nuclear Plant	Coal-Burning Plant	Oil-Burning Plant
Impact on Water			
Discharge to river Thermal	No appreciable increase above river ambient temperature, except for a few degrees in winter.	Similar to nuclear.	Similar to nuclear.
Chemical	Possibility of adverse effect on biota near discharge point.	Similar to nuclear	Similar to nuclear
Radiological	17.1 man-rem/yr to population within 50 miles.	None	None.
Accidents	Exceedingly small risk of release of radioactivity.	Small risks associated with massive transport of fuel, for example, chance of oil spillage.	
Aesthetics	Adverse effect of buildings, cooling towers, and transmission lines.	Similar to nuclear, plus adverse effect of facilities for transport and storage of fossil fuel.	

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The plants are assumed to operate at the equivalent of full capacity for 80% of the time or 7,000 hours per year. The "present worth" of annual operating costs for 30 years of operation is obtained by using a discount rate of 8.75% per year. The base year is taken as 1973, when TMI Unit 1 is expected to start commercial operation, and allowance is made for the start of operation of Unit 2 a year later. The result is that the cost of operation of both units for one year is multiplied by 10.05 to obtain the present worth of the cost of operation for 30 years.

1. Generating Costs

The capital cost of the TMI nuclear plant (Units 1 and 2 together) is estimated at $645,000,000, which corresponds to $362 per kilowatt for the ultimate capacity of 1,780 megawatts (830 megawatts for Unit 1 and 950 megawatts for Unit 2).* The annual operating cost is estimated as $23,300,000 including nuclear fuel at 1.3 mills per kilowatt hour, and nuclear insurance, operation and maintenance at 0.57 mills per kilowatt hour. The present worth for 30 years of operation is $234,000,000. The generating cost, which is the total of capital cost and present worth of operating cost, is then $879,000,000.

The capital cost of a coal-burning plant of the same capacity as TMI is estimated $401,000,000 ($225 per kilowatt) plus $71,000,000 ($40 per kilowatt) for equipment to reduce oxides of sulfur plus $89,000,000 ($50 per kilowatt) for additional transmission costs associated with location of the plant at the mouth of a coal mine in western Pennsylvania, which is more economical than transporting coal to a location near the load center. The total capital cost is then $561,000,000 ($315 per kilowatt). The annual operating cost is estimated as $52,400,000 including fuel at 3.7 mills per kilowatt hour and operation and maintenance of 0.51 mill per kilowatt hour; the present worth for 30 years of operation is $526,000,000. The generating cost, capital plus operating, is then $1,087,000,000.

The capital cost of an oil-burning plant of the same capacity as TMI is estimated as $374,000,000 ($210 per kilowatt). The annual operating cost is estimated as $94,900,000 including fuel at 7.2 mills per kilowatt hour and operation and maintenance at 0.41 mill per kilowatt hour, and the present worth for 30 years of operation is $953,000,000. The generating cost, capital plus operating, is then $1,327,000,000.

The result is that, on a present-worth basis, the generating cost for 30 years of operation is about $200,000,000 less for the TMI nuclear

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* This cost estimate and the others given below are based on the Applicants' Environmental Report submitted to the AEC in December 1971. In a Quarterly Progress Report on Status of Reactor Construction as of September 30, 1972, provided to the AEC by the GPU Service Corp., the total cost of the nuclear production plant for TMI Units 1 and 2 was indicated at $780,000,000, of which about $402,000,000 was the cumulative cost at a time when completion of physical construction was 90% for Unit 1 and 31% for Unit 2. A current comparison with the costs of a coal-burning or an oil-burning plant would need to include the eff[illegible]s of cost escalation on those plants.

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plant than for a coal-burning plant and about $450,000,000 less for the nuclear plant than for an oil-burning plant.

The above discussion deals with the situation before construction of the TMI plant began. The actual situation in late 1971 was that $278,000,000 had already been invested in the TMI plant, leaving $367,000,000 to complete the plant. Abandonment of the plant at that stage would mean payment of $70,000,000 in cancellation charges and $95,000,000 to restore the site to its original condition. The net result is that completing the plant would cost only $202,000,000 more than abandoning it. Furthermore, there would be a delay of about four years before new fossil-fuel plants with a capacity equal to that of TMI could be built, and during this period the applicant would have to increase production in existing coal-burning plants that are less economical to operate and would have to purchase power, the cost being approximately $70,000,000 per year for four years with a present worth of $228,000,000. This situation is summarized below.

Completion and Operation of TMI Plant	Incremental Cost in Millions of Dollars
Completion of Construction	367
Operation for 30 years[a/]	234
Total	601

Abandonment of TMI Plant[b/] and Construction and Operation of Fossil-Fuel Plant	Coal-Burning	Oil-Burning
TMI cancellation charges	70	70
Capital cost of fossil-fuel plant[c/]	457	305
Replacement power for 4 years[a/]	228	228
Operation of fossil-fuel plant for 26 years[a/]	363	657
Total	1,118	1,260

a/ Present worth

b/ Does not include cost of site restoration which Applicants estimate at $95 million.

c/ Present worth based on average annual construction cost during a four-year period.

The conclusion is that incremental costs for abandonment of the TMI plant and construction and operation of a f[illegible]l-fuel plant would be $600,000,000 to $650,000,000 more than for complet[illegible]d operation of the TMI plant.

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2. Use of Natural Resources

Land. Of the 470 acres of Three Mile Island, about 200 acres are to be used for the TMI plant. The 270 acres of the island previously leased for farming yielded a corn crop having an annual value of $10,000, but farming ceased as plant construction started. Land required for a coal-burning or oil-burning plant of the same capacity as the TMI nuclear plant would be somewhat greater to accommodate facilities for storing fossil fuel.

Water. The maximum rate of evaporation of water from the TMI cooling towers will be 20,800 gallons per minute, amounting to 2.7% of the minimum river flow or 0.23% of the mean river flow. A coal-burning or oil-burning plant of the same capacity would have a higher thermal efficiency than the nuclear plant and would dissipate some heat through a smokestack, so that the water evaporation would be about two-thirds as much or 14,000 gallons per minute.

Fuel. In order to provide the initial loadings of nuclear fuel for Units 1 and 2 of the TMI plant, sufficient uranium ore will have to be mined and refined to produce about 1,200 tons of U_3O_8 (yellowcake), which will then be converted to uranium hexafluoride and enriched in U-235 content in an isotope separation plant. In addition, about 330 tons of U_3O_8 will be needed each year for replacement loadings. The AEC Report to Congress for 1971 gives on page 136 a preliminary figure of 275,000 tons as of the end of 1971 for U.S. reserves of U_3O_8 recoverable at costs of $8 per pound, representing a 10 year forward supply. Potential resources at costs of $10 per pound or less were estimated at 650,000 tons, but this additional supply will require a major exploration effort to discover, develop, and bring into production. Alternatively, fuel requirements for a coal-burning plant of the same capacity as TMI would be about 4,500,000 tons of coal per year, which would be mined in western Pennsylvania. Fuel requirements for an oil-burning plant would be about 17,000,000 barrels of oil per ye , presumably obtained from foreign sources.

3. Impact on Land and Air

Fogging and Icing. The four natural-draft cooling towers for TMI Units 1 and 2 will produce a visible plume when the atmosphere is already near saturation. Under the most adverse meteorological conditions, occurring approximately 39 hours per year, there may be an effect at or near ground level of partial obscuration of the east end of the runway at Olmsted Airport about 2.5 miles away. The runway is 10,000 feet long, and the west end may still be used unless natural fog, which may occur under the same conditions, is already obscuring the runway. Similarly, there may be partial obscuration of some local roads, but this should be less frequent than in the case of the runway and should not severely restrict traffic. The concentration of water in the atmosphere near the ground will be too low for icing to occur.

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Chemicals in Drift Water. The natural-draft cooling towers will contain two-pass herringbone drift eliminators, guaranteed to keep the drift within 0.1% of the circulating water flow. Some recent data indicate that the drift will not exceed 0.03%, and this is being further tested by the manufacturer. There will also be drift eliminators in the small mechanical-draft cooling towers in the blowdown circuit. The drift is expected to be concentrated in the area immediately around the towers. Much of it will fall into the river, and some could fall on nearby farms. The concentration of dissolved and suspended solids in the drift water should be between two and five times the concentration in the riv water. However, the amounts of these materials deposited per acre per year a ich smaller than would result from using the river water for irrigation a probably have little adverse impact and possibly a beneficial impact in providing nutrients.

Noise. The principal source of noise will be the fans in the small mechanical-draft cooling towers. The effect of this noise will be acceptable on-site and will be negligible off-site.

Gaseous Radioactive Effluents. The average dose to an individual at the site boundary of the TMI Plant is estimated as 0.72 millirems per year, including direct exposure to radioactive gases and inhalation of radioactive iodine. The total population dose within 50 miles of the plant is estimated as 2.1 man-rems per year. These doses may be compared with a natural background of 125 millirems per year for an individual and 233,000 man-rems per year for the population involved. The radioactive releases from the TMI plant will be "as low as practicable" in accordance with the criteria proposed in 10 CFR 50. Radioactive emissions to the air from coal-burning plants depend on the composition of the coal but may be comparable with the emissions from nuclear plants. No radioactive emissions are expected from oil-burning plants.

Combustion Products. A coal-burning plant in the Applicants' area would discharge to the atmosphere 50,000 tons of sulfur dioxide per year, even with equipment installed to remove 80% of the material. The discharge of oxides of nitrogen would be 34,000 tons/yr and of particulates would be 5,400 tons/yr. The corresponding figures for an oil-burning plant are 43,000 tons/yr of sulfur dioxide, 16,000 tons/yr of oxides of nitrogen, and 5,400 tons/yr of particulates.

4. Impact on Water

Intake from River. Water taken from e river amounts to 54,500 gallons per minute. The normal entrance velocity to the intake is 0.2 feet per second, which is low enough to allow all but the smallest fish to escape. Any fish, fish larvae and eggs, and plankton entrained in the intake water will probably be killed by mechanical, chemical, and thermal effects in the plant. However, the intake corresponds to only 0.5% of the average yearly flow of the river or 5% of the minimum daily flow expected to occur once in 25 years. The impact on aquatic life should therefore not be significant.

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Discharge to River. Use of the natural-draft cooling towers together with mechanical-draft cooling towers for plant effluents results in a temperature of the discharged water a few degrees above the ambient river temperature in cold weather (deicing mode of operation) and essentially equal to ambient river temperature otherwise. The addition of sulfates and chlorine in the plant and the concentration of dissolved solids in the cooling towers will not be significant after the discharged water is mixed with river water, but there will be some adverse effects on aquatic life in the immediate vicinity of the discharge point. The radioactivity in the discharged water is estimated to result in an individual average dose of 0.23 millirem per year and a total dose to the populations of 17.1 man-rems per year, including the effects of drinking water, fish consumption, and water recreation. These figures are within the proposed AEC criteria for "as low as practicable" given in 10 CFR Part 50.

5. Radiological Effects of Accidents

The possibility of accidents involving radioactive materials either within the plant or during transportation is discussed in Section VI. The conclusion is that the measures taken to prevent accidents and the measures taken to contain radioactive materials safely if accidents did occur make the environmental risks exceedingly small.

6. Transmission Lines

The rights-of-way for the transmission lines from the TMI plant will consist of about 1,900 acres, mostly of cultivated farm land with some scattered woodland. The property owner is permitted to use the land for growing crops, grazing cattle, or growing trees to a limited height, but not for any structures. No historical or archaeological sites, virgin forests, or wild-life preserves are involved.

The route for the TMI-Bechtelsville line required the purchase of one home, and the route proposed by the applicant for the TMI-Juniata line would require the purchase of six homes. The authorized cost under the construction schedule existing in November 1971 was about $16,000,000 for the TMI-Bechtelsville line and about $2,000,000 for the TMI-Juniata line.

7. Aesthetics

Changes in the site from a rural area to an industrial area with buildings, cooling towers, and transmission lines will have an adverse aesthetic effect. The Applicants are trying to minimize this effect by the design of the plant and transmission system and by landscaping. A fossil-fuel plant at this site would have had the additional adverse features of smokestacks and large facilities for fuel transportation and storage.

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8. Benefits

The primary benefits of the TMI plant are associated with the installed capacity and the output of electrical energy. The capacity of 1,780 megawatts will assist in meeting reliably the electrical load on the Applicants' system and will contribute substantially to the reserves of the interconnected systems. The generation of about 12.5 billion kilowatt hours per year will supply electrical energy for industrial, commercial, and residential uses.

There are substantial benefits to the local economy from expenditures during construction. About $5,000,000 a year is being spent for materials and equipment within a 100-mile radius of the site. Employment is being provided for 2,200 men at the peak of the construction work force. The wages expected to be paid are about $35,000,000 in 1972, tapering off in subsequent years as construction is completed. This payroll is especially important to an area that has been economically depressed as a result of the closing of the Olmsted Air Force Base.

Operation of the plant will give employment to about 150 men at wages of about $2,500,000 per year. Property taxes are paid to the state on the depreciated value of the plant, and will initially amount to about $3,000,000 per year.

An educational benefit is the Information and Observation Center located on the mainland, directly across from the plant site. More than 52,000 people have visited this center by December, 1971 and have participated in a number of educational programs. The Applicants propose to spend about $750,000 on new recreational facilities on Three Mile Island, including a marina, picnic grounds, and athletic facilities.

9. Balancing of Costs and Benefits

The main environmental considerations for the TMI plant are the change from rural to industrial use of the site, the possibility that plumes from the cooling towers would contribute to fogging at the end of a runway at a nearby airport under meteorological conditions expected to occur infrequently, the possibility of adverse effects on aquatic life in a small fraction of the river flow, radiological doses that are within the proposed AEC criteria of being "as low as practicable" and are a very small fraction of natural background, and an exceedingly small environmental risk of accidents involving radioactive materials. These effects are greatly outweighed by the benefits of supplying needed electricity at large savings in costs compared with those of fossil-fuel plants and without attendant air pollution by combustion products.

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XII. DISCUSSION OF COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL STATEMENT

Pursuant to paragraph A.6 of Appendix D to 10 CFR 50, the Draft Environmental Statement of June 1972 was transmitted, with a request for comment, to:

Advisory Council on Historical Preservation
Department of Agriculture
Department of Army, Corps of Engineers
Department of Commerce
Department of Health, Education, and Welfare
Department of Housing and Urban Development
Department of the Interior
Department of Transportation
Federal Power Commission
Environmental Protection Agency
Pennsylvania Department of Health
Board of Commissioners - Dauphin County, Pennsylvania
Board of Supervisors of Londonderry Township, Pennsylvania
Pennsylvania Historical and Museum Commission
Pennsylvania Department of Environmental Resources

In addition, the AEC requested comments on the Draft Environmental Statement from interested persons by a notice published in the Federal Register on July 22, 1972 (37 FR 14734).

Comments in response to the requests referred to above were received from:

Advisory Council on Historical Preservation
Department of Agriculture
Department of Army Corps of Engineers
Department of Commerce
Department of Health, Education and Welfare
Department of the Interior
Department of Transportation
Federal Power Commission
Environmental Protection Agency
Pennsylvania Historical and Museum Commission
Pennsylvania Department of Environmental Resources

Our consideration of comments received and the disposition of the issues involved are reflected in part by revised text in other sections of this Final Environmental Statement and in part by the following discussion. The comments are included in this statement as Appendix C. The Applicants' responses to the comments are included as Appendix D.

A. SPECIFICATION OF VEGETATION MONITORING PROGRAM (AGRICULTURE, P C-6 AND HEW, P C-13

As stated in one of the Table 17 footnotes, appropriate crops will be selected for analysis during the preparational phases of the environmental monitoring program. Operational monitoring requirements will be explicitly stated in the Technical Specifications section of the operating license.

B. ADEQUACY OF METEOROLOGICAL DATA (COMMERCE, P C-11)

A comment was made that X/Q values and their probabilities should be provided. The meteorological conditions used in the analysis approximate the dispersion conditions which would prevail at least 50% of the time at a typical site. The value used for a short duration release at 610 meters agrees with the Applicants' value. However, use of alternative meteorological assumptions, such as indicated in the Department of Commerce comment, does not significantly affect the overall environmental risk.

C. HOLDUP TIMES FOR ^{131}I EFFLUENT (HEW, P C-13, EPA, P C-34)

Our evaluation shows that 30 days holdup for gaseous effluents is sufficient for this plant to meet the low as practicable criteria. Holdup for 90 days would reduce the releases to approximately 750 curies of Kr-85 for each unit. The incremental environmental effect of this reduction is inconsequential.

The I-131 releases to water previously reported resulted in a dose of 2 mrem/yr from drinking water. Since the I-131 releases in the revised source term are smaller than previously reported, the doses will be smaller and are also acceptable. We conclude that the releases are as low as practicable and that no additional waste storage tanks or treatment are required.

D. POPULATION DISTRIBUTION (HEW, P C-14)

The power company's Environmental Report lists two population distributions within a 50 mile radius of the plant in Figure 2.2-1. The two values stated refer to the 1970 Census (1,867,736) and to a projected total in the year 2014 (3,028,527). The AEC staff based the radiological impact on the population determined by the 1970 Census.

E. RADIOLOGICAL EFFECTS FROM NEARBY PLANTS (HEW, P C-14)

The Environmental Impact statements are concerned with the effects produced by a plant or plants on one site. Additive effects are generally very difficult to quantify unless the sites are adjacent, in which case this question is addressed.

F. LOCATION OF RADIOACTIVE DISPOSAL AND FUEL REPROCESSING SITES (HEW, P C-14, DI, P C-19)

Certainly all details concerning shipping points for spent fuel and solid radwastes will be completed before plant operation.

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G. DIFFERENCES IN RADWASTE EFFLUENTS: (DI, P C-18)

The releases of radioactive isotopes in the liquid and gaseous effluent in tables 4, 5 and 6 of this document represent the results of an independent evaluation by the AEC Staff.

H. DOSE TO INDIVIDUALS IN EXCLUSION AREA (EPA, P C-38)

The highest calculated value of the atmospheric dispersion value ($X/Q = 1.4 \times 10^{-4}$ sec/m^3) which could apply to people using the Susquehanna River occurs on the southwest shore of Three Mile Island. The total body dose would be less than 9 mrem/yr if a person spent all of his time at this location; therefore, there does not seem to be any potential for excessive exposure to persons utilizing this section of the river.

I. EFFECTS OF ADDITIONAL DEEP BED DEMINERALIZER (EPA, P C-36)

When the Applicants submit a revision to the present treatment system, the environmental effects of this modification will be evaluated.

J. DOCUMENTATION OF CONTACT WITH PENNSYLVANIA HISTORICAL AND MUSEUM COMMISSION (ADVISORY COUNCIL ON HISTORIC PRESERVATION, P C-2)

Comments on the Draft Statement from the Pennsylvania Historical and Museum Commission are included in Appendix C of this Final Statement.

K. USE OF ADDITIONAL STRIPPING COLUMNS FOR CS-137 AND SR-90 (HEW, P C-13)

Operating plants have demonstrated that demineralizer efficience is a function of water qualtiy, sampling method and operating conditions. The most important of these, however, is water quality. The polishing demineralizer decontamination factor of 10 for Cs and Sr used in our evaluation for average water quality conditions during the 40 year life of a nuclear plant. The calculated Sr-90 releases from Units 1 and 2 and Cs-137 releases from Unit 1 are less than .000005 of the 10 CFR 20 limits. The Cs-137 release from Unit 2 is .00002 times 10 CFR 20, because of the assumption in our evaluation that 10% of the condensate demineralizer regenerate solution is released untreated. This assumption was made to reduce the processing load on the Miscellaneous Waste Evaporator to reasonable levels. We conclude that the removal process for Cs-137 and Sr-90 in the liquid radwaste system is adequate.

L. DIMENSIONS OF FLOOD PROTECTION DIKES (DI, P C-17)

This information is included in Appendix D as part of the Applicants' response to comments.

M. ENVIRONMENTAL IMPACTS OF ACCIDENTAL RELEASES TO WATER (DI P C-20)

A comment was made that accidental releases to water should be evaluated. The doses calculated as consequences of the postulated plant operation accidents

are based on airborne transport of radioactive materials resulting in both a direct and an inhalation dose. The regulatory staff's evaluation of the accident doses assumes that the Applicant's environmental monitoring program and appropriate additional monitoring (which could be initiated subsequent to an incident detected by in-plant monitoring) would detect the presence of radioactivity in the environment in a timely manner such that remedial action could be taken if necessary to limit exposure from other potential pathways to man.

N. LOCATION OF PRINCIPAL REVISIONS OF TEXT IN RESPONSE TO COMMENTS

Topics Commented Upon	Section Where Topics are Addressed
a. Citation for National Register of Historic Places (Advisory Council on Historic Preservation, p. C-4)	References, Section II
b. Flood Protection and Drainage (Agriculture, p. C-8, HEW, p. C-13, DI, p. C-16, EPA, p. C-35, Pa. Dept. of Environmental Resources, p. C-54)	II.E.1
c. Discussion of June, 1972 Flood (Corps of Engineers, p. C-9, HEW, p. C-13, DI, p. C-16, EPA, p. C-35, Pa. Dept. of Environmental Resources, p. C-54)	II.E.1
d. Results of Applicants Fish Population Studies (Corps of Engineers, p. C-9)	II.F.2
e. Implementation Procedures for Recreational Area Construction (Corps of Engineers, p. C-10, DI, p. C-18)	V.A.1
f. Species Lists of Local Wildlife (DI, p. C-16)	II.F.1 & II.F.2
g. Endangered Species (DI, p. C-17)	II.F.1 & II.F.2
h. Intake Water Velocity at Low Flow Conditions (DI, p. C-17)	III.D.1
i. Temperature Effects During Abnormal Operating Conditions (DI, p. C-17)	III.D.1 & V.C.2
j. Effects of TMI on Wildlife Populations (DI, p. C-18)	IV.B.1

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Topics Commented Upon	Section When Topics are Addressed
k. Discussion of Class 9 Accidents (DI, p. C-19)	VI.A.
l. Discussion of Final Decommissioning (DI, p. C-20)	VIII
m. Chlorine Discharges (EPA, p. C-34, Pa. Dept. of Environmental Resources, p. C-52)	V.B.3
n. Congregation of Fish at Outfall (EPA, p. C-35)	V.C.2
o. Discharge of Demineralizer Waste Solutions (EPA, p. C-34)	III.D.2.b
p. Turbine Leak Rates (EPA, p. C-35)	III.D.2.b
q. Implications of Stoney Creek Pumped Storage Facility (EPA, p. C-40)	II.E.1
r. Entrainment of Organisms (EPA, p. C-46)	V.C.2
s. Bird Collisions With Cooling Towers (EPA, p. C-47)	V.C.1.a
t. Copper Toxicity Effects from Cooling Tower Drift (Pa. Dept. of Environmental Resources, p. C-52)	V.C.1.a
u. Restoration of Shad in the Susquehana (DI, p. C-18)	V.C.3.b

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APPENDIX A

Fishes in the Site Vicinity

ORDER AMIIFORMES

Amiidae

Amia calva - bowfin - only two adults taken.

ORDER CLUPEIFORMES

Salmonidae

Salmo trutta - brown trout - only one taken, likely came from a stream.

Esocidae

Esox masquinongy - muskie, uncommon, stocked.

ORDER CYPRINIFORMES

Cyprinidae

Cyprinus carpio - carp - common, up to 23-1/2 pound taken.
Carassius auratus - goldfish - uncommon.
Notemigonus crysoleucas - golden shiner - common.
Semotilus atromaculatus - creek chub - common in tributaries.
Semotilus corporalis - fallfish - rare in the river.
Hybopsis micropogon - river chub - uncommon.
Rhinichthys atratulus - blacknosed dace - rare in the river.
Notropis cornutus - common shiner - uncommon in the river.
Notropis spilopterus - spotfin shiner - uncommon in the river.
Notropis hudsonius - spottail shiner - uncommon in the river.
Pimephales notatus - bluntnose minnow - uncommon in the river.

Catostomidae

Carpiodes cyprinus - quillback carpsucker - common, spawns in tributaries.
Maxostoma macrolepidotum - pealip red horse - common.
Catostomus commersoni - white sucker - common, spawns in tributaries.
Hypentelium nigricans - hog sucker - uncommon, spawns in tributaries.

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APPENDIX A (continued)

Ictaluridae

Ictalurus punctatus - channel catfish - very abundant.
Ictalurus catus - white catfish - common but not abundant.
Ictalurus natalis - yellow bullhead - common but not abundant.
Ictalurus nebulosis - brown bullhead - abundant.
Shilbeodes insignis - margined madtom - rare, only one adult taken.

ORDER ANGUILLIFORMES

Anguillid
Anguillidae

Anguilla rostrata - American eel - rare, three adults taken.

ORDER PERCIFORMES

Centrarchidae

Micropterus dolomieui - smallmouth bass - common in running water.
Micropterus salmoides - largemouth bass - common in quiet water.
Lepomis cyanellus - green sunfish - uncommon but increasing in the area.
Lepomis gibbosus - pumpkinseed - abundant, particularly in quiet water.
Lepomis auritus - redbreasted sunfish - abundant near east shore of river.
Lepomis macrochirus - bluegill - common, particularly in quiet water.
Enneacanthus gloriosus - blue-spotted sunfish - only one taken.
Ambloplites rupestris - rockbass - common, particularly in slow waters.
Pomoxis nigromaculatus - black crappie - abundant.
Pomoxis annularis - white crappie - abundant.

Percidae

Stizostedion vitreum - walleye - common but sporadic in distribution.
Perca flavescens - yellow perch - rare.
Etheostoma nigrum - johnny darter - common but not caught with Applicants' gear.

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APPENDIX B

WATER QUALITY DATA TAKEN AT THREE MILE ISLAND

ANALYSIS OF SAMPLES TAKEN FROM SUSQUEHANNA RIVER AT THREE MILE ISLAND 1967-1968

THREE MILE ISLAND NUCLEAR STATION

ANALYSES OF SAMPLES TAKEN FROM SUSQUEHANNA RIVER AT THREE MILE ISLAND
METROPOLITAN EDISON COMPANY

Laboratory Number		230815	231077	231218	231510	231738	232185	232706	233957	233232	233476	[illegible]	[illegible]	** [illegible]
Flow, cubic feet/second *		11900	11500	11500	15400	23400	6400	17000	9000	36400	26100	26[illegible]	[illegible]	16400
Sampling Date		6-15 1967	6-29 1967	7-13 1967	7-27 1967	8-10 1967	9-22 1967	10-5 1967	10-19 1967	11-1 1967	11-15 1967	11-[illegible] 1967	12-[illegible] 1967	1-1[illegible] 1968
Calcium	Ca	40.0	36.8	22.4	24.3	27.2	46.4	39.2	40.8	18.4	24.0	[illegible]	[illegible]	41.0
Magnesium	Mg	15.1	14.6	7.3	7.9	10.2	13.1	14.1	14.1	7.3	10.2	[illegible]	[illegible]	15.1
Sodium	Na	9.3	9.2	9.1	10.6	11.7	15.5	9.4	13.9	7.3	11.7	[illegible]	[illegible]	16.9
Carbonates	CO_3	4.8												
Bicarbonates	HCO_3	70.7	70.7	53.7	61.0	53.7	113.4	65.9	75.6	34.1	17.4	40.2	35.4	56.1
Sulfates	SO_4	91.7	84.3	40.6	45.5	68.2	80.0	96.0	97.9	49.7	81.7	32.9	66.9	125.5
Chlorides	Cl	12.0	15.5	10.0	10.0	11.9	15.0	13.0	14.0	7.6	7.0	9.0	[illegible]	15.0
Nitrates	NO_3	4.6	5.3	6.7	6.8	6.0	7.8	5.4	8.2	2.8	4.3	4.4	4.5	6.2
Conductivity	Mmho	387	409	230	240	220	410	373	400	202	255	190	143	402
Hydrogen Ion Conc.	pH	8.2	7.3	7.2	6.8	7.4	7.6	6.8	6.9	7.3	6.8	6.9	6.5	6.8
Free Carbon Dioxide	CO_2		12	6	7	6	3	7	12	5	5	7	7	10
Total Hardness	$CaCO_3$	162	152	86	91	110	170	156	160	76	102	72	96	166
Free Mineral Acid	$CaCO_3$													
Silica - soluble	SiO_2	2.4	4.0	4.6	4.4	4.1	2.8	3.1	3.7	3.7	4.1	3.0	3.8	5.0
Silica - colloidal	SiO_2													
Iron - soluble	Fe	0.04	0.02	0.01	0.11	0.05	0.22	0.04	0.10	0.06	0.14	0.07	[illegible]	0.15
Iron - total	Fe	1.33	1.12	2.25	2.16	1.75	1.08	2.51	1.21	1.63	5.97	1.6[illegible]	[illegible]	1.22
Iron & Alum. Oxides	R_2O_3	0.8	0.6	0.4	[illegible]	0.4	1.2	0.6	0.3	0.4	0.5	[illegible]	0.4	0.6
Manganese	Mn	0.12	0.01	0.07	[illegible]	0.07	0.03	0.08	0.04	0.12	1.12	0.05	0.22	0.07
Chlorine Demand	Cl_2													
Chemical Oxygen Demand		7.23	8.3	10.5	9.4	8.[illegible]		10.0	3.6	9.4	5.6	11.1	4.4	7.9
P. Alkalinity	$CaCO_3$	4												
M.O. Alkalinity	$CaCO_3$	66	58	44	50	41	93	54	62	28	29	33	29	46
Color		10	10	10	10	5	20	25	15	20	10	10	10	10
Turbidity		40	40	70	120	25	25	35	25	25	150	30	10	40
Suspended Solids		29	30	72	75	49	32	40	32	46	416	31	[illegible]	185
Soluble Solids		216	205	123	141	165	230	213	231	113	161	[illegible]	[illegible]	254
Total Solids		245	235	210	216	214	270	253	263	159	577	[illegible]	[illegible]	439
Calcium	$CaCO_3$	100.0	92.0	56.0	61.0	68.0	116.0	98.0	102.0	46.0	60.0	51.0	[illegible]	104.0
Magnesium	$CaCO_3$	62.0	60.0	30.0	32.0	42.0	54.0	58.0	58.0	30.0	42.0	[illegible]	36.6	62.0
Sodium	$CaCO_3$	20.2	19.9	19.7	[illegible].9	25.3	33.7	20.5	30.1	15.9	25.4	17.[illegible]	17.5	36.7
Total Cations	$CaCO_3$	182.2	171.9	105.7	116.9	135.3	203.7	176.5	190.1	91.9	127.4	[illegible]	113.5	202.7
Carbonates	$CaCO_3$	8.0												
Bicarbonates	$CaCO_3$	58.0	58.0	44.0	50.0	44.0	93.0	54.0	62.0	28.0	29.0	33.0	29.0	46.0
Sulfates	$CaCO_3$	95.4	87.7	42.2	47.3	70.9	83.2	99.3	101.3	51.7	85.0	[illegible]	[illegible]	130.5
Chlorides	$CaCO_3$	16.9	21.9	14.1	14.1	15.5	21.2	18.3	19.7	9.9	9.9	12.7	21.[illegible]	21.[illegible]
Nitrates	$CaCO_3$	3.9	4.3	5.4	5.5	4.9	6.3	4.6	6.6	2.3	3.5	3.[illegible]	3.[illegible]	5.[illegible]
Total Anions	$CaCO_3$	182.2	171.9	105.7	116.9	135.3	203.7	176.5	1[illegible]	91.9	127.4	[illegible]	113.[illegible]	202.7

[illegible] upper [illegible] 12-13-67 [illegible]

* Harrisburg Gaging Station [illegible]
** Sample taken at Crawford Station intake
[illegible] 1-[illegible]

All results expressed in parts per million except pH, [illegible]

B-2

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ANALYSES OF SAMPLES TAKEN FROM SUSQUEHANNA RIVER AT THREE MILE ISLAND
METROPOLITAN EDISON COMPANY

Laboratory Number		234719	234915	235291	235707	235634	235572	236342	236515	236733	236974	236894	237131
Flow, cubic feet/second		35500	69100	40000	15000	92700	55400	19100	74200	31200	28500	28300	18500
Sampling Date		1-24 1968	2-7 1968	2-21 1968	3-6 1968	3-20 1968	4-3 1968	5-1 1968	5-15 1968	5-29 1968	6-11 1968	6-12 1968	6-26 1968
Calcium	Ca	30.4	15.2	23.8	36.8	16.0	19.2	24.0	21.2	16.8		24.8	35.0
Magnesium	Mg	11.2	5.4	10.7	14.6	4.9	6.3	7.8	6.6	5.4		12.7	10.7
Sodium	Na	10.8	2.3	7.2	14.5	14.1	5.8	7.5	8.5	6.7		5.9	6.2
Hydrogen	H_2												
Bicarbonates	HCO_3	51.2	29.2	42.7	63.4	32.9	35.4	64.6	47.6	30.5		32.9	78.0
Sulfates	SO_4	75.7	25.9	74.3	99.9	14.0	41.2	32.0	41.2	39.0		82.4	60.3
Chlorides	Cl	14.0	8.0	11.0	15.0	32.2	8.0	10.0	10.0	7.0		8.0	11.0
Nitrates	NO_3	6.3	3.3	4.7	7.9	4.6	4.3	9.7	3.1	3.8		3.5	6.6
Conductivity	Mmho	312	165	285	375	178	190	220	210	168		270	322
Hydrogen Ion Conc.	pH	6.8	7.1	7.1	7.3	6.5	7.3	7.7	7.2	7.0	7.2	7.1	7.4
Free Carbon Dioxide	CO_2	14	3	7	5	7	5	4	5	6		4	7.0
Total Hardness	$CaCO_3$	122	60	116	152	60	74	92	80	64		114	134.0
Free Mineral Acid	$CaCO_3$												
Silica - soluble	SiO_2	3.8	3.8	4.2	3.9	2.4	3.8	4.9	0.8	3.0		2.8	3.1
Silica - colloidal	SiO_2												
Iron - soluble	Fe	0.10	0.10	0.63	0.06	0.08	0.19	0.05	0.07	0.10		0.05	0.31
Iron - total	Fe	1.75	1.97	0.44	0.46	2.89	1.10	0.72	1.11	1.97		3.81	1.64
Iron & Alum. Oxides	R_2O_3	0.4	0.4	0.4	0.1	3.6	0.8	0.4	0.4	0.4		0.4	0.50
Manganese	Mn	0.03	0.33	0.82	0.92	0.29	0.32	0.22	0.03	0.03		0.26	0.01
Chlorine Demand	Cl_2	(15 min.)								1.22	1.70	2.50	1.3
Chemical Oxygen Demand		3.46	9.01	3.0	10.5	17.4	10.7	11.0	5.3	5.0		8.75	9.31
Chlorine Demand (60 min.)											2.15		
M.O. Alkalinity	$CaCO_3$	42	24	35	52	27	29	53	39	25		27	64
Color		10	10	10	10	15	8	5	5	10		10	5
Turbidity		10	60	5	20	60	40	20	25	60		20	15
Suspended Solids		25.2	69.0	2	25	120	29	18	33	135		15	28.4
Soluble Solids		178	73	162	224	105	107	128	115	97		157	172.8
Total Solids		203	147	164	250	255	136	146	148	232		172	201.2
Calcium	$CaCO_3$	76.0	38.0	72.0	92.2	40.0	48.0	60.0	53.0	42.0		62.0	90.0
Magnesium	$CaCO_3$	46.0	22.0	44.0	60.0	30.0	26.0	32.0	27.0	22.0		52.0	44.0
Sodium	$CaCO_3$	23.5	4.9	15.6	31.5	30.7	12.6	16.3	18.4	14.6		12.8	13.5
Hydrogen	$CaCO_3$												
Total Cations	$CaCO_3$	145.5	64.9	131.6	183.5	90.7	86.6	108.3	98.4	78.6		126.8	147.5
Bicarbonates	$CaCO_3$	42.0	24.0	35.0	52.0	27.0	22.0	53.0	39.0	25.2		27.0	64.0
Sulfates	$CaCO_3$	78.7	26.9	77.3	103.4	14.6	42.8	33.3	42.8	40.6		85.7	62.7
Chlorides	$CaCO_3$	19.7	11.3	15.5	21.2	45.4	11.3	14.1	14.1	9.9		[illegible]	15.5
Nitrates	$CaCO_3$	5.1	2.4	3.8	6.4	3.7	3.5	7.9	2.5	3.1		2.8	5.3
Total Anions	$CaCO_3$	145.5	[illegible]	131.6	183.5	90.7	86.6	108.3	93.4	78.6		126.8	147.5

Issue: 1-2-3-4-5

All results expressed in parts per million except pH, Mmho & Turbidity

ANALYSIS OF SAMPLES TAKEN FROM SUSQUEHANNA RIVER AT THREE MILE ISLAND
1968

THREE MILE ISLAND NUCLEAR STATION

91 301

ANALYSIS OF SAMPLES TAKEN FROM SUSQUEHANNA RIVER AT THREE MILE ISLAND
METROPOLITAN EDISON COMPANY

Laboratory Number		237304	[illegible]	237761	238011	238183	238410	233632	233339	233978	233968	239453	239642	241538
Flow, cubic feet/second		15[illegible]	7800	4500	4500	3200	14200	4800	4650	12800	32700	40500	39400	106100
Sampling Date		7-10 1968	7-24 1968	8-27 1968	8-21 1968	9-4 1968	9-18 1968	10-2 1968	10-16 1968	10-30 1968	11-13 1968	11-27 1968	12-11 1968	4-9 1969
Calcium	Ca	38.2	42.2	52.0	60.8	58.4	33.6	50.4	52.0	44.0	24.8	20.0	20.0	13.6
Magnesium	Mg	16.5	16.5	19.0	21.9	21.9	9.7	20.9	20.4	18.5	7.8	7.3	6.8	4.9
Sodium	Na	7.8	9.2	14.0	35.9	12.8	2.7	10.9	22.1	5.2	4.6	5.3	5.9	5.4
Carbonates	CO_3	3.6												
Bicarbonates	HCO_3	87.6	82.9	97.6	91.5	124.4	82.9	89.0	97.6	82.9	43.9	32.9	40.2	28.0
Sulfates	SO_4	78.8	107.1	[illegible]	204.3	122.2	48.0	127.4	142.4	96.0	46.1	42.0	43.1	28.7
Chlorides	Cl	11.0	15.0	16.0	19.5	20.0	12.0	16.0	18.0	16.0	12.0	8.0	7.0	7.0
Nitrates	NO_3	9.2	6.5	3.2	6.2	7.0	12.6	9.2	9.5	8.5	3.8	3.9	3.9	3.7
Conductivity	Mmho	376	433	470	572	537	303	475	510	420	233	208	202	140
Hydrogen Ion Conc.	pH	8.0	7.2	7.4	7.0	7.8	7.6	7.8	7.4	7.6	7.2	6.9	6.8	7.3
Free Carbon Dioxide	CO_2		10	7	6	2	5.0	7	3	4	7	7	6	6
Total Hardness	$CaCO_3$	165	183	208	242	236	124	212	214	186	94	80	78	54
Free Mineral Acid	$CaCO_3$													
Silica - soluble	SiO_2	2.7	3.0	3.6	3.1	2.6	5.2	1.7	2.4	3.0	2.2	4.2	3.9	2.9
Silica - colloidal	SiO_2													
Iron - soluble	Fe	0.05	0.02	0.07	0.07	0.06	2.37	0.13	0.06	0.06	0.07	0.15	0.17	0.23
Iron - total	Fe	2.18	2.05	1.27	1.22	1.56	3.78	1.32	1.75	0.90	4.25	1.81	1.42	5.03
Iron & Alum. Oxides	R_2O_3	0.4	0.6	0.4	0.4	0.8	0.3	0.2	0.4	0.5	0.4	0.1	0.2	0.4
Manganese	Mn	0.10	0.03	0.12	0.03	0.17	0.03	0.01	0.19	0.03	0.15	0.05	0.27	0.75
Chlorine Demand	Cl_2	2.85	5.01		2.4		3.65	0.81	2.59	2.78	2.73	2.35	3.28	1.33
Chemical Oxygen Demand		7.92	11.4	10.23	15.1		11.70	14.9	17.5	18.4	14.3	6.5	9.6	25.4
P. Alkalinity	$CaCO_3$	3												
M.O. Alkalinity	$CaCO_3$	78	68	80	75	102	68	73	80	68	36	27	33	23
Color		10	10	15	10	12	10	10	15	15	20	5	15	15
Turbidity		22	30	50	60	20	42	15	20	20	80	20	19	120
Suspended Solids		54	76	60	35	35	70.0	19	28	28	106	34	23	231
Soluble Solids		212	246	284	397	308	173	281	302	233	124	113	111	80
Total Solids		266	322	344	432	343	243	300	330	261	230	147	134	311
Calcium	$CaCO_3$	96.0	115.0	130.0	152.0	146.0	84.0	126.0	130.0	110.0	62.0	50.0	50.0	34.0
Magnesium	$CaCO_3$	65.0	68.0	78.0	90.0	90.0	40.0	86.0	84.0	76.0	32.0	36.0	[illegible]	20.0
Sodium	$CaCO_3$	17.0	19.9	[illegible]	77.0	27.7	21.0	23.6	48.0	11.3	9.9	11.4	[illegible]	11.7
Total Cations	$CaCO_3$	183.0	205.9	238.3	[illegible]	263.7	145.0	235.6	262.0	197.3	103.9	87.6	90.9	65.7
Carbonates	$CaCO_3$	6.0												
Bicarbonates	$CaCO_3$	72.0	68.0	80.0	75.0	102.0	68.0	73.0	80.0	68.0	36.0	27.0	33.0	23.0
Sulfates	$CaCO_3$	82.0	111.4	135.1	212.5	127.3	[illegible]	132.5	148.7	97.8	47.9	46.1	44.8	29.8
Chlorides	$CaCO_3$	15.5	21.2	22.6	27.5	28.2	16.9	22.6	25.4	22.6	16.9	11.3	9.9	9.9
Nitrates	$CaCO_3$	7.5	5.3	2.6	5.0	5.7	10.2	7.5	7.9	6.9	3.1	3.2	3.2	3.0
Total Anions	$CaCO_3$	183.0	[illegible]	[illegible]	[illegible]	263.7	145.0	235.6	262.0	197.3	103.9	87.6	90.9	65.7

Issue: 1-2 -3-4-5-6 -7

All results expressed in parts per million except pH, Mmho & Turbidity

ANALYSIS OF SAMPLES TAKEN FROM SUSQUEHANNA RIVER AT THREE MILE ISLAND 1968-1969

THREE MILE ISLAND NUCLEAR STATION

91 302

ANALYSIS OF SAMPLES TAKEN FROM SUSQUEHANNA RIVER AT THREE MILE ISLAND
METROPOLITAN EDISON COMPANY

Laboratory Number		241822	242058	242332	242528	242818	243166	243432	243692	243934	244139	244413	244575	244932	245257
Flow, cubic feet/second		42900	25900	23800	13100	17000	8550	20000	14000	9900	6500	4000	5300	7600	1210
Sampling Date		4-23 1969	5-7 1969	5-28 1969	6-11 1969	6-25 1969	7-11 1969	7-31 1969	8-14 1969	8-27 1969	9-10 1969	9-24 1969	10-9 1969	10-22 1969	11-7 1969
Calcium	Ca	21.6	23.0	26.4	33.5	35.0	44.8	28.0	40.0	45.6	41.6	50.0	49.6	52.0	40.0
Magnesium	Mg	6.8	10.7	11.7	11.7	10.7	15.1	10.2	13.6	15.6	13.1	16.1	16.5	16.1	13.1
Sodium	Na	12.9	10.6	10.3	17.3	52.9	28.1	25.2	13.2	15.9	20.5	26.6	24.7	16.2	20.1
Bicarbonates	HCO_3	42.7	39.3	70.5	72.0	82.9	91.5	39.0	91.5	98.8	102.4	112.2	92.7	124.4	90.2
Sulfates	SO_4	57.3	87.1	90.1	61.1	148.7	123.7	104.8	77.8	95.7	63.3	121.0	127.8	87.2	91.9
Chlorides	Cl	9.0	9.0	10.0	16.0	14.0	18.0	12.0	14.0	16.0	15.0	19.0	20.0	19.0	15.0
Nitrates	NO_3	3.2	3.3	4.4	4.4	7.1	7.3	10.3	11.1	10.4	12.5	11.3	10.4	14.3	8.4
Conductivity	Mmho	210	273	275	320	326	411	293	358	412	392	474	473	482	333
Hydrogen Ion Conc.	pH	7.1	7.2	7.2	7.4	7.3	7.0	6.9	7.5	7.4	7.3	7.4	7.2	7.2	7.4
Free Carbon Dioxide	CO_2	6	5	8	3	5	12	5	3	8	7	9	12	14	4
Total Hardness	$CaCO_3$	82	114	114	132	134	174	112	156	178	152	196	192	196	154
Silica - soluble	SiO_2	3.0	1.9	2.9	3.3	4.6	2.5	4.4	5.8	2.4	6.0	3.4	4.5	3.9	5.5
Silica - colloidal	SiO_2														
Iron - soluble	Fe	0.13	0.13	0.05	0.03	0.03	0.02	0.04	0.06	0.04	0.07	0.03	0.03	0.04	0.11
Iron - total	Fe	5.32	1.74	0.97	1.14	0.76	1.05	0.96	0.98	1.01	2.80	1.18	1.30	2.86	0.99
Iron & Alum. Oxides	R_2O_3	0.4	0.6	0.2	0.2	0.2	0.2	0.1	0.1	0.4	0.2	0.2	0.2	0.2	0.4
Manganese	Mn	0.36	0.44	0.88	0.51	0.43	0.60	0.39	0.73	0.65	0.75	0.65	0.80	0.54	0.54
Chlorine Demand	Cl_2	1.77	1.83	1.0	1.16	2.41	1.1	1.0	1.4	1.52	0.88	1.84	2.77	1.54	3.00
Chemical Oxygen Demand		2.43	2.91	13.5	14.7	23.0	14.9	19.1	16.6	13.76	12.99	19.68	15.21	10.18	14.36
Color		10	5	10	10	5	5	10	10	15	8	10	5	5	5
Turbidity		15	15	40	40	25	30	20	50	25	40	30	25	40	25
Suspended Solids		23	13	15	29	45.5	34	26	56	67	78	53.2	45	84	25
Soluble Solids		135	170	171	203	315	235	215	221	252	243	305	292	270	239
Total Solids		158	183	186	232	362	310	241	279	321	321	358	344	354	264
Calcium	$CaCO_3$	54.0	70.0	66.0	84.0	90.0	112.0	70.0	100.0	114.0	104.0	130.0	124.0	130.0	100.0
Magnesium	$CaCO_3$	28.0	44.0	48.0	48.0	45.0	62.0	42.0	56.0	64.0	54.0	66.0	68.0	66.0	54.0
Sodium	$CaCO_3$	27.0	23.0	22.4	37.5	113.9	60.9	54.6	28.6	34.5	44.5	57.8	53.5	35.1	43.6
Total Cations	$CaCO_3$	109.9	137.0	136.4	169.5	248.9	234.9	166.6	184.6	212.6	202.5	253.8	245.5	231.1	197.6
	$CaCO_3$														
Bicarbonates	$CaCO_3$	35.0	31.0	25.0	59.0	68.0	75.0	32.0	75.0	81.0	84.0	92.0	76.0	102.0	74.0
Sulfates	$CaCO_3$	59.6	90.6	93.7	64.3	154.6	128.6	109.0	80.9	100.6	67.2	125.8	132.9	90.7	95.6
Chlorides	$CaCO_3$	12.7	12.7	14.1	22.6	19.7	25.4	16.9	19.7	22.6	21.2	26.8	28.2	26.8	21.2
Nitrates	$CaCO_3$	2.6	2.7	3.6	3.6	6.3	5.9	8.7	9.0	8.4	10.1	9.2	8.4	11.6	6.8
Total Anions	$CaCO_3$	109.9	137.0	136.4	169.5	248.9	234.9	166.6	184.6	212.6	202.5	253.8	245.5	231.1	197.6

Issue: 1-?-?-4

All results expressed in parts per million except pH, conductivity, color & turbidity

ANALYSIS OF SAMPLES TAKEN FROM SUSQUEHANNA RIVER AT THREE MILE ISLAND
1969
THREE MILE ISLAND NUCLEAR STATION

91 303

APPENDIX C

COMMENTS

ON

DRAFT ENVIRONMENTAL STATEMENT

FOR

THE THREE MILE ISLAND NUCLEAR STATION, UNITS 1 & 2

DOCKET NOS. 50-289 AND 50-320

91 304

C-2

ADVISORY COUNCIL
ON
HISTORIC PRESERVATION

WASHINGTON, D.C. 20240

50-289
50-320

AUG 1 4 1972

AUG 1 5 1972

Dear Mr. Muller:

This is in response to your request for comments on the environmental impact statement identified by a copy of your cover letter attached to this document. The staff of the Advisory Council has reviewed the submitted impact statement and suggests the following, identified by checkmark on this form:

✓ The final statement should contain (1) a sentence indicating that the National Register of Historic Places has been consulted and that no National Register properties will be affected by the project, <u>or</u> (2) a listing of the National Register properties to be affected, an analysis of the nature of the effects, a discussion of the ways in which the effects were taken into account, and an account of steps taken to assure compliance with Section 106 of the National Historic Preservation Act of 1966 (80 Stat. 915) in accordance with procedures of the Advisory Council on Historic Preservation as they appear in the <u>Federal Register</u>, March 15, 1972.

_____ In the case of properties under the control or jurisdiction of the United States Government, the statement should show evidence of contact with the official appointed by your agency to act as liaison for purposes of Executive Order 11593 of May 13, 1971, and include a discussion of steps taken to comply with Section 2(b) of the Executive Order.

✓ The final statement should contain evidence of contact with the Historic Preservation Officer for the State involved and a copy of his comments concerning the effect of the undertaking upon historical and archeological resources.

✓ Specific comments attached.

Comments on environmental impact statements are not to be considered as comments of the Advisory Council in Section 106 matters.

Sincerely yours,

Robert R. Garvey, Jr.
Executive Secretary

Enclosure

cc: Mr. William J. Wewer, Deputy Executive Director, Pennsylvania Historical Museum Commission, William Penn Memorial Museum & Archives Building, P. O. Box 1026, Harrisburg, Pennsylvania 17108 w/cy inc.

91 305

cc: Dr. S. K. Stevens, Chairman, Advisory Council on Historic Preservation, 20 Center Street, Camp Hill, Pennsylvania 17011 w/cy inc.

91 306

Comments:

The draft environmental statement states that the 1969 edition of the National Register of Historic Places has been consulted. As this list has been considerably revised since then, the final statement should specify that the current listings of the National Register as published in the Federal Register, March 15, 1972, as supplemented, have been consulted.

91 307

C-5

50-289
50-320

DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20250

August 25, 1972

Mr. Daniel R. Muller
Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

We have had the draft environmental statement for the Three Mile Island Nuclear Station, Units 1 and 2, Metropolitan Edison Company and Jersey Central Power and Light Company, reviewed in the relevant agencies of this Department. Comments from the Forest Service, an agency of the Department, are enclosed.

The Soil Conservation Service, also an agency of the Department, has not yet completed its review. If it has any comments, they will be sent to you when available.

Sincerely,

T. C. Byerly

T. C. BYERLY
Coordinator, Environmental
Quality Activities

Enclosure

4717

91 308

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Washington, D. C. 20250

Re: Three Mile Island Nuclear Station, Units 1 and 2
Metropolitan Edison Co. and Jersey Central Power
and Light Company

We have reviewed the draft environmental statement for Three Mile Island Nuclear Station, Units 1 and 2, Metropolitan Edison Company and Jersey Central Power and Light Company.

As described in the draft environmental statement, the nuclear plants at Three Mile Island Nuclear Station should have little impact on vegetation. This impact will probably be considerably less than that of a comparable plant using coal or oil.

Periodic monitoring of vegetation on the east bank of the Susquehanna River could be used to establish whether or not harmful levels of chlorides or sulfates had been reached. On Page V-28, Table 1 , of the draft environmental statement, monitoring of crops is mentioned. Trees along the river and elsewhere could be monitored at the same time.

It is good to note that the company has plans to landscape the plant site once construction is completed.

We would like to receive a copy of the final environmental statement when it is printed,

4717

91 309

DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20250

September 25, 1972

50-289
50-320

Mr. Daniel R. Muller
Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

Attached are comments from the Soil Conservation Service on the draft environmental statement for the Three Mile Island Nuclear Station, Units 1 and 2, Dauphin County, Pennsylvania. Comments from the Forest Service on the same station were sent to you on August 25, 1972. This completes the Department of Agriculture review.

Sincerely,

T C Byerly

T. C. BYERLY
Coordinator, Environmental
Quality Activities

Enclosure

SOIL CONSERVATION SERVICE

COMMENTS ON DRAFT ENVIRONMENTAL STATEMENT PREPARED BY THE ATOMIC ENERGY COMMISSION FOR THREE MILE ISLAND NUCLEAR STATION UNITS 1 AND 2, DAUPHIN COUNTY, PENNSYLVANIA, DOCKET NUMBERS 50-289 AND 50-320

September 11, 1972

1. The statement should mention that 270 acres of farm land will be lost to construction of the plant.

2. No presently measurable adverse effects on farm enterprises are expected unless abnormal radioactive waste discharges occur from plant operation or accident conditions.

3. It should be mentioned that a continuous supply of electricity is expected to benefit the local rural community.

4. Erosion and sediment control measures and effects -- The provision for sediment control, as outlined on page IV-5, Part C, appears to be adequate.

5. Agricultural land use trends are not expected to show any changes. These changes will depend on the operational history of the plant.

6. It should be mentioned that the operation of the plant under normal operating conditions is not expected to impair the use of local surface water for irrigation purposes.

7. The presence of the dikes around Three Mile Island and the access bridge to the island will reduce the cross sectional area available for carrying water during flood flows. There is no mention in the environmental statement of increased backwater elevations in agricultural areas upstream from the plant. No impairment of agricultural drainage is expected.

8. No mention is made of internal drainage pumping facilities for eliminating runoff within the diked area during high river stages.

9. Within the scope of present-day knowledge, no measurable agricultural pollution is expected to occur during normal operation of the plant. The amount of radioactive pollution of local agricultural land will depend on the number and size of abnormal releases or accidents.

F 5302

91 311

C-9

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 1715
BALTIMORE, MARYLAND 21203

50-289
50-320

NABPL-E

6 September 1972

Mr. Daniel R. Muller
Assistant Director
for Environmental Projects
Directorate of Licensing
Atomic Energy Commission
Washington, D. C. 20545

RECEIVED
SEP 11 1972

Dear Mr. Muller:

In reply to your letter of 23 June 1972, the Baltimore District, Corps of Engineers has reviewed the draft environmental statement on the Environmental Considerations Related to the Proposed Issuance of an Operating License for the Three Mile Island Nuclear Station Units 1 and 2. Our comments are submitted in accordance with provisions contained in the National Environmental Policy Act of 1969 (Public Law 91-190).

There are no comments on the Probable Maximum Flood flow since we furnished this data. The maximum flood of record at Harrisburg is shown on page II-6 occurring on 19 March 1936. Due to the recent flooding, this should be changed to 24 June 1972 with an estimated peak flow of 860,000 cfs. There does not appear to be any effects from the Three Mile Island project on any constructed or proposed flood control projects.

On page I-8, the word "Pump" is spelled incorrectly under the column for purpose and next to permit number NABOP-P (Met-Ed Co) 21.

On page II-6, Swatara Creek is misspelled in Table 3.

The maximum monthly and 24-hour rainfall given on page II-8 should be revised based on the June 1972 storm.

Results of the fish population studies referred to on page II-11 should be included in the final environmental impact statement for this project.

5018

91 312

00168

NAEPL-E
Mr. Muller

6 September 1972

The map on page III-3 is of poor quality and should be improved for the final environmental impact statement.

The plans for the recreation area being proposed in conjunction with the nuclear station does not include identification of implementation procedures. It would be helpful to identify the agency or interests which will construct, operate, and maintain these facilities.

These comments are offered as suggestions to aid your office in preparing a final environmental impact statement. As requested, the Council on Environmental Quality has been furnished copies of this correspondence.

Sincerely yours,

WILLIAM E. TRIESCHMAN, Jr.
Chief, Planning Division

91 313

C-11

THE ASSISTANT SECRETARY OF COMMERCE
Washington, D.C. 20230

50-289
50-320

August 9, 1972

RECEIVED AUG 10 1972

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
U.S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

The draft environmental impact statement for the "Three Mile Island Nuclear Station Units 1 and 2 (Docket No. 50-289 and 50-320)" which accompanied your letter of June 23, 1972, has been received by the Department of Commerce for review and comment.

The Department of Commerce has reviewed the draft environmental statement and has the following comments to offer for your consideration.

From meteorological data presented by the applicant in the Final Safety Analysis Report, we have computed an annual average relative concentration value of 6×10^{-6} sec m^{-3} at the site exlusion distance of 610 miles. This is somewhat less conservative than the value of 9×10^{-6} sec m^{-3} found in the Atomic Energy Commission's analysis on page V-22.

We are unable to assess the estimates of the consequences of postulated accidents which are listed in table 18. We need to know, specifically, the meteorological assumptions used in the analysis, the resulting relative concentration values (sec m^{-3}), and the probability of occurrence of these values. The applicant, in table 6.9-1 of the Environmental Report, has listed such concentration values as a function of time of release and chance of occurrence. For example, the applicant has estimated that at the site boundary a concentration value of 3×10^{-5} sec m^{-3} has a fifty percent chance of occurrence for an assumed release period of 1 hour. Our estimate is 6×10^{-5} sec m^{-3}. We are unable to make such comparisons with the Atomic Energy Commission's analysis.

4415

91 314

00170

We hope these comments will be of assistance to you in the preparation of the final statement.

Sincerely,

Sidney R. Galler

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

91 315

C-13

50-289
50-320

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20201

SEP [illegible]

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
Directorate of Licensing
Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

This is in response to your letter of June 23, 1972, wherein you requested comments on the draft environmental impact statement for the Three Mile Island 1 and 2, Metropolitan Edison Company, Docket Numbers 50-289 and 50-320.

This Department has reviewed the health aspects of the above project as presented in the documents submitted. The following comments are offered:

1. River Characteristics: What was the maximum flow rate (cfs) of the Susquehanna River at TMI during Agnes of 1972? The use of flood gates which "can be set in place in the unlikely event that 1,100,000 cfs PMF is exceeded" is not clear (pp. II 6-8).

2. Liquid Wastes:

   a. Table 6 indicates that 60% of the liquid effluent, T^3 excepted, to be I[131] (page III 18). Table 3-6.3 of the Power Company's environmental report, item 11, states an average hold up time of 14 days. Why cannot the liquid effluent be held an additional 6 weeks, thereby reducing the 60% factor to 2.4% for Iodine 131?

   b. Cesium 137 and Strontium 90 are long-lived isotopes relative to biological systems. What is the efficiency of the polishing demineralizer for cations of cesium and strontium? If the efficiency is not the maximum available for these cations, then final stage high efficiency cesium and strontium exchange columns should be installed.

3. Radiological Environmental Monitoring: Table 5.5-4 lists "crops" as the only type of vegetation to be sampled at 13-week intervals three times a year. Some crops may only be available for a single sampling. Vegetation, particularly grasses which may be present for a long period of time, should be specified.

7270

POOR ORIGINAL

91 316

Page 2 -- Mr. Daniel R. Muller

4. Radiological Impact:

   a. The draft statement gives 1.868 x 10^6 people within the 50 mile radius (pg. V 22). The power company's report gives 3.03 x 10^6 people within the same area (6.9-1, March 1972). How many people live within the 50 mile radius of the site?

   b. The Peach Bottom Nuclear Plant is about 35 miles downstream, therefore, the 50 mile radii of TMI and Peach Bottom overlap. Both include Harrisburg, Pennsylvania. The report should show the number of people who will be receiving additional radiation from the other plant and the magnitude of the additional dose.

5. Transportation: "The applicants have not indicated where the irradiated fuel or solid wastes will be shipped, etc." (pg. V 30). Does a terminus exist? What are the site options? Plant operation should not be permitted until site(s) for waste and recycled materials are specified.

The opportunity to review the draft environmental impact statement is appreciated.

Sincerely yours,

Merlin K. DuVal, M.D.
Assistant Secretary for
Health and Scientific Affairs

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

ER 72/790

SEP 1 8 1972

Dear Mr. Muller:

This is in response to your letter of June 23, 1972, requesting our comments on the Atomic Energy Commission's draft statement, dated June 1972, on environmental considerations for Three-Mile Island Nuclear Station Units 1 and 2, Dauphin County, Pennsylvania.

Historical Significance

The draft statement adequately assesses the effects of the nuclear plant on historic and archaeological resources.

The operation of the station will not affect any existing or proposed unit of the National Park System nor any site eligible for registration as a National Historic, Natural, or Environmental Education Landmark.

River Characteristics

Protection from floods is a particular problem at this site on an island in the Susquehanna River. The design of the dikes on the northern end of the island was based on a preliminary estimate by the Corps of Engineers of the probable maximum flood of 1,100,000 cfs. Later calculations by the Corps showed that the PMF should be much higher, 1,750,000 cfs unregulated, or 1,625,000 cfs when regulation from existing reservoirs is taken into consideration. Since the draft statement was issued, tropical storm Agnes caused a flood on the Susquehanna River which reached about 1,000,000 cfs at Three-Mile Island on June 24, 1972. A review of the PMF calculations may be made by the Corps and further upward revisions are likely.

The Geological Survey reviewed hydrologic and geologic aspects of the construction permit application on request from AEC and transmitted their comments by memoranda of January 10, 1968, and June 30, 1969. In the earlier of

these reviews the applicant's calculations of stage for the estimate of 1,100,000 cfs were reviewed. However, stage calculations for the applicable PMF discharge have not yet been reviewed.

The draft statement indicates, on page II-8, that it is not practical to increase the dike height for the PMF and that the applicant has chosen to provide flood gates to be set in place should a discharge of 1,100,000 cfs be exceeded. However, the statement contains no evaluation of the adequacy of such measures. Such an evaluation should be added to the statement; it should consider the velocity and depth of water around the reactor and ancillary structures during a PMF; the safety of structures, waste tanks, etc.; and the possibility of debris production which could endanger downstream structures.

It should also be noted that the flood studies section of the applicant's environmental report contains a number of misleading statements. Among these, that large floods on the lower Susquehanna River would not result from storms of tropical origin. This contradicts "Hydrometeorological Report No. 40, Probable Maximum precipitation, Susquehanna River Drainage above Harrisburg, Pa." (U.S. Department of Commerce, Weather Bureau, 1965) which states, "although no really severe hurricane rains have been observed in the basin in the last 75 years the risk is evident from storms near the basin." It concludes after considering such storms that, "it must be assumed, therefore, that storms of tropical origin constitute a real threat to the basin . . . ." Further, the applicant's characterization of the design flood of 1,100,000 cfs as having a "frequency of occurrence in excess of 10,000 years" is misleading. On the basis of flood records available the extrapolation of flood frequencies beyond, at the most, a few hundred years is meaningless.

Terrestrial Fauna

This paragraph on page II-11 should be expanded to include song birds, raptors, waterfowl, shore birds, reptiles, amphibians, furbearers, and other non-game species. It should be noted that at least three of the species that are found in or breed in the area are on the Federal list

of Rare or Endangered Species. These are the bog turtle (*Clemmys muhlenbergi*), the bald eagle (*Haliaeetus leucocephalus*), and the osprey (*Pandion haliaetus*). The peregrine falcon (*Falco peregrinus anatum*) is on the Pennsylvania list of endangered species.

Aquatic

Delete the last sentence of the first paragraph in this section since fly fishing is not popular in winters.

Delete the last sentence of the first paragraph on page II-12 and substitute the following. "There is no commercial fishing in the area at the present time; however, the Susquehanna River has historically supported large runs of the anadromous American shad (*Alosa sapidissima*), an important commercial and sports fish. It should be noted that the Susquehanna has been studied and is considered suitable for the restoration of shad. The planning for this restoration has reached the stage of design of fish passage facilities at the dams which now block the fish runs. We think that the restoration of the runs is imminent."

External Appearance

The third paragraph of page III-1 describes the dike and materials to be used in its construction. We suggest that this paragraph be expanded to give the dimensions of the dike and the height above normal water surface levels.

Heat

The third paragraph on page III-8a gives the cooling water velocity at the intake as 0.2 fps under normal conditions. This paragraph should be expanded to include the velocity during minimum river discharge and the probable frequency of occurrence for this velocity. A river discharge-duration curve and a corresponding intake velocity-duration curve would be of value in this regard.

It is important that the extreme temperature, discharge, and intake velocity conditions be considered since fish kills are not normally caused by "normal" conditions but extremes. It also appears that a discussion should be included on the impacts expected during certain emergency

situations when the cooling water discharge may be 28°F above the river temperatures.

Radioactive Wastes

The anticipated annual releases of radioactive isotopes in the liquid and gaseous effluent as given in tables 4, 5, and 6, appear to be in disagreement with the equivalent data on pages 5.5-15 and 5.5-16 of the applicant's report dated December 1971.

Solid Wastes

The disposal of fish and other debris caught on the intake trash racks and screens is not discussed. It is recommended that such accumulations be handled as non-contaminated wastes and the method of disposal described in the final environmental statement under the section on Solid Wastes.

Impact on TMI

This section should be expanded to include a more complete and quantitative discussion of the effects of construction on the pre-project environment. Loss of wildlife habitat and its attendant wildlife resource, disruption of wildlife life patterns due to impacts such as noise, and intensified human intrusion should be discussed in a more quantitative manner in this section.

Water

Loss of fish and other wildlife habitat due to sedimentation from construction activities and erosion of denuded areas, dredging in shallow areas of the river, and disruption of fish behavior patterns, including spawning activities, due to construction activities should also be discussed in a more quantitative manner.

Land Use

We commend the applicants for including recreation development as part of the total project. These recreation development plans were previously reviewed by personnel from our Philadelphia Regional Office of the Bureau of Outdoor Recreation. The proposal as given on page V-1 and V-2 of the environmental statement is also in accord with the Pennsylvania Statewide Comprehensive Outdoor Recreation Plan.

91 321

We recommend that the development of the proposed recreation facilities be stipulated in the operating licenses for Units 1 and 2.

We also recommend that the final environmental statement include an outline of plans and responsibilities for future or ultimate recreation development on the site. This outline should include details regarding such matters as cost of future development, development schedules, and operation and maintenance responsibilities by public agencies and the applicants.

Terrestrial Ecosystem

The second paragraph of this section on page V-15 is confusing. It should assess the project caused impacts on the terrestrial ecosystem even if much of the impacts are the result of recreation development. It may be appropriate to estimate the percentage of these impacts that are caused by the operation of the plant.

Transportation of Nuclear Fuel and Solid Radioactive Wastes

This section in the final environmental statement should identify the disposal sites of the irradiated fuel or solid wastes in order to permit an accurate assessment of the effects of disposal.

Environmental Effects of Accidents

This section contains an adequate evaluation of impacts resulting from plant accidents through Class 8 for airborne emissions. However, the environmental effects of releases to water is lacking. Many of these postulated accidents listed in Tables 17 and 18 could result in releases to the Susquehanna River and should be evaluated in detail.

We also think that Class 9 accidents resulting in both air and water releases should be described and the impacts on human life and the remaining environment discussed as long as there is any possibility of occurrence. The consequences of an accident of this severity could have far-reaching effects on land and in the Susquehanna River which could persist for centuries affecting millions of people.

91 322

Land Use

This section on page VII-1 should be expanded to include loss of wildlife, wildlife habitat, disruption of wildlife patterns and increased sewage and waste disposal problems.

Short-Term Uses and Long-Term Productivity

It is stated on page VIII-1 that if the reactors are decommissioned complete restoration of the site is possible but may be deterred or delayed by cost. It is not clear if contaminated structures or reactor parts would be removed from the site, left above ground or buried at the site. The plans for such an event should be indicated in the final environmental statement.

Irreversible and Irretrievable Commitments of Resources

This section should include the annual loss of fish and wildlife resources which would be lost due to project implementation.

Summary of Cost-Benefit Analysis

The combustion products are given on page XI-13 for the alternative coal-burning and oil-burning plants. The sulfur content of the coal and oil is not given. However, the applicants' report does contain this information on page 11.2-1. This report assumes that 80 percent of the 880 tons per day of SO_2 and 115 tons per day of NO_x will be removed by air pollution control equipment. The report indicates that the remaining 20 percent of these air pollutants will not exceed the limitations of the "national ambient air quality standards." It is suggested that the final environmental statement include the calculations involved in the prediction of the ground level SO_2 and NO_x concentrations so that these values can be compared with those stipulated by the Environmental Protection Agency in its ambient air quality standards reported in the Federal Register of April 30, 1971.

91 323

We hope these comments will be helpful to you in the preparation of the final environmental statement.

Sincerely yours,

H. H. Lyon

Deputy Assistant Secretary of the Interior

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

91 324

C-22

DEPARTMENT OF TRANSPORTATION

UNITED STATES COAST GUARD

50-289
50-320

MAILING ADDRESS
U.S. COAST GUARD (CWS)
400 SEVENTH STREET SW
WASHINGTON D.C. 20590
PHONE 202/426/2262

26 JUL 1972

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

This is in response to your letter dated 23 June 1972 addressed to Mr. Herbert F. DeSimone, Assistant Secretary for Environment and Urban Systems, concerning the draft environmental impact statement and pertinent papers on the Three Miles Island Nuclear Station, Units 1 and 2, Dauphin County, Pennsylvania.

The concerned operating administrations and staff of the Department of Transportation have reviewed the material submitted and the Federal Aviation Administration noted the following:

"We have reviewed the subject Draft Environmental Impact Statement, and other than the comments noted in the Draft Detailed Statement by the U. S. Atomic Energy Commission on the environmental considerations, Pages B9 and B10, Paragraphs 4a and 4e, we find no additional environmental impact on aeronautical activities.

"The question of the effect of smoke plumes on aircraft approaching from or departing to the south is still not definitive with respect to VFR traffic. In addition, the probable instance of fogging due to the operation of the cooling towers, which is estimated to be 39 hours a year, is extremely difficult to assess as to the impact on IFR operations in terms of delay; however, some minimal impact should be expected. It is our opinion that the tradeoff of the minimal delay versus the requirements for electrical power in the area must be balanced by the agency issuing the operating license.

The Department of Transportation has no objection to the issuance of an operating license for this project. The draft statement, however, did not indicate a resolvement of the fogging problem due to the plume emanating from the cooling towers which may interfere with aircraft operations at the Harrisburg Airport. This aspect of the project should be addressed in the final environmental impact statement.

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So as to not unduly delay issuance of the operating license, it is recommended that the applicant resolve the situation by direct coordination with the Administrator, Eastern Region of the Federal Aviation Administration. He may be contacted as follows:

Administrator
Eastern Region, Federal
Aviation Administration
Federal Building
John F. Kennedy International Airport
Jamaica, New York 11430

The opportunity for this Department to review and comment upon the draft statement and other material submitted on the Three Miles Island Nuclear Station is appreciated. We would be pleased to receive a copy of the final statement and it is requested that a copy of the final statement also be sent to the Eastern Regional Administrator of Federal Aviation Administration.

Sincerely,

W. M. BENKERT
Rear Admiral, U. S. Coast Guard
Chief, Office of Marine Environment
and Systems

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FEDERAL POWER COMMISSION
WASHINGTON, D.C. 20426
August 22, 1972

IN REPLY REFER TO:

PWR-PSA

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

This is in reference to your letter of June 23, 1972, requesting comments on the AEC's "Draft Environmental Statement Related to the Proposed Issuance of an Operating License to the Metropolitan Edison Company, Jersey Central Power and Light Company and Pennsylvania Electric Company for the Three Mile Island Nuclear Station Units 1 and 2 (Docket Nos. 50-289 and 50-320)."

The Federal Power Commission's Bureau of Power has previously commented on the need for the Three Mile Island Units 1 and 2 in letters dated January 28, 1971 and February 25, 1972. In preparing these comments, the Bureau of Power staff has considered the AEC Draft Environmental Statement; the Applicant's Environmental Report and amendments thereto; related reports made in response to the Commission's Statement of Policy on Reliability and Adequacy of Electric Service (Order No. 383-2); Power System Statements submitted by the Applicant to this Commission; and an analysis of these documents by FPC staff, together with related information from other FPC reports. The staff of the Bureau of Power generally bases its evaluation of the need for a specific bulk power facility upon the load-supply situation for the critical load period immediately following the availability of the facility, as well as upon long-term considerations. The useful lives of such facilities are generally 30 years or longer, and they will continue to serve the utilities' needs during their service lives.

These comments are made by the staff in accordance with the National Environmental Policy Act of 1969, and the Guidelines of the President's Council on Environmental Quality dated April 23, 1971. They are directed toward a review of the need for the electrical capacity of the facilities as concerns the adequacy and reliability of the affected electric bulk power systems, and matters related thereto.

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Mr. Daniel R. Muller

Need for the Facilities

The three utility company Applicants and the New Jersey Power and Light Company are subsidiaries of the General Public Utilities Corporation. Together they comprise the GPU System which is operated on a fully integrated basis. The staff analysis includes both the GPU System and the Pennsylvania-New Jersey-Maryland Interconnection (PJM), in which the Applicants are members. The staff's evaluation of the need for the electric output of the Three Mile Island Units 1 and 2, scheduled for commercial operation in November 1973 and May 1975 respectively, is for the summer peak load period following the planned availability of the units. The GPU System is a winter-peaking system while PJM is a summer-peaking system. The capacity resources and system loads reported for both GPU and PJM in the draft environmental statement are in general agreement with data reported to the Commission. All of the systems involved are members of the Mid-Atlantic Area Coordination Group (MAAC) which provides coordinated planning for the interconnected bulk power facilities for those member systems, as the PJM Interconnection provides coordinated operation of the interconnected systems.

The following tabulation shows the electric system loads to be served by the Applicants and by the entire PJM Interconnection. It also shows the relationship of the electrical output of the Three Mile Island Units 1 and 2 to the available reserve capacity at the times of the 1974 and 1975 summer peak load periods. These peak load periods occur during the anticipated initial service periods of the new units, but the lives of these units are expected to be some 30 years or more, and they are expected to contribute to the Applicants' total generating capacity throughout that period. Therefore, these units will be depended upon to supply power to meet future demands over a period of many years beyond the initial service needs discussed in this report.

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Mr. Daniel R. Muller

Forecasted 1974 Summer Peak Situation

	GPU System	PJM Interconnection 1/
Conditions With Three Mile Island Unit No. 1 (850 Megawatts)		
Net Total Capability - Megawatts	7,155	42,494
Estimated Peak Hour Load - Megawatts	5,863	34,110 2/
Reserve Margin - Megawatts	1,292	8,384 3/
Reserve Margin - Percent of Peak Load	22.0	24.6
Conditions Without Three Mile Island Unit No. 1		
Net Total Capability - Megawatts	6,305	41,644
Estimated Peak Hour Load - Megawatts	5,863	34,110
Reserve Margin - Megawatts	442	7,534 3/
Reserve Margin - Percent of Peak Load	7.5	22.1
Desired Reserve Margin (20 Percent of Peak Load) - Megawatts	1,173	4/
Deficiency - Megawatts	731	

1/ Data Source - April 1, 1972 Response by MAAC to FPC Order 383-2
2/ MAAC Coincident load
3/ Reserve before scheduled maintenance of 800 MW
4/ The 24.6 percent reserve margin in 1974 with Three Mile Island is currently considered adequate by PJM.

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Mr. Daniel R. Muller

Forecasted 1975 Summer Peak Load Situation

	GPU System	PJM Interconnection 1/
Conditions With Three Mile Island Units Nos. 1 and 2 (1,800 Megawatts)		
Net Total Capability - Megawatts	8,285	48,512
Estimated Peak Hour Load - Megawatts	6,377	37,085 2/
Reserve Margin - Megawatts	1,908	11,427 3/
Reserve Margin - Percent of Peak Load	29.9	30.8
Conditions Without Three Mile Island Unit No. 2		
Net Total Capability - Megawatts	7,335	47,562
Estimated Peak Hour Load - Megawatts	6,377	37,085 2/
Reserve Margin - Megawatts	958	10,477 3/
Reserve Margin - Percent of Peak Load	15.0	28.6
Desired Reserve Margin (20 Percent of Peak Load) - Megawatts	1,275	4/
Deficiency - Megawatts	319	

1/ Data Source - April 1, 1972 Response by MAAC to FPC Order 383-2.
2/ MAAC coincident load.
3/ Before scheduled maintenance of 850 MW.
4/ The 30.8 percent reserve margin is somewhat higher than the 24.6 percent reserve margin considered adequate for 1974 by PJM.

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Mr. Daniel R. Muller

The Applicants state that the reserve criteria used on the Integrated GPU System is that adopted from the PJM Interconnection, in which the Applicants are members. MAAC and PJM are essentially totally overlapping entities and even though there may be small differences in their areas of operation for this purpose they may be considered identical. This minimum reserve criteria is equal to the summer peak load plus a 20 percent reserve margin. These reserve margins are gross and include provisions for scheduled maintenance requirements of the members, forced outages of generating equipment, and ordinary operating requirements which may be shared by pool participants when operating contingencies occur. Generally, such pool reserves do not include provisions for long term, firm power transactions. The staff of the Bureau of Power notes that for systems of the PJM Pool considering the types and sizes of generating facilities, it would not be unusual if a 20 percent reserve margin at the summer peak resulted in the probability of system load exceeding the electric supply once in about ten years.

The tabulations for the 1974 and 1975 summer peak periods on the GPU Systems show that failure to bring the Three Mile Island Unit No. 1 into commercial service prior to the 1974 summer peak will result in a reserve margin of 442 megawatts or 7.5 percent of peak load, and failure to bring Unit No. 2 into commercial operation prior to the 1975 summer peak will result in a reserve margin of 9[illegible] megawatts or 15 percent of peak load. With respect to the desired 20 percent reserve margin, a deficiency of 731 megawatts will occur on the GPU System at the 1974 summer peak period without the Three Mile Island Unit No. 1. Similarly, a deficiency of 319 megawatts will occur at the 1975 summer peak period without Three Mile Island Unit No. 2.

The loss of these units would also reduce reserves in the PJM Pool; the effect is to reduce the pool's reserves by about two percent for each unit. The reserve margins of both the GPU System and the PJM Pool through 1975 are dependent not only upon the timely commercial operation of Three Mile Island Units 1 and 2 but also on the timely commercial operation of six other new nuclear base-load units totaling approximately 6,000 megawatts and 12 new fossil base-load units totaling approximately 5,400 megawatts of capacity. In addition, a large amount of gas turbine peaking capacity is being added to the Pool's available generating resources. Capacity reserves for the PJM Pool are forecasted at 24.6 and 30.8 percent of peak load for the 1974 and 1975 summer peak periods, respectively, provided that the generation expansion plans of the Pool's member systems are realized.

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Transmission Facilities

The associated transmission system to integrate the Three Mile Island Unit No. 1 into the existing transmission network is completed and consists of approximately 7 miles of 230-kilovolt lines in three circuits. These overhead lines are supported on lattice-type combination steel and aluminum towers on 150-foot wide rights-of-way. Unit No. 2 output will be integrated into the GPU System with two 500-kilovolt circuits approximately 75 miles in length. The overhead lines will be supported on combination steel and aluminum towers on 200-foot wide rights-of-way. A third 500-kilovolt line, 11 miles in length, will be constructed, owned and operated by the Pennsylvania Power and Light Company which is not a GPU company.

The routes of the 230-kilovolt and 500-kilovolt lines traverse open farmland and second growth woodlands. The Applicants' practices in design and construction of transmission lines have used the techniques now generally accepted for reducing the impact of overhead transmission lines on the environment and are fully consistent with the Department of Agriculture's and Department of Interior's joint publication, "Environmental Criteria for Electric Transmission Systems".

The 230-kilovolt system integrates the plant output into the local Metropolitan Edison Company's system. The 500-kilovolt system integrates the plant's output into the GPU System's and other PJM Interconnection members' bulk power network for delivery of energy to more distant load centers in eastern Pennsylvania and New Jersey making a significant contribution to system reliability in the total area.

Alternatives and Costs

The Applicant, in determining the need for additional generation to meet its projected demands, considered purchase of firm power and a number of practical alternatives including alternate locations, plant types, environmental effects and economics. The decision evolved into a choice of base-load generation, either nuclear-fueled at the Three Mile Island site or a coal-fired fossil plant located at a mine in western Pennsylvania. In the economic studies which resulted in the selection of the nuclear-fueled plant, the Applicants used capital costs of $362 per kilowatt of capacity and fuel costs of 1.3 mills per kilowatt hour for the nuclear-fueled plant and capital costs of $315 per kilowatt of capacity, which includes costs of sulfur-dioxide gas-cleaning

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Mr. Daniel R. Muller

equipment and additional transmission costs, and fuel costs of 3.7 mills per kilowatt hour for the coal-fired alternative plant located at the mine. The staff of the Bureau of Power finds these costs within the range of similar costs reported by the industry.

Conclusions

The staff of the Bureau of Power concludes that the electric power output of the Three Mile Island Units 1 and 2 is needed to meet the Applicants' future demands for power, particularly during the 1974 and 1975 summer peak load periods, and to provide reasonable reserve margins for adequacy and reliability of electric service on the GPU System and the PJM Interconnection. Prudent and responsible electric utility operations require system operating reserve margins sufficient to meet various operating contingencies that could result in abnormal bulk power system conditions. These new units are needed to provide the Applicants' system with the reserve margin capacity to meet its stated criteria.

Very truly yours,

F. L. Phillips
Chief, Bureau of Power

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ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

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10 AUG 1972

OFFICE OF THE
ADMINISTRATOR

RECEIVED
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U.S. ATOMIC ENERGY COMMISSION

Mr. L. Manning Muntzing
Director of Regulation
U.S. Atomic Energy Commission
Washington, D.C. 20545

Dear Mr. Muntzing:

The Environmental Protection Agency has reviewed the draft environmental statement for the Three Mile Island Nuclear Station Units 1 and 2, and we are pleased to provide our comments.

It is anticipated that the Three Mile Island plant, which will employ a closed-cycle cooling system, will be able to operate in compliance with thermal criteria of the Federally approved state standards. We are concerned, however, that excessive levels of residual chlorine in the cooling system discharge may lead to a serious adverse effect on aquatic biota in the Susquehanna River. Thus, in our opinion, steps should be taken to reduce or eliminate the discharge of chlorine to the environment.

The recent flooding on the Susquehanna River has raised concerns regarding the adequacy of the flood protection at Three Mile Island. We request the AEC to reassess the probable maximum flood and to reconfirm the adequacy of the flood protection at this facility.

In our judgement the Three Mile Island radioactive waste management systems are capable of providing effluents which are within guidelines of the proposed Appendix I to 10 CFR Part 50. However, the proposed discharge of untreated radioactive condensate demineralizer regeneration wastes cannot be accepted as "low as practicable."

It seems appropriate that the provisions of Safety Guide 21 be applied to the effluent monitoring scheduled at Three Mile Island. As written, the draft environmental

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statement indicates that several potentially radioactive effluent streams may not be sampled or monitored before their discharge to the Susquehanna River.

We will be pleased to discuss our comments with you or members of your staff.

Sincerely,

Neil Orloff

for Sheldon Meyers
Director
Office of Federal Activities

Enclosure

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50-320

ENVIRONMENTAL PROTECTION AGENCY

Washington, D.C. 20460

AUGUST 1972

EPA#D-AEC-00059-1

ENVIRONMENTAL IMPACT STATEMENT COMMENTS

Three Mile Island Nuclear Station Units 1 and 2

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INTRODUCTION AND CONCLUSIONS

The Environmental Protection Agency (EPA) has reviewed the draft environmental statement for the Three Mile Island Nuclear Station Units 1 and 2 prepared by the U.S. Atomic Energy Commission (AEC) and issued on June 26, 1972. Following are our major conclusions:

1. Disposing of the radioactive waste solutions created by regeneration of the Unit 2 condensate demineralizer to the Susquehanna River without processing them through the radwaste system cannot be construed as "low as practicable."

2. The AEC is encouraged to apply the provisions of Safety Guide 21 to the effluent monitoring requirements for Three Mile Island.

3. The releases of liquid and gaseous radioactive waste from Three Mile Island are expected to be "low as practicable" if due consideration is given to the recommendations made by EPA. Since the plant has the necessary equipment, the ultimate release of radioactivity will depend on the waste management practices applied by the operator and the requirements of the AEC.

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4. In our opini n, the most serious impact that may result from the operation of the plant will be due to the release of residual chlorine and chlorine by-products (e.g., chloramines) in the cooling water discharge. We recommend, therefore, that the nature and extent of such impacts be evaluated and measures be taken to eliminate or substantially reduce the amounts of chlorine released.

5. We believe the closed-cycle cooling system employing two natural draft cooling towers per unit will enable the Three Mile Island plant to operate in compliance with federally approved state thermal standards. Although no impacts on aquatic biota directly attributable to thermal releases are expected, there may be impacts that arise from the congregation of fish in the vicinity of the discharge point. It is recommended that these potential impacts be addressed in the final statement.

6. As a result of the flooding on the Susquehanna River following Hurricane Agnes, we suggest that the probable maximum flood for the river at Three Mile Island be reevaluated and the adequacy of the plant flood protection be reconfirmed.

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RADIOLOGICAL ASPECTS

Radioactive Waste Management

In most respects the capabilities provided by waste management equipment for Three Mile Island Units 1 and 2 are consistent with the concept of "as low as practicable." Two notable exceptions are the discharge of the neutralized regenerant solution from the Unit 2 condensate demineralizer and the discharge of untreated sluice water from the Unit 1 powdex filter-demineralizer to the Susquehanna River.

The intended procedure of discharging untreated radioactive liquids from the sluicing and regenerating operations indicated above is not, in our opinion, "as low as practicable." We strongly encourage the AEC to insure that these radioactive liquids will be treated in the waste management system. A significant portion of the radionuclides from these sources will be long-lived and, thus, will accumulate in the environment, if discharged. The annual contribution of the sluice waste to the total annual discharge of radionuclides cannot be determined from the environmental statement. In order to indicate the potential environmental impact from the discharge of untreated sluice water, the final statement should provide an estimate of the quantities of radionculides expected from this source.

It is noted that there are provisions for the future addition of a deep-bed condensate demineralizer for Unit 1. If a deep-bed demineralizer is added for Unit 1, the yearly discharge of untreated regenerate solutions could contribute as much as 30 curies to the aquatic environment. It would be appropiate for the final statement to indicate the criteria for the installation of this demineralizer and to provide the result of an evaluation of the environmental effects of its use.

Similarly, the liquid waste from the turbine building drains (presumably both floor and equipment drains) will be discharged to the river without treatment. Although the turbine building is in a "non-nuclear" area, contaminated leakage is anticipated from the condensate pumps, st am line valves, and other sources. It is recommended that the final statement provide detailed information about leak rates, activity levels in the leakage and in the discharge, and the possibility of treatment before discharge.

The gaseous effluent control systems proposed for Units 1 and 2 are expected to be capable of maintaining the gaseous effluents from the facility at levels below the guidelines of the proposed Appendix I to 10 CFR Part 50. According to the environmental statement, a minimum decay time of 30 days for the reactor coolant off-gases will be provided even though the waste gas decay tanks are designed to provide 90 days decay. We encourage the applicant to fully utilize the off-gas decay tanks to minimize environmental effects from discharges of gaseous radionuclides. This would be consistent with the concept of "as low as practicable" and would appear consistent with t[illegible] [illegible]visions of 10 CFR Part 50.36a.

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Effluent Monitoring

It does not appear that all potential pathways for the release of radioactive effluents are being sampled and monitored. For example, it is not apparent that the liquids from the secondary coolant system (turbine building drain, powdex filter-demineralizer sluice water, and deep-bed demineralizer regenerate solutions) will be sampled and analyzed prior to their release to the Susquehanna River. We believe that such analyses should be made to these potentially contaminated liquids prior to their release. The application of Safety Guide 21 recommendations for effluent monitoring would seem appropriate for this nuclear station. Furthermore, a tabulation should be provided of the quantities of radionuclides (unidentified and ^{131}I) which could be released undetected from any effluent release point due to instrument sensitivity limitations.

Since the exclusion area for Three Mile Island includes a substantial area of the Susquehanna River to which public access is uncontrolled, it is possible for individuals to spend considerable time within the exclusion area where the dose rates will be significantly higher than at the exclusion area boundary. The final statement should include details of how the applicant intends to determine that the doses to such individuals are within the applicable guidelines and regulations.

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Transportation and Reactor Accidents

In its review of nuclear power plants, EPA has identified a need for additional information on two types of accidents which could result in radiation exposure to the public: 1) those involving transportation of spent fuel and radioactive wastes and 2) in-plant accidents. Since these accidents are common to all nuclear power plants, the environmental risk for each type of accident is amenable to a general analysis. Although the AEC has done considerable work for a number of years on the safety aspects of such accidents, we believe that a thorough analysis of the probabilities of occurrence and the expected consequences of such accidents would result in a better understanding of the environmental risks than a less-detailed examination of the questions on a case-by-case basis. For this reason, we have reached an understanding with the AEC that they will conduct such analyses with EPA participation concurrent with the review of impact statements for individual facilities and will make the results available in the near future. We are taking this approach primarily because we believe that any changes in equipment or operating procedures for individual plants, required as a result of the investigations, could be included without appreciable change in the overall plant design. If major redesign of the plants to include engineering changes were expected or if an immediate public or environmental risk were being taken while these two issues were being resolved, we would, of course, make our concerns known.

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The statement concludes "...that the environmental risks due to postulated radiological accidents are exceedingly small." This conclusion is based on the standard accident assumptions and guidance issued by the AEC for light-water-cooled reactors as a proposed amendment to Appendix D of 10 CFR Part 50 on December 1, 1971. EPA commented on this proposed amendment in a letter to the Commission on January 13, 1972. These comments essentially raised the necessity for a detailed discussion of the technical bases of the assumptions involved in determining the various classes of accidents and expected consequences. We believe that the general analysis mentioned above will be adequate to resolve these points and that the AEC will apply the results to all licensed facilities.

Even though we agree that accidents should be evaluated on a general basis, the possibility of flood damage at the Three Mile Island site would seem to warrant specific consideration. At least a comparison of flood protection with an updated probable maximum flood (PMF) estimate, which takes into account the floods caused by Hurricane Agnes, should be presented in the final statement. In addition, details of the protection provided for safety-related equipment from floods exceeding the level of the plant dike system, including those equal to and exceeding the PMF, would be particularly appropiate in the final statement. We note also that a large pumped-storage facility is to be constructed on Stony Creek upsteam from Three Mile Island, but information on the flood protection provided is not available. The final statement should include consideration of the adequacy of flood protection measures at Three Mile Island relative to the possible failure during the PMF of the planned, upstream pumped-storage project.

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NON-RADIOLOGICAL ASPECTS

Chemical Effects

It is probable that the most significant impact from operation of the Three Mile Island plant may be due to the release of effluent containing residual chlorine and chloramines to the Susquehanna River. This will occur as a result of the use of elemental chlorine in plant systems to control slime growth. As indicated in the draft statement, the chlorination systems "...will be operated intermittently for several 15 minute to half-hour periods per day, and the additions will be controlled so that the residual chlorine in the effluent cooling water stream is maintained between 0.5 and 1 ppm (parts per million)." Further, it is indicated that if the effluent stream is completely mixed with the receiving water, chlorine levels of .004 ppm and 0.05 ppm are expected under conditions of normal and low river flow, respectively. Such levels, should they routinely occur over an appreciable portion of the receiving water, could constitute a hazard to aquatic biota. Thus, we are inclined to agree with the draft statement that "...the impact on the biota of the river (due to chlorine releases) may be significant." In our opinion, however, additional information is necessary in order to determine the character and extent of the impact. This information should be provided in the final statement.

The assumption of complete mixing used in the draft statement to determine the levels of residual chlorine represents an idealized situation which would rarely, if ever, be realized in the Susquehanna River. Thus, it is unlikely that constant levels of residual chlorine would be observed across the entire width of the river, or York Haven Pool, at points immediately downstream of the discharge. Also, it is

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unlikely that concentrations would uniformly decrease with distance away from the plant site as the chlorine residuals were consumed or dissipated. A more realistic assumption would be that the characteristics of the chemical discharge plume will vary as discharge levels and conditions in the receiving water change. The final statement, in our opinion, should present an analysis of the release of chlorine and consequent effects based on such an assumption. This analysis should be supported by the following information:

details of the schedule for chlorine additions specifying amounts to be added and indicating the frequency and duration of each addition;

predictions of the shape, size, location, and behavior of the discharge plume under various conditions of river flow and chlorine residual discharge rates;

descriptions of the chemistry of free chlorine and chlorine by-products (e.g., chloramines) in the receiving water including concentrations and persistence times;

details of an effective program for monitoring residual chlorine levels in the Susquehanna River; and

additional biological base-line data concentrating on the important species likely to be significantly affected by chlorine releases; this should emphasize those biological aspects of each species likely to undergo change (e.g., feeding habits, reproductive processes, and migratory patterns).

Such information would facilitate determinations as to the chlorine levels which will provide adequate protection for the aquatic biota near the Three Mile Island site and portions of the river downstream.

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As a general guide, EPA has recommended in the past the following criteria for residual chlorine levels in the receiving water:

TYPE OF CRITERIA	RECOMMENDATION FOR TOTAL RESIDUAL CHLORINE	LEVEL OF PROTECTION
continuous	0.01 mg/liter	This level would probably not protect trout during reproduction, some important fish food organisms, and could prove lethal to sensitive fish species during certain life stages.
continuous	0.002 mg/liter	This level should protect most aquatic organisms.
intermittent	A. 0.1 mg/liter not to exceed 30 minutes per day B. 0.05 mg/liter not to exceed 2 hours per day.	These levels should not result in sigificant kills of aquatic organisms or adversely affect the aquatic ecology.

It should be understood, however, that even the above criteria may not provide an adequate degree of protection in all instances. In our opinion, whether these or more restrictive criteria are appropriate must be determined on a case-by-case basis. Thus, experience at the Three Mile Island plant may indicate that in order to reduce adverse impacts to acceptable levels, the amounts of residual chlorine in the receiving water must be kept substantially below those recommended above. For example, some species of fish show "avoidance" reactions to chlorine (chloramines) at concentrations as low as 0.001 ppm. Should this occur, the effect may make some portion of the York Haven Pool unsuitable as a fish habitat. In addition, possible changes in other aspects of the life patterns of important species could prove significant. We recommend, therefore, considering the importance of this pool as a recreational resource for the Harrisburg, York, and Lancaster area,

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that additional studies be instituted to specifically iden. .fy the nature and extent of the impact that can be expected should chlorine or chloramines be released at the planned 0.5 to 1 ppm levels. Such studies would aid in determining the degree to which discharge concentrations must be reduced or in estimating the environmental benefits provided by entirely avoiding the use of chlorine as a biocide. In this regard, the final statement should consider and evaluate in detail the following possible alternatives:

significantly reducing the amounts of chlorine used or the frequency of addition, and

removal of chlorine prior to release by employing an appropriate treatment process.

The Pennsylvania state water quality standards provide that discharges to high quality waters "...should be required to provide the highest and best practicable means of waste treatment..." and also that "the standards seek to assure optimum, not marginal, conditions to protect uses associated with clean water." In view of such non-degradation strictures, the possible effects of the discharge of dissolved solids should be further considered in the final statement. This should include, in our opinion, any dissolved substance that may cause a significant effect regardless of whether an appropriate state standard exists. For example, the effects of sulfate releases should be considered.

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Thermal Effects

The Three Mile Island Nuclear Station Units 1 and 2 will use a closed-cycle cooling system incorporating two natural draft cooling towers per unit. Blowdown from these towers will be combined with effluent from the nuclear and secondary service systems and routed through two small mechanical (forced) draft towers before discharge to the Susquehanna River. The draft statement indicates that blowdown temperatures will, in general, be approximately equal to the ambient river temperature during most of the year and no greater than 3°F above ambient during the winter months. Thus, in our opinion, this system provides the capability for plant operation in compliance with federally approved state standards which allow a 5°F rise and a maximum of 87°F.

Since, in general, discharge temperature will be close to ambient river temperatures during most of the year, no significant impact on aquatic biota directly attributable to thermal effects is expected. It is possible, however, that during the winter months when discharge temperatures will be appreciably above ambient conditions, certain impacts, related to the presence of warmer water in the discharge plume, may occur. For example, the warm water will undoubtedly cause fish to congregate near the discharge point. This situation could lead to:

exposure of greater numbers of fish to higher residual chlorine levels,

depletion of avilable food supplies, and

greater susceptibility to thermal shock should it become necessary to shut down the plant or to temporarily curtail the cooling tower anti-icing flow.

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Any or all of these possibilities could result in increased species mortality or reduced vitality. The final statement should address such possibilities and indicate methods by which the adverse effects could be avoided.

Entrainment and Impingement Effects

Due to the low intake velocity (0.2 feet/sec.), it is anticipated that there will be no appreciable impingement of fish. It is likely, however, that entrainment of larval fish, fish eggs, and fish food organisms could lead to a significant environmental impact, particularly during periods of low-flow in the Susquehanna River. The final statement should discuss this potential problem and indicate changes in operational methods or plant systems that would mitigate or avoid any adverse impact that may develop. For example, should entrainment effects result in an unacceptable impact during low-flow periods, it may be possible to operate the cooling towers at higher concentration factors and, consequently, reduce the requirements for make-up water.

ADDITIONAL COMMENTS

During the review we noted in certain instances that the statement does not present sufficient information to substantiate the conclusions presented. We recognize that much of this information is not of major importance in evaluating the environmental impact of the Three Mile Island facility. The cumulative effects, however, could be significant. It would, therefore, be helpful in determining the impact of the plant if the following information were included in the final statement:

1. A description of the treatment and ultimate disposal of the filtrate from the pressure filters for the sludge treatment;

2. A description of the lighting provisions for the natural draft cooling towers and the measures undertaken to avoid potentially harmful effects on migrating birds;

3. A description of a program for the prevention of spills and the containment and recovery of hazardous materials spilled at Three Mile Island. Additional details are needed concerning the methods used to store and handle hazardous substances (e.g., oil, chlorine, acids, alkalis) so that a reviewer can ascertain that the possibility of spillage has been adequately evaluated and that effective measures to prevent, contain, and counteract such spills have been instituted;

4. The impact of high voltage transmission lines

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discussed in the draft statement does not mention the production of ozone by the lines. Since little information concerning the production of ozone by high voltage transmission lines is available, the EPA is preparing to study this problem. It would also be desirable for the AEC to provide whatever available information the utility companies may have in the final statement.

5. A description of the air pollution control techniques provided for the onsite concrete plant; and

6. A description of the annual fuel quantities used and sulfur content of fuel used in the diesel generators.

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C-49

COMMONWEALTH OF PENNSYLVANIA
PENNSYLVANIA HISTORICAL AND MUSEUM COMMISSION
WILLIAM PENN MEMORIAL MUSEUM AND ARCHIVES BUILDING
BOX 1026
HARRISBURG, PENNSYLVANIA 17108

50-289
50-320

October 24, 1972

RECEIVED
1972 OCT 27 AM 9 55
U.S. ATOMIC ENERGY COMM.
REGULATORY
MAIL & RECORDS SECTION

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
Directorate of Licensing
Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

A review has been made of the Draft Environmental Statement for Three Mile Island Nuclear Station Units 1 and 2. That section of the draft statment which concerns itself with "historical significance" is in agreement with our findings.

The basic significance of Three Mile Island stems from its encroachment with Indian culture and the archaeological remains on the island. Our staff conducted archaeological investigations on the island prior to construction of the nuclear plant.

There are no National Register sites in the immediate vicinity of Three Mile Island. The closest registered site is St. Peter's Church in Middletown and the generating plant will have no apparent adverse effect on this site.

Very truly yours,

WILLIAM J. WEWER
Deputy Executive Director

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COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF ENVIRONMENTAL RESOURCES
P. O. Box 2351
Harrisburg 17105

August 31, 1972

RECEIVED
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U.S.ATOMIC ENERGY COMM.
REGN SRY
MAIL & RECORDS SECTION

Mr. Daniel R. Muller
Assistant Director for Environmental
Projects
Directorate of Licensing
United States Atomic Energy Commission
Washington, D.C. 20545

Re: USAEC Docket Nos. 50-289 and 50-320

Gentlemen:

This is in response to your notice of opportunity to comment on the Applicant's Environmental Impact Report and the Draft Detailed Statement by the USAEC on the environmental considerations related to the proposed issuance of an operating license for the Three Mile Island Station Units 1 and 2.

The comments as contained in the attached Staff Report include comments as appropriate from the Department of Environmental Resources and other pertinent State agencies.

They are submitted for your attention and consideration.

Very truly yours,

Wesley E. Gilbertson
Wesley E. Gilbertson
Deputy Secretary for Environmental
Protection

Enclosure

91 353 4892

September 1, 1972

PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES
COMMENTS ON ENVIRONMENTAL IMPACT OF THREE MILE ISLAND UNITS I AND II

This report is prepared for submission to the United States Atomic Energy Commission, pursuant to the Environmental Policy Act of 1969, and in response to a request for comments from the USAEC. The comments reflected in this report are those received in the Office of Radiological Health on or before September 1, 1972.

Specific Comments:

1. The Department of Environmental Resources has issued a permit to the applicant severely limiting the level of contaminants in the discharge. This permit restricts radioactive effluents to less than 1% of present AEC standards. These requirements are considered maximum limits. The Department's philosophy is that all releases of environmental pollutants should be held to the absolute minimum. The applicant has been previously notified by the Department that it must review any additional measures which could be incorporated into the plant waste management systems and install any and all systems which would further reduce both radioactive and non-radioactive pollutants.

On the basis of the information indicated on page V-14 and V-18, 19 of the draft detailed statement, we believe that chlorine in the effluents should be reduced to non-detectable levels. In lieu of this, it should be shown that the levels proposed would not adversely affect the aquatic ecosystem.

This position is re-stated as the most important comment on the environmental report.

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2. In reference to page 2.4-5 of the Applicant's Environmental Report and page II-8 of the Draft Detailed Statement, it is stated that any waters (contaminated or not) added to the ground-water of the area would follow the water table gradient to the river and be discharged to the river.

This would be true only for surface disposal, and not for sub-surface disposal. No sub-surface disposal has been authorized by the State for this plant.

3. On pages V-15, 16, 17 of the Draft Detailed Statement, there is listed the expected plume dispersal to the countryside of salt, copper, cobalt, iron, zinc and manganese. The statement in paragraph 4 on page V-17, "If a problem of copper toxicity should develop, it would be controllable by the addition of phosphates to the land. The same would be true for zinc and manganese."

These remarks cited above indicate, 1) a clear uncertainty in the prediction of what will develop, 2) no consideration of the combined effect resulting from the contaminants (even though past research may indicate that the dosage of the contaminants individually are acceptable), 3) no consideration of the undesirable aspects of adding phosphates to the water environment, and 4) no stated plans for continuous trace-element monitoring of the soils, waters, and organisms.

4. The effects of the cooling tower plume on Harrisburg International Airport visibility is a question raised previously during the construction permit hearings. The possibility of an

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effect on the airport does exist, as reported by the applicant. The probability is extremely low. In the unlikely event that airport safety is jeopardized by cooling tower fogging, some remedy to this situation must be implemented.

5. With one exception, the meteorological contents of the report appear to be acceptable. In Appendix II of the Environmental Report, a sector average model is used to describe dispersion of radioactive materials over a short period of time for determination of concentrations and dose at the site boundary. The use of sector averaging is acceptable for long term dispersion phenomena description. In the case of accidental releases (Section 6) of short duration (e.g., 2 hour doses), center line plume concentration is important in the estimating of actual doses under differing meteorological conditions. Based upon the consideration that high center concentrations and doses could be observed, it appears that the normalized doses shown in Tables 6.9.1 and 6.9.2 are low by a factor ranging between 10 and 20.

6. Section 2.5-3 should be updated to include the June, 1972 flood as the flood of record. It is remarkable how closely the design flood of 1.1 million cfs was duplicated by the flood waters produced by Hurricane Agnes. This does not appear to be the maximum flood that can occur at the site.

It is noted that no information is given to show what increase in river flow elevations would result from the construction of dikes for the protection of flood plain communities on the Susquehanna water shed, thereby eliminating a part of the flood-

91 356

way. Based on limited information it appears that the net backwater condition would not be great.

Applicant should, however, demonstrate that plant and auxiliary facility integrity will be maintained in the event of a flood to the order of the new flood of record and probable maximum flood in conjunction with adequate dike protection of upstream flood plain communities.

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METROPOLITAN EDISON COMPANY SUBSIDIARY OF GENERAL PUBLIC UTILITIES CORPORATION

POST OFFICE BOX 542 READING, PENNSYLVANIA 19603 TELEPHONE 215 – 929-3601

August 28, 1972

RECEIVED AUG 31 1972 U.S. ATOMIC ENERGY COMMISSION

Mr. Daniel R. Muller
Assistant Director for Environmental Projects
Directorate of Licensing
United States Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

SUBJECT: THREE MILE ISLAND NUCLEAR STATION
UNITS 1 AND 2
DOCKET NOS. 50-289 AND 50-320

We have reviewed the Commission's Draft Environmental Statement for the Three Mile Island Nuclear Station Units 1 and 2. We wish to forward to you the following comments on the statement:

1. Item 3.b of the Summary and Conclusions states that the blowdown from the cooling towers will be discharged to the river at a maximum of 3°F above ambient river conditions. The word "maximum" should be changed to "average" in this statement.

2. Paragraph 1 on Page III-9 indicates that the river water temperatures vary from a minimum of 35°F in the winter to a minimum of 87° in the summer. These temperatures should read 33°F winter minimum and 85°F summer maximum. (See Page 3.5-1 of Environmental Report.)

3. Figure 10, Ventilation System, Three Mile Island Nuclear Station Unit 2, on Page III-11 should be revised as shown on the attached sketch.

4. Figure 12, Liquid Radioactive Waste Treatment System, Three Mile Island Units 1 and 2, on Page III-14 should be revised to indicate the capability to direct the Powdex sluice water and the deep bed resins and effluent to the radwaste system as shown on the attached sketch.

Very truly yours,

J. G. Miller
Vice President

DW
Enclosures

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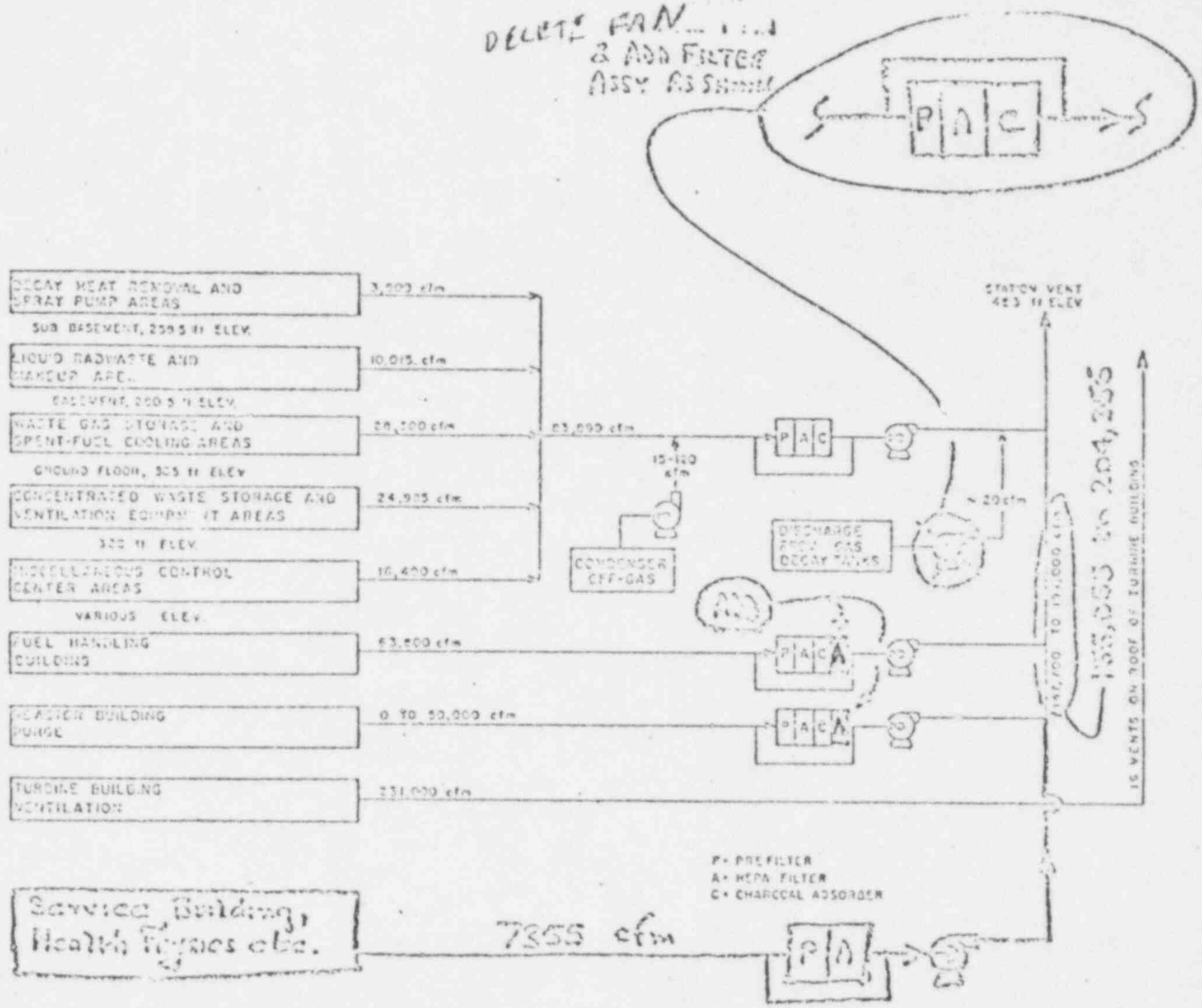

Figure 10 – VENTILATION SYSTEM, THREE MILE ISLAND NUCLEAR STATION UNIT 2

Attachment for S/N 303-GP
dated 8/2/72

C-56

III-11

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Attachment for S/N 303-GP
dated 8/2/72

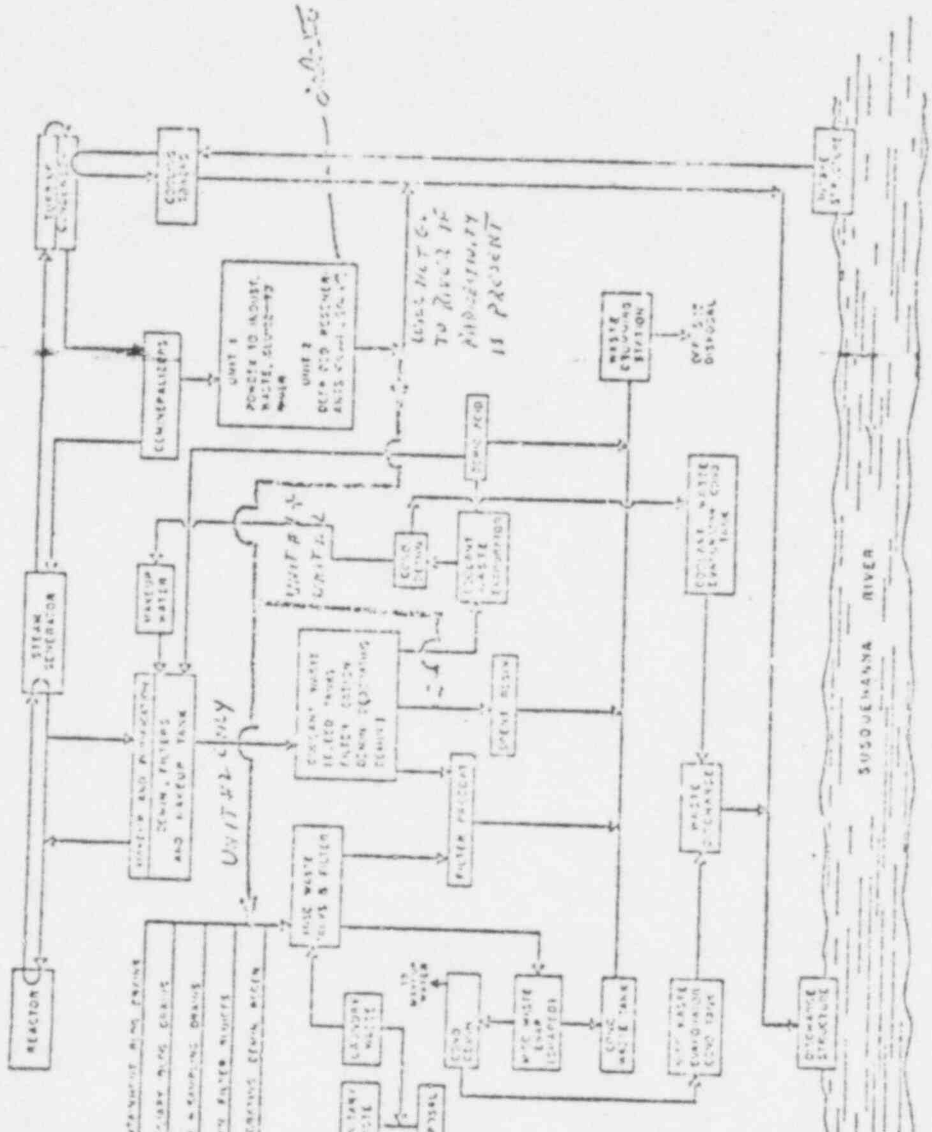

Figure 12 – LIQUID RADIOACTIVE WASTE TREATMENT SYSTEM, THREE MILE ISLAND UNITS 1 AND 2

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APPENDIX D

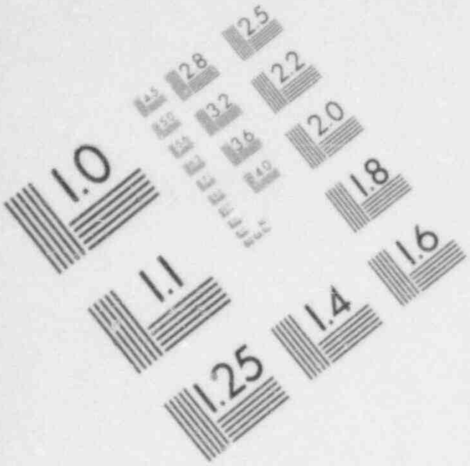
APPLICANTS' RESPONSES

TO COMMENTS

ON

DRAFT ENVIRONMENTAL STATEMENT

91 361



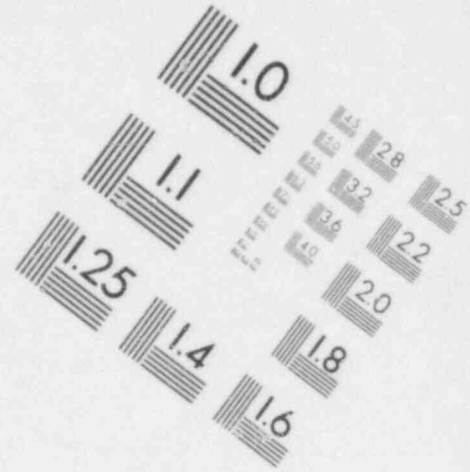
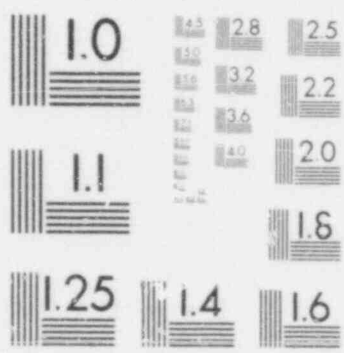


IMAGE EVALUATION
TEST TARGET (MT-3)



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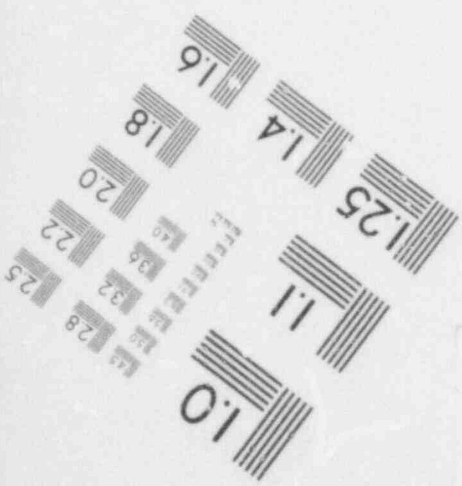
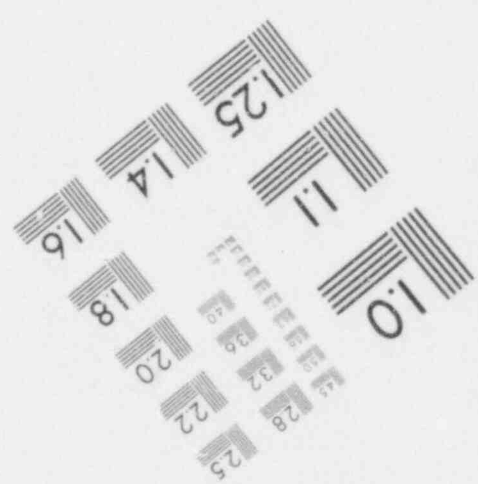
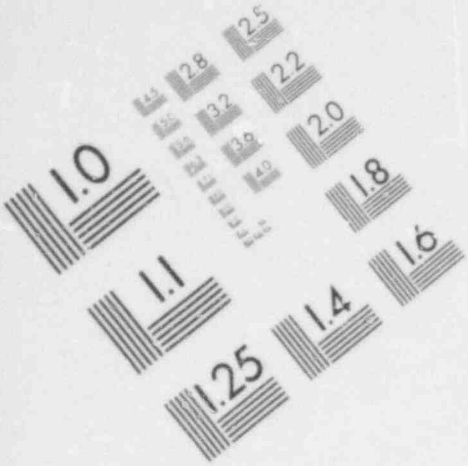






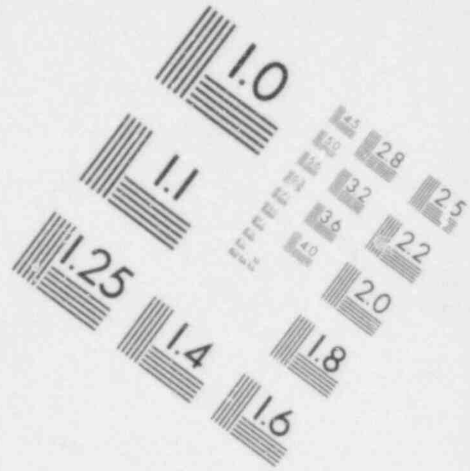
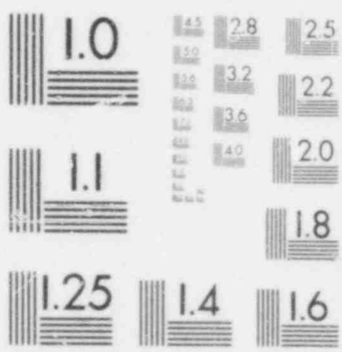
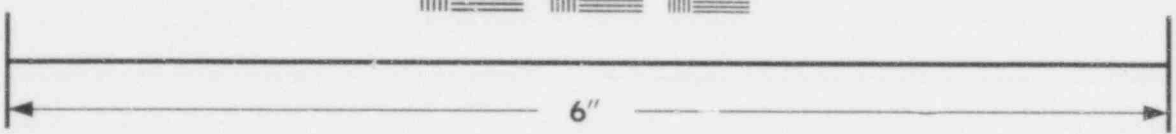
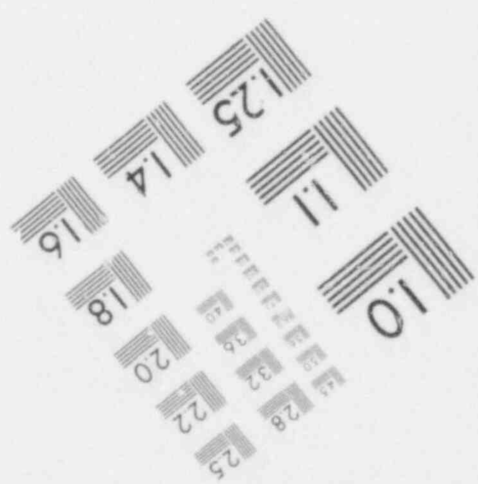


IMAGE EVALUATION TEST TARGET (MT-3)







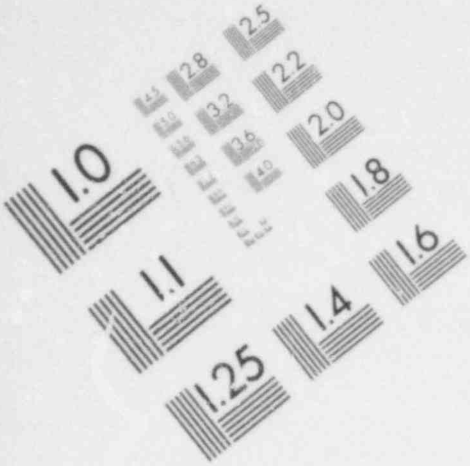
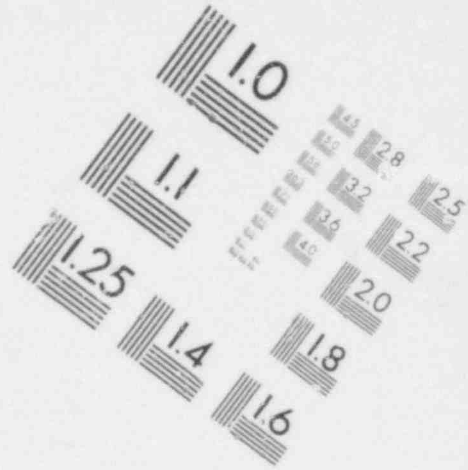
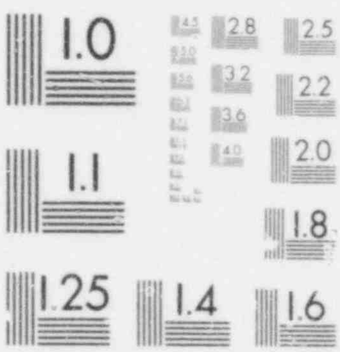



IMAGE EVALUATION
TEST TARGET (MT-3)



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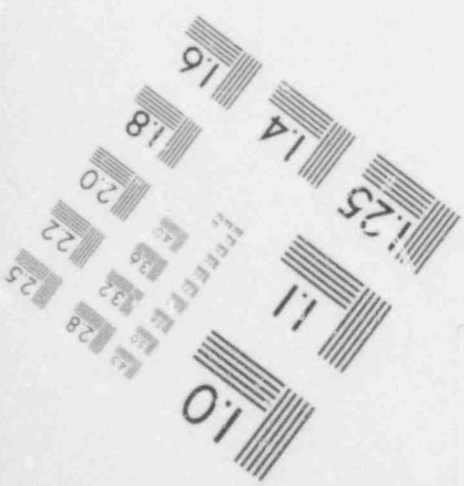
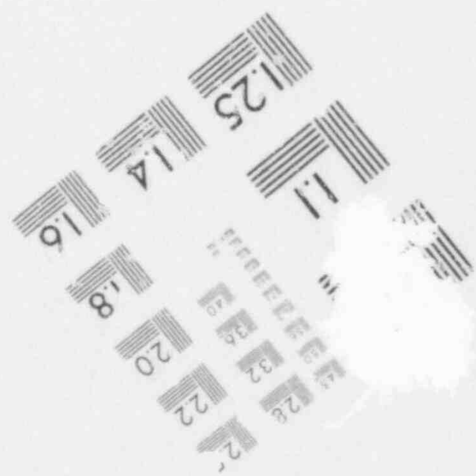

METROPOLITAN EDISON COMPANY SUBSIDIARY OF GENERAL PUBLIC UTILITIES CORPORATION

POST OFFICE BOX 542 READING, PENNSYLVANIA 19603 TELEPHONE 215 – 929-3601

50-289
50-320

September 22, 1972

Mr. Daniel R. Muller
Assistant Director for Environmental Projects
United States Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller

Enclosed please find forty (40) copies of responses to comments made by Federal and State Agencies in connection with the Commission's Draft Impact Statement for Three Mile Island Nuclear Station Units 1 and 2.

This submittal includes only a partial response to these comments. The applicant will submit additional information with regard to these comments by September 29, 1972.

Very truly yours,

J. G. Miller
Vice President

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Enclosure

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METROPOLITAN EDISON COMPANY
JERSEY CENTRAL POWER & LIGHT COMPANY
AND
PENNSYLVANIA ELECTRIC COMPANY

THREE MILE ISLAND NUCLEAR STATION, UNITS 1 AND 2

Application For
Class 104b Utilization Facility Operating License

DOCKET NOS. 50-289 AND 50-320

Applicant herewith submits 40 copies of responses to comments made by Federal and State Agencies in connection with the Commission's Draft Impact Statement for Three Mile Island Nuclear Station Units 1 and 2.

METROPOLITAN EDISON COMPANY

ATTEST:

Secretary

By ______________
Vice President

Sworn to and subscribed before me this 22nd day of September 1972.

Notary Public

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RESPONSE TO EPA QUESTIONS ON
TMI ENVIRONMENTAL REPORT, AEC DRAFT
IMPACT STATEMENT

Radioactive Waste Management

Comment, Item #1

The intended procedure for handling radioactive liquids from sluicing and regeneration operations is considered "as low as practical" in that it is the intention of the Metropolitan Edison Company to process as much as these liquids, when radioactive, as can be handled by Units 1 miscellaneous radwaste evaporator. These wastes will be discharged only if they are non-radioactive or the quantity exceeds the capacity of the evaporator-demineralizer processing system.

Comment, Item #2

Space was provided in Unit 1 to add a deep bed demineralizer condensate polishing system. The addition is dependent upon whether the existing Powdex filter/demineralizer can effectively function with condenser tube leakage. In the event this system is added, the regenerate solution, when radioactive, will be treated by miscellaneous radwaste system to the extent practical.

Comment, Item #3

In general, liquid waste from the turbine building drains are not expected to contain significant radioactive contamination. The possibility of contamination does exist in the event of plant operation with both defective fuel and a primary to secondary system leak.

The quantity of liquids entering the turbine building drains had previously been estimated(1) to be 7200 gal/day for both Units 1 and 2. Assuming 0.1 percent defective fuel and 10 gpd primary to secondary leak, a conservative estimate of the activity content of this waste is approximately .001 uc/cc for mixed isotopes. These wastes will be discharged without treatment to the river via the effluent

(1) Source Term Input (Oak Ridge Questions)

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from the tower blowdown and nucl... and secondary service systems. Under these conditions, the average annua. ncentration in the discharge, prior to dilution in the Susquehanna River, will be 4.5×10^{-10} uc/cc.

Effluent Monitoring

Comment, Item #5

The normal and potential paths for release of radioactive materials during normal reactor operations will be monitored. The release of liquids from the secondary coolant system (turbine building drains, powdex filter, demineralizer sluice water and deep bed demineralizer regenerate solutions) will be discharged via the flow and radiation monitor box. In the event of plant operation with defective fuel and a primary to secondary system leakage, these wastes will be sampled and analyzed on a regularly scheduled basis. It is the intention of the Metropolitan Edison Company to comply with the recommendations of Safety Guide 23 regarding effluent monitoring to the extent practicable.

A tabulation of the quantities of radionuclies which could be released undetected due to instrument sensitivity limitations from the various release points in the plant are as follows:

Release Point	Undetected Quantity (uc) or Release Rate (uc/sec)
1. Condenser Vacuum Pump Exhaust via Monitor Rm-A5	
Noble Gasses (Kr-85)	1.4×10^{-2} uc/sec
Iodine (I-131)	1.4×10^{-2} uc/sec
Particulates (Cs-137)	1.4×10^{-2} uc/sec

Note: Any one or combination of the above that results in a release rate of 1.4×10^{-2} uc/sec will be detected. Anything less than this activity flow rate could go undetected. If the release consists of iodine and/or particulates, this would be detected at the first scheduled sampling interval after the release occurs.

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Release Point	Undetected Quantity (uc) or Release Rate (uc/sec)
2. Auxiliary and Fuel Handling Bldg. Exhaust-via Monitor Rm-A8	
Noble Gases (Kr-85)	225 uc/sec
Iodines (I-131)	160 uc*
Particulates (Cs-137)	800 uc*
*Between sampling intervals	
3. Reactor Building Purge Exhaust-via Monitor Rm-A9	
Noble Gases (Kr-85)	50 uc/sec
Iodines (I-131)	68 uc*
Particulates (Cs-137)	340 uc*
*Between sampling intervals	
4. Plant Liquid Effluent Discharge via Monitor Rm-L7	
Mixed Isotopes	4.5 uc/sec

This release rate corresponds to a concentration of 2×10^{-6} uc/cc in the plant discharge to the river. Anything less than this activity concentration will be released undetected.

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Comment, Item #6

An analysis f flood discharge-frequency relationship was made using data gathered by the U.S. Geological Survey on past floods dating back to 1786. Until recently, the flood of record was that of March 19, 1936, which, according to the U.S. Geological Survey, was the highest known flood to have occurred since 1784 and probably the highest since 1740. The 1936 flood at Harrisburg was gaged at 740,000 cfs and resulted from a large scale snow melt over the entire area of Pennsylvania.

On June 24, 1972, a record flood of approximately 1,000,000 cfs occurred at Harrisburg as the result of tropical storm "Agnes" moving slowly up the eastern seaboard and depositing an average rainfall of 8 inches on the Susquehanna River basin. Maximum rainfall depth in the basin totaled 17.7 inches during a period of 48 hours. During this period, about 12 inches was incident on the site at Three Mile Island.

Preliminary estimates of the 1972 flood at Harrisburg place the frequency of occurrence at approximately once in 500 years, as indicated by the curve shown in Figure 2.5-12.

The design flood established for the site is 1,100,000 cfs, which was based upon the provisional probable maximum flood established by the Corps of Engineers prior to 1969. The hydraulic design of the plant inundation protection facilities is based upon the design flood to provide adequate protection with an ample margin of freeboard. The generating station and its facilities will not have any significant effect on local conditions during the design flood.

The conservatism used in designing the facilities to protect the plant from the design flood was evidenced during tropical storm "Agnes", which in effect produced a flood approaching the design flood in magnitude. The maximum water surface in the river at the site during the 1972 flood was at elevation 300.5. The curves

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shown on Figure 2.5-13 of the Environmental Report indicate that for a flow of 1,000,000 cfs the water surface at the site (Goldsboro) would be at elevation 302. Thus a 3.5 foot freeboard has been provided in design against overtopping for an Agnes flood, since the lowest dike elevation south of the site is 304. Had Three Mile Island Nuclear Station been completed and operable during the 1972 flood, it would not have experienced any adverse effects, since the dike system would have afforded adequate flood protection.

Metropolitan Edison Company and Pennsylvania Power and Light Company are planning a joint pumped storage project on Stony Creek, approximately 13 miles northeast of Harrisburg. The project consists of a lower dam and reservoir on Stony Creek and an upper reservoir between Stony and Sharp Mountains, providing a head of 975 ft. for peak-power generation of 1,100 MW. The project will have no known adverse effect on Three Mile Island, but will improve conditions on the Susquehanna River by affording some degree of flood protection and augmentation of low flows.

The Stony Creek Pumped Storage Project is in the preliminary design state. Final design is expected to begin in about two years, based upon a presently planned in-service date of 1983-84. Detailed design data is therefore not available; however, it is planned to provide sufficient spillway capacity to pass its local probable maximum flood, based upon the applicable basin PMF, Consideration will also be given in the design to enable the dams to withstand seismic effects. but neither the design criteria or material properties has been established.

Stony Creek Dam will be approximately 100 feet in maximum height and will impound about 24,000 acre feet of water depending upon the final pool elevation. The dam will be an earth embankment constructed with local materials and have a concrete spillway. Assuming a seismically-induced dam failure at times of normal stream flow, and the consequent loss of the reservoir volume during a conservative one-hour period, the resulting average downstream flow would be in the order of 300,000

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cfs. The 24-mile flow route to the plant site would serve to attenuate both the peak flow and flood wave, especially in the broad 4,000 ft-wide Susquehanna River. A flow increase of 300,000 cfs at the plant site would raise the river level about 7 feet above the normal elevation of 280. Such an occurrence will not have any adverse effect on the plant since the dikes are at a minimum elevation of 304 and provide a 24 foot protection for such an event.

Page 3.7-2 of the Environmental Report states that, "The filters pas 2,000 gph each of the clear filtered water to the cooling water discharge." The flow from two filters will be 66 gpm maximum. This water is essentially the same or better than that taken from the river except suspended matter is removed. It will be blended with 36,000 gpm of plant cooling water. The effect on the river will be insignificant unless a high concentration of any particular contaminant is present in the filtrate. This is not the case.

Radioactivity to the sludge treatment building from spent Powdex waste solution will be controlled. If there is a primary to secondary steam generator tube leak, the contaminated Powdex waste will not be transferred to the sludge treatment building. It will be pumped to the radwaste system for treatment.

RESPONSE TO PARAGRAPH 4 OF THE

JULY 26th LETTER OF REAR ADMIRAL
W. M. DENKERT TO MR. DANIEL R. MULLER

It is here pointed out as a matter of record and clarification that the plumes which will emanate from the cooling towers at Three Mile Island are not smoke, in the most commonly accepted usage of that word, which has to do with some sort of combustion or other particle producing process. The effluent from the cooling towers consists of water, in the form of very small droplets and as a vapor, mixed with atmospheric air which merely passes through the tower.

With regard to the potential effect of the estimated 39 hours per year, this may be more accurately described as a persistent but elevated plume rather than fogging which infers a ground level effect. Experience at other locations with operating towers comparable to those at Three Mile Island indicates there is a very minimal effect on even the lightest air craft in penetrating the plume, comparable to penetration of a cumulus cloud. The persistent plume will be adequately elevated (of the order of 700 to 1,000 feet above grade) to permit VFR landing and because of the relative position of the towers with respect to the airport approaches it is not conceivable that the plumes would align their longest dimension with the approaches. Due to the random direction of wind it may sometimes be necessary for approaching aircraft to penetrate the plumes, but this will be along their short dimension for a very brief interval, and they will emerge from the plume well before any lower limit of VFR restrictions. This is the potential effect which is estimated to be 39 hours per year

We concur with the opinion of Rear Admiral Denkert that this impact is minimal and that an operating license should be issued.

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METROPOLITAN EDISON COMPANY SUBSIDIARY OF GENERAL PUBLIC UTILITIES CORPORATION

POST OFFICE BOX 542 READING, PENNSYLVANIA 19603 TELEPHONE 215 – 929-3601

October 19, 1972

RECEIVED
OCT 24 1972
U.S. ATOMIC ENERGY COMMISSION
Regulatory
Mail Section

Mr. Daniel R. Muller
Assistant Director for Environmental Projects
Directorate of Licensing
United States Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

SUBJECT: THREE MILE ISLAND UNITS 1 AND 2
DOCKETS NO. 50-289 AND 50-320

Enclosed please find forty (40) copies of responses to comments made by Federal and State Agencies in connection with the Commission's Draft Impact Statement for Three Mile Island Nuclear Station Units 1 and 2.

This submittal includes the remainder of the responses to these comments, as indicated in our letter of September 22, 1972.

Very truly yours,

F. J. Smith
F. J. Smith
Vice President

ms

Enclosure

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METROPOLITAN EDISON COMPANY
JERSEY CENTRAL POWER & LIGHT COMPANY
AND
PENNSYLVANIA ELECTRIC COMPANY

THREE MILE ISLAND NUCLEAR STATION, UNITS 1 AND 2

Application For
Class 104b Utilization Facility Operating License

DOCKET NOS. 50-289 AND 50-320

Applicant herewith submits 40 copies of the balance of the responses to comments made by Federal and State Agencies in connection with the Commission's Draft Impact Statement for Three Mile Island Nuclear Station Units 1 and 2.

METROPOLITAN EDISON COMPANY

ATTEST:

Secretary

By ______________ Vice President

Sworn to and subscribed before me this 19th day of October 1972.

Notary Public

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APPLICANT'S RESPONSE

TO

QUESTIONS RAISED BY GOVERNMENTAL AGENCIES

ON THE

COMMISSION'S DRAFT ENVIRONMENTAL IMPACT STATEMENT

RESPONSE TO THE DEPARTMENT OF INTERIOR'S REQUEST
FOR DIMENSIONS OF THE DIKE AT THREE MILE ISLAND

The approximate dimensions of the periphery of the dike are as shown in the attached Figure 1-1. The following additional dimensions will be of interest:

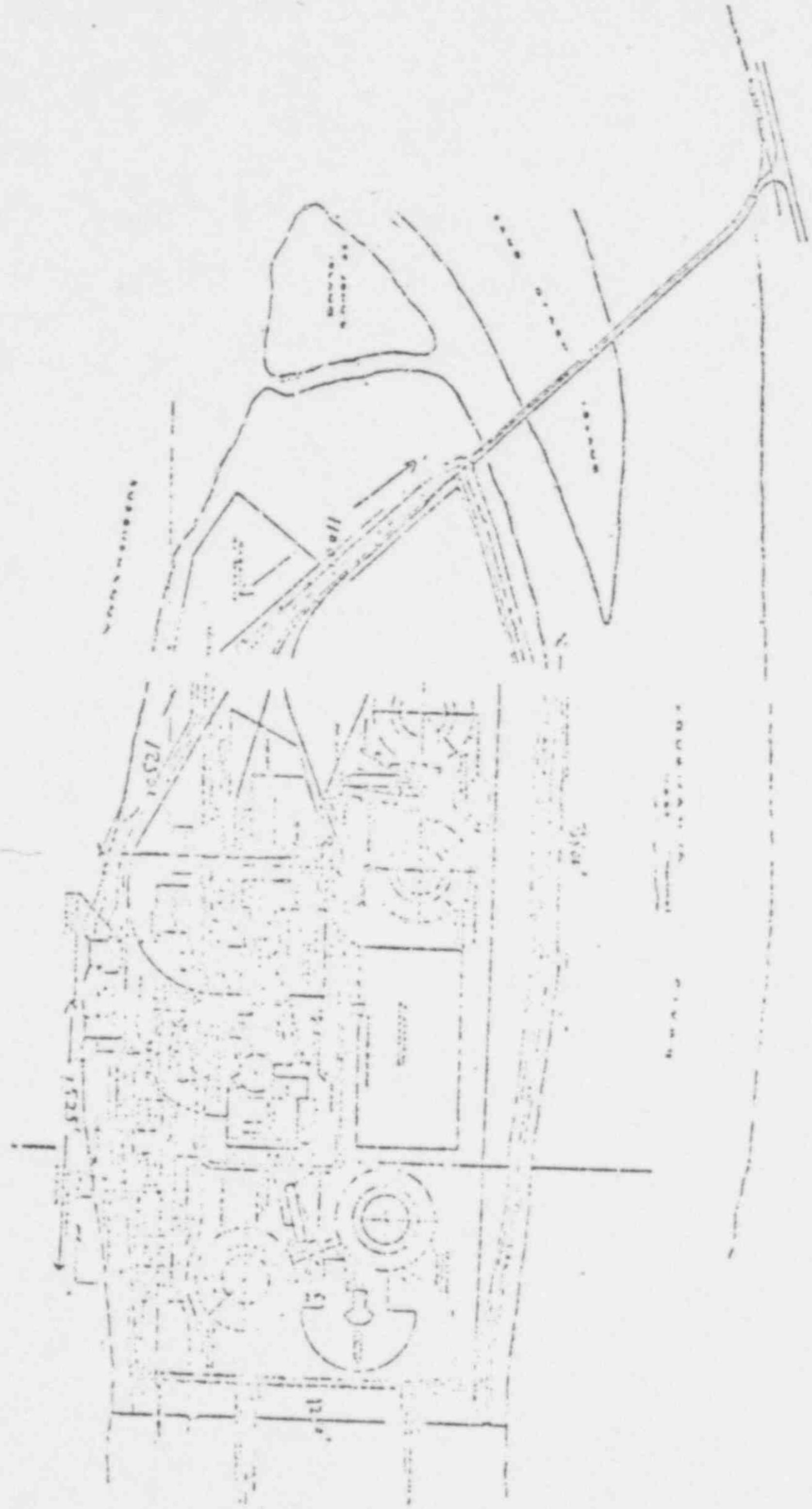
1. Normal river water level in Yorkhaven pool - 278' above sea level.

2. Elevation to top of dike North end - 310' above sea level.

3. Elevation to top of dike on both the east and west sides of the island - Slopes from 309' to 305' above sea level.

4. Elevation to top of dike South end - 304' above sea level.

5. The dike is 20' wide with a 2:1 side slope.



PLOT PLAN
THREE MILE ISLAND NUCLEAR STATION UNIT 1
FIGURE [illegible]

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-0731

RESPONSE TO EPA QUESTION ON CHLORINATION

CHLORINATION AT THE THREE MILE ISLAND PLANT

I. INTRODUCTION

Chlorine, as a gas or in some compound form, has been used in the United States for the disinfection of water since 1908. In addition to its use as a disinfectant, chlorine is also used as a biocide to prevent the development of fouling growths in condenser tubes and cooling towers. In addition to acting as a biocide, chlorine reduces and removes objectionable tastes and odors and oxidizes iron, manganese and hydrogen sulfide aiding in the removal of these materials.

Chlorine hydrolizes in water to produce hypochlorous acid, which provides the disinfecting and oxidizing properties of the solution.

Residual chlorine occurs in both free and combined forms. Free available residual chlorine exists in water as hypochlorous acid. Combined available residual chlorine is represented by compounds such as the chloramines. The bactericidal properties of free and combined chlorine residual differ. Approximately 25 times as much combined chlorine residual is required for complete bactericidal effect as is required for free residual chlorine. Further, for combined residual chlorine to be an effective bactericide contact time must be about 100 times greater than what is required for free residual chlorine to be effective.

Chlorine demand is the difference between the amount of chlorine supplied and the amount of total residual chlorine. Chlorine demand varies with water quality, contact time, pH, and temperature. Bacterial kill is usually accomplished when chlorine is added to produce a residual of 0.2 to 0.5 ppm after a minimum ten minute contact period at temperatures at and above 68°F (20°C). Higher residual values may be necessary if the residual chlorine exists as combined chlorine residual.

Free available chlorine is toxic to aquatic organisms. Chlorine compounds involving ammonia, phenols, cyanide, or other substances may have equal or greater toxicity levels. This circumstance has led to concern about the use of chlorine as a disinfectant. Alternative methods of biological control are being studied. Other biocides exist, but little is known of their effect on aquatic life. Ozonization is being used experimentally at a few sewage treatment plants as is radiation by cobalt 60. The application of these latter two techniques to generating stations apparently has not been investigated.

II. RESIDUAL CHLORINE EFFECT ON AQUATIC LIFE

A. Literature Annotation

McKee and Wolf[1] presented annotations of earlier literature on the effects of chlorine on aquatic life. Results reported by various workers include:

1. Aquatic plants are harmed by concentrations of chlorine of 3.0 mg/l or more.

2. Most algae can be controlled by chlorine concentrations of 0.25 to 3.0 mg/l. Synura, a flagellate alga, was killed by 5 to 10 mg/l.

3. Midge larvae (Chironomus), important fish food organisms, were killed by doses of chlorine of 15 to 50 mg/l.

4. Small invertebrate organisms (crustaceans, rotifers) were killed by chlorine at 1.0 mg/l, but larger organisms (worms, mollusks) were not killed by this concentration.

5. Freshwater clams, snails and sponges in cooling systems were killed by 2.5 mg/l.

From the material presented by McKee and Wolf it would appear that the primary producers and fish food organisms of aquatic communities would not be affected by free available residual chlorine of less than 1 ppm.

Fish, however, in some cases appear to be more sensitive to chlorine than do lower forms of life. The fish data presented by McKee and Wolf appear somewhat contradictory. Concentrations of chlorine as mg/l that caused kills or permitted survival as reported by McKee and Wolf are tabulated below:

	DEATH CONCENTRATIONS	SURVIVAL CONCENTRATIONS
Trout	0.03, 0.08, 0.3, 0.8, 1.0	0.1, 0.5
Carp	0.15 to 0.2	1.0
Goldfish	1.0, 2.0	0.25, 1.0, 5.0
Minnows	0.8	0.3, 1.0

As McKee and Wolf point out, the apparent contradictions stem from differences in water quality among the various studies reviewed as well as the time of duration of exposure.

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In an early (1950) literature review Doudoroff and Katz[2] summarized the effects of chlorine on fish. Methods of analysis for measuring chlorine or chlorine residuals were not presented. The authors did observe that there was no very great difference between the toxicity of free chlorine and that of chloramines. Among the concentrations they found reported as having adverse effects were:

1. Free chlorine at 0.3 ppm killed rainbow trout in two hours.

2. Eels and tench* were resistant to residual chlorine of about 1 ppm for long periods.

3. Trout and pike died at concentrations of residual chlorine at 1 ppm in 40 hours.

4. Chloramine concentrations of 0.76 to 1.2 ppm were fatal to hardy minnows, carp and bullheads while 0.4 ppm killed trout, sunfish and some bullheads.

Jones[3] said that chlorine was found toxic to rainbow trout at less than 0.2 ppm while eels and tench* were more resistant. Roach* had a threshhold toxicity of about 0.4 ppm. Jones did not identify the methods of analysis. The work he cited was experimental laboratory work by the Water Pollution Research Laboratory (England). Apparently these were investigations on the effect of chlorine as an inorganic gas in aqueous solution rather than residual chlorine following its use as a disinfectant. Jones also referred to an earlier (1958) work by Merkens[4] who felt that for pollution control purposes it should be assumed that all residual chlorine was present as free chlorine. Merkens found 0.08 ppm chlorine fatal to trout in seven days and assumed, based on extrapolation of a survival curve, that the safe threshhold (for trout) was as low as 0.004 ppm chlorine. A trout population, of course, is not resident in the Susquehanna River at the Three Mile Island site. In spite of this experimental work in England, the Mersey River Board (England) has proposed that the free chlorine residual of discharges should be limited only to the extent that it should not exceed 1.0 mg/l.

Zillich[5] studied the toxicity of combined residual chlorine to fathead minnows. He found the lowest concentration to produce an adverse effect was 0.04 mg/l residual chlorine. (The iodometric method was used to measure the residual chlorine.) The chlorinated effluents used in his investigation were toxic after diluting to two to four percent. Zillich observed that avoidance reaction by fish prevented fish kills below

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* British fish species not found in North America.

chlorinated discharges. He went on to say: "It seems probable that the greatest effect of discharging chlorinated wastewater to a stream is not that it is lethal to fish but that its presence renders the water unavailable to many fish."

Tsai[6] studied the effect of sewage pollution in the upper Patuxent River. He found that chlorinated effluents are toxic and reduce fish populations below the effluent outfalls. Tasi did not measure the amounts of residual chlorine present, but his text suggests that toxicity was due to combined residual chlorine and particularly the chloramines. Tsai did find 29 fish species occurring below sewage outfalls. Of these, 15 are included among the 37 Susquehanna River fish species presented in Section 2.7.1 of the Environmental Report. (The ecological differences between the Susquehanna River and the upper Patuxent River waters are pronounced and would account for differences between the respective fish communities.)

Basch et al[7] studied the effect of chlorinated municipal waste on caged rainbow trout and fathead minnows below four sewage treatment plant outfalls in Michigan. Total residual chlorine was measured by amperometric titration. They found the trout to be more sensitive to the effluent than the minnow. The latter species, however, was adversely affected by the discharge in one instance for a distance of 0.6 mile below the outfall. In two of the four cases fathead minnows were not affected by the chlorinated discharges. In the two where these fish were affected, toxicity concentrations of residual chlorine were given as less than 0.1 mg/l in the Conclusions (p.1) and as less than 0.2 mg/l in the General Discussion (p. 34). Tabular data in the publication show calculated lethal levels of total residual chlorine for fathead minnows as 0.007 (with 120 hours of exposure) and 0.072 (with 96 hours of exposure) mg/l. Apparently the 20 experimental fish (10 trout; 10 minnows), caged in a one cubic foot box, were not fed during exposure. Differences, of course, would be expected if the nature of the combined residual chlorine differed between the two outfalls, which appears probable.

The four plants studied by Basch et al apprently practiced continuous chlorination. Operator practice at the plants was to chlorinate to a chlorine residual of 0.5 (Plants 1 and 2), 1.5 (Plant 4) and 2.0 - 2.5 (Plant 3) mg/l as measured by the orthotolidine arsenite color comparator. This technique has been established as one of the poorest analytical methods for the determination of residual chlorine (Lishka and McFarren[8]).

Most of the literature on the effect of residual chlorine fails to identify the analytical method used. The orthotolidine arsenite method is one of the commonest in use. Where this method has been used, the results expressed are probably much lower than actual concentrations. This should be borne in mind when considering older literature.

The total residual chlorines found in the effluents studied by Basch et al as measured by amperometric titration were: 0.96 to 2.94 mg/l (Plant 1), 0.95 to 1.89 mg/l (Plant 2), 5.01 to 32.5 mg/l (Plant 3), and 1.82 to 3.89 mg/l (Plant 4).

The volume of discharge for the four plants in relation to the receiving streams was 3.84 percent (Plant 1), 1.50 percent (Plant 2), 0.06 percent (Plant 3), and 5.00 percent (Plant 4). Toxic effects for fathead minnows were associated with Plants 1 and 4.

B. Three Mile Island Discharge

The average annual flow of the Susquehanna River at the Three Mile Island site is 34,000 cfs and the average discharge from the Three Mile Island Plant is 80 cfs, which represents 0.24 percent of the total river flow.

At the Three Mile Island site the Susquehanna River is about 7,000 feet wide and divided by islands into three channels. These islands represent about 4,000 of the 7,000 foot width of the river. The plant draws from and discharges to the center channel. The eastern channel, smallest of the three, is blocked at its lower end by the York Haven Dam. At times of normal flow all river water would flow downstream through the center and western channels.

Anderson[9] published on variations in the chemical characteristics of the Susquehanna River at Harrisburg where City Island forms an eastern and western channel. Anderson found strong chemical differences through the cross section of the river. Water samples from the western side of the river were alkaline and characteristic of water drained from limestone regions. Samples from the center of the river resembled water quality of the West Branch Susquehanna River. The eastern part of the river had water quality characteristics associated with mine drainage from eastern tributaries. The great width of the river in conjunction with its relatively shallow nature prevents lateral mixing and these various waters forming the river retain their identity for long distances. Anderson found that the various waters were still separate masses at least as far downstream as Columbia. This continuity to the thread of flow from tributaries entering the river would also exist for any entering discharge. Thus, when a plume develops it will, in effect, squeeze into the river flow at its point of origin but have minimal lateral spreading until its identity is lost.

The extent of a theoretical plume has been calculated for the discharge from the Three Mile Island Plant. This theoretical plume was developed for winter conditions. The choice of winter is appropriate since it has been suggested (though inconclusively) that chlorine is most harmful at low temperatures (Ebeling and Schrader[10] and Ebeling[11] in Doudoroff and Katz).

The plume was calculated with a discharge of 80 cfs into a low river flow of 10,000 cfs, with a temperature increment of 3°F above an ambient river temperature of 38°F. The plume is virtually lost after a flow distance of 220 feet, and at that distance the discharge would have been subject to a tenfold dilution.

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Other plumes calculated for beginning of cooldown and 12 hours later, with a discharge of 113 cfs into 10,000 cfs, varied slightly. At the beginning of cooldown the discharge would be 12°F above river ambient, but 12 hours later this would have decayed to 3°F. These two plumes would extend for about 300 feet and 260 feet respectively. Again, at these distances dilution would be tenfold. The maximum width of the calculated plumes would be about 75 feet. The center channel into which the discharge enters is more than 1,000 feet wide.

Residual chlorine in the discharge will, of course, be intermittent, correlating with the chlorination schedule of the Three Mile Island Plant. Chlorination is expected to occur about three or four times per 24 hour day for 15 minute periods. No aquatic life would be subject to persistent, long-term exposure to chlorine residuals. The maximum area of possible influence would be a plume two or three feet deep extending for a distance of 300 feet with a width of 75 feet (<7.5 percent of channel width) for one hour a day under flow conditions of less than one-third normal river flow.

The total chlorine residual at the plant cooling water discharge [illegible] nominally be less than 0.3 ppm as measured by the orthotolidine method. Chlorine injection will occur intermittently not more than two hours per unit over a 24 hour period. Monitoring of chlorine residual will be performed by analysis of grab samples in the discharge. Analysis will be logged during a chlorination period at regular intervals.

Accumulated field experience clearly demonstrates that a discharge containing a total of 0.3 ppm total residual chlorine, as measured by the orthotolidine method, creates no biologically adverse conditions.

Lishka and McFarren state that 0.05 mg/l free chlorine is about the minimum amount that can be measured by analysis using the following methods: leuco crystal violet, stabilized neutral orthotolidine, DPD-titrimetric, amperometric titration, DPD-colorimetric, methyl orange, and orthotolidine-arsenite. In the literature where chlorine residual values are expressed as lower than 0.5 ppm they have been based on controlled feeding in laboratory experiments or extrapolations from data observed at higher concentrations. Those values given as direct readings must be considered highly suspect.

C. Susquehanna River Biota

Since the discharge plume from the Three Mile Island plant will have a slight temperature increment over ambient temperatures the plume, with any entrained residual chlorine, will float over cooler, deeper waters. As a result, aquatic life associated with the river bottom will not be subjected to exposure to residual chlorine. With the exception of fish, the vast majority of Susquehanna River species of aquatic life, representing all trophic levels, is associated with the substrate material. No true plankton is found in the Susquehanna River. Plankters are associated with non-flowing waters. Those found in flowing waters are

tycheplankton, which are drift organisms flushed into the river from ponds, lakes, etc., in the watershed area. Such forms are not major biological components of the river's biological community except sporadically as transient conditions associated with periods of heavy runoff.

The macroinvertebrate species (bottom organisms) found by Wurtz[12] at four sampling stations in the area of Three Mile Island during the course of annual surveys numbered as follows:

1967	43 species
1968	37 species
1969	23 species
1970	39 species
1971	29 species

The coefficient of variation ($V = 100\ s/\bar{x}$) for the successive years was found to be:

1967	13.3%
1968	36.1%
1969	43.9%
1970	34.2%
1971	36.8%

Coefficient of variation values of less than about 25 percent reflect biological stability. Thus, from 1968 through 1971 environmental conditions during the time of sampling (first week of August each year) were in flux and the macroinvertebrate population was lagging in adjustment to biological equilibrium with the environment. This phenomenon was independent of activity at the Three Mile Island site.

When collections across the center channel at the head of Three Mile Island and between Three Mile Island and the foot of Shelley Island are compared strong environmental differences are found. For example, in 1971 a total of 26 species was found at the upper station but only 17 species were found at the lower station. Eleven species were common to both stations, giving a similarity coefficient of 0.261. The difference rests in the greater diversity of habitats at the upper station. This would support a more diverse invertebrate fauna.

The species of macroinvertebrates found in the York Haven Pool are characteristic of upland waters in the temperate zone of eastern North America. Included in the 1971 collections (and earlier years) were worms, leeches, bryozoans, clams, snails, scuds, crayfish; nymphs of mayflies, dragonflies and damselflies; water striders and water bugs; caddisflies nymphs; beetles and their larvae; various fly larvae, and midge larvae.

Personnel from Millersville State College[13] have been making biological studies of the Three Mile Island site. Two center channel stations have been collected; one above and one below the proposed discharge. Fish

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were collected at these stations in June and October, 1971, (the most recent available data). No long-range migratory species of fish were found. The species found, and the number of individual of each species taken, are presented below:

Catfish (Ictaluridae)			
1. Channel catfish	*Ictalurus punctatus*	1059	
2. Brown bullhead	*Ictalurus nebulosus*	165	
3. Yellow bullhead	*Ictalurus natalis*	31	
4. White catfish	*Ictalurus catus*	29	
		1284	Subtotal
Sunfish and bass (Centrarchidae)			
5. Pumpkinseed	*Lepomis gibbosus*	157	
6. Rock bass	*Ambloplites rupestris*	68	
7. White crappie	*Pomoxis annularis*	29	
8. Black crappie	*Pomoxis nigromaculatus*	15	
9. Bluegill	*Lepomis macrochirus*	9	
10. Redbreast sunfish	*Lepomis auritus*	5	
11. Smallmouth bass	*Micropterus dolomieui*	1	
12. Largemouth bass	*Micropterus salmoides*	1	
		285	Subtotal
Minnows (Cyprinidae)			
13. Golden shiner	*Notemigonus crysoleucas*	20	
14. Carp	*Cyprinus carpio*	2	
		22	Subtotal
Suckers (Catostomidae)			
15. White sucker	*Catostomus commersoni*	10	
16. Quillback	*Carpiodes cyprinus*	9	
17. Northern redhorse	*Moxostoma macrolepidotum*	1	
		20	Subtotal
Perches (Percidae)			
18. Walleye	*Stizostedion vitreum*	8	
		8	Subtotal
Pikes (Esocidae)			
19. Muskellunge	*Esox masquinongy*	1	
		1	Subtotal
		1620	TOTAL

It is evident from the 1971 Milersville data that 80 percent of the resident fish taken were bottom dwelling forms (catfish and suckers). These fish would not be subjected to plume influence. Piscivorous, predator fish (walleyes, the introduced muskellunge, smallmouth and largemouth bass) represented less than one percent of the fish community. These species are highly mobile and would very readily evade stress conditions if any were present in the plume. The sunfish and bass along with the minnows represented 19 percent of the catch. These fish are also evasive and would avoid stress conditions.

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None of the fish found deposit bouyant eggs that could drift into the discharge plume.

The catfish, sunfish and bass prepare nests in coarse sand, gravel or stone substrate material or deposit eggs in substrate crevices. In the case of the catfish, the eggs are adhesive and cemented to substrate surfaces. The bottom under the area of inundation by the plume is soft, and eggs would not be deposited in such materials.

Suckers spawn in riffles over gravel. The nearest sucker spawning ground to the discharge would be about a mile above the discharge.

The minnows present scatter adhesive eggs over vegetation and hard substrate materials. Such an area is found at the head of Shelley Island but not in the area of the discharge plume.

The walleye spawns in shoal water on the edges of bars, or on hard or gravel bottoms. Such bottom conditions are not found under the plume area.

The muskellunge is not known to reproduce in the Susquehanna River (though it may do so) where it has been stocked. In its native haunts the muskellunge scatter their eggs along a shoreline for several hundred yards in water six to thirty inches deep. The shoreline nearest the discharge plume is the western shore of Three Mile Island. This shoreline has a steep angle of repose and is not suited to muskellunge spawning.

In their larval stage the young of the fish species collected seek shelter in shoal waters or in aquatic vegetation. The discharge plume will not inundate any such nursery grounds.

The fish sampling stations in the center channel were above and below the proposed discharge and roughly approximate the sampling sites for bottom organisms. All 19 species were found at the upper station while 15 species were found at the lower station. For the fish the coefficient of similarity between the two stations was 0.789: much higher than that found for the bottom organisms. This reflects the r[illegible]ing capacity of fish as compared to invertebrate animals. Obviously such life forms could avoid a discrete slug of water such as the discharge plume if they found the water of the plume irritating.

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14. A memorandum from G. H. Whipple to John G. Miller, GPU Service Corporation relative to a report prepared by Millersville State College personnel titled: Biological and Chemical Survey of the Three Mile Island Area, a Report to the Metropolitan Edison Company. Dated June 7, 1972.

RESPONSE TO EPA COMMENTS ON THERMAL EFFECTS

The draft statement indicates that blowdown temperature (we prefer to designate this M.D. cooling tower effluent or discharge) will, in general, be approximately equal to the ambient river temperature during most of the year and no greater than 3°F above ambient during the winter months. This is not a correct statement and was corrected by Metropolitan Edison Company's letter of August 28, 1972, to reflect the wording "maximum" to "average" in Item 3b of the Summary and Conclusions.

Table 3.7-1 of the Environmental Report tabulates a winter intake temperature of 39.3°F and an average winter discharge temperature of 41.5°F(1). The footnote (1) states "Based upon average winter wet bulb temperature of 28.1°F and average winter river temperature of 39.3°F". It can only be concluded from these two (2) average temperatures that the difference or rise is an average value.

On page 5.1-3 of the Environmental Report is stated - "A sudden warm day in winter (with a very cold river) or extremely cold weather will preclude effective tower operation". On such a sudden warm day in winter, tower operation could add additional heat and operation would be terminated for a few hours until air ambient temperatures would again provide some cooling. This statement was specifically included in the Environmental Report to denote the extreme of weather variation over which one has no control.

Average river and discharge temperatures have been provided in the Environmental Report to best understand the effectiveness of the mechanical draft towers. It should be understood that several variables exist in the tower operation in a given day and often in varying directions. Ambient air temperature may cycle 30°F in a 28 hour period while the river ambient lags and cycles through a lesser total temperature variation. Cloud cover or the absence thereof, also affects river temperature. Since the tower discharge is a function of both inlet temperature to the tower (which is a function of river temperature) and air ambient (wet bulb), the tower may discharge both above and below river ambient in that 24 hour period. Secondly, the weather may tend to become progressively warmer (or colder) over several days duration with the river naturally tracking but lagging the air temperature. (During very cold winter weather, the river temperature tends to be more stabilized in a 33° - 41° range.) Hence, cycling variation in both air and river temperature occur daily and further vary in several day trends. It is thus impractical to define a "normal" variation of discharge vs. river temperature.

A description of the planned operation of the tower would be helpful to further understand tower capability in summer and winter together with temperature variation and durations.

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During summertime, the towers will be operated manually. Under normal operation, the towers have the capability to reduce the discharge to river ambient and can produce 5 - 8°F colder discharge on an average weather/river basis. The operator will, however, try to match the discharge to river ambient by varying fan speed or by shutting off any combination of three (3) fans per tower. Under cooldown conditions, the tower capability is adequate to prevent the discharge from exceeding 87°F. On an average river/air basis, the discharge could be 2° higher than river ambient in a 75 - 80° discharge range during cooldown. Since the Susquehanna River is not a trout stream, the species of fish present are warm water fish. The low temperature differential obtainable through the use of the cooling towers will have no adverse effect on the fish.

During wintertime, the towers will be operated manually down to 34°F D.B. air temperature. Below 34°F, the towers will be operated automatically to achieve cooling without experiencing freezing in the tower fill. The automation basically senses dry bulb temperature and actuates fan operations of three fans full speed, 3 fans half speed, two fans half speed, one fan half speed, all fans off with water free falling over the fill. A few degrees may be sacrificed in the automatic mode to preclude freezing. Wintertime normal operation will provide discharge water 3°F (average) higher than river ambient on an average river/air basis above 4°F D.B.; this can hardly be considered an appreciable rise. At 4°F, a discharge 7° above river ambient is experienced when all fans are tripped which reduces to 4°F rise with continuing colder weather. In the manual mode, it is also possible for the discharge to be several degrees colder than river ambient. The maximum rise that can be achieved during normal operation in winter is approximately 10°F with both plants operating with the N.D. towers ineffective due to a postulated river/weather extreme mismatch and it is considered reasonable to expect these to come back into a more natural balance in 6 - 12 hours. At the beginning of cooldown in winter, the towers will discharge water, an average of 12°F higher than river ambient, and this will reduce to 2°F differential in 12 hours. (If only one unit is cooling down with the other at norm[illegible] operation, the mixture from both towers is 8°F instead of 12°F - this will [illegible] the usual probability.) At the beginning of cooldown, the heat rise through the delay heat coolers can reach 36°F; selecting a freak winter warm day (March 23, 1966 - 50°F river and 67°F D.B.), the tower serving the cooldown would discharge 69°F water or a 19° rise over river ambient. It should be mentioned that the air temperature dropped as follows in 3 hour intervals following the 67°F D.B. maximum on March 23, 1966 - 56, 50, 47, 44°F. When both the decaying heat load and the dropping air temperature is considered simultaneously, it can be seen that the duration of this condition is a relatively short one. It is also to be noted that cooldown results in a temperature rise as compared with a fossil plant or any power plant with the condensers "operated run-off river". This value is further reduced to 15.2°F difference when the discharge of the cooldown is mixed with the second, normally operating unit.

Winter operation provides an average discharge +3°F above river ambient and with the cooling effect of evaporation on the river surface, this 3°F would be further reduced downstream of the discharge point. It is not an established

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fact that this is conducive to fish congregation at the point of discharge at the surface on the shoreline. Further, the temperature change encountered at the beginning of cooldown is a temperature rise: fish are far more tolerant of a sudden temperature increase than decrease. The cooldown over a 12 hour period provides a gradual decrease (from the 36° rise across the decay heat coolers to a 4°F rise or a tower discharge of 15.2°F to 2 - 3°F or less than 1°/hour at the discharge. State and Federal restrictions limit changes to 2°/hour mixed river discharge temperature. It should also be borne in mind that the discharge volume is small as compared to a run of river plant (less than 5 percent).

Throughout the above, no credit is taken for dilution by running spare river water pumps (or systems nor normally running during cooldown). The State of Pennsylvania takes a dim view of dilution and does not consider "dilution the answer to pollution". The State does permit mixing of wastes and considers a heated discharge a waste. Therefore, no attempt will be made to run additional, spare pumps during normal operation to achieve temperature dilution. However, it is permissible to continue to run the secondary services cooling water system during cooldown and this may be done in winter, particularly on the freak warm days.

In all of the above, discharge temperatures measured at the plant discharge are discussed. Both State and Federal restrictions apply to the mixed river discharge temperatures, i.e.: +5°F rise, 87°F max. and 2°F/hr rate of change.

COOLING TOWER EFFLUENT & COOLING WATER PLUME ANALYSIS

IN RESPONSE TO EPA QUESTION ON PLUMES

The objective of this analysis is to determine chlorine and temperature concentrations resulting from the discharge of cooling tower effluent and cooling water from Three Mile Island Nuclear Plant to the Susquehanna River.

The discharge of tower effluent and cooling water fro a normal cooldown condition is to center channel of the Susquehanna River. The plumes resulting under the following conditions were determined:

1. Cooling tower effluent: $\Delta T = 3.0°F$ $Q = 80.0$ cfs
2. Normal cooldown @ t = 0.0 hrs. $\Delta T = 12.0°F$ $Q = 113$ cfs
e. Normal cooldown @ t = 12.0 hrs. $\Delta T = 3.0°F$ $Q = 113$ cfs.

All were computed for the following winter river conditions:

1. Low river flow of 10,000 cfs - 10 yr. avg. flow for December, January, and February center channel flow is 2700 cfs.
2. Natural river water temperature of 33°F.

Initial chlorine concentration at point of discharge was taken to be 0.30 ppm.

The technique utilized to determine the extent of the plumes is based on a widely accepted method of analysis* of turbulent mixing of a horizontal jet discharged at the surface of the receiving water body. Concentrations of substances throughout the plume are determined assuming they are conserved. Therefore, the results of the analysis are conservative. Reductions in concentration are accomplished solely by dilution which results from the entrainment of ambient water into the turbulent jet. Jet trajectory is determined by vectorially summing jet and river water velocities.

Cooling tower effluent is discharged continuously and, therefore, the plume shown in Figure 1 represents steady state conditions. The magnitude of the plume may be described in terms of the dimensions of the river and island. At the point of discharge the river is 1200 ft. wide, while the

* Jen, Y., Wiegel, R. L., and Mobarek, I., "Surface Discharge of Horizontal Warm Water Jet," Journal of the power Division, A.S.C.E., Vol. 92, No. PO2, Proc. Paper 4801, April 1966, pp. 1-28.

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plume, as defined by the 10 dilution contour, projects only 200 ft. into the river. The plume extends downstream about 120 ft. as compared to the length of Three Mile Island which is about 12,000 ft. The conditions of cooldown are, however, time dependent. The plumes resulting from these transient conditions are presented in Figures 2 and 3. Initially the cooldown flow is at a ΔT of 12.0°F (Figure 2). This temperature reduces to 3°F within 12 hrs. (Figure 3). The plumes under these conditions are not significantly larger than the tower effluent plume. The plume extends about 225 ft. into the river and about 220 ft. downstream.

It can be seen in reviewing Figure 1 that substances will undergo 10 dilutions in about 220 ft. of plume travel. The cooling water discharge at a ΔT = 12°F (Figure 2) reaches 10 dilutions after about 300 ft. of travel. The cooling water discharge at a ΔT of 3°F (Figure 3) reaches 10 dilutions after about 250 ft. of travel.

METROPOLITAN EDISON COMPANY
THREE MILE ISLAND

PLUME COMPUTATIONS

COOLING TOWER EFFLUENT

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PENNA.

4192-51

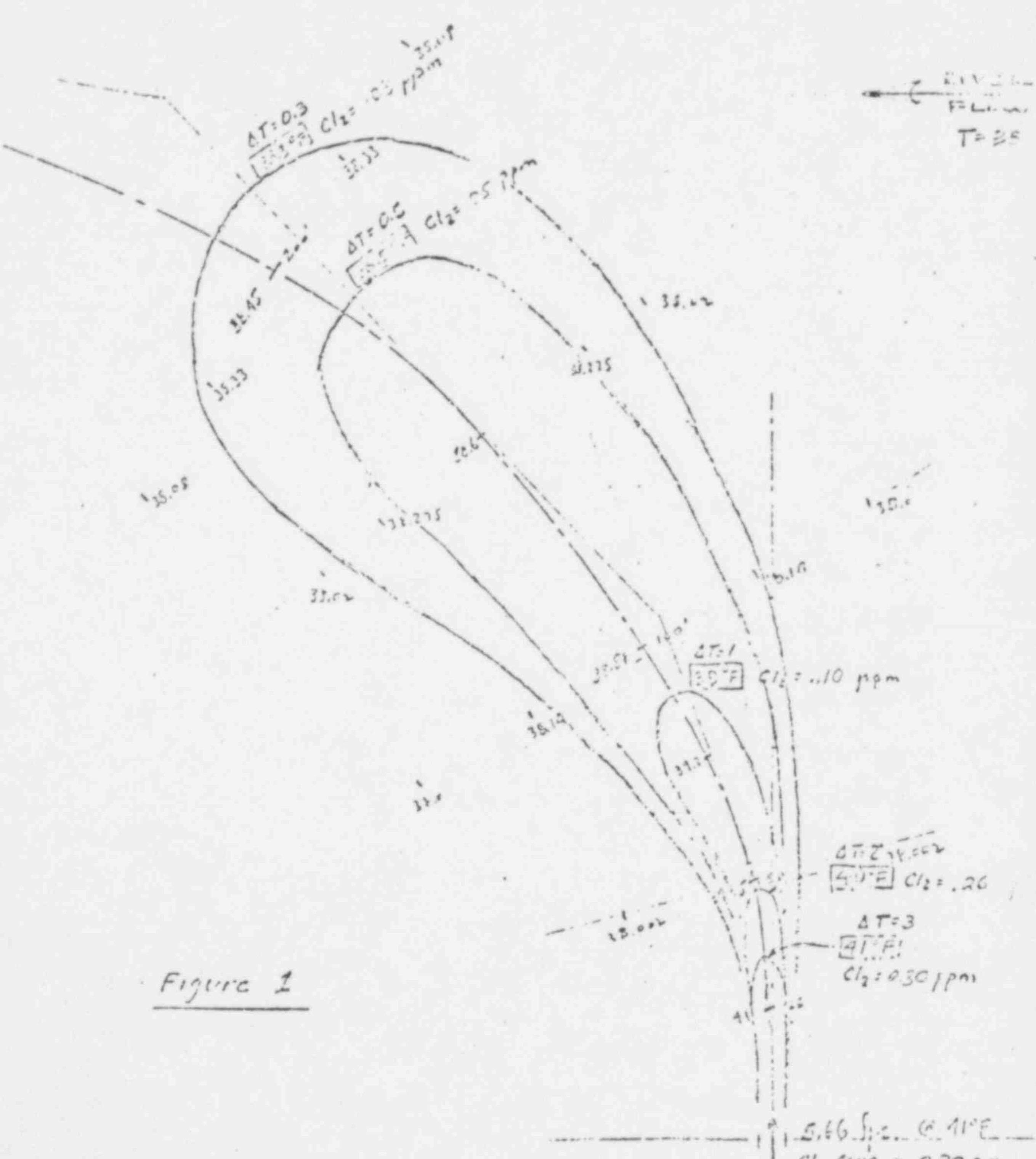

Figure 1

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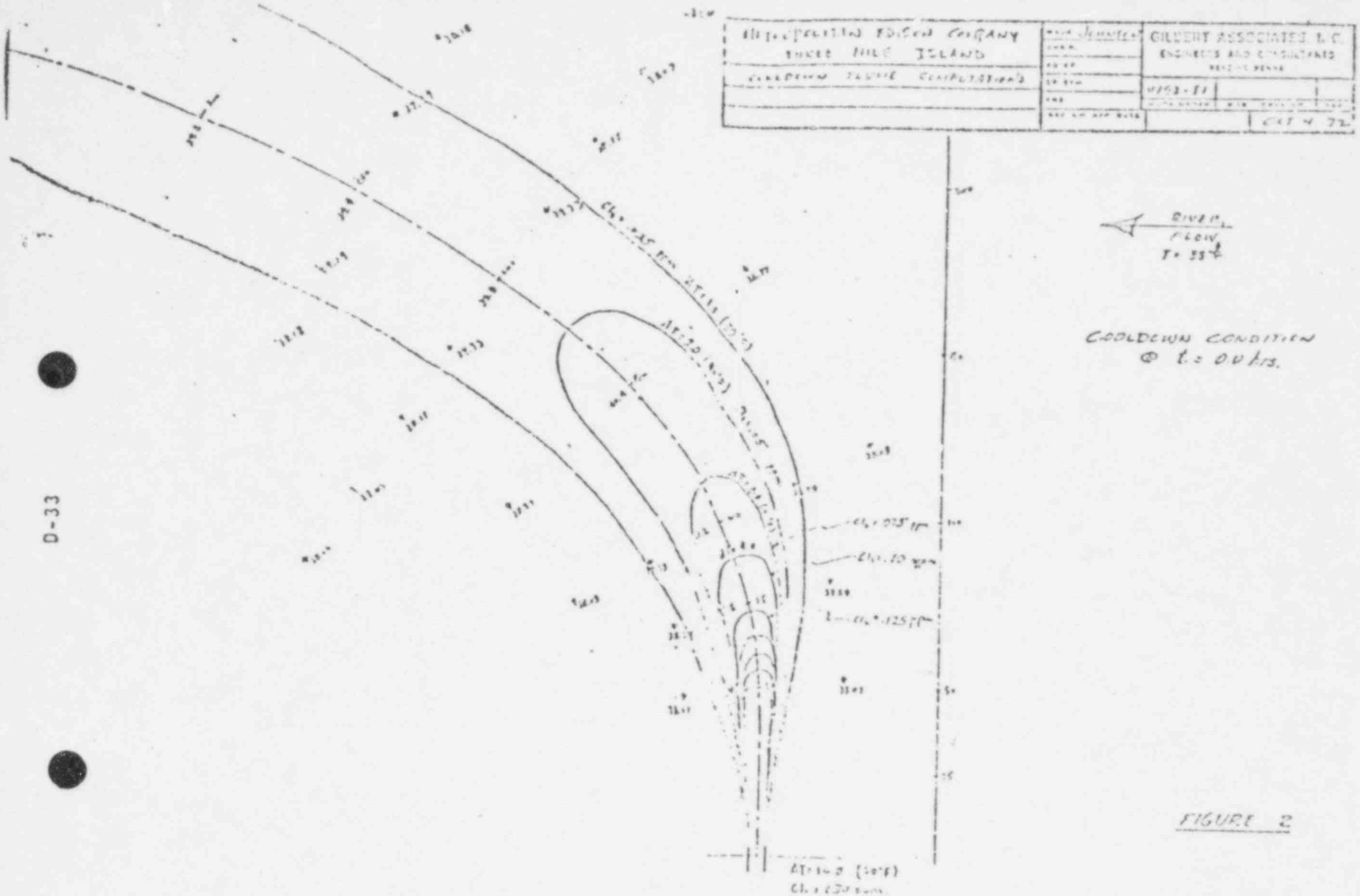

FIGURE 2

92 033

Metropolitan Edison Company Three Mile Island		Gilbert Associates, Inc. Engineers and Consultants
Cooldown Plume Computations		4/12-27
t = 12.0 hrs		
		661 H 7

River Flow
T = 38.0°F

Cooldown Condition
@ t = 12.0 hrs.

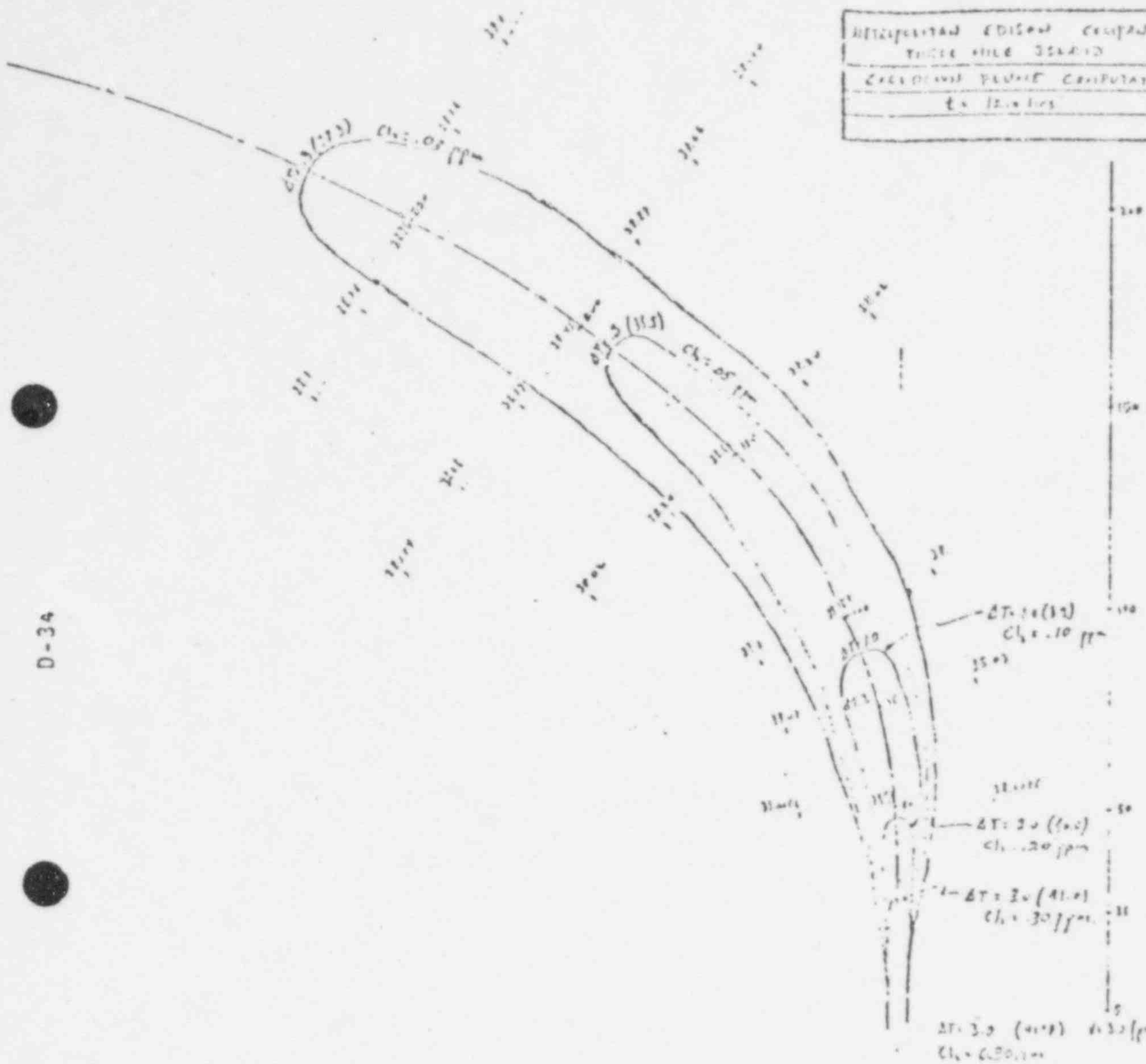

FIGURE 3

ENTRAINMENT AND IMPINGEMENT EFFECTS - EPA QUESTION

The applicant has performed a study to determine intake velocities under various adverse conditions. The results of the study are as follows:

1. Low river water level - normal plant operation = .2 fps.
2. Loss of Yorkhaven Dam - normal plant operation = .3 fps.
3. Cooldown flow - normal plant cooldown = .25 fps.
4. Cooldown flow - Loss of Yorkhaven Dam = .4 fps.

It can be seen that even during extreme conditions the intake velocities experienced are still very low. The biological studies performed on the river have shown that the intake structure is not located in the spawning grounds for any species of fish in the Yorkhaven pool. In addition, the fish study has shown that the species of fish found in the pool do not lay buoyant eggs. When the eggs hatch the larvae will remain in the vicinity of the nests in shoal water.

RESPONSE TO EPA COMMENT ON BIRD KILLS

After three years experience with Unit 1, natural draft towers, and two years with Unit 2, no evidence of bird kills have been reported by the plant operating staff. If such had occurred, one would expect to find the remains on the canopy joining shell and fill neck; no dead birds were found.

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