NIAGARA MOHAWK
NIAGARA MOHAWK POWER CORPORATION/300 ERIE BOULEVARD WEST, SYRACUSE, N.Y. 13202/TELEPHONE (315) 474-1511

April 6, 1983

Darrell G. Eisenhut
Director, Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, DC 20555

In the Matter of
Niagara Mohawk Power Corporation
(Nine Mile Point, Unit 2)
Docket No. 50-410

Dear Mr. Eisenhut:

Your letter of March 29, 1983 to me concluded that the application for an operating license for Nine Mile Point Nuclear Station, Unit 2 which was tendered on January 31, 1983, taken as a whole, is sufficiently complete for docketing and for initiation of the safety and environmental reviews. In accordance with 10 C.F.R. 2.101(a)(3), I am hereby filing for docketing three (3) originals of the application and the following copies as requested in your letter:

1. Fifteen (15) copies of the General Information portion of the application;

2. Forty-one (41) copies of the Environmental Report-Operating License Stage;

3. Forty (40) copies of the Final Safety Analysis Report.

Within ten days, we will provide an affidavit that distribution in accordance with Enclosure 1 of your letter has been made. A response to the requested information detailed in enclosures 1 through 15 of your March 29, 1983 letter will be provided within 60 days of the date of this letter. Also, an evaluation in accordance with 10CFR50.34(g) (Standard Review Plan Deviations) will be provided by April 15, 1983, as agreed by telephone between members of your staff and mine on March 31, 1983.

Very truly yours,

C V Mangan

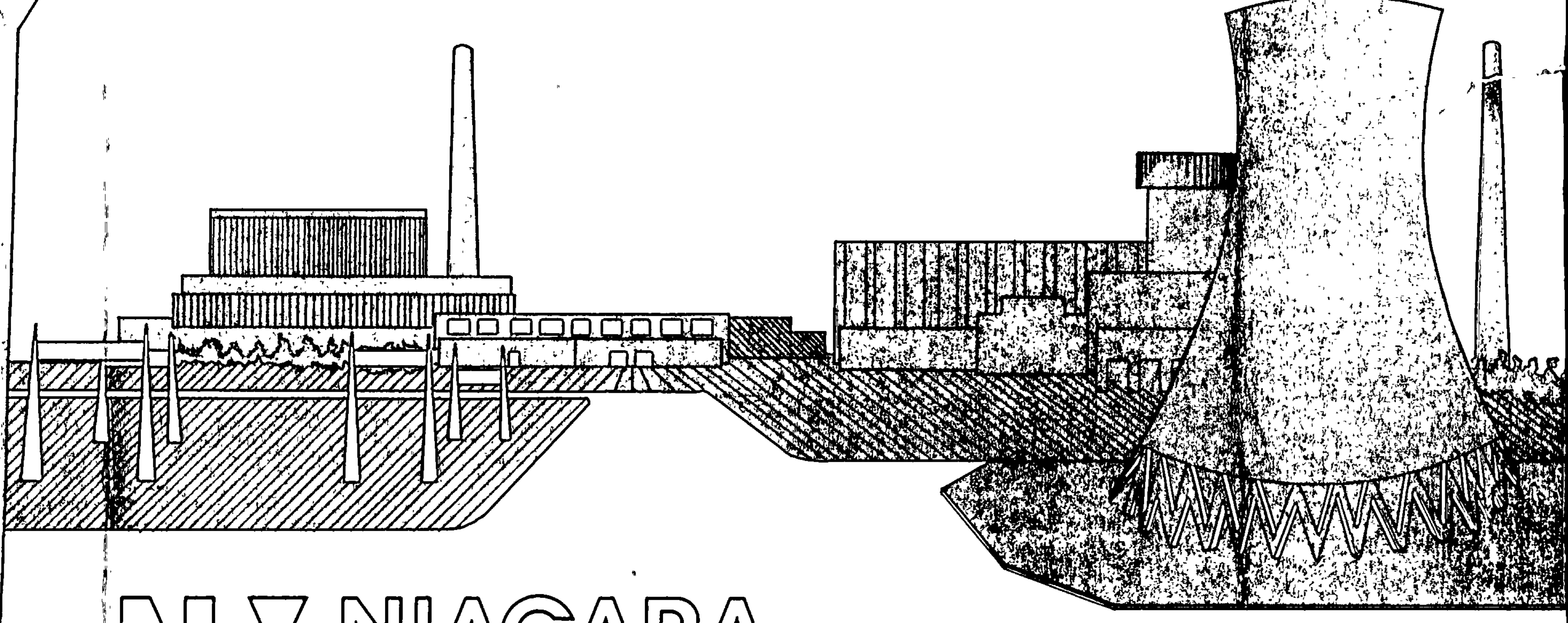
C. V. Mangan
Vice President
Nuclear Engineering & Licensing

6 Rids See Attached For Distributions

ENVIRONMENTAL REPORT

OPERATING LICENSE STAGE

NINE MILE POINT NUCLEAR STATION — UNIT 2



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5.7 URANIUM FUEL CYCLE IMPACTS

The environmental effects of the uranium fuel cycle, including uranium mining and milling, the production of uranium hexafluoride, isotopic enrichments, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials, and management of low-level and high-level wastes, are set forth in Table S-3 of paragraph (e) of 10CFR51.20, which is provided as Exhibit 5.7-1. Rn-222 and Tc-99 (the values of which are not provided in Table S-3) are under consideration by the NRC.

Chapter 10 provides a comparison of the environmental effects of Unit 2 versus the benefits of the plant.

EXHIBIT 5.7-1

Table S-3.—*Table of Uranium Fuel Cycle Environmental Data*[1]

[Normalized to model LWR annual fuel requirement [WASH-1248] or reference reactor year [NUREG-0116]]

Environmental considerations	Total	Maximum effect per annual fuel requirement or reference reactor year of model 1,000 MWe LWR
NATURAL RESOURCES USE		
Land (acres):		
Temporarily committed [2]	100	
Undisturbed area	79	
Disturbed area	22	Equivalent to a 110 MWe coal-fired power plant.
Permanently committed	13	
Overburden moved (millions of MT)	28	Equivalent to 95 MWe coal-fired power plant.
Water (millions of gallons):		
Discharged to air	160	=2 percent of model 1,000 MWe LWR with cooling tower.
Discharged to water bodies	11,090	
Discharged to ground	127	
Total	11,377	<4 percent of model 1,000 MWe LWR with once-through cooling.
Fossil fuel:		
Electrical energy (thousands of MW-hour)	323	<5 percent of model 1,000 MWe LWR output.
Equivalent coal (thousands of MT)	118	Equivalent to the consumption of a 45 MWe coal-fired power plant.
Natural gas (millions of scf)	135	<0.4 percent of model 1,000 MWe energy output.
EFFLUENTS—CHEMICAL (MT)		
Gases (including entrainment): [3]		
SO_x	4,400	
NO_x [4]	1,190	Equivalent to emissions from 45 MWe coal-fired plant for a year.
Hydrocarbons	14	
CO	29 6	
Particulates	1,154	
Other gases:		
F	67	Principally from UF_6 production, enrichment, and reprocessing. Concentration within range of state standards—below level that has effects on human health.
HC1	.014	
Liquids:		
SO^-_4	9 9	From enrichment, fuel fabrication, and reprocessing steps. Components that constitute a potential for adverse environmental effect are present in dilute concentrations and receive additional dilution by receiving bodies of water to levels below permissible standards. The constituents that require dilution and the flow of dilution water are:
NO^-_3	25 8	
Fluoride	12 9	
Ca^{++}	5 4	
$C1^-$	8 5	
Na^+	12.1	
NH_3	10 0	
Fe	.4	NH_3—600 cfs. NO_3—20 cfs. Fluoride—70 cfs.
Tailings solutions (thousands of MT)	240	From mills only—no significant effluents to environment.
Solids	91,000	Principally from mills—no significant effluents to environment.
EFFLUENTS—RADIOLOGICAL (CURIES)		
Gases (including entrainment):		
Rn-222		Presently under reconsideration by the Commission.
Ra-226	.02	
Th-230	.02	
Uranium	.034	
Tritium (thousands)	18 1	
C-14	24	
Kr-85 (thousands)	400	
Ru-106	.14	Principally from fuel reprocessing plants.
I-129	1.3	
I-131	.83	
Tc-99		Presently under consideration by the Commission.
Fission products and transuranics	.203	
Liquids:		
Uranium and daughters	2.1	Principally from milling—included tailings liquor and returned to ground—no effluents; therefore, no effect on environment.
Ra-226	.0034	From UF_6 production.
Th-230	.0015	
Th-234	.01	From fuel fabrication plants—concentration 10 percent of 10 CFR 20 for total processing 26 annual fuel requirements for model LWR.
Fission and activation products	5.9×10^{-6}	
Solids (buried on site):		
Other than high level (shallow)	11,300	9,100 Ci comes from low level reactor wastes and 1,500 Ci comes from reactor decontamination and decommissioning—buried at land burial facilities. 600 Ci comes from mills—included in tailings returned to ground. Approximately 60 Ci comes from conversion and spent fuel storage. No significant effluent to the environment.
TRU and HLW (deep)	1.1×10^7	Buried at Federal Repository.
Effluents—thermal (billions of British thermal units)	4,063	<5 percent of model 1,000 MWe LWR.
Transportation (person-rem):		
Exposure of workers and general public	2 5	
Occupational exposure (person-rem)	22 6	From reprocessing and waste management.

[1] In some cases where no entry appears it is clear from the background documents that the matter was addressed and that, in effect, the Table should be read as if a specific zero entry had been made. However, there are other areas that are not addressed at all in the Table. Table S-3 does not include health effects from the effluents described in the Table, or estimates of releases of Radon-222 from the uranium fuel cycle or estimates of Technetium-99 released from waste management or reprocessing activities. These issues may be the subject of litigation in the individual licensing proceedings.

Data supporting this table are given in the "Environmental Survey of the Uranium Fuel Cycle," WASH-1248, April 1974, the "Environmental Survey of the Reprocessing and Waste Management Portion of the LWR Fuel Cycle," NUREG-0116 (Supp. 1 to WASH-1248); the "Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," NUREG-0216 (Supp. 2 to WASH-1248); and in the record of the final rulemaking pertaining to Uranium Fuel Cycle Impacts from Spent Fuel Reprocessing and Radioactive Waste Management, Docket RM-50-3. The contributions from reprocessing, waste management and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no recycle). The contribution from transportation excludes transportation of cold fuel to a reactor and of irradiated fuel and radioactive wastes from a reactor which are considered in Table S-4 of § 51.20(g). The contributions from the other steps of the fuel cycle are given in columns A-E of Table S-3A of WASH-1248.

[2] The contributions to temporarily committed land from reprocessing are not prorated over 30 years, since the complete temporary impact accrues regardless of whether the plant services one reactor for one year or 57 reactors for 30 years.

[3] Estimated effluents based upon combustion of equivalent coal for power generation.

[4] 1.2 percent from natural gas use and process.

SOURCE: Office of the Federal Register, Code of Federal Regulations, 10CFR51.20(e), General Services Administration, Washington, DC, January 1, 198[illegible].

5.8 SOCIOECONOMIC IMPACTS

5.8.1 Physical Impacts

5.8.1.1 Land Use Impacts

Of the 364-ha (900-acre) site owned by NMPC, approximately 13.5 ha (33.4 acres), or 3.7 percent of the total area, will be affected by Unit 2 operation. Unit 2 facilities account for 5.9 ha (14.5 acres), while parking, roads, and railroad spurs account for the balance of 7.6 ha (18.9 acres). The remaining site land will be generally unaffected by operations, except for providing access to the plant buildings and laydown storage space. Specific land uses and roadways are identified in Section 2.2.1.1.

A private east-west road, connecting county Route 1A and NYS Route 29, is located on NMPC property. This road will be used for site access by the operation work force for the delivery and pickup of maintenance and refuse materials and, to some extent, by Scriba town residents.

In addition, a rail spur that was built onsite, from the Consolidated Railroad's Oswego-Mexico branch line, will be used occasionally during plant operation to transport materials that are used for maintenance and operation. However, shipments will be delivered more regularly by truck via Lake Road, NYS Route 29, and US Route 104 during working hours, 7:00 am to 5:30 pm. The frequency of operation materials deliveries is limited, generally less than that associated with construction materials. Further, the area within 3 km (1.9 mi) of the site is sparsely populated. Therefore, deliveries of operation and maintenance materials are expected to have a minimal effect on the local area.

Unit 2 operation will have no impact on historic or recreational sites in the area. Section 3.1.2 discusses the visual impact of Unit 2.

5.8.1.2 Nonradioactive Gaseous Emissions

Economic and social effects of plant operation resulting from nonradioactive gaseous emissions will be negligible, since the auxiliary boilers will be electrically operated (i.e., no emissions) and the fossil-fired diesel generators and fire pumps will be operated infrequently. Section 3.6.3.4 discusses emissions in more detail.

Plant operation is not expected to create any adverse meteorological conditions outside the plant boundary that

would result in economic or financial loss to the area. This aspect of plant operation is discussed in Section 5.3.3.1.4.

5.8.1.3 Potential Adverse Impacts Due to Noise

This section discusses several potential noise sources, predicts their noise level impact in the surrounding community, and compares these estimated levels with the measured ambient sound levels discussed in Section 2.10 and listed in Table 2.10-2.

The Community Sound Level computer model (COMSOL EN-055), developed by Stone & Webster Engineering Corporation (SWEC), was used to predict the noise impact due to Unit 2 operation. This computer program models each of the power plant noise sources with respect to their generated noise characteristics and their onsite location relative to a fixed reference point (the center of the reactor building). The sound levels for each noise source are then extrapolated to each of the receiver locations, which, for the purposes of this analysis, are the nine measurement locations selected for the ambient sound level survey (Figure 2.10-1). The COMSOL sound propagation model calculates the effects of hemispherical divergence, atmospheric absorption, source directivity and reflectivity, and barrier attenuation due to the surrounding power plant structures. No corrections are made for the attenuation effects of trees, topography, or meteorological conditions. The predicted noise levels from Unit 2 are, therefore, conservative; i.e., the actual plant noise levels in the community during operation will frequently be less than indicated. At each receiver location, the sound level contribution from each noise source is determined and the overall predicted impact is calculated (the logarithmic sum of the noise sources).

To predict the noise impact expected from the operation of Unit 2, the following primary noise sources were modeled for the COMSOL computer input:

1. Natural-draft cooling tower.

2. Four main transformers (three of four operating).

3. Two reserve transformers.

4. Two auxiliary transformers.

5. Normal station transformer.

6. Turbine building (estimates of interior noise levels propagating through the turbine building walls).

7. Large ventilation supply and exhaust fans for the turbine, reactor, and radwaste buildings.

Unit 2 operational noise levels for each of the preceding noise sources were calculated at the ambient measurement locations shown on Figure 2.10-1. The predicted Unit 2 noise levels are given in Table 5.8-1, which also includes the measured ambient noise levels (including the operating noise levels from Unit 1 and the JAF plant) for comparison.

At all offsite locations, Unit 2 noise levels are predicted to be less than 40 dBA. Predicted noise levels along the southwest boundary of the power plant (Lakeview Road) range from 33 dBA at location 2 to 37 dBA at location 1. Predicted noise levels along Miner Road, south of the plant, range from 28 dBA at location 3 to 32 dBA at location 9. Along the southeast boundary of the power plant (Route 29), predicted noise levels range from 28 dBA at location 3 to 39 dBA at location 6.

An analysis of the predicted noise levels from each of the primary noise sources indicates that, in areas east of the power plant (locations 4, 5, and 6), the reactor building ventilation system supply fans located at the rear of the standby gas treatment building are the dominant noise source (above 30 dBA), with a level of 37 dBA at location 6. At all other locations, the noise levels from each of the individual noise sources were less than 30 dBA. However, the total noise level obtained by logarithmically adding these noise sources generally produced noise levels in the range of 25-39 dBA, depending on the distance of each location from Unit 2. Also, because of the distance of the natural-draft cooling tower from the nearest property line (approximately 1.6 km [1 mi] to locations 1 and 6), predicted noise levels from this source are expected to be less than 29 dBA.

Combining (logarithmically adding) the predicted Unit 2 operational noise levels (Table 5.8-1, column 7) and the measured ambient noise levels (Table 5.8-1, column 5, without crickets) results in the expected overall noise levels listed in Table 5.8-1, column 8. These results indicate that, with Unit 2 operating, the expected noise levels at each of the measurement locations will increase between 1 and 4 dBA, except at location 6 where the increase will be approximately 7-8 dBA. This increase at location 6

is primarily due to the expected impact from the reactor building ventilation supply fans. Although the addition of Unit 2 will result in a general increase in ambient sound
6 levels, these levels are in compliance with both HUD and EPA noise guidelines, discussed in Section 2.10.3, which are used to define community noise acceptability.

5.8.2 Social and Economic

5.8.2.1 Direct Impact of Station Operation

Ad valorem taxes for Unit 2 have been estimated for the first 10 yr of plant operation. The estimated payments are listed in Table 5.8-2 and apply only to Unit 2. Estimated tax payments range from $15,147,586 in the first year of station operation to $29,149,859 in the tenth year (1982 dollars).

Effects of these revenues on the town of Scriba and Oswego County depend on local planning of capital expenditures. The potential exists for the town of Scriba and the county of Oswego to gain significant benefits from the taxes generated by Unit 2.

In addition to local property tax benefits, the local economy will also benefit from revenues generated by the purchase of goods and services for Unit 2. Based on expenditures made at Unit 1, it is estimated that annual expenditures of approximately one million dollars will be made for goods and services purchased for Unit 2 within a 50-mile radius of the site.

5.8.2.2 Impacts Associated With Operating Staff

Operating phase manpower levels for the Unit 2 site are presented in Table 5.8-3. As indicated in this table, the operating staff will progressively increase from approximately 235 employees during the preoperational testing phase (1983) to 645 employees in 1986 when startup testing will be conducted. The estimated payroll for the full complement of regular Unit 2 operating employees is 18 million dollars (expressed in 1982 dollars and based on 635 employees).

To the extent possible, operating personnel will be drawn from the local area. Other personnel are expected to settle in communities surrounding Unit 2 throughout the county.

Some operating personnel and their families will probably settle in the town of Scriba, but no significant impacts are anticipated from their relocation. In the town of Scriba and Oswego County, existing public services, including police, fire, school, and medical, are able to absorb some growth. In addition, as discussed in Section 2.5.2, recreational opportunities are available throughout the county and throughout the region surrounding Unit 2.

Because a portion of the construction work force of as many as 5,000 has been accommodated in the region without a significant impact, it is expected that the operation staff will disperse throughout the region and not impact any community.

Scheduled station outages are expected every 12 to 24 months. The additional workers required during these periods are expected to seek temporary lodging within the local area. This would not impact any community. However, it will result in increased revenue to local businesses in the area.

TABLE 5.8-1

COMPARISON OF MEASURED AMBIENT NOISE LEVELS
WITH PREDICTED UNIT 2 NOISE LEVELS

Location	Measurement Period (hr)	dBA Levels for: L_{90} Community Noise Analyzer*	dBA Levels for: L_{90} Hand-Held Statistical Data*	dBA Levels Calculated from Residual Octave Band Data: With Crickets	dBA Levels Calculated from Residual Octave Band Data: Without Crickets	Predicted Unit 2 Noise Levels (COMSOL)	Predicted Unit 2 Levels + Measured Ambient Levels
1	Day 0700-2200	37-43	38-44	39-44	35-36	37	39-40
	Night 2200-0700	34-42	34-40	34-40	33-36		34-40
2	Day 0700-2200	32-36	34-40	35-42	27-33	33	34-36
	Night 2200-0700	35-36	30-34	32-35	31-32		35-36
3	Day 0700-2200	40-48	46-48	48-49	29-32	28	32-34
	Night 2200-0700	45-47	44-50	45-49	32-36		34-36
4	Day 0700-2200	31-38	38-44	38-46	35-37	35	38-39
	Night 2200-0700	30-32	32-40	34-40	27-35		35-38
5	Day 0700-2200	-	40-46	41-48	37	32	38
	Night 2200-0700	-	31-40	31-40	28-37		34-38
6	Day 0700-2200	-	36-46	37-44	32-33	39	39-40
	Night 2200-0700	-	38-40	38-41	29-31		39
7	Day 0700-2200	-	42	41	29	25	31
	Night 2200-0700	-	42	42	34		34
8	Day 0700-2200	-	44-46	44-49	35-38	33	37-39
	Night 2200-0700	-	38	42	31		35
9	Day 0700-2200	-	44-48	44-50	31-36	32	35-38
	Night 2200-0700	-	32-42	34-41	31-38		35-39

*Noise dBA level exceeded 90 percent of the time.

TABLE 5.8-2

ESTIMATED REAL ESTATE AND PERSONAL PROPERTY TAXES
TO BE PAID ON UNIT 2
(In Millions of Dollars)[1]

Year	NMPC Portion[2]	Co-Owner Portion	Total Tax
1986	6,210,510	8,937,076	15,147,586
1987	6,791,645	9,773,344	16,564,989
1988	7,288,794	10,488,752	17,777,546
1989	7,822,333	11,256,529	19,078,862
1990	8,394,928	12,080,507	20,475,435
1991	9,009,437	12,964,800	21,974,237
1992	9,668,928	13,913,823	23,582,751
1993	10,376,693	14,932,316	25,309,009
1994	11,136,267	16,025,361	27,161,628
1995	11,951,442	17,198,417	29,149,859

[1] 1982 dollars.
[2] NMPC retains 41 percent ownership of Unit 2.

TABLE 5.8-3

MID-YEAR OPERATING PHASE
WORKFORCE AT UNIT 2

	1983	1984	1985	1986	1987
Plant Personnel[1]	235	370	565[2]	645[2]	635[2]

[1] Includes all regularly employed personnel at the site.
[2] Includes security personnel.

5.9 DECOMMISSIONING AND DISMANTLING

The potential environmental impacts associated with decommissioning and dismantling Unit 2 at the end of its useful life are assessed in this section, including current plans and policies.

5.9.1 Plans and Policies for Action to be Taken at the End of the Plant's Useful Life

Unit 2 is designed for an operating life of approximately 40 yr. Therefore, its decommissioning activities are expected to commence about 2026. The current NMPC policies for decommissioning and dismantling Unit 2 are to use the most economical approach based on then-demonstrated technologies, as well as one that is consistent with regulatory requirements to ensure the health and safety of the decommissioning workers and the public.

Current NMPC plans for decommissioning and dismantling Unit 2 are based on the immediate removal and disposal of all materials and structures, radioactive or not, and restoring the site to essentially preconstruction condition.

5.9.2 Decommissioning Plans as Described in Regulatory Guide 1.86

Regulatory Guide 1.86 identifies three basic options for the decomissioning of nuclear power plants at the end of their useful life. However, based on analyses that are a part of the NRC's ongoing Rulemaking on Decommissioning, the NRC has indicated that options not involving removal will be unacceptable and that prompt removal decommissioning is the preferred method. Based on this NRC position, plus economic assessments indicating that prompt removal is comparable to, or less expensive than, other options that involve ultimate removal, NMPC intends to perform prompt removal decommissioning. This method includes removal of all fuel assemblies, radioactive fluids, and other materials having activities above accepted unrestricted activity levels, disposal offsite to an approved facility, and site restoration. The monetary costs associated with current NMPC plans for prompt removal decommissioning of Unit 2 as well as the long-term uses of the land and the amount of land irretrievably committed are presented as follows.

5.9.2.1 Monetary Costs

The total cost of decommissioning Unit 2 is estimated to be $123 million in terms of 1982 dollars.

5.9.2.2 Site Condition After Decommissioning and Dismantling

Upon completion of the decommissioning and dismantling activities, the Unit 2 site will have been restored to essentially preconstruction condition for unrestricted use, except for parts of the electrical switchyard which may remain in the NMPC system electrical grid.

5.9.2.3 Amount of Land Irretrievably Committed

The construction and operation of Unit 2 has been and will be conducted to preclude the irreversible and irretrievable commitments of land. In addition, current NMPC plans for decommissioning call for immediate removal and disposal of all materials and structures. As a result, no land is foreseen to be irretrievably committed.

5.9.3 Summary of Adverse Environmental Impacts

The principal environmental impact of decommissioning a reactor will be the occupational radiation doses received by the decommissioning workers. These doses will be minimized in accordance with the intent of ALARA, and in no case will individual dosages exceed permissible levels. Very small amounts of radioactivity could be released off site as a consequence of onsite decommissioning, but onsite radioactive material control practices will assure that these are minimal and substantially below permissible levels. In addition, there may be small amounts of nonradioactive dust associated with physical demolition, but these will be controlled to acceptable limits by employment of standard demolition dust control practices. Finally, there will be truck or rail transport of demolition equipment, of radioactive wastes packaged in licensed containers to licensed disposal sites, and of nonradioactive components and wastes to a local licensed landfill or other disposal or salvaged equipment site. Approximately 2 yr before the actual decommissioning, a detailed assessment of environmental impacts will be made as a part of the licensing process, and mitigation procedures appropriate to the specific circumstances that prevail at that time will be undertaken.

5.9.4 Commitment of Resources for the Site

Consideration has been given, during plant design, to measures or features that facilitate operations activities. To the extent that design features that make decontamination easier for operational reasons also improve the ease of

decommissioning, such features are available. However, in many areas, the goals of safe operation are in conflict with the goals of easing decommissioning (such as structural strength for seismic reasons versus easier demolition), and operational safety goals must prevail. Thus, there is essentially no commitment of present resources that are uniquely relevant to future decommissioning.

The commitment of future resources is best represented in aggregate by the cost of decommissioning, which is identified in Section 5.9.2.1. These costs include labor, equipment rental, and a variety of materials and fuels that are used in the decommissioning activity.

5.10 MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS

Many features of the design and operation of Unit 2 limit adverse environmental impacts. Impacts relative to the operation of Unit 2 have been discussed previously in this chapter. The principal features of Unit 2 provided to limit or minimize environmental impacts are the cooling tower, the discharge diffuser system, the intake/fish return system, shoreline protection, and various waste treatment systems. These and other mitigative measures are discussed in the following paragraphs.

5.10.1 Noise Impacts

Site and Vicinity

Because of the location of Unit 2 on the site, and the design of the various plant systems, noise levels are in compliance with both HUD and EPA guidelines (Section 5.8.1.3) and no additional mitigative measures are required.

Transmission Corridor and Offsite Areas

Considering the transmission line voltage, rural nature of the area, and location of the line adjacent to an existing corridor, no major noise impact is expected. Therefore, no mitigative measures are needed.

5.10.2 Erosion

Site and Vicinity

Erosion is not expected to be a concern during Unit 2 operation. The shoreline is protected by the revetment-ditch system. All other site areas are graded and either paved or planted with grass or other vegetation to prevent erosion.

Transmission Corridor and Offsite Areas

Erosion potential will be limited in the transmission line corridor by the maintenance practices discussed in Section 5.6.2.1. In general, vegetative buffers will be retained in stream and wetland areas, and vehicular access will be restricted to existing access roads and stream crossings.

5.10.3 Impacts of Effluents and Wastes on Water Quality

Site and Vicinity

As discussed in Section 5.5.3, the two major wastes discharged to Lake Ontario are the combined plant discharge (cooling tower blowdown, service water discharge, chemical waste treatment, and treated liquid radwaste effluent) and the sanitary system effluent. These effluents are subject to appropriate treatment as necessary to comply with federal effluent limitations and state water quality standards (Section 5.5). There are no effluents or wastes that will affect groundwater quality.

Transmission Corridor and Offsite Areas

There are no effluents potentially affecting surface or groundwater quality associated with the operation of the transmission line.

5.10.4 Surface Water Impacts

Site and Vicinity

Unit 2 operation is expected to have little impact on Lake Ontario, the only surface water body affected. Consumptive water use of the plant is small (Sections 3.3.1 and 5.2). In addition, the shoreline revetment-ditch system does not affect current patterns in the lake. The site drainage path has been improved by the presence of Unit 2 and does not alter any permanent water bodies.

The cooling tower reduces the amount of water utilized; consequently, operation of the intake system does not significantly alter natural velocity patterns in the area (Section 5.3.1). As a result of cooling tower operation, reduced heat is dissipated in Lake Ontario. The discharge diffuser system, while adding small amounts of heat to the lake, is designed and operated to minimize bottom scouring and to rapidly mix the heated effluent with ambient lake water (Section 5.3.2.1). In the worst case, surface water temperatures are increased by less than 1.7°C (3°F) and comply with New York State thermal criteria.

Transmission Corridor and Offsite Areas

Unit 2 operation will have minimal impact on surface water bodies (streams and wetlands) crossed by the transmission corridor because of the proposed mitigative measures (Section 5.6.2).

5.10.5 Groundwater Impacts

As discussed in Sections 5.2.1.1 and 5.2.2.1, Unit 2 operation has no impact on groundwater outside the vicinity of the plant.

5.10.6 Terrestrial Ecosystem Impacts

Site and Vicinity

The potential for adverse impact on plants or animals in the vicinity of the site due to Unit 2 operation is extremely low (Section 5.3.3.2).

Transmission Corridor and Offsite Areas

Minimal impact is expected due to the operation and maintenance of the transmission line. Successional development within the corridors will be held in the old field stage, creating a greater vegetative diversity and improved wildlife habitat (Section 5.6.1). The right-of-way (ROW) management plan is designed to protect ecologically sensitive areas in the transmission corridor.

5.10.7 Aquatic Ecosystem Impacts

Site and Vicinity

The intake and discharge systems of Unit 2 are designed and operated to minimize impact on aquatic organisms. The small volume of water utilized, the low intake velocities, and the presence of a fish protection and removal system result in minimal potential impact to Lake Ontario aquatic populations (Section 5.3.1.2). Similarly, the diffuser discharge system with its low-volume, high-velocity plume will minimize thermal impacts on the biota of Lake Ontario (Section 5.3.2.2). Benthic habitats may be subjected to some minor scouring near the diffuser, and planktonic organisms may briefly be subjected to thermal stress during plume entrainment. However, no observable impacts are anticipated. Due to high discharge velocities, fish will not be able to maintain position in areas of the plume where potentially harmful temperatures occur. Further, fish will not be subject to cold shock, as discussed in Section 5.3.2.2.

Transmission Corridor and Offsite Areas

Section 5.6.2 discusses the impact of transmission line maintenance and operation on aquatic life. The potential

for impact is small since few aquatic habitats are crossed by the corridor. The transmission line maintenance program, which limits access to existing roads and stream crossings, and provides vegetative buffer areas around the streams and wetlands, protects these habitats.

5.10.8 Socioeconomic Impacts

Site and Vicinity

The adverse land use impacts associated with Unit 2 operation are minimal and are related to the visual impact of the cooling tower under certain meteorological conditions (Section 5.1.1). Similarly, adverse socioeconomic impacts are insignificant because the small operating staff is dispersed over a relatively large geographic area (Section 5.8). No mitigative actions are necessary to control socioeconomic impacts.

Transmission Corridor and Offsite Areas

Because of the location of the transmission line within an existing ROW and the agricultural uses of the ROW, there will be no socioeconomic impacts (Sections 5.1 and 5.8).

5.10.9 Other Site-Specific Impacts

There are no other known impacts of operation on the environment in the vicinity of Unit 2.

APPENDIX 5A

DOSE CALCULATION MODELS AND ASSUMPTIONS

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DOSE CALCULATION MODELS AND ASSUMPTIONS

Calculation of dose rates to biota other than man was performed by means of the computer programs ARRRG and CRITER[1], developed at the Pacific Northwest Laboratory of Battelle Memorial Institute under contract to the Atomic Energy Commission (AEC), currently the Nuclear Regulatory Commission (NRC). The calculation of the dose rate to deer and the resultant dose to the maximum individual from the consumption of these animals was performed using the Stone & Webster Engineering Corporation (SWEC) computer code BAMBIE, which employs the methodology of CRITER, and Regulatory Guide 1.109, Revision 1. Except where noted, the calculation of doses to man was performed using the methodology described in Regulatory Guide 1.109, Revision 1. Bioaccumulation factors used in ARRRG and CRITER have been updated to correspond to the latest published values in Regulatory Guide 1.109, Revision 0 (plants) and Regulatory Guide 1.109, Revision 1 (all others).

A summary of the dose models and a list of assumptions used for the site are contained in this Appendix and in Tables 5A-1 through 5A-3.

5A.1 DOSE TO BIOTA OTHER THAN MAN

5A.1.1 Internal Doses to Aquatic Organisms

Aquatic organisms were considered to receive an internal dose rate from uptake and concentration of radiochemicals in the water and from exposure through the food chain. Dose rates to primary organisms were calculated directly from radioisotopic concentrations in discharge water and from equilibrium bioaccumulation factors listed in Table 5.4-3. The dose rate through the food chain was estimated for secondary organisms such as muskrats and raccoons feeding on primary organisms whose radionuclide content was estimated in the first calculation.

The dose rates to biota other than man are expressed in units of mrad rather than mRem, since mRem is the unit used specifically to express the effect of radiation on human tissue. Therefore, when dose conversion factors for man (expressed in mRem/yr) are used to derive dose rates to biota other than man, it is assumed that mRem/yr equals mrad/yr for biota.

Equations used by the program CRITER for these calculations are as follows:

$$(DR)_i = AE_i b_i \qquad (5A-1)$$

Where:

$(DR)_i$ = Dose rate for radionuclide i (mrad/yr)

E_i = Effective absorbed energy (MeV/disintegration in organ of interest)

b_i = Specific body burden of nuclide i (pCi/kg)

A = Conversion factor
= $0.0187 \frac{\text{dis-kg-mrad}}{\text{pCi-yr-MeV}}$

and:

$$b_i = C_{iw} B_i$$

Where:

C_{iw} = Concentration of nuclide i in water (pCi/l)

B_i = Equilibrium bioaccumulation factor for nuclide i (pCi/kg per pCi/l)

The concentration in water C_{iw} is calculated from:

$$C_{iw} = 1,119 \frac{Q_i R_i M_p}{F} \exp(-\lambda_i t_p) \qquad (5A-2)$$

Where:

Q_i = Release rate of nuclide i (Ci/yr)

R_i = Reconcentration factor to estimate recycling of effluent (dimensionless)

M_p = Mixing ratio at point of exposure (1/dilution factor)

F = Flow rate of the liquid effluents (cfs)

λ_i = Radiological decay constant of nuclide i (hr^{-1})

t_p = Transit time for nuclides to reach point of exposure (hr)

1,119 = Constant to convert Ci/yr per cfs to pCi/l

The total-body dose rate to secondary organisms was calculated as[1]:

$$DR'_i = 0.365\ b_i\ P'\ D'_i \qquad (5A-3)$$

Where:

DR'_i = Total-body dose rate to secondary organisms due to nuclide i (mrad/yr)

0.365 = kg-day/g-yr

b_i = Specific body burden of nuclide i (pCi/kg)

P' = Consumption rate of primary organisms by the secondary organisms (g/day)

and:

$$D'_i = 70{,}000\ \frac{D_i(\text{man})}{e_i(\text{man})}\ \frac{e'_i}{m'}$$

$D_i(\text{man})$ = Total-body dose conversion factor for man for radionuclide i $\left(\frac{\text{mRem}}{\text{pCi}}\right)$

$e_i(\text{man})$ = Effective absorbed energy for man for radionuclide i (meV/disintegration)

e'_i = Effective absorbed energy for secondary organism for radionuclide i (meV/disintegration)

m' = Mass of secondary organisms (grams)

70,000 = Total-body mass of adult (grams)

The actual equation used by CRITER was of the form:

$$DR' = 2.86 \times 10^{7} \frac{M_p P'}{F\ m'} \sum_{i=1}^{n} Q_i\ R_i\ B_i\ e'_i \exp\left(-\lambda_i t_p\right) [D_i / e_i]^{(man)} \qquad (5A\text{-}4)$$

Where:

DR' = Total-body dose rate to secondary organisms (mrad/yr)

n = 136, number of radionuclides

2.86×10^{7} = (0.365) (1,119) (70,000)

All other terms are as previously defined.

5A.1.2 External Doses to Aquatic Organisms

5A.1.2.1 Doses From Shoreline Deposits

The doses from shoreline deposits were calculated using the following equation:

$$(DR)' = 111{,}900 \frac{U_p M_p W_f}{F} \sum_{i=1}^{n} Q_i\ R_i\ T_i \exp\left(-\lambda_i\ t_p\right) \left(1-\exp\left(-\lambda_i t\right) D_{ipr}\right) \qquad (5A\text{-}5)$$

Where:

(DR)' = Total-body dose to organisms from shoreline deposits (mrad/yr)

U_p = Duration of exposure to external radiation sources (hr/yr)

W_f = Shore width factor
= 0.3 (lake shoreline)

T_i = Radiological half-life of radionuclide i (days)

t = Total time the sediment is exposed to the contaminated water, normally taken to be the operating lifetime of the facility (hr)

D_{ipr} = Dose conversion factor for radionuclides deposited in lake sediments (mrad/hr per pCi/m^2)

111,900 = Factor to convert (Ci/yr)/(cfs) to pCi/l and to account for the proportionality constant used in the sediment radioactivity model

All other terms are as previously defined.

5A.1.2.2 Dose From Swimming and Water Surface Exposure

The doses from swimming and water surface exposure were calculated using the following equation:

$$(DR)_{pr} = 1{,}119 \frac{U_p M_p}{F\, K_p} \sum_{i=1}^{n} Q_i\, R_i\, D_{ipr}\, \exp\left(-\lambda_i\, t_p\right) \qquad (5A\text{-}6)$$

Where:

$(DR)_{pr}$ = Total-body dose rate to primary and secondary organisms (mrad/yr)

K_p = Hemispherical correction constant, 1 for total water immersion, and 2 for water surface activities

All other terms are as previously defined.

5A.1.2.3 Dose From Immersion in Gaseous Effluents

These doses were calculated in the same manner as doses to humans, with appropriate changes in use factors as presented in Table 5A-1.

5A.2 DOSE TO HUMANS

Dose rates to humans were calculated using the equations recommended in Regulatory Guide 1.109, Revision 1.

5A.2.1 Doses From Liquid Pathways

The generalized equation for calculating radiation doses to humans via liquid pathways is:

$$R_{aipj} = (C_{ip})\ (U_{ap})\ (D_{aipj}) \qquad (5A\text{-}7)$$

Where:

R_{aipj} = Annual dose to organ j, of an individual of age group a, from nuclide i, via pathway p (mRem/yr)

C_{ip} = Concentration of nuclide i, in the media of pathway p (pCi/l, pCi/kg, or pCi/m²)

U_{ap} = Exposure time or intake rate (usage) associated with pathway p, for age group a (hr/yr, l/yr, or kg/yr, as appropriate)

D_{aipj} = Dose factor, specific to age group a, radionuclide i, pathway p, and organ j (mRem/pCi ingested or mRem/hr per pCi/m² from exposure to deposited activity in sediment or on the ground)

5A.2.1.1 Potable Water

The doses from ingestion of potable water were calculated using the following equation:

$$R_{apj} = 1{,}100 \frac{M_p U_{ap}}{F} \sum_i Q_i D_{aipj} \exp\left(-\lambda_i t_p\right) \qquad (5A\text{-}8)$$

Where:

R_{apj} = Total annual dose to organ j, of individuals of age group a, from all nuclides i, in pathway p (mRem/yr)

M_p = Mixing ratio (reciprocal of the dilution factor) at the point of exposure, or the point of withdrawl of drinking water, or point of harvest of aquatic food (dimensionless)

F = Flow rate of the liquid effluent (cfs)

Q_i = Release rate of nuclide i (Ci/yr)

λ_i = Radioactive decay constant of nuclide i (hr^{-1})

t_p = Average transit time required for nuclides to reach point of exposure. For internal dose, t_p is the total time elapsed between release of the nuclides and ingestion of food or water (hr)

1,100 = Factor to convert Ci/yr per cfs to pCi/l

All other terms are as previously defined.

5A.2.1.2 Aquatic Foods

The doses from ingestion of aquatic food were calculated using the following equation:

$$R_{apj} = 1{,}100 \frac{U_{ap} M_p}{F} \sum_i Q_i B_{ip} D_{aipj} \exp\left(-\lambda_i t_p\right) \qquad (5A-9)$$

Where:

R_{apj} = Total annual dose to organ j, of individuals of age group a, from all nuclides i, in pathway p (mRem/yr)

B_{ip} = Equilibrium bioaccumulation factor for nuclide i, in pathway p, expressed as the ratio of the concentration in biota (pCi/kg) to the radionuclide concentration in water (pCi/l), (l/kg)

M_p = Mixing of ratio (reciprocal of the dilution factor) at the point of exposure (or the point of withdrawal of drinking water, or point of harvest of aquatic food), (dimensionless)

F = Flow rate of the liquid effluent (cfs)

Q_i = Release rate of nuclide i (Ci/yr)

λ_i = Radioactive decay constant of nuclide i (hr^{-1})

t_p = Average transit time required for nuclides to reach the point of exposure. For internal dose, t_p is the total time elapsed between release of the nuclides and ingestion of food or water (hr)

1,100 = Factor to convert from Ci/yr per cfs to pCi/l

All other terms are as previously defined.

5A.2.1.3 Doses From Shoreline Deposits

The doses from shoreline recreation were calculated using the following equation:

$$R_{apj} = 110{,}000 \frac{U_{ap} M_p W}{F} \sum_i Q_i T_i D_{aipj} \left[\exp(-\lambda_i t_p)\right]\left[1-\exp(-\lambda_i t_b)\right] \qquad (5A-10)$$

Where:

R_{apj} = Total annual dose to organ j, of individuals of age group a, from all nuclides i, in pathway p (mRem/yr)

W = Shoreline width factor that describes the geometry of the exposure (dimensionless)
= 0.3 (lake shoreline)

T_i = Radiological half-life of nuclide i (days)

t_b = Period of time for which sediment or soil is exposed to the contaminated water (hr)

110,000 = Factor to convert Ci/yr per cfs to pCi/l and to account for the proportionality constant used in the sediment radioactivity model

All other terms are as previously defined.

5A.2.1.4 Doses From Foods Grown on Land With Contaminated Water

The doses to the maximum individual from consumption of vegetables grown in a garden irrigated with receiving water were calculated using the following equation:

$$R_{apj} = U_{ap} \sum_i^{veg} C_{iv} D_{aipj} + u_{ap} \sum_i^{animal} C_{iA} D_{aipj} \qquad (5A\text{-}11)$$

Where:

R_{apj} = Total annual dose to organ j, of individuals of age group a, from all nuclides i, in pathway p (mRem/yr)

C_{iv} = Concentration of radionuclide i in the edible portion of crop species v (pCi/kg)

C_{iA} = Concentration of radionuclide i in the animal product, either meat or milk (pCi/kg or pCi/l)

All other terms are as previously defined.

5A.2.1.5 Doses From Swimming and Boating

The dose from swimming and boating was calculated using the methodology described in WASH 1258[2].

The equation for calculation of external dose to skin and total body from swimming (water immersion) or boating (water surface) is:

$$R_{apj} = 1{,}100 \frac{U_{ap} M_p}{F K_p} \sum_i Q_i D_{ij} \exp\left(-\lambda_i t_p\right) \qquad (5A\text{-}12)$$

Where:

K_p = Geometry correction factor equal to 1 for swimming and 2 for boating, dimensionless (no credit is taken for the shielding provided by the boat)

D_{ij} = Dose conversion factor for radionuclide i and organ j in water exposure (mRem/hr per pCi/l)

All other terms are as previously defined.

5A.2.2 Doses From Air Pathways

5A.2.2.1 Gamma and Beta Doses From Noble Gases Discharged to the Atmosphere

5A.2.2.1.1 Annual Gamma and Beta Air Doses From Noble Gas Releases

The annual gamma and beta air doses from noble gas releases were calculated using the following equations:

$$D^{\gamma}(r,\theta) \text{ or } D^{\beta}(r,\theta)$$

$$= 3.17\times10^{4} \sum_i Q_i [\chi/Q] (r,\theta) \left(DF_i^{\gamma} \text{ or } DF_i^{\beta}\right) \qquad (5A\text{-}13)$$

Where:

$D^{\gamma}(r,\theta)$, $D^{\beta}(r,\theta)$ = Annual gamma and beta air doses at distance r in the sector, at angle θ from the discharge point (mrad/yr)

Q_i = Release rate of the radionuclide i (Ci/yr)

$[\chi/Q](r,\theta)$ = Annual average gaseous dispersion factor at distance r in sector θ (sec/m^3)

$DF_i^{\gamma}, DF_i^{\beta}$ = Gamma and beta air dose factors for a uniform semi-infinite cloud of radionuclide i, (mrad-m^3/ pCi-yr)

3.17×10^4 = Number of pCi/Ci divided by the number of sec/yr

5A.2.2.1.2 Annual Total-Body Dose From Noble Gas Releases

The annual total-body doses from noble gas releases were calculated using the following equation:

$$D_{\infty}^{T}(r,\theta) = S_F \sum_i \chi_i (r,\theta)\, DFB_i \qquad (5A\text{-}14)$$

Where:

$D_{\infty}^{T}(r,\theta)$ = Annual total-body dose due to immersion in a semi-infinite cloud at distance r in sector θ (mRem/yr)

S_F = Attention factor that accounts for dose reduction due to shielding provided by residential structures (dimensionless)

$\chi_i(r,\theta)$ = Annual average ground-level concentration of radionculide i at distance r in sector θ (pCi/m^3)

DFB_i = Total-body dose factor for a semi-infinite cloud of the radionuclide i which includes the attenuation of 5 g/cm^2 of tissue ($mRem\text{-}m^3/pCi\text{-}yr$)

5A.2.2.1.3 Annual Skin Dose From Noble Gas Releases

The annual skin doses from noble gas releases were calculated using the following equation:

$$D_{\infty}^{S}(r,\theta) = 1.11\, S_F \sum_i \chi_i(r,\theta)\, DF_i^{\gamma} + \sum_i \chi_i(r,\theta)\, DFS_i \qquad (5A\text{-}15)$$

Where:

$D_{\infty}^{S}(r,\theta)$ = Annual skin dose due to immersion in a semi-infinite cloud at distance r in sector θ (mRem/yr)

DFS_i = Beta skin dose factor for a semi-infinite cloud of radionuclide i, which includes the attenuation by the outer "dead" layer of the skin ($mRem\text{-}m^3/pCi\text{-}yr$)

1.11 = Average ratio of tissue to air energy absorption coefficients

All other terms are as previously defined.

5A.2.2.2 Doses From Radioiodines and Other Radionuclides (Not Including Noble Gases) Released to the Atmosphere

5A.2.2.2.1 Annual Organ Dose From External Irradiation From Radionuclides Deposited Onto the Ground Surface

The annual organ dose from external irradiation from radionuclides deposited onto the ground surface was calculated using the following equation:

$$D_j^G (r,\theta) = 8{,}760\ S_F \sum_i C_i^G (r,\theta)\ DFG_{ij} \qquad (5A\text{-}16)$$

Where:

$D_j^G (r,\theta)$ = Annual dose to the organ j at location (r,θ), (mRem/yr)

S_F = Shielding factor that accounts for the dose reduction due to shielding provided by residential structures during occupancy (dimensionless)

$C_i^G (r,\theta)$ = Ground plane concentration of radionuclide i at distance r in sector θ (pCi/m^2)

DFG_{ij} = Open field ground plane dose conversion factor for organ j from radionuclide i (mRem-m^2/pCi-hr)

8,760 = Number of hours in a year

5A.2.2.2.2 Annual Organ Dose From Inhalation of Radionuclides in Air

The annual organ dose from inhalation of radionuclides in air was calculated using the following equation:

$$D_{ja}^A (r,\theta) = R_a \sum_i \chi_i (r,\theta)\ DFA_{ija} \qquad (5A\text{-}17)$$

Where:

$D_{ja}^A (r,\theta)$ = Annual dose to organ j, of an individual in age group a, at location (r,θ), due to inhalation (mRem/yr)

R_a = Annual air intake for individuals in age group a (m^3/yr)

$\chi_i(r,\theta)$ = Annual average concentration of radionuclide i, in air at location (r,θ) (pCi/m^3)

DFA_{ija} = Inhalation dose factor for radionuclide i, organ j, and age group a (mRem/pCi)

5A.2.2.2.3 Annual Organ Dose From Ingestion of Atmospherically Released Radionuclides in Food

The annual organ dose from ingestion of atmospherically released radionuclides in food was calculated using the following equation:

$$D^D_{ja}(r,\theta) = \sum_i DFI_{ija} \Big[U^v_a f_g C^v_i(r,\theta) + U^m_a C^m_i(r,\theta) + U^F_a C^F_i(r,\theta) + U^L_a f_l C^L_i(r,\theta) \Big] \quad \text{(5A-18)}$$

Where:

$C^v_i(r,\theta)$, $C^m_i(r,\theta)$, $C^L_i(r,\theta)$, $C^F_i(r,\theta)$ = Concentrations of radionuclide i in produce (nonleafy vegetables, fruits, and grains), milk, leafy vegetables, and meat, respectively, at location (r,θ), (pCi/kg or pCi/l)

$D^D_{ja}(r,\theta)$ = Annual dose to the organ j of an individual in age group a from ingestion of produce, milk, leafy vegetables, and meat at location (r,θ), (mRem/yr)

DFI_{ija} = Ingestion dose factor for radionuclide i, organ j, and age group a (mRem/pCi)

f_g, f_l = Respective fractions of the ingestion rates of produce and leafy vegetables that are produced in the garden of interest

U_a^v, U_a^m, U_a^F, U_a^L = Annual intake (usage) of produce, milk, meat, and leafy vegetables, respecttively for individuals in age group a (kg/yr or l/yr)

5A.3 GENERAL EXPRESSION FOR POPULATION DOSES

The general expression for calculating the annual population-integrated dose is:

$$D_j^P = 0.001 \sum_d P_d \sum_a D_{jda} f_{da} \qquad (5A\text{-}19)$$

Where:

D_j^P = Annual population-integrated dose to organ j (total body or thyroid), (man-Rems or thyroid man-Rems)

P_d = Population associated with subregion d

D_{jda} = Annual population-integrated dose to organ j (total body or thyroid) of an average individual of age group a in subregion d (mRem/yr)

f_{da} = Fraction of the population in subregion d that is in age group a

0.001 = Conversion factor from mRem to Rem

Equation 5A-19 used in conjunction with the preceding equations and average adult usage factors was used to calculate the population doses.

For further refinements on the preceding equation used to calculate the doses to man, refer to Regulatory Guide 1.109, Revision 1.

5A.4 REFERENCES

1. Soldat, S.K.; Robinson, N.M.; and Baker, D.A. Models and Computer Codes for Evaluating Environmental Radiation Doses. Battelle Pacific Northwest Laboratories, BNWL-1754, Richland, WA, February 1974.

2. Nuclear Regulatory Commission (NRC). 10CFR50, Appendix I, Annex: Concluding Statement of Position of the Regulatory Staff (Docket-RM-50-2), Guides on Design Objectives for Light-Water-Cooled Nuclear Power Reactors, 1973.

TABLE 5A-1

ASSUMPTIONS USED IN ESTIMATING DOSES TO AQUATIC AND TERRESTRIAL BIOTA

	Values Assigned					
	Primary Organisms	Secondary Organisms				
Parameter	(Fish, Crustaceans, Mollusks, Algae)	Muskrat	Heron	Duck	Raccoon	Deer
R (recirculation factor)	1	1	1	1	1	-
F (flow rate, cfs)	66.8	66.8	66.8	66.8	66.8	-
M (mixing ratio)[1]	0.17	0.17	0.17	0.17	0.17	-
W (shore width factor)	-	0.3	0.3	0.3	0.3	-
K (water immersion)	1	1	-	-	-	-
(water surface)	2	-	2	2	-	-
Effective radius (cm)	2	6	11	5	14	30
M mass (kg)	-	1	4.6	1	12	115
P food consumption (gpd)						
aquatic plants	-	100	-	100	-	-
fish	-	-	600	-	-	-
invertebrate	-	-	-	-	200	-
U usage (hr/yr)						
shoreline	-	2,922	2,922	4,383	2,191	-
water immersion	-	2,922	-	-	-	-
water surface	-	-	2,922	4,383	-	-
holdup time (hr)	0	0	0	0	0	-
Residence time (month)	12	12	12	12	12	12
Additional deer parameters[2]						
X/Q (sec/m^3)						
Release Point 1A[3]						8.86-09
Release Point 1B[4]						4.64-08
Release Point 2[5]						1.60-07
D/Q (1/m^2)						
Release Point 1A[3]						1.40-09
Release Point 1B[4]						4.31-09
Release Point 2[5]						3.51-09
Crop ingestion (kg/d)						10

TABLE 5A-1 (Cont)

Parameter	Values Assigned: Primary Organisms (Fish, Crustaceans, Mollusks, Algae)	Secondary Organisms: Muskrat	Heron	Duck	Raccoon	Deer
Vegetation yield (kg/sq m)						0.7
Vegetation exposure period (hr)						6,574.5
Holdup time - crop exposure to ingestion by deer						0.0
Effective soil surface density (kg/sq m)						240
Buildup time on soil, t (hr)						1.75+05
Crop retention factor particulates/iodine						0.2 particulates; 1.0 iodine
Absolute humidity (g/cu m)						10.3
Fraction of year deer consumes crop						0.75
C-14 fractional equilibrium ratio: continuous release						1.0
intermittent release						0.073

NOTE: 8.86-09 = 8.86×10^{-9}

(1) Edge of dilution zone and nearest shoreline
(2) 1,603 m (5,259 ft) east
(3) Unit 2 stack (continuous)
(4) Unit 2 stack (intermittent)
(5) Radwaste/reactor building vent (continuous)

TABLE 5A-2

DILUTION FACTORS, POPULATION SERVED, AND TRAVEL TIMES FROM THE SITE

Public Water Systems[1]	Approximate Distance From Site to Point of Intake (mi)	Dilution Factor	Population Served (people/yr)	Transit Time to Intake (hr)
Ontario Water District	46 WSW	874	5,000	225
Williamson Water District	41 WSW	825	4,700	200
Wolcott Village	25 WSW	644	2,500	122
City of Oswego	11 WSW	427	32,000	54
Metropolitan Water Board Onondaga County[2]	8 WSW	364	120,000	39
Sackets Harbor Village	32 NNE	486	1,200	156
Chaumont Village	38 NNE	529	550	186
Sodus Village	36 WSW	773	4,500	176
Sodus Point	33 WSW	740	1,800	161
Cape Vincent Village	41 N	550	750	200
R. J. Sweezey	49 N	601	170	240
Township of Ernestown	48 NNW	595	892	235
Kingston Water Intake Plant, Kingston, Ontario	47 N	589	77,000	230
Picton Public Utility	48 NW	595	6,000	235
Kingston Township	46 N	582	22,000	225
Sandhurst Water Works	48 NNW	595	200	235

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TABLE 5A-2 (Cont)

Incremental Regions[3] (km)	Approximate Distance From Site to Point of Analysis (km)	Dilution Factor	Population Usage (people/yr) Boating	Recreation Shoreline	Transit Time to Point of Analysis (hr)
0 to 10	5	152	1.5+04	0	15
10 to 20	15	263	1.5+04	3.1+05	46
20 to 30	25	339	1.5+04	4.7+05	76
30 to 40	35	402	1.5+04	6.9+04	107
40 to 50	45	455	1.5+04	1.9+05	137
50 to 60	55	503	1.5+04	1.8+04	168
60 to 70	65	547	1.5+04	1.2+04	199
70 to 80	75	588	1.5+04	1.4+05	229

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Other Locations	Approximate Distance From Site to Point of Intake (km)	Dilution Factor	Transit Time to Intake (hr)
Edge of initial dilution zone[4]	0	5.9	0.0 (assumed)
Closest accessible shoreline[5]	15	263	46

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NOTE: 1.5+04 = 1.5×10^4

[1] Public water supply systems used to calculate 80-km (50-mi) radius population doses from ingestion of potable water.
[2] Public water supply system used to calculate the dose to the maximum offsite individuals from the ingestion of potable water and irrigated foods.
[3] Regions used to calculate 80-km (50-mi) radius population doses from ingestion of fish, boating, shoreline recreation (assumed one-eighth of fish caught in each region), and swimming.
[4] Locations used to calculate doses to maximum offsite individuals from ingestion of aquatic foods, and from swimming and boating.
[5] Location used to calculate doses to maximum offsite individuals from shoreline recreation. Closest accessible shoreline - closest occupied beach.

TABLE 5A-3

PARAMETERS AND ASSUMPTIONS USED IN EQUATIONS FOR ESTIMATING DOSES TO HUMANS[1]

Parameter[2]	Values
Effluent flow rate, F (cfs)	66.8
Transit time, T_p[3]	[4]
Average irrigation rate, I ($l/m^2/hr$)	0.05
Fraction of year that crops are irrigated, f_i	0.5 (6 months)
Fractional equilibrium ratio of C-14, p	
Continuous releases	1
Intermittent release	0.073
Fraction of year that animals graze on pasture, f_p	0.5 (6 months)
Fraction of daily feed which is pasture grass when animal is grazing, f_s	1 (100%)
Absolute humidity of atmosphere at location of analysis, H (g/m^3)	10.3
Usage factor, U_{ap} (hr/yr of exposure)	
Swimming	
Maximum individual adult	100
Maximum individual teen	100
Maximum individual child	56
80-km (50-mi) radius population adult	3.4
80-km (50-mi) radius population teen	19
80-km (50-mi) radius population child	12
Boating	
Maximum individual adult	200
Maximum individual teen	200
Maximum individual child	114

TABLE 5A-3 (Cont)

Parameter[2]	Values
Boating (Cont)	
80-km (50-mi) radius population adult	70
80-km (50-mi) radius population teen	70
80-km (50-mi) radius population child	40
Total commercial U.S. fish harvest, V_p (kg/yr)	1.1×10^9
80-km (50-mi) commercial fish harvest, V_{dp}(kg/yr)	2.7×10^5
80-km (50-mi) sports fish harvest, V_{dp}' (kg/yr)	2.8×10^6
80-km (50-mi) milk production, V_{dp}'' (l/yr)	6.3×10^8
80-km (50-mi) meat production, V_{dp}''' (kg/yr)	6.6×10^6
80-km (50-mi) vegetation production, V_{dp}'''' (kg/yr)	3.2×10^8

(1) All parameters and assumptions used are recommended values from Regulatory Guide 1.109, Revision 1, in lieu of site-specific data.

(2) Site-specific parameters or parameters for which there are no recommended value.

(3) T used in calculations was increased, where appropriate, by the distribution or holdup time recommended by Regulatory Guide 1.109, Revision 1.

(4) Refer to Table 5A-2 for calculated values.

CHAPTER 6

ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

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ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

6.1 THERMAL

6.1.1 Preoperational/Preapplication Thermal Monitoring

Temperature measurements have been conducted at the Nine Mile Point site since 1969. Temperature profiles were collected at the site by Stone & Webster Engineering Corporation (SWEC) in 1969 and 1970. These measurements were part of the design studies for Unit 2 and the James A. Fitzpatrick (JAF) plant. During 1970, Dr. J. F. Storr commenced routine monitoring of the Nine Mile Point Unit 1 (Unit 1) thermal plume(1). During 1972, discussions with the NRC staff led to Environmental Technical Specifications (ETS) (issued for Unit 1) requiring aquatic studies and thermal monitoring for the site. A similar ETS is part of the JAF plant operating license. These ETS (and their revisions) are the basis for most of the thermal and aquatic ecology studies conducted at the site. They also reflect the monitoring requirements resulting from the Unit 2 Environment Report - Construction Permit Stage (ER-CPS). From 1973 through 1978, temperature measurements to determine the movement and timing of natural lake thermal stratification were taken weekly from April through December(2). These data, describing thermal structure at the site, fulfilled requirements of the Unit 1 and JAF plant operating license ETS.

In the fall of 1975, the JAF plant went into commercial operation. As required by the ETS, triaxial thermal plume and dye measurements were made in 1976 and 1977.

The following sections provide further details of the thermal monitoring of the site prior to construction of Unit 2. The results of these measurements are summarized in Section 2.3.1.1.1.

6.1.1.1 Measurements of Vertical Temperature Profiles

Each year from 1973 through 1978 weekly surveys were conducted from April through December at various water depths at three transects: directly off Unit 1 (NMPP), east of the plant (NMPE), and west of the plant (NMPW), as shown on Figure 6.6-1. The east or west transects act as controls depending on the ambient lake current, while the plant

transect is at the Unit 1 outfall. The study area includes the existing Unit 1 plume and the area potentially affected by Unit 2. Some data were also collected near the Oswego Steam Station, 11 km (7 mi) west of Nine Mile Point.

Measurements of temperature at 1-m (3.3-ft) intervals were made to define the seasonal progression of thermal stratification at the 30-m (100-ft) depth contour in 1973 through 1978, and at the 15-m (50-ft) depth contour in 1973 and 1974. Measurements were made with a Martek Mark II multiprobe analyzer, a Montedoro Whitney Model TF-20 thermistor, or a GM Model OC-1/S bathythermograph. Temperatures were also measured with most biological collections and water quality sampling; these data are consistent with the Unit 1 and JAF plant plume survey data described in Sections 6.1.1.2 and 6.1.1.3. The profile data were evaluated to identify when and where thermal stratification existed in the lake. Stratification is defined as a vertical temperature gradient in excess of 1°C/m (1.8°F/3.3 ft).

6.1.1.2 Unit 1 Plume Surveys

The Unit 1 plume surveys were conducted by Dr. J. F. Storr[1,3-7]. The area surveyed varied among dates in response to the Unit 1 thermal configuration. The western boundary was commonly 1 km (0.6 mi) west of Unit 1, while the eastern boundary of the surveyed area occasionally extended 1 km (0.6 mi) east of the JAF plant.

Instrumentation used in the surveys consisted of four thermistors spaced to measure the temperature at desired depths below the lake surface. The thermistor string was attached to a weighted line suspended from the side of the boat, with the topmost detector within the upper 0.3 m (1 ft) of water as the boat followed the transect course.

Four Rustrak recorders, Model 2133, and four Gulton Industries thermistor probes, #133, were used in each survey. In combination, the recording range is 0 to 40°C (32°F to 104°F), the accuracy is ±0.5 percent of the scale, and the response time is 90 percent in 5 sec. A Taylor precision thermometer (mercury) with an accuracy of ±0.1°C (±0.2°F) was used to calibrate the recorders prior to each thermal run. Later, the recorders were rechecked at ambient temperatures on the lake and in the discharge plume. Periodic checks of equipment were made throughout the study.

Temperature at the four detector depths was continuously recorded by a four-pen strip chart recorder. As the

preselected transect was followed, the recorder chart was marked when the traverse intersected another transect as sighted against a shoreline marker. Temperatures recorded at this time were plotted later as depth and isothermal points for that particular grid location. The course along each transect was maintained and temperatures recorded until the temperature was within about 0.5°C (1°F) of ambient.

To allow the determination and reproduction of boat location in the water, shoreline markers, in the form of triangular arrays of poles, were installed to form a base for each lakeward transect. The arrays were spaced at approximately 305-m (1,000-ft) intervals along the entire site shoreline. While one pair of poles was used to traverse a course along a 45-deg angle to the shore, a pair of poles at each shore base of successive transects was used to mark boat position along the course. Runs were made at speeds generally between 0.3 and 1.0 m/s (1 and 3 fps). Meteorological data were recorded during each survey.

A complete survey was performed on each day. Daily surveys were plotted as triaxial isotherm contours at 0.5°C (1°F) or 1.0°C (1.8°F) intervals on a grid map of the survey area. Ambient temperatures, meteorological conditions, and plant operating parameters were listed on each map.

6.1.1.3 James A. FitzPatrick Plant Plume Surveys

The JAF plume surveys, which included dye and temperature measurements, were conducted by Aquatec, Inc. under the direction of SWEC[8]. The study area included the JAF plant plume, the Unit 1 plume, and farfield ambient monitoring locations. The data acquisition system used in the surveys included a data logger which records on magnetic tape. This system was used to collect data in two sampling modes during the JAF plant hydrothermal surveys. In the first mode, horizontal sampling, the tracking boat traveled along a transect while water was pumped at a constant rate from selected depths and passed through the fluorometer cell(s) where its dye content was continuously measured. Water temperature was measured with a thermistor probe near the pump intake. In the second mode, vertical sampling, the boat remained stationary at a buoy and a hose was raised from the bottom to the surface at a constant rate while the sample was continuously pumped through the sensing units.

During those surveys when dye was used, Rhodamine WT dye was injected into the JAF plant circulating water system upstream of the center circulating water pump in the screenhouse, using an FMI positive displacement fluid

metering pump. The weight of the dye was recorded each hour as a check on the rate of dye release.

Circulating water intake and discharge dye concentrations were measured at the intake and discharge shafts inside the pumphouse. Measurements of dye scale readings and temperature, used for dye correction, were recorded on analog strip chart recorders. Background fluorescence was determined before each survey.

Following the survey, the dye concentrations were converted to equivalent temperature rises, neglecting atmospheric heat exchange and plotted as a calculated thermal plume.

Temperature measurements were converted to temperature rise by subtracting an ambient surface temperature for each survey. The resulting triaxial plume was then compared with the calculated thermal plumes, based on dye results, for surveys that included the dye release. These data are summarized in Section 2.3.1.1.1.

6.1.2 Operational Thermal Monitoring

Intake and discharge temperatures will be monitored as required by the NRC operating license and the New York State Department of Environmental Conservation State Pollutant Discharge Elimination System (SPDES) permit. Under average operating conditions, the Unit 2 discharge plume is predicted to encompass approximately 210 cu m (0.17 acre-ft). However, this size will vary depending upon unit heat rejection, nearshore lake dynamics, and local meteorology. Since maximum surface temperature rises will be less than 1.3°C (2.3°F) under all operating conditions, the discharge will be in full compliance with New York State surface temperature criteria (Section 5.3.2).

Operational thermal plume measurements will be conducted as required by the SPDES permit and the Environmental Protection Plan.

6.1.3 References

1. Storr, J.F. Mr. R. Clancy. Re: Three-Dimensional Thermal Study, Nine Mile Point, July 22, 1970. Prepared for Niagara Mohawk Power Corporation, January 16, 1971.

2. Lawler, Matusky & Skelly Engineers. Nine Mile Point Aquatic Ecology Study Summary (1973-1981). Prepared for Niagara Mohawk Power Corporation, 1982.

3. Storr, J.F. Mr. R. Clancy. Re: Three-Dimensional Thermal Studies, 1971. Prepared for Niagara Mohawk Power Corporation, February 15, 1972.

4. Storr, J.F. Mr. R. Clancy. Re: Three-Dimensional Thermal Surveys. Prepared for Niagara Mohawk Power Corporation, August 28, 1973.

5. Storr, J.F. Mr. R. Clancy. Re: Three-Dimensional Thermal Surveys, Nine Mile Point, 1973. Prepared for Niagara Mohawk Power Corporation, May 15, 1974.

6. Storr, J.F. Mr. R. Clancy. Re: Three-Dimensional Thermal Surveys, Nine Mile Point, 1974. Prepared for Niagara Mohawk Power Corporation, May 28, 1975.

7. Storr, J.F. Three-Dimensional Thermal Surveys, Nine Mile Point, 1975. Prepared for Niagara Mohawk Power Corporation, 1976.

8. Aquatec, Inc. James A. FitzPatrick Nuclear Power Plant, Second Operational Hydrothermal Survey, August 19 and 20, 1976. Power Authority of the State of New York. Prepared for Stone & Webster Engineering Corporation. Aquatec, Inc., South Burlington, VT, 1976.

6.2 RADIOLOGICAL

6.2.1 Preoperational Monitoring

The preoperational radiological environmental monitoring program for Unit 2 was described in Niagara Mohawk Power Corporation's Environmental Report, Construction Permit Stage, Nine Mile Point Nuclear Station Unit 2[1] and the Final Environmental Statement Related to Construction of Nine Mile Point Nuclear Station Unit 2[2]. The environmental monitoring program is expected to be modified by the NRC with the issuing of the Radiological Effluent Technical Specifications (RETS)[3,4]. The RETS are expected to be issued in 1983. Since this report is in support of an operating license, further discussion of preoperational monitoring is not required.

6.2.2 Operational Monitoring

6.2.2.1 Objectives

A radiological environmental monitoring program will be conducted to evaluate the effects of Unit 2 operation on the environs and to verify the effectiveness of the controls on radioactive materials sources.

6.2.2.2 Descriptions

The operational radiological environmental monitoring program for Unit 2 will be performed jointly with the James A. FitzPatrick (JAF) and Unit 1 plants. The program includes the collection and analysis of samples for air particulates, air radioiodine, direct radiation, surface lake water, shoreline sediment, milk, fish, and food crops. In addition, a yearly milch animal census will be conducted. The required sample collection and analysis frequencies are listed in Table 6.2-1.

Air sampling stations are located downwind of the site at locations where there is high potential for the presence of radionuclides. Three stations are located offsite in three different 22 1/2-deg sectors (the offsite areas are designated as sixteen 22 1/2-deg sectors originating from the center of the site). In addition to these three downwind stations, there is one station located near a community having the highest potential for the presence of radionuclides and one station located 14.5 to 32.2 km (9 to 20 mi) distant from the site. The designated stations sample ambient air for particulates and radioiodine. Air samples are collected weekly or as required by loading.

Samples are analyzed weekly for I-131 and for gross beta after each filter change. In addition, a gamma isotopic analysis for gamma-emitting nuclides is performed on composites (by location) on a quarterly basis (as a minimum).

Thermoluminescent dosimeters (TLDs) are used to measure direct radiation in the environment. The TLDs are located in land-based 22 1/2-deg sectors. TLDs are placed in an inner ring in the general area of the site boundary, in an outer ring 6.4 to 8.0 km (4 to 5 mi) from the site, in special interest areas (population centers, etc), and in control locations. TLDs are changed and read out on a quarterly basis.

Surface lake water samples are taken from the respective intake canals of the JAF and Unit 1 plants. A third sample is taken as a control station sample at a location beyond influence of the site. A fourth lake sample will be collected from the Unit 2 inlet canal when the unit becomes operational. Monthly composite samples are analyzed for gamma-emitting radionuclides (gamma isotopic analysis). Quarterly composites are analyzed for tritium.

Shoreline sediment samples are taken from a location downstream with existing or potential recreational value. Sediment samples are analyzed for gamma-emitting radionuclides (gamma isotopic analysis) twice per year.

Milk samples are collected from three locations within 5.6 km (3.5 mi) distant of the site. In the event of sample unavailability, collections are made beyond a 5.6-km (3.5-mi) distance. In addition, a sample is taken from a control location 14.5 to 32.1 km (9 to 20 mi) distant from the site. Milk samples are collected twice per month from April through December. Samples are analyzed for gamma-emitting radionuclides (gamma isotopic analysis) and I-131.

Fish samples are taken from the vicinity of the plant discharges. Two samples will be taken of species that are commercially or recreationally important. In addition, one sample is taken from a control location of at least 8.0 km (5 mi) distant from the site. Fish samples are collected twice per year. Samples are analyzed for gamma-emitting radionuclides (gamma isotopic analysis) on edible portions.

Food crop samples are collected from six offsite locations. The six locations are from areas of highest calculated average site deposition values (D/Q). D/Q values are

considered for both elevated (three locations) and ground-level (three locations) releases. In addition, one sample is collected as a control sample located 14.5 to 32.1 km (9 to 20 mi) distant from the site in a less prevalent wind direction. Food crop samples considered here are typically broadleaf vegetables. Food crop samples are collected once per year during the harvest season. Samples are analyzed for gamma-emitting radionuclides (gamma isotopic analysis) and I-131.

A milch animal census is conducted to identify the location of milch animals in each sector of the 16 land-based 22 1/2-deg sectors out to a distance of 4.8 km (3 mi). The census is conducted once per year using information that will provide the best results, such as door-to-door surveys and consultations with agricultural authorities.

6.2.2.3 Analysis Procedures

Samples analyzed for gamma-emitting radionuclides (gamma isotopic analysis) are counted on Ge(Li) or NaI systems. Samples for I-131 analysis are either counted on the Ge(Li) or NaI systems or a radiochemical extraction is performed with counting on a beta-gated gamma coincidence system. Gross beta samples are counted on high sensitivity, low background beta counters.

Samples for analysis are analyzed either by the site's environmental laboratory or by a contractor laboratory. Samples taken for quality control are analyzed by alternate facilities.

6.2.3 References

1. Nine Mile Point Nuclear Station Unit 2, Applicant's Environmental Report - Construction Permit Stage. NRC Docket No. 50-410, Niagara Mohawk Power Corporation, June 1972.

2. United States Atomic Energy Commission. Final Environmental Statement Related to Construction of Nine Mile Point Nuclear Station Unit 2. NRC Docket No. 50-410, Niagara Mohawk Power Corporation, June 1973.

3. Nuclear Regulatory Commission. Draft Radiological Effluent Technical Specifications for BWR's, NUREG-0473, Revision 1, Washington, DC, October 1978.

4. Nuclear Regulatory Commission. Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants, NUREG-0133, Revision 1, Washington, DC, October 1978.

TABLE 6.2-1

OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
Airborne			
Radioiodine and particulates	Samples from 5 locations: 3 samples from offsite locations in different sectors of the highest calculated site average D/Q 1 sample from the vicinity of a community having the highest calculated site average D/Q 1 sample from a control location 14.5-32.1 km (9-20 mi) distant and in a least prevalent wind direction	Continuous sampler operation with sample collection weekly or as required by dust loading, whichever is more frequent.	Radioiodine canisters: analyze weekly for I-131 Particulate samplers: Gross beta radioactivity following filter change, composite (by location) for gamma isotopic quarterly (as a minimum)
Direct radiation	40 stations with two or more dosimeters to be placed as follows: an inner ring of stations in the general area of the site boundary and an outer ring in the 6.4- to 8.0-km (4- to 5-mi) range from the site with a station in each land-based sector of each ring (16 sectors and 2 rings = 32 stations). The balance of the stations (8) should be placed in special interest areas, such as population centers, nearby residences, and schools, and in 2 or 3 areas to serve as control stations.	Quarterly	Gamma dose quarterly

TABLE 6.2-1 (Cont)

Exposure Pathway and/or Sample	Number of Samples and Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
Waterborne			
Surface	1 sample upstream 1 sample from the site's most downstream cooling water intake	Composite sample over 1-month period	Gamma isotopic analysis monthly; composite for tritium analysis quarterly
Sediment from shoreline	1 sample from a downstream area with existing or potential recreational value	Twice per year	Gamma isotopic analysis
Ingestion			
Milk	Samples from milking animals in 3 locations within a 5.6-km (3.5-mi) distance having the highest calculated site average D/Q. If there are none, then 1 sample from milking animals in each of 3 areas 5.6-8.0 km (3.5-5.0 mi) distant having the highest calculated site average D/Q. 1 sample of milking animals at a control location 14.5-32.1 km (9-20 mi) distant and in a less prevalent wind direction	Twice per month, April-December (samples will be collected in January-March if I-131 is detected in November and December of the preceding year)	Gamma isotopic and I-131 analysis twice per month when animals are on pasture (April-December); monthly at other times, if required
Fish	2 samples of commercially or recreationally important species in the vicinity of a site discharge point 1 sample each of the same species (or of a species with similar feeding habits) from an area at least 8.0 km (5 mi) distant from the site	Twice per year	Gamma isotopic analysis of edible portions

TABLE 6.2-1 (Cont)

Exposure Pathway and/or Sample	Number of Samples and Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
Ingestion (Cont)			
Food products	3 samples of broadleaf vegetables will be collected from available offsite locations of highest calculated site average D/Q for elevated release points. In addition, 3 samples will be collected from available offsite locations of highest calculated site average D/Q for ground-level release points.	Once during harvest season	Gamma isotopic analysis of edible portions (isotopic to include I-131)
	1 sample each of similar broadleaf vegetation grown 14.5-32.1 km (9-20 mi) distant in a less prevalent wind direction	Once during harvest season	Gamma isotopic analysis of edible portions (isotopic to include I-131)

6.3 HYDROLOGICAL

6.3.1 Preapplication and/or Preoperational Monitoring

Hydrologic measurements to determine the magnitude and direction of currents in the Nine Mile Point vicinity were made off the Nine Mile Point promontory in 1969, 1970, 1976, and 1977. The 1976 and 1977 studies were conducted after both Unit 1 and the James A. FitzPatrick (JAF) plant were operational. The scope of each study is summarized below; results are provided in Section 2.3.1.

Currents were measured continuously from May through October 1969 and from July through October 1970 at two fixed towers placed offshore from the Nine Mile Point site, one in 7 m (24 ft) of water and one in 14 m (46 ft) of water. Hourly current speed and direction were recorded simultaneously from three depths at each location, utilizing reduced-sized Savonius rotor meters. In addition, drifting drogues were released and tracked during the 1969 study. These studies have been reported by Gunwaldsen et al[1] and the Power Authority of the State of New York[2].

During 1976 and 1977, additional postoperational hydrothermal surveys were conducted for the JAF plant[3]. The focus of this study was on thermal plume mapping. Current speed and direction, lake temperature, and lake level were also monitored.

During the two June 1976 surveys, the current was monitored 3 m (10 ft) below the water surface at a fixed tower positioned approximately 610 m (2,000 ft) east and along the same depth contour (9 m [30 ft]) of the JAF plant discharge. During the two August 1976 and October 1976 surveys, currents were monitored at the 3-, 6-, and 9-m (10-, 20-, and 30-ft) depths at the same location.

The first 1977 survey was conducted on April 13 and 14. Three in situ current monitoring locations were established: one was the same as the 1976 location; the second was approximately 0.8 km (0.5 mi) directly offshore of the JAF plant; and the third was midway between the JAF plant and Unit 1 and 2 sites at the 9-m (30-ft) depth contour (Figure 6.6-1). Currents were monitored at the 4.5-m (15-ft) depth at all three locations during the 2-day April study. Subsequent 1977 surveys were conducted on June 14 with monitoring at the same location and depth. The last survey was conducted on November 2 with current monitoring at a 4.5-m (15-ft) depth at the original station east of the

JAF plant, and a second station located 0.8 km (0.5 mi) offshore of the JAF plant[3].

The results of all current measurement programs are summarized in Section 2.3.1.

6.3.2 Site Preparation and Construction Monitoring

Drainage of the site during construction is provided by two ditches and five storm water lines. One of the drainage ditches is located at the eastern edge of the site and the other at the western edge of the site, as shown on FSAR
1 Figure 2.4-1. The western ditch drains the majority of the site area, as well as conveying all discharges from the sanitary treatment plant to the lake. Flows in this ditch are measured on a weekly basis by a rectangular weir located at the discharge outlet. Suspended solids, pH, settleable solids, and oil and grease are also measured. Monitoring data are reported to the New York State Department of Environmental Conservation in accordance with State Pollutant Discharge Elimination System Permit requirements. The eastern drainage ditch and the storm water lines handle only runoff and, therefore, are not required to be monitored.

As discussed in FSAR Section 2.5.4, groundwater levels during construction are monitored by four piezometers located at the reactor building site. Only groundwater elevation data are collected at each piezometer approximately once every week. Monitoring by these piezometers will continue until the completion of construction.

6.3.3 Operational Monitoring

Station operation will not affect surface water flow or groundwater; therefore, no operational hydrological-monitoring programs are planned for these parameters. Sediment transport in Lake Ontario will not be altered; therefore, sediment transport monitoring is not required.

6.3.4 References

1. Gunwaldsen, R. W.; Brodfeld, B.; and Hecker, G. E. Current and Temperature Surveys in Lake Ontario for James A. FitzPatrick Nuclear Power Plant. Proc. 13th Conf. Great Lakes Res., 1970.

2. Power Authority of the State of New York. Environmental Report for James A. FitzPatrick Nuclear Power Plant. Prepared for United States Atomic Energy Commission, 1971.

3. Stone & Webster Engineering Corporation. Final Report - Postoperational Hydrothermal Surveys, June 1976-November 1977 for James A. FitzPatrick Nuclear Power Plant. Prepared for Power Authority of the State of New York, 1978.

6.4 METEOROLOGICAL MONITORING

The following sections provide summaries of meteorological information compiled in a detailed technical report prepared in support of the Unit 2 ER-OLS[1]. Where appropriate, references to related FSAR sections have been provided.

6.4.1 Preoperational Monitoring Program

The preoperational monitoring program is designed to establish a climatologically representative data base for assessing environmental impacts resulting from plant operation. The program provides meteorological data to be used in appropriate models to develop transport and diffusion estimates used in assessing routine and accidental releases of radioactive material to the atmosphere. The data are also used for cooling tower impact assessments and local climatological summaries.

The Nine Mile Point meteorological station is located approximately 2.0 km (1.2 mi) west-southwest of Unit 2 near the shore of Lake Ontario, as shown on Figure 6.4-1. The station has been in routine operation since January 1974. The meteorological tower is 61 m (200 ft) high and instrumented at three levels: 9 m (30 ft), 30 m (100 ft), and 61 m (200 ft). Wind speed and direction are measured at all three levels. Ambient air temperature, difference temperatures, and atmospheric moisture are also measured. In addition to these measurements, barometric pressure and precipitation are recorded at appropriate locations near the base of the tower.

Instrumentation for digital and analog recording systems is located in a temperature-controlled instrument shelter approximately 23 m (75 ft) from the base of the tower.

A detailed description of the preoperational monitoring program, including instrument siting, sensor performance specifications, and data acquisition and reduction systems, appears in FSAR Section 2.3.3.

6.4.2 Operational Monitoring Program

The operational meteorological monitoring program is designed to provide a complete climatology of the site area. The operational monitoring instrumentation is in accordance with NUREG-0654, and the system accuracy meets the requirements of Regulatory Guide 1.23. The main components of the system are a central processor, meteorological sensors at three locations, and equipment for displaying

pertinent parameters. A complete description of the system is given in FSAR Section 2.3.3.

6.4.3 Reference

1. Meteorological and Radiological Technical Report in Support of the Nine Mile Point - Unit 2 Environmental Report - Operating License Stage. Prepared for Niagara Mohawk Power Corporation by Meteorological Evaluation Services, Inc. July 1982.

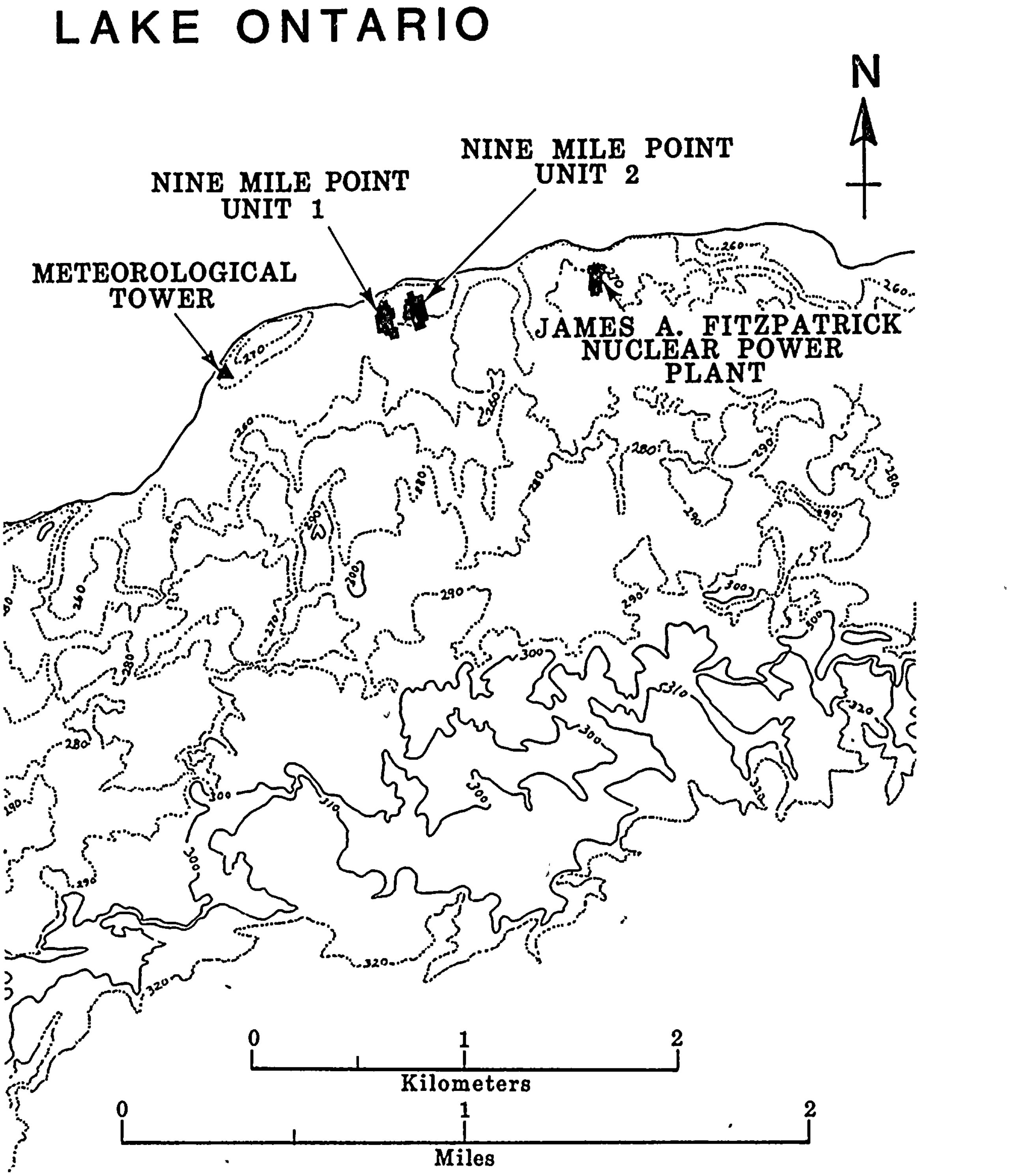

FIGURE 6.4-1

LOCATION OF METEOROLOGICAL TOWER

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS

6.5 BIOLOGICAL

6.5.1 Terrestrial Ecology

Baseline terrestrial ecology studies were described in the Unit 2 ER-CPS.

A supplemental baseline ecological study was designed to update available information on the existing terrestrial ecosystem, to document construction impacts, and to help predict the potential effects of plant operation. The study consisted of a literature survey, aerial photography of the site, and an onsite field study. Study results are provided in Section 2.4.1.

Stereoscopic false-color infrared and true-color aerial photographs were taken of the land area within a 1.6-km (1-mi) radius of Unit 2 in August 1979. These photographs were used to develop site descriptions, including a preliminary vegetative cover type map, and to delineate areas of stress. The photographs and the preliminary cover type map were then used to set up the field study.

The terrestrial field study was conducted over a period of 7 days in September 1979. Vegetation cover type designations that were previously determined from photogrammetric analysis were verified. Qualitative and quantitative information were obtained for forested vegetation types by sampling selected forest communities. A list of commonly occurring understory and ground-cover species was compiled for each sampled forest community. Lists of commonly occurring species for old field shrub, agricultural, or pasture vegetation types that were greater than 4.0 ha (10 acres) were also compiled.

Forest communities sampled were those greater than 4.0 ha (10 acres) in size and with dominant species averaging greater than 10 cm (4 in) diameter at breast height (DBH). The standard point quarter technique was used along transects in the representative vegetative communities (Figure 6.5-1). Measurements were taken on the nearest tree in each of four quadrants at sample points located 30 m (98 ft) apart along these transects. Quantitative information obtained from this sampling effort included density, frequency, dominance, relative density, relative frequency, relative dominance, and importance values for overstory species[1].

Wildlife was identified during the vegetation survey using direct observations and enumeration, and by examination of tracks, road kills, and scat. Small mammals were also qualitatively sampled using double transects (Figure 6.5-1), totaling 24 Sherman live traps placed in four of the major vegetation types (early second growth forest [T-1], mixed hardwood forest [T-3], transmission line [T-4], and open field [T-5]). Traps were baited with peanut butter and oatmeal, checked once each day during the early morning hours, and maintained for 5 trap nights.

Literature sources surveyed in support of the descriptive ecology section included scientific journal articles and standard field guides and references. State and federal biologists and local specialists were contacted to obtain available data.

During the first 2 yr of operation, an infrared aerial photography program, similar to the supplemental baseline study, will be performed to assess vegetative stress due to salt drift accumulation or diseases of unknown origin. Further details of this operational monitoring program will be included in the Environmental Protection Plan (EPP).

6.5.2 Aquatic Ecology - Monitoring Program

6.5.2.1 Preapplication and/or Preoperational Monitoring

The data base of the preoperational monitoring program at Unit 2 was developed principally from studies of the Nine Mile Point vicinity conducted by Lawler, Matusky, & Skelly Engineers (LMS) from 1972 through 1977[2-5] and by Texas Instruments, Inc. (TI) during 1977 through 1981[6-9]. Other studies in the immediate vicinity of the study area have been conducted by the Lake Ontario Environmental Laboratory (LOTEL)[10], McNaught and Fenlon[11], McNaught and Buzzard[12], and Storr[13].

6.5.2.1.1 Objectives

The objective of the aquatic ecology monitoring programs for Unit 2 was to determine the taxonomic composition of the biota and characterize the temporal/spatial abundance and distribution of major groups and selected species in the Nine Mile Point vicinity of Lake Ontario. The biotic groups studied included phytoplankton, microzooplankton, macrozooplankton, ichthyoplankton, benthic invertebrates, periphyton, and nekton (fish).

Other variables were monitored for some biota to obtain additional information on the ecology of the area. For example, primary productivity, chlorophyll a and phaeopigments, and biovolume were measured as part of the phytoplankton study; length-frequency or developmental stage was determined for ichthyoplankton; and data on reproduction, age, growth, and food habits were obtained for fish. Supporting data (e.g., water temperature, light intensity, sediment characteristics) were obtained as necessary to aid in interpretation of the biological data.

Finally, entrainment and impingement studies conducted at Nine Mile Point Unit 1 (Unit 1) and the James A. FitzPatrick (JAF) plant provided information necessary to estimate intake effects for Unit 2.

6.5.2.1.2 Descriptions and Methodologies

6.5.2.1.2.1 Phytoplankton Field Methods

Lake Studies

Details of the field procedures used to collect phytoplankton in the Nine Mile Point vicinity of Lake Ontario in 1973 through 1978 are provided in LMS 1980[14]. A summary of the program is presented in the following paragraphs.

Phytoplankton samples were collected in the Nine Mile Point vicinity along four transects (NMPE, NMPP, NMPW, and FITZ) approximately 4.0 km (2.5 mi) along the lake shore at four depth contours (3, 6, 12, and 18 m [10, 20, 40, and 60 ft]), as depicted on Figure 6.5-2. These sampling locations, established in 1973, were used throughout the program without further modification.

The frequency of sample collection varied from 2- to 4-week intervals, depending on year and season[14]. Whole water samples collected using plastic water samplers were processed in the field and returned to the laboratory for analysis. Between 1973 and 1975, in addition to the regular lake phytoplankton program, samples were collected as part of the windrow phytoplankton program. A complete description of the windrow phytoplankton program is found in the LMS yearly reports[2-4].

Entrainment Studies

A summary of the field procedures used in the phytoplankton entrainment programs at Unit 1 and the JAF plant is provided in LMS 1980[14]. Details of these programs are found in the LMS[2-5] and TI[6-8] yearly reports.

The phytoplankton entrainment programs generally consisted of sample collections at the intake and discharge to determine cross-plant effects on standing stock (as abundance and/or chlorophyll a) and primary productivity. The 1976 through 1979 program at the JAF plant included studies of plume entrainment, which involved either collection of samples at the +1.7°C (+3°F) and +1.1°C (+2°F) zones in the lake or simulation of plume entrainment when inclement weather prevented lake collections. Simulations of plume entrainment were achieved by mixing discharge samples with filtered intake water at rates that approximated temperature decay to the +1.7°C (+3°F) and +1.1°C (+2°F) levels in the lake.

6.5.2.1.2.2 Phytoplankton Laboratory Methods

Identification and Enumeration

To facilitate analysis, the preserved whole water samples were concentrated by allowing the phytoplankton to settle. The phytoplankton present in two subsamples were then enumerated and identified to the lowest possible taxonomic level.

Phytoplankton abundance was calculated using equations described in the LMS annual reports[4,5]. Biovolume was estimated by calculating an average cell volume for individuals of a species[15].

Photosynthetic Pigments

Samples for pigment analysis were filtered onto either 0.45 um membrane filters (1973) or glass fiber filters (1974 through 1978) with subsequent extraction in acetone. Spectrophotometric measurements of the extract were made on either a Spectronic 20 or a Beckman Model 26 spectrophotometer. Phaeopigment concentrations were obtained by acidifying the acetone extract with dilute HCl and determining the absorbance at 663 nm. Chlorophyll a and phaeopigments were calculated according to the methods described by Golterman[16].

Primary Production

The ^{14}C labeled samples were analyzed according to the Millipore filtration-liquid scintillation technique, similar to one described by Vollenweider[17].

After correction for background radiation, ^{14}C-uptake/unit volume/unit time was calculated for light and dark bottles. Primary production (generally considered to approximate net production using the ^{14}C-uptake method) was calculated by subtracting ^{14}C-uptake in the dark bottle from the mean of ^{14}C-uptake in the light bottle.

From 1974 through 1976, total inorganic carbon was determined by titration according to the method described by Golterman[16]. During 1977 and 1978, alkalinity was measured[18] and available inorganic carbon was calculated from these measurements.

6.5.2.1.2.3 Microzooplankton Field Methods

Lake Studies

Details of the field and laboratory procedures used to study microzooplankton in the Nine Mile Point vicinity from 1973 through 1978 are provided in LMS 1980[14]. Additional descriptions of the program are found in the annual reports prepared by LMS[2-5] and TI[6,7].

Microzooplankton samples were collected in the Nine Mile Point vicinity along four transects (NMPW, NMPP, FITZ, and NMPE) encompassing approximately 4.0 km (2.5 mi) at four depth contours (3, 6, 12, and 18-m [10, 20, 40, and 60 ft]), as depicted on Figure 6.5-2. The same sampling locations were used throughout the program without modification. The frequency with which samples were collected varied from 2 to 4 weeks, depending on year and season[14]. All surveys were conducted during the day. Samples were collected with 76 um mesh nets towed vertically or obliquely through the water column. Either a Wisconsin-type net or Clarke-Bumpus quantitative plankton sampler was used, both with mouth diameters of approximately 12 cm (5 in)[14].

Entrainment Studies

The microzooplankton entrainment program at Unit 1 and the JAF plant generally consisted of collecting samples from the intake forebay, discharge bay, and sometimes (1976 through 1979) the discharge areas in the lake, and analyzing them

for viability and/or abundance and species composition[14]. As in the lake, microzooplankton were collected on a 76 um mesh for all years of study. Collection techniques were designed to minimize collection-induced mortality.

6.5.2.1.2.4 Microzooplankton Laboratory Methods

The following procedure was used for analyses of enumeration and taxonomy. A 1-ml (0.3-oz) aliquot of a measured, well-mixed sample was pipetted into a Sedgwick-Rafter cell, and all organisms in a specified number of horizontal strips the length of the cell were counted and identified. For identification and enumeration of microzooplankton in entrainment samples, dead organisms in unpreserved samples were counted and identified immediately after collection or incubation. These numbers were then compared with the total count after preservation to determine the plant-induced mortality[5-7].

6.5.2.1.2.5 Macrozooplankton Field Methods

Lake Studies

Macrozooplankton sampling was conducted at the same 15 stations in the Nine Mile Point vicinity from 1973 through 1978[14]. The stations were located at the 6- and 12-m (20- and 40-ft) depth contours east and west of the Unit 1 plant and at the 18-, 24-, and 30-m (60-, 80-, and 100-ft) depth contours directly offshore. The stations were arranged to permit samples to be obtained within concentric arcs 4.8, 1.6, and 0.8 km (3,1, and 0.5 mi) from the plant (Figure 6.5-2).

Samples were collected weekly from April through December. Samples were collected with a 1.0-m (3.3-ft) mouth diameter Hensen-type plankton net of 571 um mesh from just below the surface, at mid-depth, and near the bottom. A single TSK flowmeter was mounted in the net mouth to permit the volume of water sampled to be calculated.

Entrainment Studies

Macrozooplankton entrainment studies were conducted from 1973 through 1976 at Unit 1 and from 1975 through 1979 at the JAF plant. Details were presented by LMS[2-5] and TI[6,7].

The basic program at Unit 1 consisted of sample collection at the intake and discharge to determine organism density

and viability at both locations[14]. The study at the JAF plant was similar to that at Unit 1; however, density measurements were obtained only at the intake, and viability analyses were limited to a dominant organism, the amphipod Gammarus. In addition to investigation of plant entrainment effects on viability, laboratory simulations of plume entrainment were conducted and samples in the discharge plume were obtained to investigate the effects of plume entrainment on Gammarus viability[14].

Samples were collected with 0.5-m (1.6-ft) mouth diameter conical plankton nets of 571 um mesh or a 0.05-cu m^3/s (13-gal) centrifugal water pump with a 571 um mesh screen (net). A single TSK or digital flowmeter was used to monitor flow through the plankton nets, and the pump had been calibrated prior to use to determine volume sampled per unit time.

Plume entrainment was simulated by adding filtered discharge water (at discharge temperature) to intake collections and then ambient temperature intake water at rates that approximated temperature decay in the plume (to +1.1°C and 1.7°C [+2°F and +3°F]). Temperature decay (to 1.1°C [+2°F]) was also simulated for all discharge samples collected after June 1976.

6.5.2.1.2.6 Macrozooplankton Laboratory Methods

After fish larvae and eggs were sorted and removed from the ichthyoplankton samples, macrozooplankton from the same samples were counted and identified. Details were presented by LMS[2-5] and TI[6,7]. Several subsampling schemes were used, with the choice dependent on organism density. Viability from the entrainment samples was estimated on the basis of motility; samples were examined as soon as possible following collection. Analyses to determine entrainment macrozooplankton density were as described for lake samples.

6.5.2.1.2.7 Benthos Field Methods

The 1973 through 1978 surveys are summarized in LMS 1980[14] with additional details in the annual reports[2-7]. Benthic macroinvertebrate samples were collected along four transects perpendicular to the shoreline (Figure 6.5-3). From 1973 through 1975, when Cladophora beds were present, samples were collected in non-Cladophora and Cladophora areas, if possible, at the 3-m (10-ft) depth contours.

Benthos samples were collected with a diver-operated pump. A metal ring was used to define the bounds of the sampling area at each station.

Sediment analyses were carried out as part of the 1973 through 1976 benthos studies. These involved visual analyses by divers and various chemical and physical analyses over the 4-yr period[14].

6.5.2.1.2.8 Benthos Laboratory Methods

Analysis preparation involved sieving, to separate organisms and sediment, followed by preservation (70 percent ethanol) of the material on the sieve. A 420 um sieve was used from 1973 through 1976; a 500 um sieve was employed during 1977 and 1978. A stain, Phloxine-B, was added to the preservative from 1973 through 1976 to aid in organism recognition[19].

Organisms were identified to the lowest feasible taxonomic level using a dissecting microscope or, for diptera larvae and oligochaetes, slide mounts and a light microscope.

Biomass estimates were based on wet weight, measured on a Mettler balance after washing and removal of interstitial water by blotting or by drying 30 min over desiccant.

6.5.2.1.2.9 Periphyton Field Methods

Bottom Periphyton

Bottom periphyton studies were carried out in the Nine Mile Point vicinity from 1973 through 1978. Four transects (NMPW, NMPP, FITZ, and NMPE) were established perpendicular to the shoreline in the vicinity of Unit 1 (Figure 6.5-3). Sampling locations were established at the 2-, 3-, 6-, 10-, and 12-m (7-, 10-, 20-, 33-, and 40-ft) depth contours.

The duration of these studies varied among years, but generally samples representative of spring, summer, and fall conditions were obtained. Exposure periods also varied among years; 4-week exposures were common to 1975 through 1978 programs and were used for some months during ealier years.

In 1973, glass slides were used as the substrates. The artificial substrates used from 1974 through 1978 were doubled Plexiglas plates. On each collection date, scuba divers collected the exposed substrates and replaced them

with cleaned plates. Exposed substrates were returned to the laboratory for analysis preparation.

Buoy Periphyton

Buoy periphyton studies were conducted from 1973 through 1978. Three stations were used for buoy periphyton collections: NMPE, NMPP, and NMPW (Figure 6.5-3). Samples were collected from the 1-, 2-, 4-, and 5-m (3-, 7-, 13-, and 16-ft) depths[14]. The same sampling locations were used from 1973 through 1976. In 1977 and 1978, the transects used were NMPW, NMPP, and FITZ (Figure 6.5-3).

In 1973, glass slides and Styrofoam blocks were used as the substrates. From 1974 through 1978, doubled Plexiglas plates were used. On each collection date, scuba divers retrieved the exposed substrates and replaced them with clean ones. Exposed substrates were returned to the laboratory for analysis.

6.5.2.1.2.10 Periphyton Laboratory Methods

Methods of periphyton analysis were essentially the same for bottom and buoy collections and were basically similar among the years of study. Details were presented in annual reports prepared by LMS[2-5] and TI[6,7].

Taxonomy and Abundance

Material was scraped from glass slides or sections of Plexiglas plates, agitated to break up algal films and clumps, and preserved in 5 percent formalin. Basically, the same procedure was followed for Styrofoam substrates, except that the surfaces of the blocks were sliced off and homogenized in a blender at low speed to separate the substrate from sample material.

A Palmer-Maloney and/or Sedgwick Rafter counting chamber and light microscope were used for analyses. Counts were expressed as clumps, algal cells, and organisms (for zooperiphyton) per square decimeter or centimeter. Taxonomic identifications were to the lowest feasible level.

Biomass

Biomass determinations used either entire glass slides or scrapings from sections of Plexiglas plates. In both cases, samples were dried in a hot air oven, cooled, weighed, ashed in a muffle furnace, cooled, and reweighed. Dry weight, ash

weight, and ash-free dry weight were computed as appropriate for the two drying techniques[14].

Chlorophyll a

The trichromatic method was used for chlorophyll a analyses during 1973 through 1975[20].

6.5.2.1.2.11 Ichthyoplankton Field Methods

Lake Studies

Ichthyoplankton samples were collected at the same stations in the Nine Mile Point vicinity from 1973 through 1978. The stations were located at the 6- and 12-m (20- and 40-ft) depth contours east and west of Unit 1 and at the 18-, 24-, and 30-m (60-, 80-, and 100-ft) depth contours directly offshore from the plant.

Samples were collected weekly at all stations from April through December during all years of study. The samples were collected with a 1.0-m (3.3-ft) mouth diameter Hensen-type plankton net of 571 um mesh from just below the surface, at mid-depth, and near the bottom. A single TSK flowmeter was mounted in the net mouth to permit the volume of water sampled to be computed.

Entrainment Studies

Ichthyoplankton entrainment studies were conducted from 1973 through 1978 at Unit 1 and from 1975 through 1979 at the JAF plant. Details were presented by LMS[2-5] and TI[6-8].

The basic program at Unit 1 consisted of sample collection at the intake and discharge to determine organism density at these locations and changes in viability after plant entrainment. Samples were collected at least twice per month during the day and at night. Discharge collections were omitted after 1974.

The entrainment study at the JAF plant was similar to that at Unit 1[14]. In addition to investigating organism density and plant entrainment effects on viability, laboratory simulations of plume entrainment were conducted and samples from the discharge plume were obtained to investigate the effects of plume entrainment on ichthyoplankton viability.

Samples were collected with 0.5-m (1.6-ft) mouth diameter conical plankton nets of 571 um mesh or a 0.05-cu m/s (13-gal/s) centrifugal water pump with a 571 um mesh screen (net). A single TSK flowmeter was used to monitor flow through the plankton nets, or the pump calibrated prior to use to determine volume sampled per unit time.

Plume entrainment was simulated by adding filtered discharge water (at discharge temperature) to intake collections and then ambient temperature intake water at rates approximating temperature decay in the plume (to +1.1°C and +1.7°C [+2°F and +3°F]). Temperature decay (to +1.1°C [+2°F]) was also simulated for all discharge samples collected after June 1976.

6.5.2.1.2.12 Ichthyoplankton Laboratory Methods

Lake Studies

After sorting and transfer to 70 percent alcohol, ichthyoplankton were counted, identified, and measured for total length. Details of analysis were presented by LMS[2-5] and TI[6-8]. Viability observations on entrainment collections were estimated on the basis of motility; samples were examined as soon as possible following collection. Methods and procedures for identification by species and life stage, enumeration, and length measurements were as for lake studies.

6.5.2.1.2.13 Fish Field Methods

Lake Studies

Early in the design-construction phase of Unit 1, Dr. J. F. Storr assessed Lake Ontario fish populations near the Nine Mile Point area. Abundance and distribution of fish stocks were determined by fathometric surveys and by gill net collections[21-35]. Additional studies were conducted to determine the food preferences of yellow perch[36,37] and other fish[38-43].

LMS (QLM prior to 1975) conducted additional studies on the distribution and abundance of fish in the Nine Mile Point area from 1972 to 1977[2-5,44,45]. TI conducted studies from 1977 to 1981[6-9]. Fish populations were sampled periodically by surface and bottom trawling; surface, bottom, and mid-depth gill netting; and beach seining. Anatomical and meristic data from these fish were used to determine population characteristics, i.e., length-weight

relationship, condition factors, length-frequency distributions, coefficients of maturity, and sex ratios for selected species.

The gear used to sample fish in the vicinity of Nine Mile Point from 1972 through 1981 and the dimensions for each gear type are provided in the annual reports prepared by LMS[2-5] and TI[6-9]. Trawl runs (Otter and Yankee) and gill net sets were made parallel to shore along the selected depth contour. Trap nets were set at sunset and retrieved shortly after sunrise on each sampling date.

Table 6.5-1 summarizes the sampling schedule, and includes sampling location and frequency for the period from 1972 through 1981. The basic program was to sample fishes with a variety of gear from four transects distributed around Unit 1 and the JAF plant. Figure 6.5-4 gives the transects sampled from 1972 through 1981. Special sampling was conducted during a number of years. From 1973 through 1978, special gill net sampling was employed to obtain specimens for food habit studies[14]. In 1975, a special seine sampling program was conducted at 10 sites from April through December. Two sites were located at the end of transect NMPW, and eight sites were distributed along the shore east of Nine Mile Point to the mouth of the Salmon River[14]. The purpose of this program was to collect as large a number and variety of species as possible, particularly young-of-the-year.

From 1972 through 1978, fishes were sampled intensively, with few changes in the program from year to year. The reduced sampling program after 1978 reflects changes in the Unit 1 and the JAF plant technical specifications.

<u>Impingement Studies</u>

Impinged fishes were sampled at Unit 1 from 1973 through 1981 and at the JAF plant from September 1975 through 1981. The gear used to collect fish and the sampling frequency are summarized in LMS 1980[14]. Before each 24-hr sampling period, the bar racks and traveling screens were cleaned to remove accumulated fish so that each collection represented exactly 24 hr of impingement.

All fish were identified to the species level and enumerated at the collection site except when the traveling screens were continuously washed because of large <u>Cladophora</u> accumulations or large numbers of impinged fish[14].

In most cases, the collections were made from all three traveling screens. However, if one or two of the screens were not in operation, the numbers of fish collected were extrapolated, assuming uniform impingement among screens. Similarly, during the continuous wash sampling program when subsampling was necessary, the numbers of fish impinged were extrapolated according to the hourly rate. These adjustments are incorporated into the estimates of the total annual number impinged.

6.5.2.1.2.14 Fish Laboratory Methods

Fish were identified to the species level and enumerated where possible. Total length and weight were determined for all individuals (up to 40) per net catch. From 1972 through 1976, the sex and gonadal development of each fish (up to 40 individuals for abundant species) were determined, while in 1977 and 1978 these characteristics were determined for only three key species (white perch, yellow perch, and smallmouth bass).

For fish collected in 1972, condition factor ($K = W \times 10^5/L^3$, where W = weight in grams, L = length in millimeters) and coefficient of maturity were determined for all species collected in substantial abundance. The studies were expanded from 1973 through 1976 to include age and growth, fecundity, coefficient of maturity, and food habits of five important species: alewife (Alosa pseudoharengus), rainbow smelt (Osmerus mordax), white perch (Morone americana), yellow perch (Perca flavescens), and smallmouth bass (Micropterus dolomieui). In 1977 and 1978, these same studies were conducted for white perch and smallmouth bass only. In addition, fecundity was determined for alewife and rainbow smelt in 1977. The techniques used for these studies are discussed in LMS 1980[14].

6.5.2.1.3 Data Analysis Procedures and Statistical Methods

Data analysis procedures included some methodologies conducted in the field or laboratory in conjunction with routine data accumulation. Those procedures are explained in individual sections earlier in this chapter.

Data for each biotic group and for water quality were presented in the annual reports in either graphic or tabular form but do not necessarily represent all the data analyzed. When a single year or event was representative of several, a representative unit may be shown and reference made to the total data set. The taxonomic level for data interpretation

varied with sampling program (e.g., fish at species level, phytoplankton at class level).

Data were compared within and between sampling programs wherever such comparisons were biologically meaningful; parameters monitored in the water quality program were also discussed in relation to biotic groups where appropriate.

Various statistical tests were conducted, using both original and replicate samples wherever possible, to increase the sensitivity of the test and to determine levels of significance for spatial/temporal distribution patterns.

The statistical tests used are described and referenced in detail in the annual reports[2-9]. The tests used included Bartlett's test for homogeneity of variance, T-tests, paired T-tests, least significant differece test, analysis of variance, analysis of covariance, Student-Newman-Keuls procedure, and simple linear regression.

Specific tests were chosen after each individual data base was reviewed to ensure correct application of the statistic being used. For example, to analyze the impingement data collected in 1975, parametric techniques, following the method of Steel and Torrie[46] and Sokal and Rohlf[47], were used because of the large sample sizes and the high sensitivity of the tests. The analysis of variance and the correlation analysis techniques were used whenever their application was meaningful; an $\alpha = 0.05$ was chosen for the significance level for all correlations. Statistical techniques for stratified sampling and the optimum allocation procedures were applied to the impingement data analyzed.

To facilitate handling the extensive data base, cluster analyses were used where applicable[48]. Two measures of association have been used with Nine Mile Point data: Gower's similarity coefficient[49] for quantitative data and the Per Cent Similarity (PS) measure given by Haedrich[50].

The clustering strategy chosen was the group average, also known as the unweighted pair-group average[49]. This strategy has proved generally satisfactory in many ecological studies, and, since it gives only moderately sharp clustering (i.e., it is a relatively conservative strategy), it has the advantage of being relatively immune to misclassification and is generally not group-size dependent[51].

6.5.2.2 Operational Monitoring of Aquatic Ecology

Present aquatic ecology studies at the Nine Mile Point site fulfill the requirements of the Environmental Technical Specifications of the Unit 1 and JAF power plants, as well as programs specified in the State Pollutant Discharge Elimination System (SPDES) permits for these facilities. Unit 2 operational aquatic ecology studies will comply with the requirements of the Unit 2 SPDES permit and the NRC Environmental Protection Plan.

6.5.3 References

1. Cox, G. W. Laboratory Manual of General Ecology. William C. Brown Co. Publishers, Dubuque, IA, 1972.

2. Quirk, Lawler & Matusky Engineers. 1973 Nine Mile Point Aquatic Ecology Studies. Prepared for Niagara Mohawk Power Corporation and Power Authority of the State of New York, 1974.

3. Lawler, Matusky & Skelly Engineers. 1974 Nine Mile Point Aquatic Ecology Studies. Prepared for Niagara Mohawk Power Corporation and Power Authority of the State of New York, 1975.

4. Lawler, Matusky & Skelly Engineers. 1975 Nine Mile Point Aquatic Ecology Studies. Prepared for Niagara Mohawk Power Corporation and Power Authority of the State of New York, 1976.

5. Lawler, Matusky & Skelly Engineers. 1976 Nine Mile Point Aquatic Ecology Studies. 2 Vol. Prepared for Niagara Mohawk Power Corporation and Power Authority of the State of New York, 1977.

6. Texas Instruments, Inc. 1977 Nine Mile Point Aquatic Ecology Studies. Prepared for Niagara Mohawk Power Corporation and Power Authority of the State of New York, 1978.

7. Texas Instruments, Inc. 1978 Nine Mile Point Aquatic Ecology Studies. Prepared for Niagara Mohawk Power Corporation and Power Authority of the State of New York, 1979.

8. Texas Instrument, Inc. 1979 Nine Mile Point Aquatic Ecology Studies. Prepared for Niagara Mohawk Power Corporation and Power Authority of the State of New York, 1980.

9. Texas Instruments, Inc. 1980 Nine Mile Point Aquatic Ecology Studies. Prepared for Niagara Mohawk Power Corporation and Power Authority of the State of New York, 1981.

10. Rochester Gas and Electric. The Sterling Power Project. Rochester, NY, August 1973, Revised January 1974.

11. McNaught, D. C. and Fenlon, M. The Effects of Thermal Effluents Upon Secondary Production. Verh. Int. Verein. Limnol. 18:204-212, 1972.

12. McNaught, D. C. and Buzzard, M. Changes in Zooplankton Populations in Lake Ontario (1939-1972). Proc. 16th Conf. Great Lakes Res., 19736.

13. Storr, J. Aquatic Environmental Studies 1968-1972. Nine Mile Point Nuclear Station Unit 1. Prepared for Niagara Mohawk Power Corporation, 1973.

14. Lawler, Matusky & Skelly Engineers. Nine Mile Point Aquatic Ecology Study Summary (1973-1981). Prepared for Niagara Mohawk Power Corporation, 1982. 8

15. Findenegg, I. Expressions of Populations, p 16-17. In R. A. Vollenweider (ed.), A Manual on Methods for Measuring Primary Production in Aquatic Environments. IBP Handbook No. 12. Blackwell Scientific Publications, London, 1969.

16. Golterman, H. T. Methods for Chemical Analysis of Freshwaters. IPB Handbook No. 8, International Biological Programme. Blackwell Scientific Publications, Oxford, 1971.

17. Vollenweider, R. A. (ed.); et al. A Manual on Methods for Measuring Primary Production in Aquatic Environments. IBP Handbook No. 12. Blackwell Scientific Publications, Oxford, 1974.

18. American Public Health Association [APHA]. Standard Method for the Examination of Water and Wastewater. 14th ed. Amer. Public Health Assoc., Amer. Water Works Assoc., and Water Poll. Cont. Fed., Washington, DC, 1976

19. Mason, W. T., Jr. and Yevich, P. P. The Use of Phloxine B and Rose Bengal Stains to Facilitate Sorting Benthic Samples. Trans. Am. Microsc. Soc. 86(2):221-223, 1967.

20. American Public Health Association. Standard Method for the Examination of Water and Wastewater. 13th ed. M. J. Taras (chm. of eds.). American Public Health Assoc., Washington, DC, 1971.

21. Storr, J. F. Letter to R. Clancy, Niagara Mohawk Power Corporation. Fish Net Catch Report from Nine Mile Point, August 12-15, 1969. September 2, 1969.

22. Storr, J. F. Letter to R. Clancy, Niagara Mohawk Power Corporation. Fish Distribution Study, Nine Mile Point, July 27, 1968. December 15, 1969.

23. Storr, J. F. Letter to R. Clancy, Niagara Mohawk Power Corporation. Fish Distribution Studies Using Fathometric Tracing Records Nine Mile Point, Summer 1969.

24. Storr, J. F. Letter to R. Clancy, Niagara Mohawk Power Corp. Fish net catch report for Nine Mile Point. October 7-10, 1969. May 22, 1970.

25. Storr, J. F. Letter to R. Clancy, Niagara Mohawk Power Corporation. Fish Net Studies Off Nine Mile Point, May 26-29, 1970. July 14, 1970.

26. Storr, J. F. Letter to R. Clancy, Niagara Mohawk Power Corporation. Fish Net Studies Off Nine Mile Point, July 8-11, 1970. August 13, 1970.

27. Storr, J. F. Letter to R. Clancy, Niagara Mohawk Power Corporation. Fish Net Study Off Nine Mile Point, August 19-22, 1970. September 4, 1970.

28. Storr, J. F. Letter to R. Clancy, Niagara Mohawk Power Corporation. Fish Net Study Off Nine Mile Point, October 21-24, 1970. November 30, 1970.

29. Storr, J. F. Letter to R. Clancy, Niagara Mohawk Power Corporation. Fish Distribution Studies of Four Periods in 1970. February 17, 1971.

30. Storr, J. F. Letter to R. Clancy, Niagara Mohawk Power Corporation. Fish Net Study, Nine Mile Point, June 1-2, 1971. July 9, 1971.

31. Storr, J. F. Letter to R. Clancy, Niagara Mohawk Power Corporation. Fish Net Catch Study, Nine Mile Point, June 29-July 2, 1971. August 30, 1971.

32. Storr, J. F. Letter to R. Clancy, Niagara Mohawk Power Corporation. Fish Distribution Study-Nine Mile Point, June 1-12, 1971. October 7, 1971.

33. Storr, J. F. Letter to R. Clancy, Niagara Mohawk Power Corporation. Fish Net Catch Study, Nine Mile Point, August 17-20, 1971. October 19, 1971.

34. Storr, J. F. Letter to R. Clancy, Niagara Mohawk Power Corporation. Fish Distribution Study, Nine Mile Point, August 17-19, 1971. January 3, 1972.

35. Storr, J. F. Letter to R. Clancy, Niagara Mohawk Power Corporation. Fish Distribution Study, Nine Mile Point, November 1-2 and 5, 1971. January 12, 1972.

36. Storr, J. F. Letter to R. Clancy, Niagara Mohawk Power Corporation. Fish Food Preference Study, Nine Mile Point, November 2, 4-6, 1971. January 17, 1972.

37. Storr, J. F. Letter to R. Clancy, Niagara Mohawk Power Corporation. Analysis of Fish Food Preference of Yellow Perch (*Perca flavescens*) Collected at Nine Mile Point, May 26-29, 1970. July 29, 1970.

38. Storr, J. F. Letter to R. Clancy, Niagara Mohawk Power Corporation. Analysis of Food Preference of Yellow Perch (*Perca flavescens*) Collected at Nine Mile Point, July 8-11, 1970. July 31, 1970.

39. Storr, J. F. Letter to R. Clancy, Niagara Mohawk Power Corporation. Fish Food Preference, August 19, 1970. December 4, 1970.

40. Storr, J. F. Letter to R. Clancy, Niagara Mohawk Power Corporation. Fish Food Preference, October 21, 1970. December 4, 1970.

41. Storr, J. F. Letter to R. Clancy, Niagara Mohawk Power Corporation. Fish Food Preference Study, Nine Mile Point, June 1-2, 11-12, 1971. July 7,1971.

42. Storr, J. F. Letter to R. Clancy, Niagara Mohawk Power Corporation. Fish Food Preference Study, Nine Mile Point, June 29-July 2, 1971. August 30, 1971.

43. Storr, J. F. Letter to R. Clancy, Niagara Mohawk Power Corporation. Fish Food Preference Study, Nine Mile Point, August 17-20, 1971. January 30, 1972.

44. Quirk, Lawler & Matusky Engineers. Effects of Circulating Water Systems on Lake Ontario Water Temperature and Aquatic Biology. Prepared for Niagara Mohawk Power Corporation. Nine Mile Point Nuclear Power Station, 1973.

45. Quirk, Lawler & Matusky Engineers. Effect of Circulating Water Systems on Lake Ontario Water Temperature and Aquatic Biology. Vol. IV Appendix D, 1972 Ecological Investigations of Lake Ontario. Prepared for Niagara Mohawk Power Corporation, 1973.

46. Steel, R. G. D. and Torrie, J. H. Principles and Procedures of Statistics. McGraw-Hill Book Co., Inc., New York, 1960.

47. Sokal, R. R. and Rohlf, F. J. Biometry. W. H. Freeman and Co., San Francisco, CA, 1969.

48. Stephenson, W.; Cook, S. D.; and Williams, W. T. Computer Analyses of Petersen's Original Data on Bottom Communities. Ecol. Monogr. 42(4):387-408, 1972.

49. Sneath, P. H. A. and Sokal, R. R. 1973. Numerical taxonomy: The Principles and Practice of Numerical Classification. W. H. Freeman and Co., San Francisco, CA., 1973.

50. Haedrich, R. L. Diversity and Overlap as Measures of Environmental Quality. Water Res. 9:945-952, 1975.

51. Clifford, H. T. and Stephenson, W. Introduction to Numerical Classification. Academic Press, New York, 1975.

TABLE 6.5-1

SUMMARY OF FIELD MATERIALS AND METHODS FOR FISH COLLECTIONS
NINE MILE POINT VICINITY - 1972-1981

Year	Gear	Frequency	Transect	Depth Contour m (ft)	Sample Depth	Comments
1972	Otter trawl	Monthly (D&N) Apr, Oct	NMPW, NMPP	6, 12, (20, 40)	Surface and bottom	Floats were attached to trawl for surface sampling. Bottom trawls were made with net slightly above bottom to avoid net fouling.
	Gill net	Monthly (D) Sept, Oct	NMPW, NMPP	5, 9, 12, (15, 30, 40)	Mid-depth at 5 m (15 ft); surface and bottom at 10 and 12 m (30 and 40 ft)	
	Beach seine	Monthly (D) Sept	-	-	Shoreline to 2.5 m (8 ft)	
1973	Otter trawl	Monthly (D&N) Mar-May, Dec	NMPW, NMPP, NMPE	6, 12, 18 (20, 40, 60)	Surface and bottom	Trawling at NMPP crossed the FITZ transect eliminating the need for trawling at the FITZ transect (comments for 1972 apply)
	Gill net	Semimonthly (D&N) June-Dec	NMPW, NMPP, FITZ, NMPE	5, 9, 12, 18 (15, 30, 40, 60)	Bottom at 5 m (15 ft); surface and bottom at 10, 12, and 20 m (30, 40, and 60 ft)	Nets set for 48 hr and harvested every 12 hr at dawn and dusk approximately
	Beach seine	Semimonthly (D) June-Nov	NMPW, NMPP, FITZ, NMPE	-	Shoreline to 2.5 m (8 ft) at end of each transect	
1974	Otter trawl	Semimonthly (D&N) Apr-Nov	NMPW, NMPP, NMPE	6, 12, 18 (20, 40, 60)	Surface and bottom	Comments for 1972 and 1973 apply

TABLE 6.5-1 (Cont)

Year	Gear	Frequency	Transect	Depth Contour m (ft)	Sample Depth	Comments
1974 (Cont)	Gill net	Apr, May and July, 3 samples; June, 4 samples; Aug-Nov, 2 samples; Dec, 1 sample (D&N for all months)	NMPW, NMPP, FITZ, NMPE	5, 9, 12, 18 (15, 30, 40, 60)	Bottom at 5 m (15 ft); surface and bottom at 10, 12, and 20 m (30, 40, and 20 m)	Comments for 1973 apply
	Beach seine	Semimonthly Apr-Nov, 1 sample in Dec	NMPW, NMPP, FITZ, NMPE	-	Shoreline to 2.5 m (8 ft) at end of each transect	
1975	Otter trawl	Apr, Aug, Sept, 3 samples; May, June, July, Oct, 2 samples; Nov, 4 samples; Dec, 1 sample (D&N for all months)	NMPW, NMPP NMPE	6, 12, 18 (20, 40, 60)	Surface and bottom	Comments from 1972 and 1973 apply
	Gill net	Apr & Dec, 1 sample; Semimonthly May; Nov (D&N)	NMPW, NMPP, FITZ, NMPE	5, 9, 12, 18 (15, 30, 40, 60)	Surface at 5 m (15 ft); surface and bottom at 10, 12 and 20 m (30, 40, and 60 ft)	Comments for 1974 apply
	Beach seine	Apr, July, Oct, Nov, Dec, 1 sample; May and June, 2 samples; Aug, Sept, 3 samples	NMPW, NMPP, FITZ	-	Shoreline to 2.5 m (8 ft) at end of each transect	See text for special seine sampling program in 1975
1976	Otter trawl	Semimonthly (D&N) Apr-Dec (12- and 20-m, [40- and 60-ft] contours at NMPE from Apr-June only)	NMPW, NMPP, NMPE	6, 12, 18 (20, 40, 60)	Bottom	Comments for 1972 and 1973 apply

TABLE 6.5-1 (Cont)

Year	Gear	Frequency	Transect	Depth Contour m (ft)	Sample Depth	Comments
1976 (Cont)	Yankee trawl	Semimonthly (D&N) June-Dec	NMPE	12, 18 (40, 60)	Bottom	See text for trawl comparison study in 1976
	Gill net	Semimonthly (D&N) Apr-Dec	NMPW, NMPP, FITZ, NMPE	5, 9, 12, 18 (15, 20, 40, 60)	Bottom only at 5, 10, and 18 m (15, 30, and 60 ft); surface and bottom at 12 m (40 ft)	Comments for 1973 apply; surface at 12-m (40-ft) contour was a night collection only and bottom net was for day collection only
	Beach seine	Semimonthly (D) Apr-Dec	NMPW, NMPP, FITZ, NMPE	-	Shoreline to 2.5 m (8 ft) at end of each transect	
1977	Otter trawl	Semimonthly (D&N) Apr-Dec	NMPW, NMPP, NMPE	6, 12, 18 (20, 40, 60)	Bottom	Comments for 1972 and 1973 apply
	Yankee trawl	Semimonthly (D&N) Apr-Dec	NMPE	12, 18 (40, 60)	NA	
	Gill net	Semimonthly (D&N) Apr-Dec	NMPW, NMPP, FITZ, NMPE	5, 6, 9, 12, 18 (15, 20, 30, 40, 60)	Bottom	Comments for 1973 apply. No sampling at 6-m (20-ft) contour for NMPP
	Beach seine	Semimonthly (D) Apr-Dec	NMPW, NMPP, FITZ, NMPE	-	Shoreline to 2.5 m (8 ft) at end of each transect	
	Trap net	Semimonthly (N) Apr-Dec	NMPW, NMPP, FITZ, NMPE	6 (20)	Bottom	
1978	Otter trawl	Semimonthly (D&N) Apr-Dec	NMPW, NMPP, NMPE/FITZ	6, 12, 18 (20, 40, 60)	Bottom	Comments for 1972 and 1973 apply
	Gill net	Semimonthly (D&N) Apr-Dec	NMPW, NMPP, FITZ, NMPE	5, 6, 9, 12, 18 (15, 20, 30, 40, 60)	Bottom	Comments for 1973 apply. No sampling at 6-m (20-ft) contour for NMPP
	Beach seine	Semimonthly (D) Apr-Dec	NMPW, NMPP, FITZ, NMPE	-	Shoreline to 2.5 m (8 ft) at end of each transect	

TABLE 6.5-1 (Cont)

Year	Gear	Frequency	Transect	Depth Contour m (ft)	Sample Depth	Comments
1978 (Cont)	Trap net	Semimonthly (N) Apr-Dec	NMPW, NMPP, FITZ, NMPE	6 (20)	Bottom	
1979	Gill net	Semimonthly (N) Apr-Dec; monthly (N) Sept-Dec	NMPW, NMPP, FITZ, NMPE	9 (30)	Bottom	
1980	Gill net	Same as during 1979	Same as during 1979	Same as during 1979	Same as during 1979	
1981	Gill net	Same as during 1979-1980	Same as during 1979-1980	Same as during 1979-1980	Same as during 1979-1980	

KEY: NA = Not available
D = Day sampling
N = Night sampling

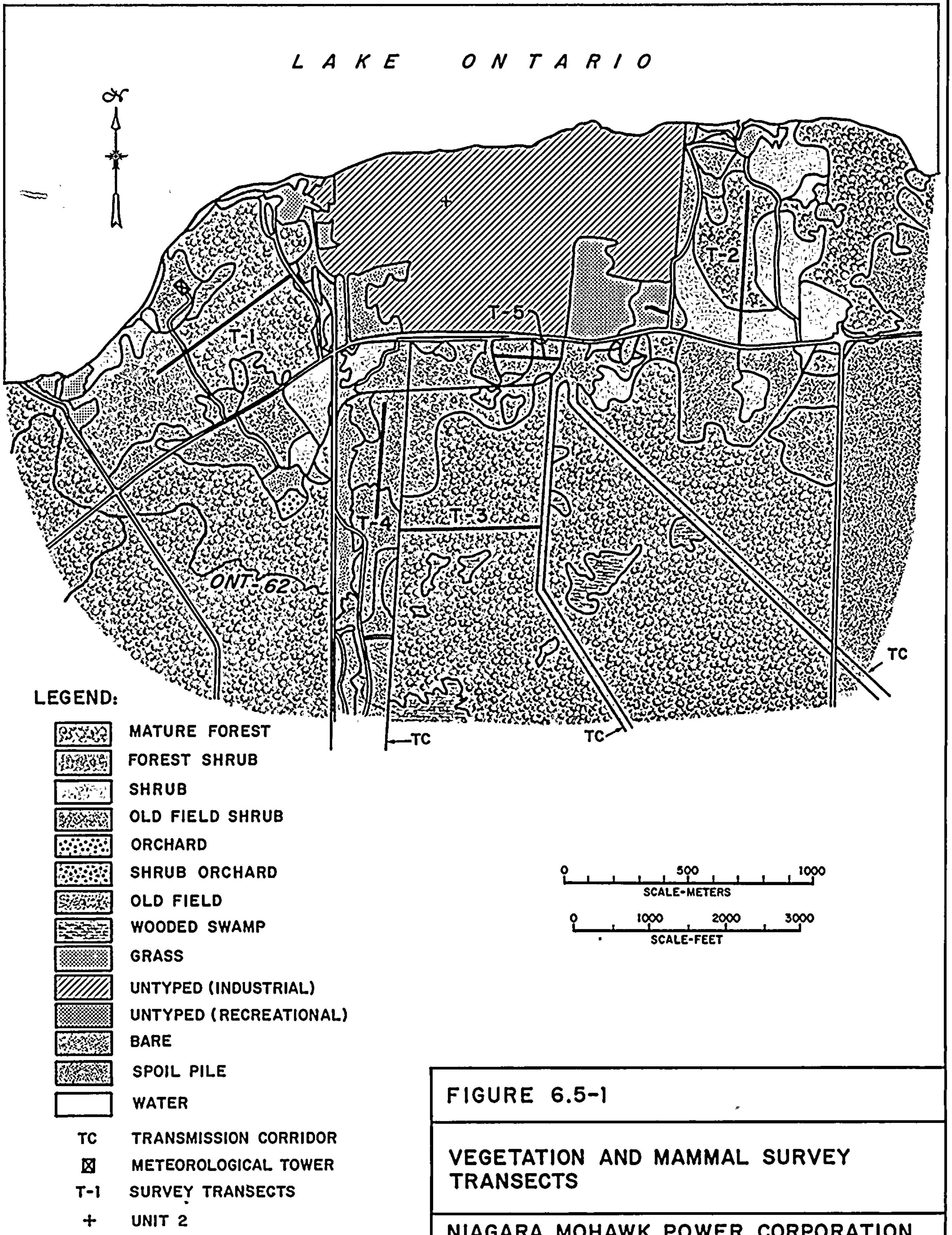

FIGURE 6.5-1

VEGETATION AND MAMMAL SURVEY TRANSECTS

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT - UNIT 2
ENVIRONMENTAL REPORT - OLS

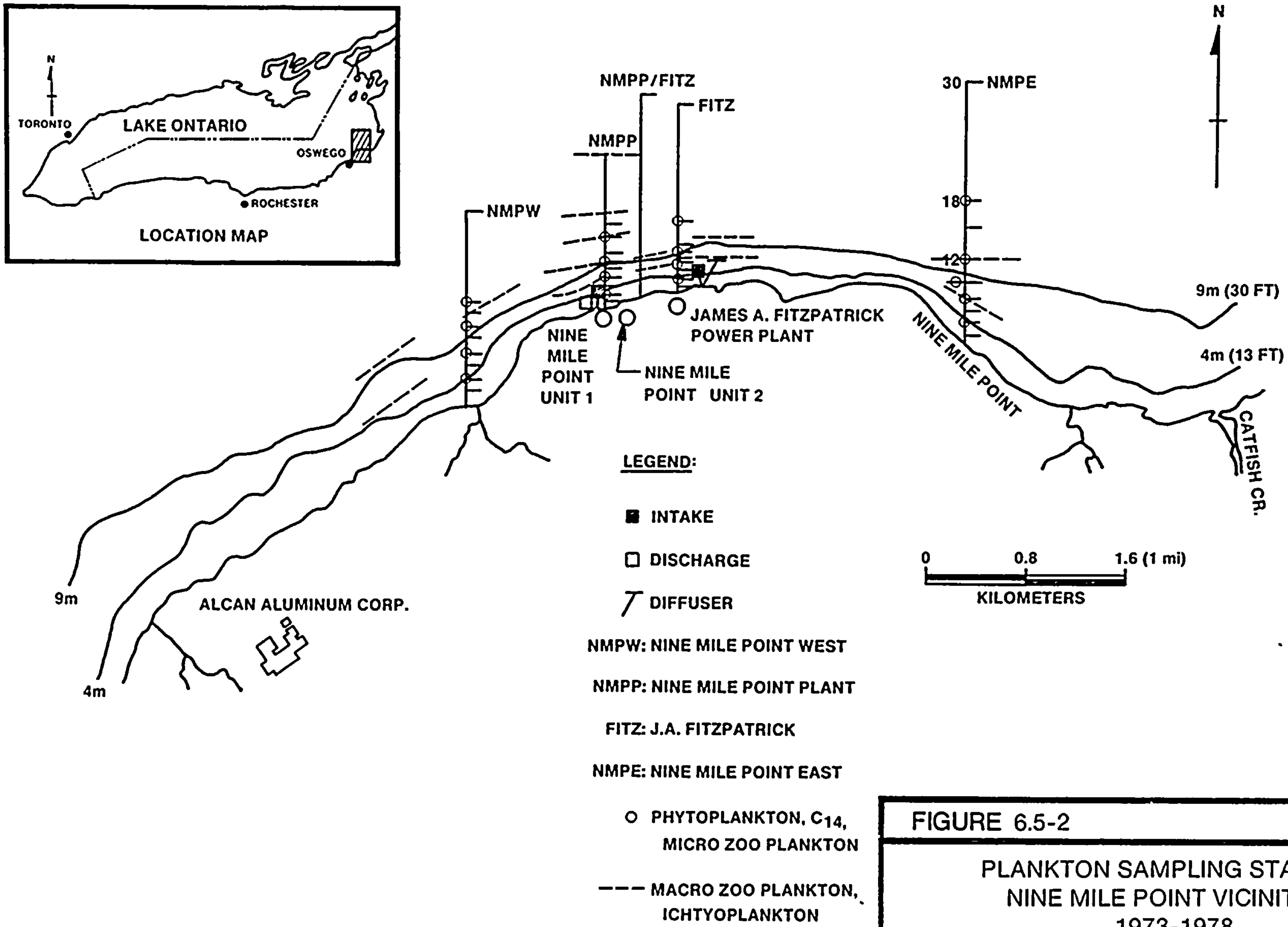

FIGURE 6.5-2

PLANKTON SAMPLING STATIONS
NINE MILE POINT VICINITY —
1973-1978

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS

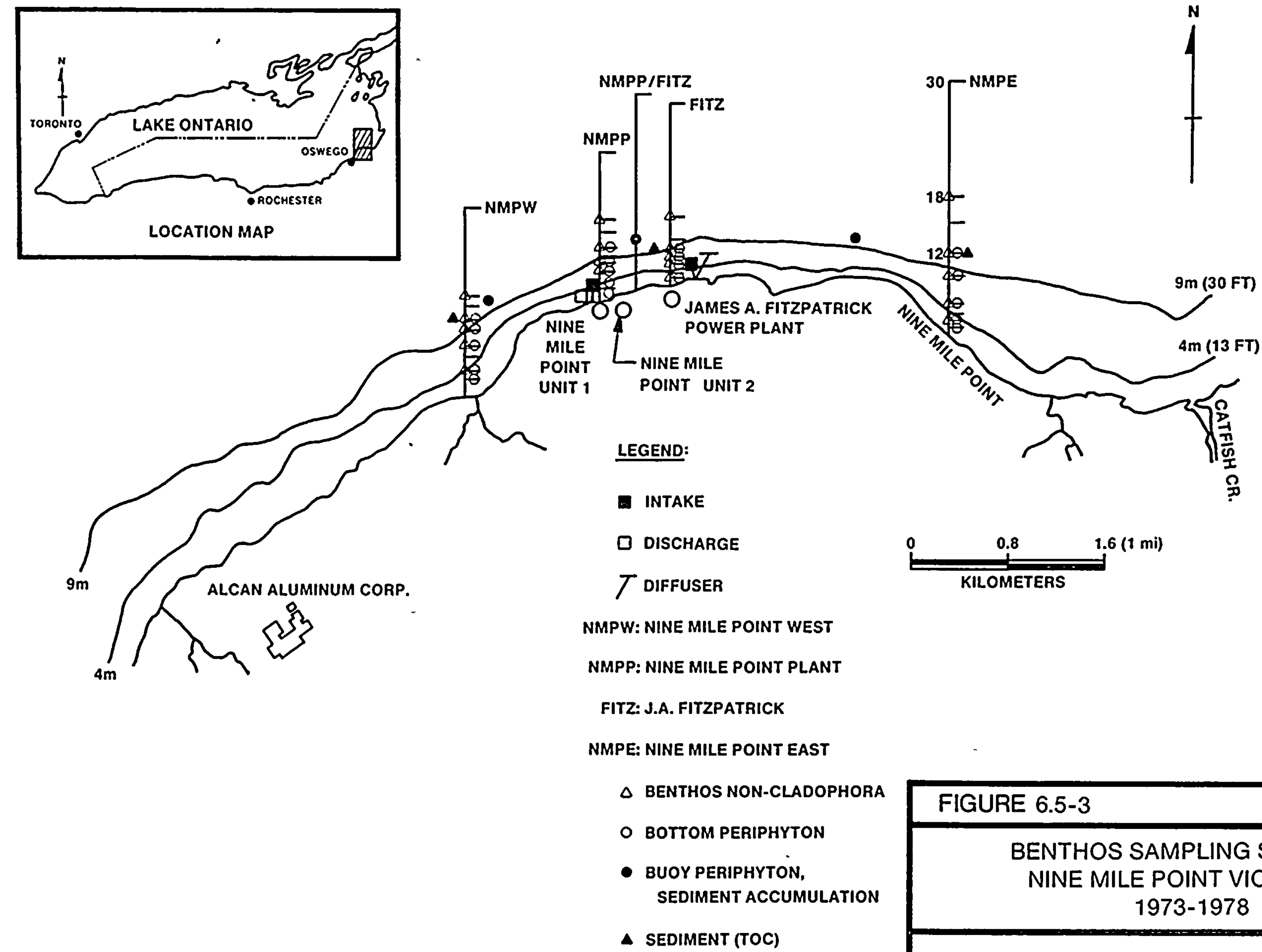

FIGURE 6.5-3

BENTHOS SAMPLING STATIONS
NINE MILE POINT VICINITY —
1973-1978

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS

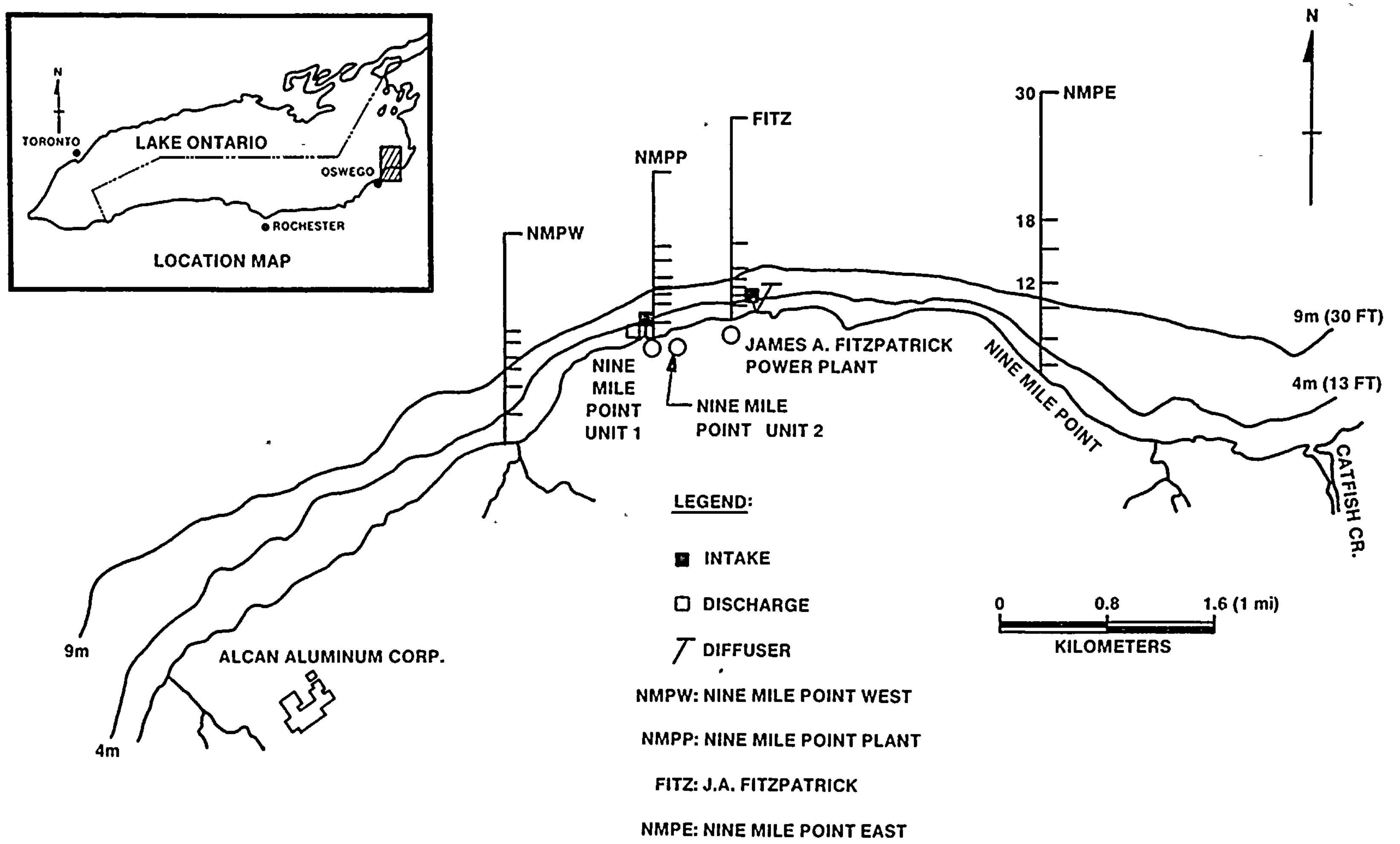

FIGURE 6.5-4

SAMPLING TRANSECTS FOR FISH COLLECTIONS NINE MILE POINT VICINITY — 1972-1981

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS

6.6 CHEMICAL

6.6.1 Groundwater

6.6.1.1 Preoperational Monitoring

The purpose of preoperational monitoring of groundwater quality is to establish a baseline for the assessment of water quality changes resulting from plant operation. Since Unit 2 does not use groundwater for operational purposes and does not discharge wastes to the groundwater system, no changes in water quality are expected to result from plant operation. Therefore, no preoperational groundwater monitoring of water quality was performed.

6.6.1.2 Operational Monitoring

An operational program to monitor groundwater quality is not planned, since the potential for affecting groundwater quality is negligible.

6.6.2 Surface Waters (Water Quality)

6.6.2.1 Preoperational Monitoring

6.6.2.1.1 Description of Sampling

A number of comprehensive studies of the water quality in Lake Ontario were undertaken during the late 1960s. These surveys were performed under the auspices of several state, national, and international agencies and include the International Joint Commission(1), Weiler and Chawla(2), and Chau et al(3). A review of these water quality surveys, along with a review of surveys conducted in the subject area from 1970 through 1972, was included in a report by Quirk, Lawler & Matusky Engineers (QLM) to Niagara Mohawk Power Corporation (NMPC)(4). Several other studies, conducted in the area during 1970 by Storr, concerned nitrate and phosphate concentrations(5).

Since 1970, Lawler, Matusky & Skelly Engineers (LMS) and Texas Instruments, Inc. (TI) have been surveying the water chemistry of the nearshore waters and sediments in the general area of Oswego and Nine Mile Point. The early (1970 through 1972) studies are summarized in QLM report 1974(4). A summary of the 1973 through 1980 water quality sampling programs is given below. Details of each program are provided in LMS report 1982(6). The results of these studies are presented in Section 2.3.3.

1973

Water quality sampling conducted during 1973 in the Nine Mile Point vicinity included weekly thermal measurements, bimonthly (twice per month) chemistry collections in conjunction with biological sampling, and monthly collections for extensive water quality analyses. Special studies were conducted to characterize the bottom sediment and the storm drain and sanitary effluent. The specific locations of lake sampling stations are shown on Figure 6.6-1. The water quality parameters measured are presented in Table 6.6-1.

Weekly temperature surveys were conducted from April through November at the NMPC, NMPE, and NMPW transects at the 6-, 12-, 15-, 18-, and 30-m (20-, 40-, 50-, 60-, and 100-ft) depth contours (Figure 6.6-1). Bimonthly chemistry collections were made from June through December at the same three transects (Table 6.6-2). Monthly collections were made from March through November as outlined in Table 6.6-2.

The Unit 1 sanitary sewage treatment plant effluent was monitored monthly from August through November 1973. A separate 1.2-m (4-ft) storm drain located at the edge of the lake on the west side of Unit 1 was also sampled monthly from August through November. Additional sampling was conducted in the Oswego vicinity[4].

1974

The 1974 water quality sampling program was similar to the 1973 program (Tables 6.6-1 and 6.6-2). The analyses were designed to supplement the 1973 study and to determine which parameters should continue to be monitored[6].

Thermal profiles were conducted weekly during 1974 at the 15- and 30-m (50- and 100-ft) depth contours at NMPW, NMPP/FITZ (formerly NMPC), and NMPE (Figure 6.6-1). Bimonthly and monthly sampling was conducted as outlined in Tables 6.6-1 and 6.6-2.

1975

Temperature measurements were taken weekly from April through December 1975 at the 30-m (100-ft) contour at three transects: NMPW, NMPP/FITZ, and NMPE (Figure 6.6-1).

Bimonthly and monthly sampling was conducted as described in Tables 6.6-1 and 6.6-2. Sediment samples were collected once during the year at the 6- and 12-m depth (20- and

40-ft) contours along NMPW, NMPP, FITZ, and NMPE transects[7].

1976

Three water quality sampling programs were conducted during 1976: the Nine Mile Point monthly water quality program, the James A. FitzPatrick (JAF) plant monthly water quality program, and the JAF plant twice-monthly water quality program[8]. The parameters measured and the stations sampled are provided in Tables 6.6-1 and 6.6-2, respectively.

Temperature was measured for the 1976 thermal profile programs approximately weekly at the 30-m (100-ft) contour of three transects (NMPW, NMPP/FITZ, and NMPE). Temperature measurements were also made in conjunction with each of the biological sampling programs.

1977 and 1978

The water quality programs for these years were essentially the same as the 1976 program[9,10]. Locations and frequencies remained the same; some parameters were added and some deleted (Tables 6.6-1 and 6.6-2).

1979 and 1980

For these 2 yr, the water quality program was designed to provide environmental information (dissolved oxygen and water temperature) in the vicinity of the gill net sampling locations. Water samples were collected from the bottom at the 9-m (30-ft) contour of the NMPW, NMPP, FITZ, and NMPE transects. Collections were made twice per month from April through August and once per month from September through December[11,12].

6.6.2.1.2 Analysis Methodologies

From 1973 through 1980, most temperature measurements were made with a Martek Mark II multiprobe analyzer or Y.S.I. Model 57 DO Meter, in which cases pH, DO, and specific conductivity were also measured. On occasion, thermal stratification measurements were made with a Montedoro Whitney Model TF-20 thermistor or a GM Model OC-1/S bathythermograph.

For the bimonthly and monthly water collections, samples were taken with a 4- or 9-l (1-gal or 2.4-gal) PVC Van Dorn sampler and were dispensed into 4-l (1-gal) polyethylene

bottles for immediate transport to the laboratory; sterile 300-ml (0.6-qt) Pyrex BOD bottles were used for bacteriological and DO analyses. Free CO_2 was determined in the field by titration.

Bottom sediment collections were performed by scuba divers. The samples were placed in ice chests and returned to the laboratory for analysis. Effluent samples of the sewage treatment plant were 24-hr composites of the oxidation pond influent and effluent. Sampling at the 1.2-m (4-ft) storm drains was carried out by grab samples taken every 6 hr for 24 hr.

The EPA has promulgated mandatory guidelines establishing test procedures for the analysis of pollutants[13,14]. All analyses conformed either to these guidelines or, by permission of the EPA Region II laboratory, to current standard methods[15-17]. The orthotolidine field measurement technique for total chlorine residual was used at Nine Mile Point. Details of specific analytical procedures are available in the annual reports [4,7-12].

6.6.2.1.3 Data Analysis Procedures and Statistical Methods

Data reduction procedures are included in the annual reports[4,7-12]. Concentrations of most water quality parameters were usually displayed graphically or in tables, and visual comparisons were made between stations. In some instances, analysis of variance was conducted to test for possible differences among dates of collection, stations, and sample depth means. Biologically significant water quality parameters received special attention to aid in interpreting certain biological patterns.

6.6.2.2 Operational Monitoring of Surface Water Chemistry

No operational studies for surface water chemistry are planned for Unit 2.

6.6.3 References

1. International Lake Erie Water Pollution Board and the International Lake Ontario-St. Lawrence River Water Pollution Board. Pollution of Lake Erie, Lake Ontario and the International Section of the St. Lawrence River-III. Report to the International Joint Commission, 1969.

2. Weiler, R. R. and Chawla, V. K. Dissolved Mineral Quality of Great Lakes Waters. Proc. 12th Conf. Great Lakes Res. 1969.

3. Chau, Y. K.; Chawla, V. K.; Nicholson, H. F.; and Vollenweider, R. A. Distribution of Trace Elements and Chlorophyll _a_ in Lake Ontario. Proc. 13th Conf. Great Lakes Res. 1970.

4. Quirk, Lawler & Matusky Engineers. 1973 Nine Mile Point Aquatic Ecology Studies. Prepared for Niagara Mohawk Power Corporation and Power Authority of the State of New York, 1974.

5. Storr, J. Aquatic Environmental Studies 1968-1972. Nine Mile Point Nuclear Station Unit 1. Prepared for Niagara Mohawk Power Corporation, 1973.

6. Lawler, Matusky & Skelly Engineers. Nine Mile Point Aquatic Ecology Study Summary (1973-1981). Prepared for Niagara Mohawk Power Corporation and Power Authority of the State of New York, 1982.

7. Lawler, Matusky & Skelly Engineers. 1975 Nine Mile Point Aquatic Ecology Studies. Prepared for Niagara Mohawk Power Corporation and Power Authority of the State of New York, 1976.

8. Lawler, Matusky & Skelly Engineers. 1976 Nine Mile Point Aquatic Ecology Studies. 2 Vols. Prepared for Niagara Mohawk Power Corporation and Power Authority of the State of New York, 1977.

9. Texas Instruments, Inc. 1977 Nine Mile Point Aquatic Ecology Studies. Prepared for Niagara Mohawk Power Corporation and Power Authority of the State of New York, 1978.

10. Texas Instruments, Inc. 1978 Nine Mile Point Aquatic Ecology Studies. Prepared for Niagara Mohawk Power Corporation and Power Authority of the State of New York, 1978.

11. Texas Instruments, Inc. 1979 Nine Mile Point Aquatic Ecology Studies. Prepared for Niagara Mohawk Power Corporation and Power Authority of the State of New York, 1979.

12. Texas Instruments, Inc. 1980 Nine Mile Point Aquatic Ecology Studies. Prepared for Niagara Mohawk Power Corporation and Power Authority of the State of New York, 1981.

13. U.S. Environmental Protection Agency. Methods for Chemical Analysis of Water and Wastes, 1971.

14. U.S. Environmental Protection Agency. Quality Criteria for Water. U.S. EPA, Office of Water and Hazardous Materials, 1976. [Prepublication copy].

15. American Public Health Association. Standard Methods for the Examination of Water and Wastewater. 13th ed. M.J. Taras (chm. of eds.). American Public Health Association, Washington, DC, 1971.

16. American Public Health Association. Standard Methods for the Examination of Water and Wastewater. 14th ed. American Public Health Association, American Water Works Association, and Water Pollution Control Federation, Washington, DC, 1976.

17. American Society for Testing and Materials. Annual Book of Standards. Part 23. Water, Atmospheric Analysis, 1972.

TABLE 6.6-1

WATER QUALITY PARAMETERS MEASURED IN THE MONTHLY AND BIMONTHLY SAMPLING PROGRAMS
NINE MILE POINT VICINITY

Parameter	1973		1974		1975		1976		1977-1978		1979-1980
	Mo	Bi	Mo	Bi	Mo	Bi	Mo	Bi	Mo	Bi	Bi
pH	X	X	X	X	X	X	X	X	X	X	
Temperature	X	X	X	X	X	X	X	X	X	X	X
Specific conductance	X	X	X	X	X	X	X	X	X	X	
Turbidity	X	X	X	X	X	X	X	X	X	X	
Color	X		X		X		X		X		
Alkalinity	X		X		X		X		X		
Carbon dioxide		X		X		X		X		X	
Dissolved oxygen	X	X	X	X	X	X	X	X	X	X	X
Biological oxygen demand	X	X	X	X	X	X	X	X	X	X	
Chemical oxygen demand	X	X	X	X	X	X	X	X	X	X	
Chlorophyll *a*		X		X		X		X			
Total solids	X	X	X	X	X	X	X	X	X	X	
Total dissolved solids	X		X		X		X		X		
Total suspended solids	X	X	X	X	X	X	X	X	X	X	
Total volatile solids	X		X		X		X		X		
Settleable solids	X				X		X				
Total coliforms	X		X		X		X		X		
Fecal coliforms	X		X		X		X		X		
Phenols	X		X		X		X		X		
Surfactants	X		X		X		X		X		
Nitrate nitrogen	X	X	X	X	X	X	X	X	X	X	
Ammonia nitrogen	X		X	X	X	X	X	X	X	X	
Total Kjeldahl nitrogen	X	X	X	X	X	X	X	X	X	X	
Orthophosphate	X	X	X	X	X	X	X	X	X	X	
Total phosphorus	X	X	X	X	X	X	X	X	X	X	
Silicate	X	X	X	X	X	X	X	X	X	X	
Sulfate	X		X		X	X	X		X		
Aluminum	X		X		X		X		X		
Arsenic	X		X		X		X		X		
Barium	X		X		X		X		X		
Beryllium	X		X		X		X		X		
Cadmium	X		X		X		X		X		
Calcium	X		X		X	X	X		X		
Chloride	X		X		X		X		X		
Chromium	X		X		X	X	X		X		
Copper	X		X		X		X		X		
Cyanide	X		X		X		X		X		
Fluoride	X		X		X		X		X		
Iron	X		X		X		X		X		
Lead	X		X		X		X		X		
Magnesium	X		X		X		X		X		

TABLE 6.6-1 (Cont)

Parameter	1973		1974		1975		1976		1977-1978		1979-1980
	Mo	Bi	Mo	Bi	Mo	Bi	Mo	Bi	Mo	Bi	Bi
Manganese	X		X		X		X		X		
Mercury	X		X		X		X		X		
Nickel	X		X		X		X		X		
Potassium	X		X		X		X		X		
Silver	X		X		X		X		X		
Sodium	X		X		X	X	X		X		
Vanadium	X		X		X		X		X		
Zinc	X		X		X		X		X		
Total organic carbon			X				X				
Selenium	X		X				X		X		
Organic nitrogen	X		X		X		X		X		
Radiological	X		X		X		X		X		
Carbon chloroform extract									X		

KEY: Mo = Monthly
Bi = Bimonthly

TABLE 6.6-2

SAMPLING LOCATIONS USED IN THE MONTHLY AND BIMONTHLY
WATER QUALITY PROGRAMS
NINE MILE POINT VICINITY: 1973-1980

Station	Depth Contour m	ft	1973	1974	1975	1976	1977	1978	1979	1980
Monthly										
NMPI	Intake		X	X						
NMPI	Discharge		X	X						
NMPC	6	20	X							
	14	45	X							
NMPP/FITZ	6	20		X	X	X	X	X		
	12	40				X	X	X		
	14	45		X	X	X	X	X		
NMPN	6	20				X	X	X		
	12	40				X	X	X		
NMPE	6	20				X	X	X		
	12	40				X	X	X		
Bimonthly										
NMPE	6	20	X	X	X	X	X	X		
	9	30							X	X
	12	40			X					
	18	60	X	X	X	X	X	X		
NMPW	6	20	X	X	X	X	X	X		
	9	30							X	X
	12	40			X					
	18	60	X	X	X	X	X	X		
NMPC	6	20	X							
	12	40	X							
	18	60	X							
NMPP/FITZ	6	20		X	X	X	X	X		
	12	40			X					
	18	60		X	X	X	X	X		
NMPP	9	30							X	X
FITZ	9	30							X	X

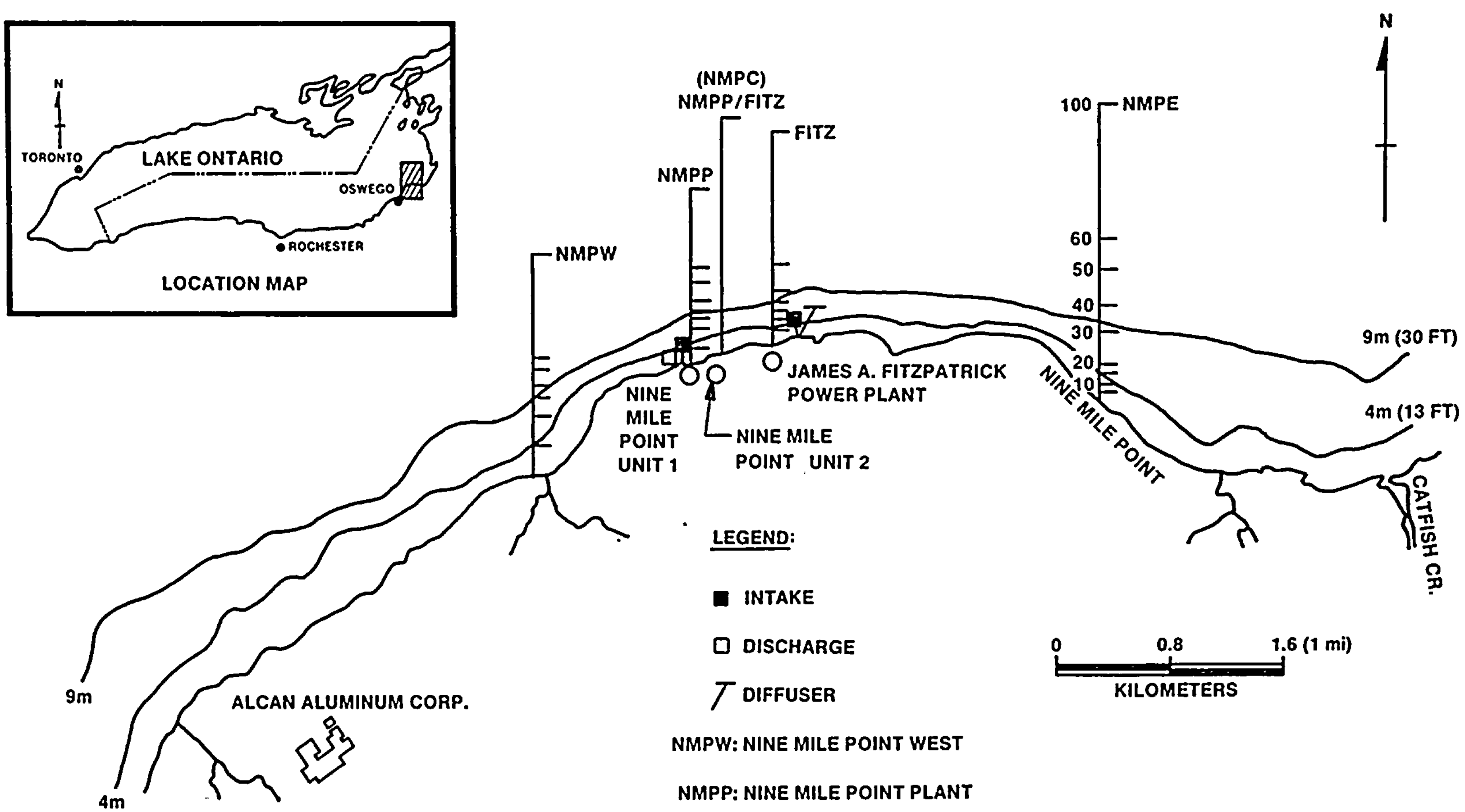

FIGURE 6.6-1

WATER SAMPLING STATIONS
NINE MILE POINT VICINITY

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS

6.7 OTHER MONITORING PROGRAMS

6.7.1 Ambient Noise Survey

The objective of the ambient noise survey performed was to define the existing acoustical environment of the Nine Mile Point area by obtaining sound level measurements at a number of locations within a 4.8-km (3-mi) radius of the site. The site characteristics and results of the noise survey are provided in Section 2.10. The acoustical environment of an area, which can be quantitatively defined as the ambient sound level, encompasses all sounds, whether from manmade noise sources such as the existing two power plants, traffic, aircraft, and other industrial sites, or from natural sources such as animals, insects, and the wave action of water bodies such as Lake Ontario. Ambient sound levels in a given area can vary greatly with time and locale. The proximity of a specific location within an area to noise sources such as highways can influence ambient levels, as can temporal variations in the activities that produce sound.

To evaluate the impact of introducing a new noise source (Unit 2) into the acoustical environment of the area, a detailed analysis of the existing ambient sound levels, including the impact from the existing two nuclear power stations, was necessary. The Nine Mile Point ambient noise survey was conducted during a 5-day period between September 27 and October 1, 1979. Except for 1 day of rain during which no noise data were obtained, the weather conditions were favorable for taking noise measurements. The wind was relatively calm during the entire measurement period, minimizing the noise impact of wind in the trees.

The following sections describe the techniques used to assess the existing ambient noise environment in the area surrounding the Nine Mile Point site. These sections include a description of the instrumentation used during the ambient noise survey, a description of the data measurement methodology, and the type of analysis performed in defining the ambient noise levels. In addition, Section 2.10 contains a description of the general site characteristics, as well as a summary of the measured ambient noise levels. Section 5.8.1 deals with the prediction and evaluation of the noise impact expected from the operation of Unit 2.

6.7.1.1 Description of Site Selection

Site 1, located at the end of Lakeview Road, approximately 152 m (500 ft) from the shore of Lake Ontario, is

representative of the nearest residential area along the western boundary of the power plant property line. This site is owned and operated by the Ontario Bible Conference Group and is located approximately 1.6 km (1 mi) from Units 1 and 2. Although several of the homes in this area are occupied year-round, the majority of the dwellings are utilized during the summer months to house those attending the Bible Conference. During the time of the ambient noise survey, this area was relatively quiet because the camp was closed. Site 2, also located on Lakeview Road, is near the southwest corner of the power plant property line, approximately 2.4 km (1.5 mi) from Units 1 and 2. The largest concentration of homes within a 4.8-km (3-mi) radius of the power plant site is located in the Lycoming area at the intersection of Miner Road and Route 29. As a result, Site 3, located on Miner Road approximately 137 m (450 ft) from the intersection, was selected as one of the primary noise-monitoring sites. This site, located near the southeast corner of the power plant boundary line, was approximately 2.9 km (1.8 mi) from Units 1 and 2 and 2.7 km (1.7 mi) from the James A. FitzPatrick (JAF) plant.

Site 4 was located east of the power plant site, at the intersection of Lake Road and Parkhurst Road, approximately 2.4 km (1.5 mi) from Units 1 and 2, and 1.6 km (1 mi) from the JAF plant. Site 5 was located along Lake Ontario, east of the power plant site, approximately 2.7 km (1.7 mi) from Units 1 and 2, and 1.7 km (1.1 mi) from the JAF plant. This site is on a lightly traveled dirt road leading to a number of homes along the waterfront, approximately half of which appear to be year-round residences. As with Site 1, this site was located approximately 152 m (500 ft) from the water to avoid any noise impact from the wave action on Lake Ontario.

Site 6, located on Route 29, was selected because it represented a location along the eastern boundary of the power plant property line. This site was located 365 m (1,200 ft) from the intersection of Lake Road, approximately 1.9 km (1.2 mi) from Units 1 and 2, and 1.2 km (0.8 mi) from the JAF plant.

Site 7, located on North Road, approximately 4.0 km (2.5 mi) south of the power plant site, was on a hill overlooking the entire power plant facility. Site 8, located west of the power plant site approximately 130 m (425 ft) from Lake Road, was selected because it represented an area that was in contrast to Site 1, where there was very little activity. This site was located approximately 2.2 km (1.4 mi) from Units 1 and 2, and 3.0 km (1.9 mi) from the JAF plant.

Site 9, located on Miner Road directly south of the power plants, was approximately 2.4 km (1.5 mi) from Units 1 and 2, and 2.7 km (1.7 mi) from the JAF plant. In addition, this site was near the transmission line corridor leading away from the power plant site. Measurements taken at this site provided noise-monitoring data for the southern boundary of the power plant property line.

All nine noise-monitoring sites were located in open areas so that there were no problems with sound reflections from buildings.

6.7.1.2 Description of Noise-Monitoring Equipment

The measured ambient sound level data consisted of continuous, automatically recorded statistical measurements, as well as manually recorded hand-held statistical noise samples obtained during both daytime and nighttime noise-monitoring periods.

The following instrumentation was used during this ambient noise survey:

1. Two Metrosonics dB-602 Community Noise Analyzers (CNA).

2. General Radio 1945-9730 Weatherproof Microphone Systems.

3. Two General Radio 1961-9601 1-in Electret Microphone.

4. One General Radio 1562A Acoustic Calibrator.

5. One Bruel & Kjaer (B&K) 2209 Sound Level Meter.

6. One B&K 1613 Octave Band Filter Set.

7. One B&K 4145 1-in Condenser Microphone.

8. One B&K 4220 Pistonphone Calibrator.

9. One B&K UA0207 Windscreen.

10. One NAGRA IV-SJS Tape Recorder.

The CNA is an automatic instrument powered by an internal dc power supply, and as a result, could be left in the field unattended for a period of 24 to 36 hr, depending on the temperature. The CNA samples the existing sound level twice

per second and stores the result in working memory for future analysis. At the end of an hourly period, the CNA processes the data stored in the working memory and computes the equivalent sound level, L_{eq}, which is the steady A-weighted sound level that has the same total sound energy as the fluctuating noise levels occurring during the measurement period. During the measurement period, the CNA also computes the L_{10}, L_{50}, and L_{90} sound levels, which are the A-weighted levels exceeded 10, 50, and 90 percent of the time, respectively. These hourly statistical sound levels are then placed in storage memory for later retrieval by the survey team. Each of the CNAs was configured with a General Radio 1945-9730 Weatherproof Microphone System and a 1961-9601 1-in Microphone.

For the hand-held statistical measurements, the noise-monitoring instrumentation included a B&K 4145 Microphone mounted on a tripod approximately 1.5 m (5 ft) high. The microphone was connected by cable to a B&K 2209 Sound Level Meter. Calibration of the measurement system was performed at each site (prior to beginning each measurement period) with a B&K 4220 Pistonphone. The B&K Sound Level Meter was also fitted with a B&K Type 1613 Octave Band Filter Set. This provided residual octave band sound level data at each site. The residual octave band sound level is the minimum sound level reading obtained in each octave band in the absence of any identifiable or intermittent local noise sources, such as passing cars and barking dogs. In addition, a NAGRA IV-SJS tape recorder was used to record a 3-min noise sample at each of the nine noise-monitoring sites for further analysis, if necessary.

6.7.1.3 Data Collection Methodology

In order to adequately define the ambient noise levels surrounding the Nine Mile site, a series of both daytime and nighttime noise measurements was obtained at each of the nine noise-monitoring locations. The continuously monitoring CNAs were used at the four primary noise-monitoring sites (1, 2, 3, and 4) to obtain a complete 24-hr time history of the noise environment at each of these locations. Except for 1 day of rain (September 28) when no ambient noise levels were obtained, one of the CNAs was left in operation at Site 1 for almost the entire ambient noise survey to serve as a constant reference data point. The second CNA was used at the other three primary noise-monitoring sites and was moved after each 24-hr noise measurement period. The following is a summary of the times and dates that the CNAs were in operation:

Site 1 - 1300 hr September 27, 1979
to 1200 hr September 28, 1979
0100 hr September 29, 1979
to 1500 hr September 30, 1979

Site 2 - 1500 hr September 30, 1979
to 1500 hr October 1, 1979

Site 3 - 1500 hr September 27, 1979
to 1200 hr September 28, 1979

Site 4 - 1400 hr September 29, 1979
to 1400 hr September 30, 1979

During the ambient noise measurement program, the noise-monitoring sites were visited once during the daytime and once during the nighttime hours. At each visit to the primary noise-monitoring sites, the system was switched into the standby mode, and the hourly statistical data (L_{eq}, L_{90}, L_{50}, and L_{10}) stored in the analyzer memory was retrieved and recorded on a data sheet. The B&K system was then set up and calibrated for the hand-held statistical measurements. This method of data collection consisted of using a statistical sampling technique that provides an accurate description of the short-term variations in the ambient noise environment and a sound level meter to sample the existing A-weighted sound levels in 5-sec intervals. A series of 50 samples was generally more than sufficient to provide a statistically reliable sample defining the minimum (L_{90}) dBA noise levels obtainable at each site. During the 50-sample time period (4 min, 10 sec), all activity in the area was noted and all noise sources were identified. Each of the 50 instantaneous sound level readings was recorded on a data sheet by a checkmark next to the correct dBA level. The collected data were later used to determine the appropriate statistical descriptors, such as the L_{90}, L_{50}, L_{10}, and L_{eq} levels, which correspond to the residual, average, intrusive, and equivalent levels, respectively.

Residual octave band sound levels were also obtained. The residual octave band sound level is the minimum repeatable sound level reading obtained in each octave band (63, 125, 250, 500, 1k, 2k, 4k, and 8k Hz) in the absence of any identifiable or intermittent local noise sources, such as passing cars and barking dogs. From the residual octave band data, the residual dBA noise level can be calculated at each site and should agree with the minimum (L_{90}) dBA levels obtained by using the hand-held statistical sampling technique.

This ambient noise measurement procedure was followed during each visit to the noise-monitoring sites. At the end of each visit, the CNA was recalibrated and switched from the standby mode to the active mode to begin another noise measurement period. Each site was visited twice daily for a total of four or five ambient noise measurement sessions during the survey. In addition, the NAGRA tape recorder was used to record a 3-min ambient noise sample at each of the nine noise-monitoring sites. These tape recordings were obtained during the nighttime, when the ambient noise levels were generally lower, so that power plant noise was usually audible at each of the noise-monitoring sites.

Throughout the survey, periodic observations and measurements were made of the meteorological conditions, including wind speed and direction, wet-bulb and dry-bulb ambient air temperature, and sky conditions. For the entire ambient noise survey, the winds were generally calm, ranging from 0 to 8 km/h (5 mph). This minimized the impact of wind in the trees, which tends to be a problem when measuring low ambient noise levels.

6.7.2 Seismic Monitoring

There is no preoperational seismic monitoring program planned at the Unit 2 site. However, Niagara Mohawk Power Corporation, in conjunction with other state utilities, is funding a seismic monitoring research program in New York
1 state, as described in FSAR Section 2.5.2.3.2.

6.7.3 Air Quality Monitoring Programs

The potential sources of gaseous emissions at Unit 2 are two standby diesel generators, one HPCS diesel generator, one diesel-driven emergency fire pump, and a natural-draft cooling tower (NDCT). The diesel units will burn No. 2 fuel oil (0.5 percent sulfur content) and, due to infrequent operation, will emit small amounts of pollutants (i.e., nitrogen oxides [NO], sulfur dioxide [SO_2], and particulates), as described in Section 3.6.3.4. Criteria-pollutant emissions from these sources, even with the addition of the particulate emissions from the NDCT, will not exceed an emission requirement of 100 tons/yr and are not considered a major source. Therefore, the sources are not subject to prevention of significant deterioration (PSD) or emission offset (EO) regulations. On this basis, a post-operational air quality monitoring program is neither necessary nor required by state or federal regulations for this facility.

6.7.4 Geotechnical Monitoring

Preoperational subsurface monitoring has been undertaken subsequent to submission of the ER-CPS and is discussed in FSAR Section 2.5.4.13.

There are no plans for operational monitoring of geotechnical parameters at Unit 2.

6.8 ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

A summary of preoperational monitoring and operational monitoring programs for Unit 2 is presented in Tables 6.8-1 and 6.8-2.

TABLE 6.8-1

SUMMARY OF PREOPERATIONAL MONITORING

Section Reference	Description	Frequency	Location	Method
6.1.1.1	Vertical temperature distribution (Lake Ontario)	Weekly April-December 1973-1978	Transects NMPP, NMPE, and NMPW	1-m intervals at 15-m contour in 1973-1974 and 30-m contour in 1973-1978. Measurements made with Martek MK II multiprobe analyzer, Montedoro Whitney TF-20 thermistor, or GM model OC-1/s bathythermograph.
6.1.1.2	Unit 1 thermal plume survey	Periodically 1970-1975	Unit 1 thermal plume	Vertical profile at 4 depths utilizing Gulton Industries thermistor probes (No. 133) and Rustrak recorder (model 2133).
6.1.1.3	James A. FitzPatrick (JAF) thermal discharge	June, August, October 1976; April, June, November 1977	JAF thermal plume and vicinity	Fluorescent dye (Rhodamine WT) and temperature, vertical and horizontal transects, utilizing fluorometer thermistor probes and data logger.
6.3.1	Hydrological measurements (Lake Ontario)	Hourly 1969 and 1970	Offshore of Nine Mile Point, 7.3-m (24-ft) and 14.2-m (46-ft) depth contour	Current speed and direction at 3 depths, utilizing reduced-size Savonius rotor meters.
		Continuous measurements during 1- or 2-day surveys; June, August, October 1976, and April, June, November 1977	Various, offshore of Nine Mile Point	In situ current measurements at various depths.
6.4.1	Meteorological	Continuous since 1974	Meteorological tower site	
	Wind speed/direction	Continuous since 1974	9 m (30 ft), 30 m (100 ft), 61 m (200 ft)	Bendix 120 Aerovanes, Climatronics F-460 vane and anemometer.
	Air temperature	Continuous since 1974	8 m (27 ft), 30 m (100 ft), 61 m (200 ft)	Climatronics TS-10 aspirated thermistor.

TABLE 6.8-1 (Cont)

Section Reference	Description	Frequency	Location	Method
6.4.1 (Cont)	Relative humidity	Continuous 1974-1978	9 m (30 ft), 61 m (200 ft)	Xeritron humidity sensors.
	Dew point	Continuous since 1978	8 m (25 ft)	EG&G 220 dew point sensor.
	Precipitation	Continuous since 1974	Near base of tower	Weathermeasure P511E rain gauge.
	Barometric pressure	Continuous since 1974	Near base of tower	Climatronics sensor.
6.5.1	Terrestrial Ecology	August and September 1979	1.6 km (1 mi) radius of Unit 2	Literature survey, aerial photography, onsite field study 3
6.5.2	Aquatic Ecology			
6.5.2.1	Preoperational Monitoring			
6.5.2.1.2.1	Phytoplankton Lake studies	Bimonthly or monthly depending upon year and season 1973 through 1978	NMPE, NMPP, NMPW, FITZ at 3,6,12, and 18-m (10,20,40, and 60-ft) depth contours	Whole water samples; Palmer-Maloney cell 1973-1974 and 1977-1978 Utermohl 1975-1976 Chlorophyll 1973-1978 C-14 1974-1978
	Entrainment	Bimonthly or monthly depending upon year and season 1973-1974, 1976-1979	Unit 1 intake and discharge 1973-1975 JAF intake and discharge 1976-1979	Whole water, 1974, 1976; Chlorophyll, 1973-1974, 1976-1979; Productivity, 1973-1979
6.5.2.1.2.3	Microzooplankton Lake studies	Bimonthly or monthly depending upon year and season 1973-1978	NMPE, NMPP, NMPW, FITZ at 3,6,12, and 18-m (10,20,40, and 60-ft) depth contours	76-um mesh vertical tows 1973-1974 Clarke-Bumpus oblique tow 1975-1976, Wisconsin net oblique 1977-1978; Sedgewick-Rafter counting cell 1973-1978.

TABLE 6.8-1 (Cont)

Section Reference	Description	Frequency	Location	Method
	Entrainment	Bimonthly or monthly depending upon year and season 1973-1979	Unit 1 intake and discharge 1973-1975 JAF intake and discharge 1976-1979	Bucket collection 1973 Pump collection 1974-1979 Viability by motility
6.5.2.1.2.5	Macrozooplankton Lake sampling	Weekly April-December 1973-1977; monthly 1978	6 and 12-m (20 and 40-ft) depth contour E and W of Unit 1; 18,24, and 30-m (60,80, and 100-ft) depth contour directly off Unit 1	1.0-m diameter Hensen net 1973-1978 5-min tow; S, M, B enumeration and identification
	Entrainment	Weekly or bimonthly depending upon year and season 1973-1979	Unit 1 intake and discharge 1973-1974 Unit 1 and JAF intake 1975 JAF intake and discharge 1976-1979	0.5-m diameter conical net, 571-um mesh Centrifugal pump into a 571-um mesh net Viability by motility
6.5.2.1.2.7	Benthos	Monthly or bimonthly depending upon year 1973-1978	NMPW, NMPP, FITZ, NMPE 3,6,9,12, and 18-m (10,20, 30,40, and 60-ft) depth contours	Diver-operated pump, washed through 420-um screen 1973-1976 washed through 500-um screen 1977-1978 Enumeration and identification
6.5.2.1.2.9	Periphyton Bottom	Spring, summer, and fall seasons, 1973-1978	NMPW, NMPP, FITZ, NMPE 2,3,6,10, and 12-m (5,10, 20,30, and 40-ft) depth contours	Glass slides, 1973; plexiglass plates 1974-1978; collected by divers; Biomass, Chlorophyll and Enumeration and identification

TABLE 6.8-1 (Cont)

Section Reference	Description	Frequency	Location	Method
	Buoy	Spring, summer, and fall seasons, 1973-1978	NMPE, NMPP, NMPW 12-m (40-ft) depth contour @ 1,2,4, and 5-m (3,6,12, and 15-ft) depths 1973-1976 NMPW, NMPP, and FITZ 1977-1978	Glass slides and styrofoam 1973 plexiglass plates 1974-1978 collected by divers; Biomass, Chlorophyll and Enumeration and identification
6.5.2.1.2.11	Ichthyoplankton			
	Lake studies	Weekly or bimonthly depending upon year and season 1973-1979	NMPE, NMPW at 6 and 12-m (20 and 40-ft) depth contour NMPP at 18,24, and 30-m (60,80, and 100-ft) depth contour	1.0-m diameter Hensen net, 571-um mesh, S, M, B Enumeration and identification of eggs and larvae
	Entrainment	Weekly or bimonthly depending upon year and season 1973-1979	Unit 1 intake and discharge 1973-1974 Unit 1, JAF intake 1975-1978 JAF intake and discharge 1975-1979	0.5-m diameter conical net 571-um mesh 1973-1975; Centrifugal pump into a 571-um mesh net; 1976-1979
6.5.2.1.2.13	Fish			
	Otter trawl	Bimonthly or monthly depending upon year and season 1973-1978	NMPW, NMPP 6 and 12-m (20 and 40-ft) 1972 NMPW, NMPP, NMPE 6,12, and 18-m (20,40, and 60-ft) depth contour 1973-1978	9.1-m (30-ft) otter trawl, surface and bottom
	Gill net	Bimonthly or monthly depending upon year and season 1972-1981	NMPW, NMPP 5,10,12-m (16,33, and 40-ft) depth contour 1972 NMPW, NMPP, FITZ, NMPE 5,10,12, and 20-m (16,33,40, and 66-ft) 1973-1978 NMPW, NMPP, NMPE, FITZ 10-m (33-ft) 1979-1981	Surface and bottom 1972-1976 bottom only 1977-1981 2,4x46-m (8x150-ft) experimental net

TABLE 6.8-1 (Cont)

Section Reference	Description	Frequency	Location	Method
	Beach seine	Bimonthly or monthly depending upon year and season 1972-1978	NMPE,NMPW,NMPP,FITZ	30-m (100-ft) long 1972-1973; 15-m (50-ft) long 1974-1978
	Trap net	Bimonthly April-December 1977-1978	NMPW,NMPE,FITZ,NMPP at 6-m (20-ft) depth contour	Set overnight, two 7.6-m (25-ft) leads
	Impingement	Unit 1 1973-1981 JAF 1975-1981 24-hr collections on a variable schedule	Unit 1 and JAF traveling screens	Identification and enumeration; Length and weight on subsample
6.6.2	Chemical-surface water			
6.6.2.1	Preoperational monitoring	Bimonthly and monthly depending upon parameters and stations 1973-1978; Bimonthly only 1979-1981	Monthly, NMPC,NMPP intake and discharge 1973-1974 NMPP/FITZ, 1975, NMPP/FITZ, NMPW,NMPE 1976-1978 Bimonthly, NMPE,NMPW,NMPC 1973; NMPE,NMPW,NMPP/FITZ 1974-1978	Monthly, 49 to 51 chemical parameters Bimonthly; 16 to 21 parameters 1973-1978 2 parameters (temp, D.O.) 1979-1981

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TABLE 6.8-2

SUMMARY OF OPERATIONAL MONITORING

Section Reference	Description	Frequency	Location	Method
6.1.2	Thermal	As required by SPDES permit	As required by SPDES permit	As required by SPDES permit
6.4.2	Meteorological	Continuous	Main 61-m (200-ft) tower site	
	Wind speed/direction	Continuous	9 m (30 ft), 30 m (100 ft), 61 m (200 ft)	Teledyne Geotech 40.12C Wind Speed Processor 50.1B Wind Speed Sensor 52.1 Standard Anemometer 21.21 Wind Direction Processor 50.2C Wind Direction Sensor 53.2 Quick Two Vane
		Continuous	Inland supplemental tower, 9 m (30 ft)	Teledyne Geotech 40.12C Wind Speed Processor 50.1B Wind Speed Sensor 52.12 Standard Anemometer 21.21 Wind Direction Processor 50.2C Wind Direction Sensor 53.2 Quick Two Vane
		Continuous	James A. FitzPatrick backup meteorological pole 27 m (90 ft)	Teledyne Geotech 40.12C Wind Speed Processor 50.1B Wind Speed Sensor 52.2 Standard Anemometer 21.21 Wind Direction Processor 50.2C Wind Direction Sensor 53.2 Quick Two Vane
	Air temperature/ T	Continuous	9 m (30 ft), 30 m (100 ft), 61 m (200 ft)	Teledyne Geotech 21.32 Temperature Processor T-200 Platinum RTD 327B Aspirated Thermal Shield
	Dew point	Continuous	9 m (30 ft)	General Eastern 1200 EPS Chilled Mirror Dew Point System
	Precipitation	Continuous	Ground level	Teledyne Geotech 21.52 Precipitation Processor PG-200A-H Heated Precipitation Sensor S-100 Wind Screen

TABLE 6.8-2 (Cont)

Section Reference	Description	Frequency	Location	Method
6.4.2 (Cont)	Barometric pressure	Continuous	Ground level	Teledyne Geotech 40.61 Barometric Pressure Processor BP-100 Aneroid Pressure Sensor
6.5.1	Vegetative stress study	First two years of project operation	1.6-km (1 mi) radius of Unit 2	Aerial infrared photography 3
6.5.2	Aquatic ecology	As required by SPDES permit	As required by SPDES permit	As required by SPDES permit
6.6.2.2	Chemical	As required by SPDES permit	As required by SPDES permit	As required by SPDES permit

KEY: SPDES = State pollutant discharge elimination system.

CHAPTER 7

ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS INVOLVING RADIOACTIVE MATERIALS

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CHAPTER 7

ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS INVOLVING RADIOACTIVE MATERIALS

7.1 PLANT ACCIDENTS

This section discusses the radiological environmental impact of Unit 2, as required by 10CFR51 and based on the accident assumptions provided in the Environmental Standard Review Plan (ESRP), Section 7.1, and meets the criterion of Regulatory Guide 4.2. For each postulated accident, the following is provided:

1. Description of a representative type of accident appropriate for each accident class, together with its basic assumptions.

2. Determination of the radiological doses for each accident class as it applies to Unit 2.

Table 7.1-1 identifies the accidents considered. Table 7.1-2 summarizes the radiological doses for each accident to a hypothetical maximum exposed individual at the exclusion area boundary (EAB), as defined in 10CFR100. Table 7.1-3 summarizes the population doses for each accident at an 80-km (50-mi) radius, utilizing the projected demography for the year 2000.

The demographic data and the realistic X/Q values (50-percent probability level) that were used in these analyses can be found in Sections 2.5.1 and 2.7, respectively. Both the demographic data and X/Q values were based on the most recent information available, thus providing more representative individual and population doses.

7.1.1 Identification of Design Basis Accidents

7.1.1.1 Trivial Incidents (Class 1 Accidents)

These incidents are included and evaluated under routine release in accordance with Appendix I to 10CFR50 and are discussed in Section 5.4.

7.1.1.2 Small Releases Outside Containment (Class 2 Accidents)

These releases include releases from small spills or leaks of radioactive materials outside the containment. These releases are included and evaluated under routine releases in accordance with Appendix I to 10CFR50 and are discussed in Section 5.4.

7.1.1.3 Radwaste System Failures (Class 3 Accidents)

7.1.1.3.1 Equipment Leakage or Malfunction

The sources for this event are the largest radioactive liquid and gas storage tanks, which are the phase separator tank and the off-gas system charcoal delay bed, respectively. The rupture of a phase separator tank would cause the release of 25 percent of the maximum inventory of the liquid tank. The source of activity for the tank is based on the reactor water cleanup filter/demineralizer backwash. The duration of the accident is assumed to be 2 hr. A rupture of the off-gas system charcoal delay bed would cause the release of 25 percent of the average inventory on the bed. The source of activity for a bed is based upon the expected reactor steam activities. The effective charcoal delay bed holdup time for krypton is 41.5 hr and for xenon is 717.5 hr. The duration of the accident is assumed to be 2 hr.

7.1.1.3.2 Release of Waste Gas Storage Tank Contents

This event is similar to the previous accident with the exception that 100 percent of the charcoal bed inventory is released to the atmosphere.

7.1.1.3.3 Release of Liquid Waste Storage Tank Contents

This event is similar to the accident described in Section 7.1.1.3.1 with the exception that 100 percent of the tank inventory is spilled on the floor of the building. A partition factor of 0.002 is used for halogens released to the atmosphere.

7.1.1.4 Fission Products to Primary System (Class 4 Accidents)

7.1.1.4.1 Fuel Cladding Defects

These events are included and evaluated under routine releases in accordance with Appendix I to 10CFR50 and are discussed in Section 5.4.

7.1.1.4.2 Off-Design Transients That Induce Fuel Failures Above Those Expected

An off-design transient is postulated inducing fuel failures greater than those expected. Radioactivity is assumed to be carried to the condenser.

A representative source is defined as 0.02 percent of the core inventory of noble gases and halogens released to the reactor water. One percent of the halogens and 100 percent of the noble gases are assumed to be carried to the condenser, where all the gases and 10 percent of the halogens are available for leakage from the condenser to the turbine building at 0.5 percent/day. The accident is assumed to continue for 24 hr, after which all radioactive releases are terminated.

All activity released during the accident is assumed to be released from the turbine building, with no credit taken for holdup or plateout on the turbine building internal structures and no credit taken for an elevated release.

7.1.1.5 Refueling Accidents (Class 6 Accidents)

7.1.1.5.1 Fuel Bundle Drop

One fuel assembly is assumed to be dropped underwater during refueling, damaging one row of fuel pins. Activity is released from the rod gaps of the damaged pins and
transported to the reactor building atmosphere. Release is
through the reactor building vent for 30 sec. After 30 sec, 7
the reactor building ventilation is isolated and the release
is through the main stack via the standby gas treatment
system (SGTS).

A representative source is defined as the average rod-gap activity for eight rods as predicted for each isotope, assuming 1 week of decay has taken place. Gap activity is assumed to be 1 percent of the total activity in a pin. The activity is released underwater, and the retention factor of the water for iodine is assumed to be 500. The released activity is conservatively assumed to be instantaneously

7 available in the containment atmosphere. The reactor building vent exhaust is unfiltered. The main stack exhaust is passed through charcoal filters whose efficiency is assumed to be 99 percent for iodines.

7.1.1.5.2 Heavy Object Drop Onto Fuel in Core

A heavy object is assumed to be dropped onto the reactor core during the refueling operation, damaging the equivalent of one complete fuel assembly. Activity is released from the rod gaps of the damaged pins and transported to the reactor building atmosphere. Release is through the reactor 7 building vent for 30 sec. After 30 sec, the reactor building ventilation is isolated and the release is through the main stack via the standby gas treatment system (SGTS).

A representative source is defined as the average rod-gap activity for one fuel assembly as predicted for each isotope, assuming 100 hr of decay have taken place. The activity release mechanism is as described in Section 7.1.1.5.1.

7.1.1.6 Spent Fuel Handling Accident (Class 7 Accidents)

7.1.1.6.1 Fuel Assembly Drop in Fuel Storage Pool

A fuel assembly is assumed to be dropped into the fuel storage pool during refueling, damaging one row of fuel pins. Activity is released from the rod gaps of the damaged pins into the water.

A representative source is defined as the average rod-gap 7 activity for eight rods as predicted for each isotope, assuming 1 week of decay has taken place. Gap activity is assumed to be 1 percent of the total activity in a pin. The activity is released underwater, and the retention factor of the water for iodine is assumed to be 500. The released activity is assumed to be instantaneously exhausted through the main stack via the standby gas treatment system (SGTS) through charcoal filters whose efficiency is assumed to be 99 percent for iodines.

7.1.1.6.2 Heavy Object Drop Onto Fuel Rack

A heavy object is assumed to be dropped onto the spent fuel rack, damaging the equivalent of one complete fuel assembly. Activity is released from the rod gaps of the damaged pins 7 and transported to the reactor building atmosphere. Release is through the main stack via the SGTS.

A representative source is defined as the average rod-gap activity for one fuel assembly as predicted for each isotope, assuming 30 days of decay have taken place.

Gap activity is assumed to be 1 percent of the total activity in a pin. The activity is released underwater, and the retention factor of the water for iodine is assumed to be 500. The released activity is conservatively assumed to be instantaneously available in the containment atmosphere. The exhaust is passed through charcoal filters whose efficiency is assumed to be 99 percent for iodines. 7

7.1.1.6.3 Fuel Cask Drop

One fully loaded spent fuel shipping cask is assumed to fall off a truck while exiting the reactor building truck dock, damaging the equivalent of 24 fuel assemblies. Noble gas activity is released from the rod gaps of the damaged pins directly to the environment at a very high rate. 7

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A representative source is defined as the average noble gas rod-gap activity for 24 fuel assemblies as predicted for each isotope, assuming 120 days of decay have taken place. No ventilation systems or filters are considered in the release to the environment.

7.1.1.7 Accident Initiation Events Considered in Design Basis Evaluation in the Safety Analysis Report (Class 8 Accidents)

7.1.1.7.1 Loss-of-Coolant Accidents

7.1.1.7.1.1 Small Pipe Break

As a result of a postulated small pipe break inside the primary containment, 100 percent of the expected noble gas and halogen activity in the steam and 100 percent of the expected halogen activity in the water are assumed to be released. The total primary coolant mass releases are 279,000 kg (614,079 lb) of water and 11,700 kg (25,722 lb) of steam. This activity is assumed to leak from the primary containment at a rate of 1.1 percent per day; then it is mixed with 50 percent of the reactor building volume. The total leakage is assumed to be released through the SGTS charcoal filters, which are postulated to be 99 percent efficient for removal of iodine. Also, the dose reduction due to plateout and the decontamination factor in the suppression pool is assumed to be 20 percent for halogens. The dose at the EAB is calculated for a 30-day release period. |7

7.1.1.7.1.2 Large Pipe Break

The assumptions for a postulated accident of a large pipe break inside the primary containment are similar to those given in Section 7.1.1.7.1.1, except that an additional source corresponding to 0.2 percent of the core inventory of iodines and noble gases is assumed to be released instantaneously to the primary containment.

The representative source is defined as 100 percent of the expected noble gas and halogen activity in the steam, 100 percent of the expected halogen activity in the water, and an additional 0.2 percent of the core inventory of iodines and noble gases. The source is assumed to be instantly available to the primary containment leaks at 1.1 percent per day. This activity is mixed with 50 percent of the reactor building volume. The total leakage is assumed assumed to be released through the SGTS charcoal filters, which are assumed to be 99 percent efficent for removal of iodine. The dose reduction due to plateout and the decon-

tamination factor in the suppression pool is assumed to be 20 percent for halogens.

7.1.1.7.2 Break in Instrument Line from Primary System That Penetrates the Primary Containment

7 This event postulates that an instrument line with a 0.64-cm (0.25-in) restricting orifice carrying primary coolant ruptures in the reactor building. The inventory of the line is based on expected coolant activity. The dose reduction due to plateout and mixing is assumed to be 10 percent. Release is through the reactor building vent for 30 seconds. After 30 seconds, the reactor building ventilation is isolated and the release is through the main stack via the standby gas treatment system (SGTS). The main stack release is passed through the SGTS charcoal filters, which are assumed to be 99 percent efficient for removal of iodine.

7.1.1.7.3 Rod Drop Accident

This event postulates that a control rod is dropped out of the core, resulting in a transient which induces fuel failure. Activity is assumed to be carried to the condenser, where condenser leakage is released to the turbine building and subsequently to the atmosphere.

A representative source is defined as 0.025 percent of the core inventory of noble gases and halogens released to the reactor water. One percent of the halogens and 100 percent of the noble gases are assumed to be carried to the condenser, where all the noble gases and 10 percent of the halogens are available for leakage from the condenser to the environment via the turbine building at 0.5 percent per day, for 1 day, with no credit taken for holdup or plateout on the turbine building internal structures.

7.1.1.7.4 Steam Line Breaks

7.1.1.7.4.1 Small Pipe Break

This event is postulated as a sudden and complete severance of a small (0.023-sq m [0.25-sq ft]) steam line in the turbine building. As a result, an integrated quantity of 4.9×10^3 kg (1.07×10^4 lb) of steam is released. The
7 representative source is defined as 10 percent of the expected halogen activity in the reactor coolant and 100 percent of the expected noble gas activity in the reactor steam. The halogens and noble gases are released to the environment through the main stack via the turbine building ventilation system, which has no charcoal filtration.

7.1.1.7.4.2 Large Pipe Break

This event is postulated as the sudden, complete severance of a main steam line in the turbine building. The isolation signal is expected to occur within 0.5 sec after the break, and an additional 5 sec are assumed for effecting full closure of the main steam isolation valve. During this 5.5-sec period, an integrated quantity of 4.1×10^4 kg (9.13×10^4 lb) of water and 7.1×10^3 kg (1.56×10^4 lb) of steam are estimated to be released in the turbine building.

The representative source has been defined as 100 percent of the expected noble gas activity in the reactor steam and 50 percent of the halogens in the fluid exiting the break. The halogens and noble gases are released to the environment via the turbine building blowout panels.

7.1.2 Discussion of Plant Accidents and Methodology Used to Calculate Doses

Doses are calculated for a representative accident from each accident class defined in ERSP Section 7.1. Calculations of doses to individuals and the population are performed in accordance with the method and assumptions of ESRP Section 7.1 and the Regulatory Guides 1.3 and 1.145. Population doses are calculated by adjusting the individual doses by a factor that incorporates population density and X/Q values for each sector. 7

7.1.2.1 Estimates of Doses for Accidents

A summary of the radiological doses to an individual at the EAB is provided in Table 7.1-2. For each accident, the resultant thyroid, beta, and gamma doses are listed.

7.1.2.2 Man-Rem Values for Accidents

A summary of the population doses with an 80-km (50-mi) radius of Unit 2 is provided in Table 7.1-3. For each accident, the resultant thyroid, beta, and gamma population doses are listed.

7.1.3 Class 9 Accidents Analysis

The effect of Class 9 atmospheric accidents at Unit 2 is analyzed probabilistically by comparing the Unit 2 plant with a referenced BWR plant for which a full analysis has been completed. The reference BWR plant chosen for accident/event and system analyses is the Grand Gulf 1 (GG1) plant. The reference BWR chosen for primary containment

analysis is the Limerick plant. The consequence analysis is plant and site specific to Unit 2. Analysis methods are similar to those presented in the GC1 study (NUREG/CR-1659/4 of 4), WASH-1400 (NUREG-75/014), and the Limerick probabilistic risk assessment (Docket Nos. 50-352 and 50-353). Details of the analysis, results, and conclusions are presented in Appendix 7A.

The effects of Class 9 accident releases to the hydrosphere are analyzed by comparing key hydrologic, geologic, and environmental parameters at the Unit 2 site with those contained in the liquid pathway generic study (LPGS)
6 (NUREG 0440) for a Great Lakes' sited, land-based, commercial nuclear power plant. Details of the analysis, results, and conclusions are presented in Appendix 7D.

TABLE 7.1-1

REACTOR FACILITY - CLASSIFICATION OF POSTULATED ACCIDENTS AND OCCURRENCES

Class Description	Accident*	Plant Design Analyses
Trivial incidents	Releases in accordance with Appendix I to 10CFR50	Included in normal releases
Small releases outside containment	Spills, leaks, and pipe breaks	Included in normal releases
Radwaste system failures	Equipment leakage or malfunction (including operator error)	25 percent of charcoal bed activity - 2-hr release period
	Release of gas storage tank contents	100 percent of charcoal bed activity - 2-hr release period
	Release of liquid storage tank contents	100 percent of phase separator tank activity - 2-hr release period
Fission products to primary system	Fuel-cladding defects	Included in normal releases
	Off-design transients that induce fuel failure	0.02 percent core inventory release through condenser leakage - 24-hr release period
Refueling accidents	Fuel bundle drop	One row of fuel pins at 1-week decay - 2-hr release period
	Heavy object drop onto fuel in core	One assembly at 100-hr decay - 2-hr release period

TABLE 7.1-1 (Cont)

Class Description	Accident*	Plant Design Analyses
Spent fuel handling accident	Fuel assembly drop in storage pool	One row of fuel pins at 1-week decay - 2-hr release period
	Heavy object drop onto fuel rack	One assembly at 30 days decay - 2-hr release period
	Fuel cask drop	24 fuel assemblies at 120 days decay - 2-hr release period
Accident initiation events considered in design basis evaluation in the safety analysis report	Loss of coolant	Small and large break - 30-day release period
	Rod drop accident	0.025 percent core inventory with releases through condenser leakage - 24-hr release period
	Main steam line break	Small and large break - 2-hr release period

*As defined in ESRP Section 7.1.

TABLE 7.1-2

SUMMARY OF RADIOLOGICAL DOSES AT THE EXCLUSION AREA BOUNDARY

Accident	Thyroid Dose (Rem)	Total Beta Dose (Rem)	Total Gamma Dose (Rem)	
10CFR100 dose criteria	3.0+02*	-	2.5+01	
Equipment leakage or malfunction				
Liquid	2.30-03	8.50-07	3.35-06	
Gas	-	8.75-04	1.05-03	
Release of gas storage tank	-	3.5-03	4.2-03	
Release of liquid storage tank	9.18-03	3.40-06	1.34-05	
Off-design transients that induce fuel failure	8.86-04	1.66-04	2.27-04	
Fuel bundle drop	3.59-05	2.44-06	1.50-06	
Heavy object drop onto fuel in core	3.47-04	2.68-05	1.63-05	
Fuel assembly drop in storage pool	1.1-07	5.6-07	3.4-07	7
Heavy object drop onto fuel rack	1.11-07	2.99-07	1.32-07	
Fuel cask drop	-	3.72-04	3.83-06	
Loss-of-coolant -				
Small break	9.38-09	4.32-10	1.07-09	
Large break	2.30-03	6.57-05	8.72-05	
Instrument line break	1.57-07	2.22-09	9.62-09	
Rod drop accident	1.10-03	2.08-04	2.84-04	

TABLE 7.1-3

SUMMARY OF POPULATION DOSES WITHIN AN 80-KM (50-MI) RADIUS

Accident	Thyroid Dose (man-Rem)	Total Beta Dose (man-Rem)	Total Gamma Dose (man-Rem)
Radwaste equipment leakage or malfunction -			
Gaseous	-	8.16+00*	9.79+00
Liquid	2.14+01	7.92-03	3.12-02
Release of gas storage tank	-	3.26+01	3.91+01
Release of liquid storage tank	8.56+01	3.17-02	1.25-01
Off-design transients that induce fuel failure	8.36+00	1.57+00	2.13+00
Fuel bundle drop	3.83-01	2.76-01	1.68-01
Heavy object drop onto fuel in core	3.70+00	3.04+00	1.85+00
Fuel assembly drop in storage pool	5.17-02	2.63-01	1.60-01
Heavy object drop onto fuel rack	5.22-02	1.41-01	6.20-02
Fuel cask drop	-	3.47+00	3.57-02
Loss-of-coolant -			
Small break	3.50-03	1.72-04	4.44-04
Large break	8.02+02	2.44+01	3.49+01
Instrument line break	5.49-02	9.93-04	4.31-03
Rod drop accident	1.04+01	1.97+00	2.66+00

7

TABLE 7.1-3 (Cont)

Accident	Thyroid Dose (man-Rem)	Total Beta Dose (man-Rem)	Total Gamma Dose (man-Rem)
Main steam line -			
Small break	1.65-01	7.52-03	1.03-02
Large break	2.59+01	3.35-01	1.08-01

7

*8.16+00 = $8.16x10^0$ 7

NOTES: 1. Based on U.S. and Canadian population projected for the year 2000.
2. Natural background radiation is 6.56+01 mRem/yr.

7.2 TRANSPORTATION ACCIDENTS

The transportation of fuel and wastes to and from Unit 2 is within the scope of paragraph (g) of 10CFR51.20. The expected environmental risk for Unit 2 falls within the evaluation provided in Summary Table S-4 of 10CFR51.

APPENDIX 7A

PROBABILISTIC RISK ANALYSIS

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PROBABILISTIC RISK ANALYSIS (PRA)

7A.1 INTRODUCTION

The design and construction of Unit 2 has included considerable effort to produce a highly reliable and safe plant. This is achieved through correct design, manufacture, and installation of basic plant structures and components, within the context of an effective quality assurance program. Similar emphasis is placed on the operational aspects in terms of developing detailed procedures and providing for quality training of plant operating and maintenance personnel. In the very unlikely event that serious accidents might occur, the station is equipped with a complement of emergency safety features for mitigating the effects and consequences of such accidents.

In this appendix the potential environmental effects of postulated core melt accidents from internal initiators at Unit 2 are assessed. The assessment is done in a risk analysis format. That is, the probabilities of realizing various levels of consequences from a wide spectrum of possible but low probability accidents and associated environmental conditions are considered. The intent of such an analysis is to produce an assessment which realistically reflects the environmental risk from postulated accidents and which is responsive to the recent interim policy statement issued by the NRC regarding nuclear power plant accident assessments under the National Environment Policy Act. 2

7A.1.1 General Approach and Scope of Analysis

The Unit 2 risk analysis is performed using the methodology presented in WASH-1400, Reactor Safety Study (RSS)[1]. In October 1981, the RSS methodology was applied to four U.S. light-water reactors (LWR), one of which was Grand Gulf 1 (GG1). The GG1 results are presented in the following report: Reactor Safety Study Methodology Applications Program: Grand Gulf 1 BWR Power Plant (RSSMAP)[2]. GG1 is a MARK III/BWR 6, while Unit 2 uses the MARK II/BWR 5 design. For the safety-related systems (including reactor core isolation cooling [RCIC]), the designs are identical, with the exception of some improvements in certain systems at Unit 2. Therefore, the systems analysis and accident sequence analysis presented in the Reactor Safety Study Methodology Applications Program for GG1 are used for performing the Unit 2 analyses. Equipment failure data,

operator failure data, and similar information are taken from WASH-1400 unless otherwise stated.

Recent risk assessments clearly indicate that the risk from LWR power plants is dominated by the severe accidents[1,2]. Since the observation is based upon a comparative evaluation rather than upon absolute assessed risk, it is applicable to any particular LWR power plant. Accordingly, the scope of the present analysis for Unit 2 emphasizes consideration of environmental effects from postulated severe accidents.

The offsite consequences of the specified releases are evaluated in this study using a similiar calculational mechanism as was used in WASH-1400[1], but the weather data file and the population distributions used are specific to the site. The treatment of evacuation in the analysis also utilizes population movement data that have been developed from actual site survey studies.

The particular methodologies employed in both the accident frequency determinations and in the consequence assessment portions of the analysis are discussed in more detail in the following sections. The combined risk assessment results for all accident release categories are displayed in probabilistic format. These results adopt many of the measures of risk that are customarily used in probabilistic risk assessments of nuclear facilities..

7A.2 SYSTEMS ANALYSIS

In lieu of developing detailed fault trees for safety-related systems, Unit 2 systems are analyzed in the same manner as the GG1 study; that is, system failures are determined by writing the Boolean equation for the system and then substituting failure rate data into the equations to calculate system unavailability. The same types of failures as analyzed in a fault tree are analyzed in tabular format. These types of failures are:

1. Hardware failures.
2. Maintenance outage.
3. Valve plugged.
4. Testing outage.
5. Initiating circuit failure.

The following accident cases were chosen for Unit 2:

1. Transient requiring reactor scram initiated by the loss of offsite power, designated transient T_1.
2. Transient requiring reactor scram initiated by the loss of the power conversion system (PCS) or reactor scram initiated by other causes (except loss of offsite power) where the PCS is initially available, designated transient T_{23}. Offsite and/or onsite emergency power is assumed to be available during T_{23}.
3. Small loss-of-coolant accident (LOCA) where the equivalent leak diameter is less than 34 cm (13.5 in), designated S.

In the GG1 study and in the RSS, these cases were the initiating events that mostly contributed to risk; therefore, system unavailabilities are calculated for these cases only. Transients, not LOCAs, strongly dominate the risk in BWRs. The Boolean reduction of the transient and LOCA event trees in this study came directly from the GG1 study. Large LOCAs were several orders of magnitude less significant than small LOCAs and transients.

The following safety-related systems are analyzed:

1. Reactor protection system (RPS).
2. Emergency ac power system (EPS).
3. DC power system (DCPS).
4. Vapor suppression system (VSS).
5. High-pressure core spray system (HPCS).
6. Reactor core isolation cooling system (RCIC).
7. Low-pressure core spray system (LPCS).
8. Automatic depressurization system (ADS).
9. Low-pressure coolant injection system (LPCI).
10. Residual heat removal system (RHR).
11. Service water system (SW).

A brief system description is presented in the following paragraphs. Table 7A.2-1 provides a listing of the calculated system unavailabilities for Unit 2.

7A.2.1 Reactor Protection System

The RPS consists of two subsystems: the reactor protection system logic (RPSL) and the control rod drive (CRD) system. The RPSL monitors various plant parameters and systems status and initiates a reactor scram if predetermined values are reached. When a scram is initiated by the RPS, the CRD system inserts negative reactivity necessary to shut down the reactor. Each control rod is individually controlled by a hydraulic control unit (HCU). When a scram signal is received, high-pressure water stored in an accumulator in the HCU or reactor pressure forces the control rod into the core.

1 Complete descriptions of these subsystems are provided in FSAR Sections 7.1.1, 3.9.4B, and 4.6, respectively.

7A.2.2 Emergency AC Power System

A standby power supply system is provided for the operation of emergency systems and engineered safety features (ESF) during and following the shutdown of the reactor when the preferred power supply is not available. The standby power supply system consists of three standby diesel generators. One generator is dedicated to each of the three divisions of the safety-related electric power distribution system feeding each Class 1E load group. Any two of the three standby diesel generators have sufficient capacity to start, and accelerate to rated speed, all needed ESFs and emergency shutdown loads in case of a LOCA and/or loss of offsite power. The standby diesel generator fuel oil storage tanks are sized to hold a 7-day supply of fuel oil based on the engine running continuously at full load. A LOCA and/or loss of offsite power signal initiates start of the standby diesel generators and the generators pick up the loads in a programmed sequence. Standby diesel generators are independent and feed separate load groups through separate physically and electrically isolated distribution systems.

A full description of the EPS is provided in FSAR Section 8.3.1.

7A.2.3 DC Power System

A 125-V emergency dc power system feeds all safety-related dc protection, control and instrumentation loads, and safety-related dc motors under normal operation of the plant as well as during emergency conditions. The system is divided into three redundant divisions each consisting of its own battery, primary and backup battery chargers, switchgears/motor control centers, and distribution panels. Each division feeds dc loads associated with corresponding divisions of the safety-related electric power distribution system. Batteries and battery chargers are redundant and feed separate load groups through separate and isolated distribution systems.

A complete description of the dc power system is provided in FSAR Section 8.3.2.

7A.2.4 Vapor Suppression System

The VSS consists of the primary containment structure, the downcomer piping from the drywell air space to the suppression pool, and the containment spray system.

The primary containment structure is a steel-lined, reinforced concrete structure consisting of a conical drywell chamber above a cylindrical suppression pool chamber separated by a drywell floor. The downcomer piping system consisting of 122 25-cm (10-in) diameter pipes penetrate the drywell floor and direct steam emitted from a LOCA into the suppression pool resevoir where it is quenched. The containment spray system consists of two redundant subsystems, each with its own full-capacity spray header. Each subsystem is supplied from a separate, redundant RHR loop.

A complete description of the VSS is provided in FSAR Section 6.2.

7A.2.5 High-Pressure Core Spray System

The HPCS system provides and maintains an adequate coolant inventory inside the reactor pressure vessel (RPV) to limit fuel cladding temperatures in the event of a LOCA. The system is initiated by either high pressure in the drywell or low water level in the vessel, and pumps water from the condensate storage tanks (preferred source) or the suppression pool (backup source) directly into the RPV via an electrically driven pump. It operates independently of all other systems over the entire range of pressure differences from greater than normal operating pressure to zero. The HPCS cooling decreases vessel pressure to enable the low-pressure cooling systems to function. The HPCS system pump motor is powered by a dedicated onsite diesel generator if offsite power is not available. The system may also be used as a backup for the RCIC system.

A complete description of the HPCS system is provided in FSAR Section 6.3.

7A.2.6 Reactor Core Isolation Cooling System

The RCIC system provides makeup water to the RPV from the condensate storage tanks (preferred) on the suppression pool (backup) when the vessel is isolated. The RCIC system uses a steam-driven turbine-pump unit and automatically operates to maintain adequate water level in the RPV.

A complete description of the RCIC system is provided in FSAR Section 5.4.6.

7A.2.7 Low-Pressure Core Spray System

The LPCS system consists of one independent pump and valves and piping to deliver cooling water from the suppression pool to a spray sparger over the core. The system is actuated by either low water level in the RPV or high pressure in the drywell, but water is delivered to the core only after RPV pressure is reduced. This system provides the capability to cool the fuel by spraying water into each fuel channel. The LPCS loop functioning in conjunction with the ADS or HPCS can provide sufficient fuel cladding cooling following a LOCA.

A complete description of the LPCS system is provided in FSAR Section 6.3.

7A.2.8 Automatic Depressurization System

The ADS rapidly reduces RPV pressure in a LOCA situation in which the HPCS system fails to maintain the RPV water level. The depressurization provided by the system enables the low-pressure emergency core cooling system (ECCS) to deliver cooling water to the RPV. The ADS uses some of the relief valves that are part of the nuclear system pressure relief system. The automatic relief valves are arranged to open on conditions indicating both that a break in the reactor coolant pressure boundary (RCPB) has occurred and that the HPCS system is not delivering sufficent cooling water to the RPV to maintain the water level above a preselected value. The ADS is not activiated unless either the LPCS or LPCI pumps are operating. This is to ensure that adequate makeup coolant is available for core delivery prior to allowing coolant loss through the relief valves.

A complete description of the ADS is provided in FSAR Sections 5.4.13 and 6.3.

7A.2.9 Low-Pressure Coolant Injection

LPCI is an operating mode of the RHR system, but is discussed here because the LPCI mode acts as an ESF in conjunction with the other ECCSs. LPCI uses the pump loops of the RHR to inject cooling water into the RPV from the suppression pool. LPCI is actuated by either low water level in the RPV or high pressure in the drywell, but water is delivered to the core only after RPV pressure is reduced. LPCI operation provides the capability of core reflooding, following a LOCA, in time to maintain the fuel cladding below the prescribed temperature limit.

A complete description of the LPCI operating mode of the RHR system is provided in FSAR Sections 5.4.7 and 6.3.

7A.2.10 Residual Heat Removal System

The RHR system is a system of pumps, heat exchangers, and piping that fulfills the following functions:

1. Removes decay and sensible heat during and after plant shutdown.

2. Injects water into the RPV following a LOCA to reflood the core independently of other core cooling systems.

3. Removes heat from the containment following a LOCA, to limit the increase in containment pressure. This is accomplished by cooling and recirculating the suppression pool water (containment cooling) and by spraying the drywell and suppression pool air spaces (containment spray) with suppression pool water.

A complete description of the RHR system, is provided in FSAR Sections 5.4.7 and 6.3.

7A.2.11 Service Water System

The SW system provides cooling water to various essential and nonessential components throughout the plant. Essential components are serviced by two 100-percent redundant subsystems. The nonessential components will be automatically isolated upon receipt of a LOCA signal coincident with a loss of offsite power. The SW pumps take their suction from Lake Ontario via the screenwell complex and intake tunnels. After passing through the system, the discharge is returned to the lake and to the circulating water system as makeup.

A complete description of the SW system is provided in FSAR Section 9.2.1.

7A.2.12 Systems Analysis Summary

Table 7A.2-1 shows a comparison between Unit 2 and Peach Bottom 2 (PB2) (RSS) for those systems analyzed in Sections 7A.2.1 through 7A.2.11. The PB2 values are median unavailabilities computed using a Monte Carlo statistical simulation. The Unit 2 and GG1 values are point estimates

of unavailabilities computed for different initiating events, i.e., LOCA (S) and transients (T_1 and T_{23}).

The system unavailabilities presented in Table 7A.2-1 represent independent unavailabilities because system interactions are not represented. To properly analyze unavailability, the interactions and system successes must be factored into the problem, which is done in Section 7A.3, where the event sequence probabilities are developed. The system success and failure Boolean equations, not the numerical system unavailability values, are properly combined according to the laws of Boolean algebra. However, computing the numerical values does provide an indication of what dominates the system unavailability.

TABLE 7A.2-1

COMPARISON OF SYSTEM UNAVAILABILITIES
BETWEEN UNIT 2, PB2, AND GG1

System	Median Unavailability PB2 (from RSS)	GG1 Unavailability	Unit 2 Unavailability
RPS	1.3×10^{-5}	RPS(S, T_{23}) 7.7×10^{-6} RPS(T_1) 5.8×10^{-6}	RPS(S,T_{23}) 7.7×10^{-6} RPS(T_1) 5.8×10^{-6}
EPS[1]	1×10^{-6}	6×10^{-5}	5.0×10^{-6}
DCPS	1×10^{-3}	1×10^{-3}	1×10^{-3}
VSS	Large LOCA 4.6×10^{-5} Small LOCA 1.6×10^{-3}	8.0×10^{-5}	5.5×10^{-5}
HPCS/HPCI	HPCI 9.8×10^{-2}	HPCS(S) 2.2×10^{-2} HPCS(T_1) 3.3×10^{-2} HPCS(T_{23}) 2.2×10^{-2}	HPCS(S) 4.0×10^{-2} HPCS(T_1) 4.0×10^{-2} HPCS(T_{23}) 3.8×10^{-2}
RCIC	8×10^{-2}	5.2×10^{-2}	6.7×10^{-2}
LPCS/CSIS	CSIS(one loop) 6×10^{-2} CSIS(both loops) 9.5×10^{-4}	LPCS(S,T_{23}) 2.2×10^{-2} LPCS(T_1) 3.5×10^{-2}	LPCS(S,T_1,T_{23}) 3.6×10^{-2}
ADS	5×10^{-3}	ADS(S) 5×10^{-3} ADS(T_1,T_{23}) 1.5×10^{-3}	ADS(S) 5×10^{-3} ADS(T_1,T_{23}) 1.5×10^{-3}
LPCI	1.5×10^{-2}	LPCIA,B(S) 2.8×10^{-2} LPCIA,B(T_1) 4.1×10^{-2} LPCIA,B(T_{23}) 2.8×10^{-2} LPCIC(S) 2.3×10^{-2} LPCIC(T_1) 3.6×10^{-2} LPCIC(T_{23}) 2.3×10^{-2}	LPCIA,B(S) 3.1×10^{-2} LPCIA,B(T_1) 3.1×10^{-2} LPCIA,B(T_{23}) 2.8×10^{-2} LPCIC(S) 2.6×10^{-2} LPCIC(T_1) 2.6×10^{-2} LPCIC(T_{23}) 2.3×10^{-2}
RHR/LPCRS[2]	LPCRS 1.2×10^{-4}	RHR(S) 3.0×10^{-3} RHR(T_1,T_{23}) 2.7×10^{-4}	RHR(S) 4.3×10^{-3} RHR(T_1, T_{23}) 8.5×10^{-6}

TABLE 7A.2-1 (Cont)

System	Median Unavailability PB2 (from RSS)	GG1 Unavailability	Unit 2 Unavailability
Service Water/ HPSWS and ESWS[3]	HPSWS(30 min) 4.3×10^{-4} HPSWS(25 hr) 1.1×10^{-4} ESWS 1.2×10^{-4}	SSWA,B(S) 2.2×10^{-2} SSWA,B(T_1) 2.3×10^{-2} SSWA,B(T_{23}) 2.2×10^{-2} SSWC(S) 1.5×10^{-2} SSWC(T_1) 1.6×10^{-2} SSWC(T_{23}) 1.5×10^{-2}	SWA,B(S) 5.5×10^{-3} SWA,B(T_1) 2.7×10^{-3} SWA,B(T_{23}) 2.7×10^{-3}

[1]All unavailabilities shown are on a per reactor-year basis.

[2]This unavailability represents total loss of ac power (offsite and onsite). The Unit 2 calculation of total loss of ac power is: $T_1*EPS1*EPS2*EPS3 = (5.9\times10^{-2})*(4.8\times10^{-2})*(4.8\times10^{-2})*(3.7\times10^{-2}) = 5.0\times10^{-6}$

[3]The PB2 value of LPCRS is completely dominated by failure to cool the CSIS and LPCI pump rooms, which is caused by ESWS failures.

[4]The combined Unit 2 service water unavailability is: $(2.7\times10^{-3})*(2.7\times10^{-3}) = 7.3\times10^{-6}$ for transients and $(5.5\times10^{-3})*(5.5\times10^{-3}) = 3.0\times10^{-5}$ for LOCAs.

KEY:
- CSIS = Core spray injection system
- LPCIA,B,C = LPCI loops A,B, or C
- LPCRS = Low-pressure coolant recirculation system
- SSWA,B,C = Standby service water loop A, B, or C
- SWA,B = Service water loop A or B
- HPSWS = High-pressure service water system
- ESWS = Emergency service water system

7A.3 ACCIDENT SEQUENCES

Accidents are analyzed using the event tree methodology presented in the RSS. Separate event trees are developed for transients and LOCAs. The event tree method shows, in a logical manner, which event sequences lead to core melt and which sequences result in an adequately cooled core. Event sequences are defined as combinations of required system operations in which one or more systems fail to perform as designed to protect the core. Symbols for event trees in this section are listed in Table 7A.3-1.

7A.3.1 Transient Event Tree

The transient event tree for Unit 2 is shown on Figure 7A.3-1. Transients considered are those that are anticipated, are not LOCA-induced, and require prompt reactor shutdown. Functions required to mitigate the effects of these transients are:

1. The reactor must be rapidly brought to a subcritical condition.

2. Reactor coolant system pressure must be controlled and kept from exceeding a value that would fail the RCPB.

3. RPV level must be maintained above the top of the active fuel bundles.

4. Core decay heat must be transferred to the ultimate heat sink (UHS).

System operations (or combinations of systems) that perform these functions are the column headings of the event tree and are described as follows:

1. The RPS promptly renders the reactor subcritical, if it functions properly, by rapidly inserting all control rods into the core. Subcriticality can also be effected by use of alternative shutdown systems, such as recirculation pump trip (RPT), initiation of poison injection (standby liquid control [SLC] system), and alternate rod insertion. These alternative functions are actuated manually.. Collectively, these functions, as installed at Unit 2, are referred to as ATWS Mod 2A.

2. The safety/relief valves (SRVs) perform the pressure control function. Both the opening of the

valves at high pressure and the proper reseating of valves are considered in the analysis.

3. Several systems provide makeup water to the core after a transient. The low-pressure systems require that the ADS functions properly in order to lower RPV pressure and allow delivery to the core. Systems designated as core makeup systems are:

   a. PCS (consisting of feedwater and condensate)

   b. HPCS

   c. RCIC

   d. LPCS

   e. LPCI

4. The PCS or the RHR system, in conjunction with the SW system, must function to remove decay heat from the core and transfer it to the UHS (Lake Ontario).

Systems required to perform successfully during a transient are summarized in Table 7A.3-2.

7A.3.2 LOCA Event Tree

The LOCA event tree for Unit 2 is shown on Figure 7A.3-2. Functions required to mitigate the effects of a LOCA are:

1. The reactor must be rapidly brought to a subcritical condition.

2. The core must be kept covered and cooled.

3. Overpressurization of the containment must be prevented.

4. Radioactive material must be prevented from escaping to the environment.

Systems that perform these functions are the column headings of the event tree and are as follows:

1. The RPS or ATWS Mod 2A components promptly render the reactor subcritical.

2. Several systems are available to make up core inventory lost through a leak: HPCS, RCIC, LPCS, and LPCI. For small leaks, ADS is necessary to depressurize the RPV in order to allow LPCS and/or LPCI operation. For large leaks, the RPV will depressurize through the leakage path and the ADS is not required. Although RCIC is not an ECCS, it is effective in providing makeup water during small LOCAs and credit is taken for its operation and account is made for its failure to operate over the whole spectrum of small LOCAs (up to 34-cm [13.5-in] equivalent diameter). The RSS assumed credit for RCIC only up to 5-cm (2-in) diameter leaks. In the GG1 study (BWR 6), credit was taken for RCIC during all small LOCAs, and the difference in final overall core melt probability was less than 1 percent. Therefore, credit for RCIC during all small LOCAs is assumed for Unit 2.

   No credit for the PCS is taken for injection or long-term cooling, because the PCS may be isolated by main steam isolation valve (MSIV) closure at the outset of the accident . In addition, the manual actions required to recover PCS renders it inoperable during the initial stages of the accident.

3. The VSS is expected to quench steam emitted from the reactor coolant system throughout a LOCA. Failure of the VSS to perform this function could eventually compromise containment integrity. As the event progresses, the suppression pool will heat up, requiring the RHR and SW systems to function to remove heat in the suppression pool cooling mode or containment spray mode.

4. The VSS also plays an important role in limiting the emission of radioactive material to the environment. As steam is condensed in the suppression pool, radioactive material is deposited in the pool. Also, the containment spray mode of the RHR system scrubs radioactivity from the containment atmosphere. Successful containment spray requires successful RHR system operation.

Systems required to successfully operate are summarized in Table 7A.3-3.

7A.3.3 Accident Sequence Summary

The following sections provide a short description and the probability for each dominant accident sequence for Unit 2.

7A.3.3.1 Sequence T_1PQI

This sequence is initiated by a loss of offsite power followed by an SRV failing to reseat, a failure of the PCS, and a failure of the RHR system to remove decay heat.

When an SRV fails to reseat, the suppression pool will heat up due to the constant deposition of core decay heat in the pool. Failure of the RHR system to remove this heat will eventually overpressurize the containment.

Recovery of the PCS requires the recovery of offsite power. Terms LOPNRS and LOPNRL reflect the failure to accomplish this within 28 hr. Since long-term failures are required to cause core melt in this sequence, a recovery factor is applied to all cut sets, which accounts for plant personnel attempting to restore or repair critical equipment or to take other possible corrective actions to mitigate the event.

The most probable cut sets are dominated by the inability to recover offsite power, failure of onsite emergency power, and RHR system hardware faults.

The probability of occurrence for sequence T_1PQI is $5.8x10^{-10}$/reactor-year.

7A.3.3.2 Sequence $T_{23}PQI$

This sequence is initiated by a T_{23} transient, followed by the same failures as T_1PQI. The same recovery factor used in sequence T_1PQI is applied in sequence $T_{23}PQI$. The most probable cut sets are dominated by failure of the PCS to remove decay heat long term (even with ac power available) and valve failures in the RHR system that prevent the suppression pool from being cooled.

The probability of occurrence of sequence $T_{23}PQI$ is $3.2x10^{-6}$/reactor-year.

7A.3.3.3 Sequence T_1PQE

This sequence is initiated by a loss of offsite power, followed by an SRV failing to reseat, a failure of PCS (due to unavailability of ac power), and a failure of core makeup (ECCS) systems to deliver water to the RPV.

Core makeup can be accomplished by HPCS, RCIC, LPCS, or two of three LPCI loops. LPCS and LPCI require ADS operation to lower RPV pressure. It is assumed that the transient does not automatically initiate ADS; therefore, the operator must perform this action. Failure to make up water to the RPV with a stuck-open relief valve will quickly lead to core melt.

The PCS will be interrupted shortly after the sequence develops, when the MSIVs close on low RPV level or low steam pressure. No credit is taken for PCS providing core makeup because of the relatively long period of time required to restore the steam, feedwater, and condensate systems to operation. Since this sequence is not long term, the recovery factor is not included.

The most probable cut sets are dominated by RCIC and HPCS hardware faults, ac power unavailability, and operator failure to actuate ADS.

The probability of occurrence of sequence T_1PQE is $2.4x10^{-8}$/reactor-year.

7A.3.3.4 Sequence $T_{23}PQE$

This sequence is initiated by a T_{23} transient followed by the same failures as sequence T_1PQE. The most probable cut sets are dominated by HPCS and RCIC hardware (mechanical and electrical) faults and the failure of the operator to manually initiate the ADS.

The probability of occurrence of sequence $T_{23}PQE$ is $2.1x10^{-6}$/reactor-year.

7A.3.3.5 Sequence SI

This sequence is initiated by a small LOCA followed by a failure of the RHR system to remove decay heat from the suppression pool. Failure to cool the pool will eventually cause containment failure due to overpressure. No credit for the PCS is taken in this sequence because it is assumed that the MSIVs will be shut during the accident. Since this

is a long-term sequence, the recovery factor for long-term cooling is incorporated.

The most probable cut sets are dominated by RHR hardware faults and SW loop B hardware faults.

The probability of occurrence of sequence SI is 1.0×10^{-6}/reactor-year.

7A.3.3.6 Sequence T_1QW

This sequence is initiated by a loss of offsite power, followed by the unavailability of the PCS and RHR system. Failure to remove decay heat from the suppression pool within about 28 hr will eventually cause containment failure due to overpressure. Successful operation of either the PCS or RHR system will require ac power (offsite power to operate the PCS). This is reflected in the cut sets. Since this sequence involves long-term failures, the recovery factor is applied to each cut set.

The most probable cut sets are dominated by ac power system failures and RHR system valve failures.

The probability of occurrence of sequence T_1QW is 3.5×10^{-9}/reactor-year.

7A.3.3.7 Sequence $T_{23}QW$

This sequence is initiated by a T_{23} transient and is followed by the same failures as sequence T_1QW. Since ac power is available, other failures within the PCS must cause its unavailability. This is accounted for by the term Q in the cut sets. Also, this is a long-term failure sequence; therefore, the recovery factor has been included.

The most probable cut sets are dominated by PCS unavailability, RHR system valve failures, and SW loop hardware failures.

The probability of occurrence of sequence $T_{23}QW$ is 1.1×10^{-5}/reactor-year.

7A.3.3.8 Sequence T_1QUV

This sequence is initiated by a loss of offsite power followed by the unavailability of the PCS and a failure of the high-pressure and low-pressure core makeup systems to deliver water to the RPV. Failure to keep the core covered will quickly lead to core melt and containment failure due

to overpressure or hydrogen burning. Credit is not taken for the PCS because it is assumed that offsite power cannot be restored within 1/2 hr. Successful low-pressure makeup depends upon the operator manually actuating the ADS, because it is assumed that system parameters do not reach automatic ADS set points. This is a short-term sequence; therefore, no recovery factor is included.

The most probable cut sets are dominated by failure to recover offsite power within 1/2 hr, diesel failures, operator failure to manually actuate the ADS, and HPCS/RCIC hardware failures.

The probability of occurrence of sequence T_1QUV is $3.1x10^{-7}$/reactor-year.

7A.3.3.9 Sequence $T_{23}C$

This sequence is initiated by a T_{23} transient followed by a failure to achieve reactor subcriticality. Failure of the RPS and the operator is expected to leave reactor power low in the power range. The SRVs will lift to reject heat to the suppression pool; however, this heat load is beyond the heat removal capability of the RHR system and will cause containment failure due to overpressure. It is assumed ECCS pumps will cavitate and fail due to suppression pool boiling, which will lead to core melt.

The probability of occurrence of sequence $T_{23}C$ is 5.4×10^{-6}/reactor-year.

The following is a summary of Unit 2 dominant accident sequence probabilities:

T_1PQI	$5.8x10^{-10}$
$T_{23}PQI$	$3.2x10^{-6}$
T_1PQE	$2.4x10^{-8}$
$T_{23}PQE$	$2.1x10^{-6}$
SI	$1.0x10^{-6}$
T_1QW	$3.5x10^{-9}$
$T_{23}QW$	$1.1x10^{-5}$
T_1QUV	$3.1x10^{-7}$
$T_{23}C$	$5.4x10^{-6}$

Total core melt frequency is $2.4x10^{-5}$.

Table 7A.3-4 provides a comparison of predicted core melt frequencies between Unit 2 and several other BWRs.

The preceding sequence probabilitues are combined with the containment failure mode probabilities . developed in Section 7A.4 to produce the BWR release category probabilities for Unit 2 in Section 7A.5.

TABLE 7A.3-1

ACCIDENT SEQUENCE SYMBOLS

Initiating Events

T_1 = Loss of offsite power-induced transient

T_{23} = Any other transient requiring reactor scram

S = Small LOCA (break diameter < 34 cm (13.5 in)

System, Component, and Functional Failures

C = Failure to make the reactor subcritical

D = Failure of the VSS

E = Failure to keep the core covered

I = Failure of RHR after LOCA (including transient-induced LOCA)

M = Failure of SRVs to open

P = Failure of SRVs to reseat

Q = Failure of the PCS

U = Failure of HPCS and RCIC

V = Failure of low-pressure ECCS to provide core makeup

W = Failure of RHR after transient

TABLE 7A.3-2

SYSTEM SUCCESS COMBINATIONS
FOR TRANSIENTS

Reactor Subcriticality	Overpressure Protection	Core Makeup	Decay Heat Removal
RPS inserts all control rods rapidly	SRVs open at high-pressure set point and reclose properly at reseat set point	PCS	PCS
OR		OR	OR
ATWS Mod 2A systems function to shut down the reactor (alternate rod insertion, recirculation pump trip, automatic poison injection)		HPCS	RHR loop A and SW loop A in suppression pool cooling mode
		OR	OR
		RCIS	RHR loop A AND SW loop A in steam condensing mode
		OR	OR
		ADS AND LPCS	RHR loop B AND SW loop B in suppression pool cooling mode
		OR	OR
		ADS AND 2 of 3 LPCI loops	RHR loop B and SW loop B in steam condensing mode

TABLE 7A.3-3

SYSTEM SUCCESS COMBINATIONS
FOR LOCA'S

LOCA Size	Reactor Subcriticality	Core Makeup	Early Containment Overpressure Protection	Long-Term Containment Overpressure Protection	Post-Accident Radioactivity Removal
Greater than 34 cm (13.5 in) large LOCA	RPS OR ATWS Mod 2A components	HPCS OR LPCS OR All 3 LPCI loops	VSS	RHR loop A AND SW loop A in suppression pool cooling mode or spray mode OR RHR loop B AND SW loop B in suppression pool cooling mode or spray mode	VSS (including containment sprays)
Less than 34 cm (13.5 in) small LOCA	RPS ATWS Mod 2A components	RCIC OR HPCS OR ADS AND LPCS OR ADS AND 2 of 3 LPCI loops	VSS	RHR loop A AND SW loop A in suppression pool cooling mode or spray mode OR RHR loop B AND SW loop B in suppression pool cooling mode or spray mode	

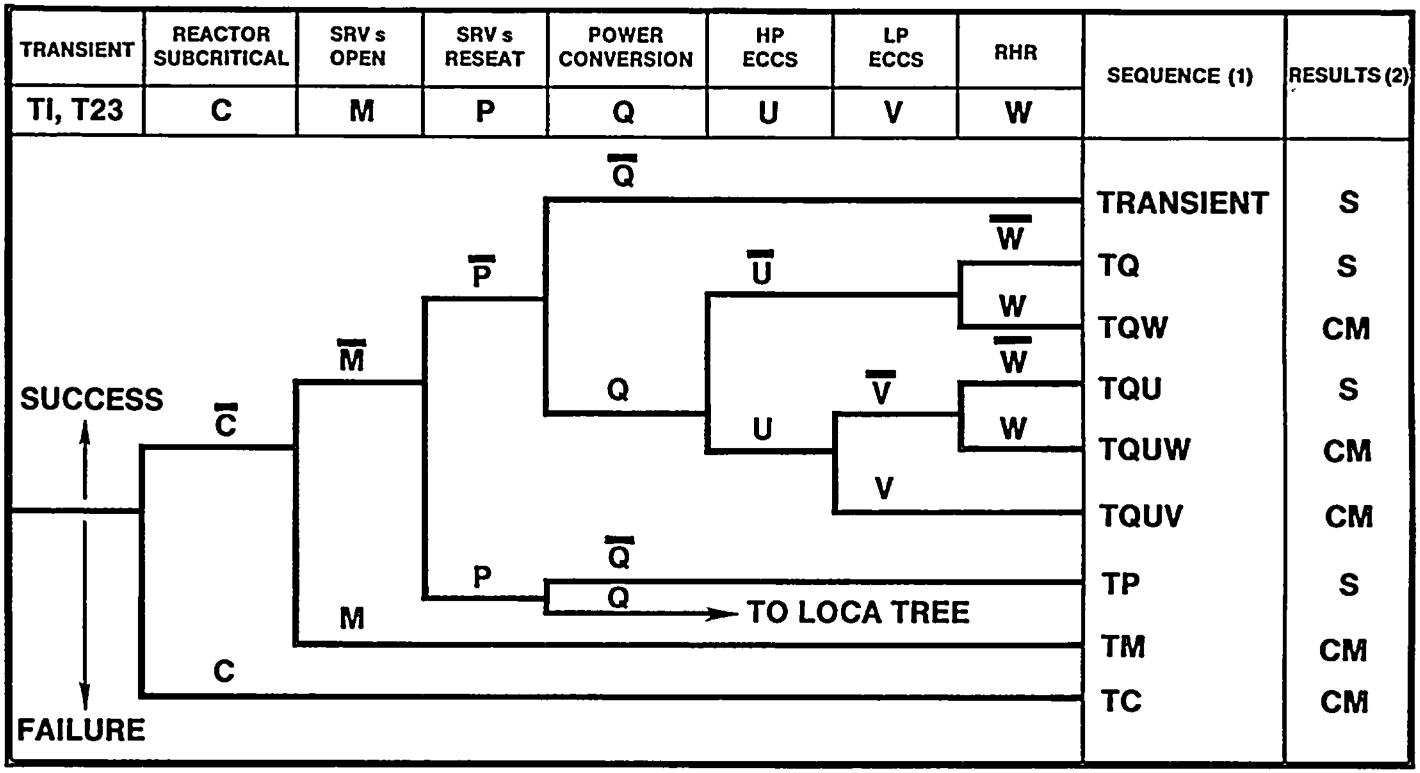
TABLE 7A.3-4

COMPARISON OF PREDICTED CORE MELT FREQUENCIES

BWR Plant	Core Melt Frequency (per reactor-year)
Peach Bottom 2 (BWR 4/MK I)	3.0×10^{-5}
Big Rock Point (early vintage BWR)	1.0×10^{-3}
Limerick (BWR 4/MK II)	1.5×10^{-5}
Grand Gulf 1 (BWR 6/MK III)	3.6×10^{-5}
Nine Mile Point 2 (BWR 5/MK II)	2.4×10^{-5}

SOURCES: Peach Bottom 2 - RSS (Reference 1)
Big Rock Point - IDCOR Program (Reference 3)
Limerick - Limerick PRA (Reference 4)
Grand Gulf 1 - RSSMAP - GG1 (Reference 2)

UNIT 2 TRANSIENT EVENT TREE



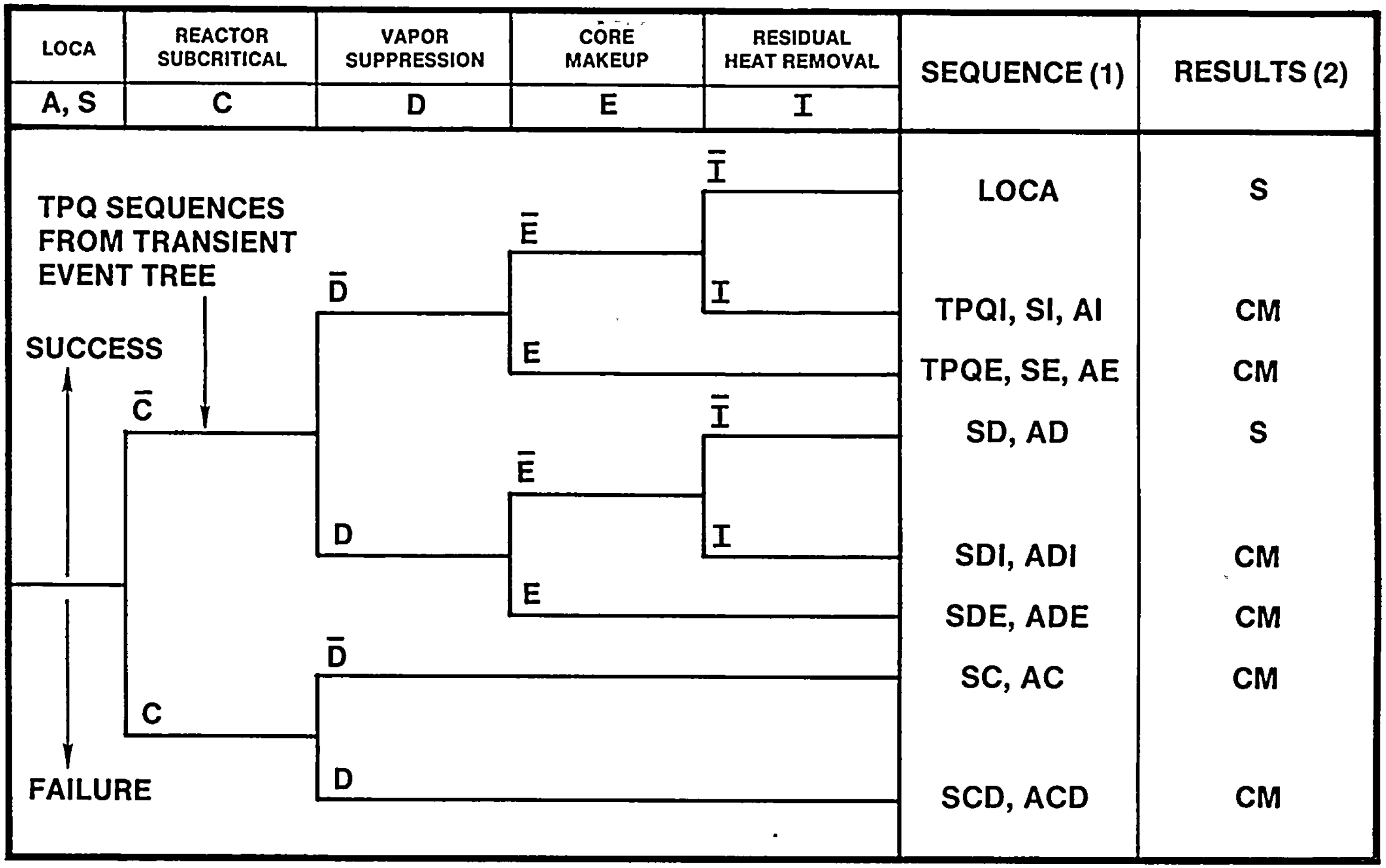
(2) KEY TO RESULTS
S = SAFE CONDITION
CM = CORE MELT EXPECTED

(1) SEQUENCES ARE DESIGNATED ONLY IN TERMS OF SYSTEM FAILURES; e.g., SEQUENCE TP IS ACTUALLY TCMP; TAKING THE SUCCESS OF C AND M INTO ACCOUNT, HOWEVER, C AND M ARE APPROXIMATELY EQUAL TO ONE BECAUSE C AND M ARE VERY LOW PROBABILITIES ($\overline{C}$ = 1-C≈1) AND ARE, THEREFORE, NOT INCLUDED IN SEQUENCE DESIGNATIONS.

FIGURE 7A. 3-1

UNIT 2 TRANSIENT
EVENT TREE

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS



(1) SEQUENCES ARE DESIGNATED ONLY IN TERMS OF SYSTEM FAILURES; e.g. SEQUENCE SI IS ACTUALLY SCDEI ACCOUNTING FOR THE SUCCESS OF C, D, AND E; HOWEVER, C, D, AND E ARE ALL APPROXIMATELY EQUAL TO 1 BECAUSE C, D, AND E ARE ALL VERY LOW PROBABILITY EVENTS ($\bar{C} = 1\text{-}C \approx 1$) AND, THEREFORE, SUCCESS TERMS ARE NOT INCLUDED IN SEQUENCE DESIGNATIONS.

(2) KEY TO RESULTS:
S = SAFE CONDITION
CM = CORE MELT EXPECTED

FIGURE 7A.3-2

LOCA EVENT TREE

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS

7A.4 CONTAINMENT ANALYSIS

The Unit 2 containment employs the BWR Mark II design (Figure 7A.4-1) as opposed to the Mark I design utilized by the RSS BWR. The Limerick Generating Station also uses the Mark II design. The Limerick containment is fully analyzed in the Limerick PRA (Reference 4). While both designs employ the pressure suppression concept, the major difference is the internal configuration of the drywell and its relationship to the wetwell. Both containment atmospheres are inerted during operation.

7A.4.1 Containment Event Tree

The containment event tree for the Unit 2 analysis was developed from the Limerick and RSS BWR containment event trees, with a few modifications as follows:

1. Although the Unit 2 containment will be inerted, the analysis considers generation of a combustible gas mixture and subsequent containment failure due to burning or detonation. The reason for this assumption is that there will be short periods prior to shutdown and after startup when the containment will be deinerted. Credit is not taken for the presence of hydrogen recombiners even though redundant safety-grade combiners are installed.

2. Containment isolation system failure causing significant containment leakage is included in the containment event tree.

The resultant containment event tree is shown on Figure 7A.4-2. Symbology for this figure is listed in Table 7A.4-1.

TABLE 7A.4-1

CONTAINMENT FAILURE MODE SYMBOLS

Containment Failure Modes After Core Melt

α = Containment failure due to RPV steam explosion

β = Containment failure due to containment steam explosion

μ = Containment failure due to overpressure from burning of a combustible gas mixture

μ' = Containment failure due to detonation of a combustible gas mixture

δ = Containment isolation failure

γ = Containment failure due to wetwell overpressure

γ' = Containment failure due to drywell overpressure

ξ = Containment failure due to large leakage

ε = Standby gas treatment system (SGTS) failure

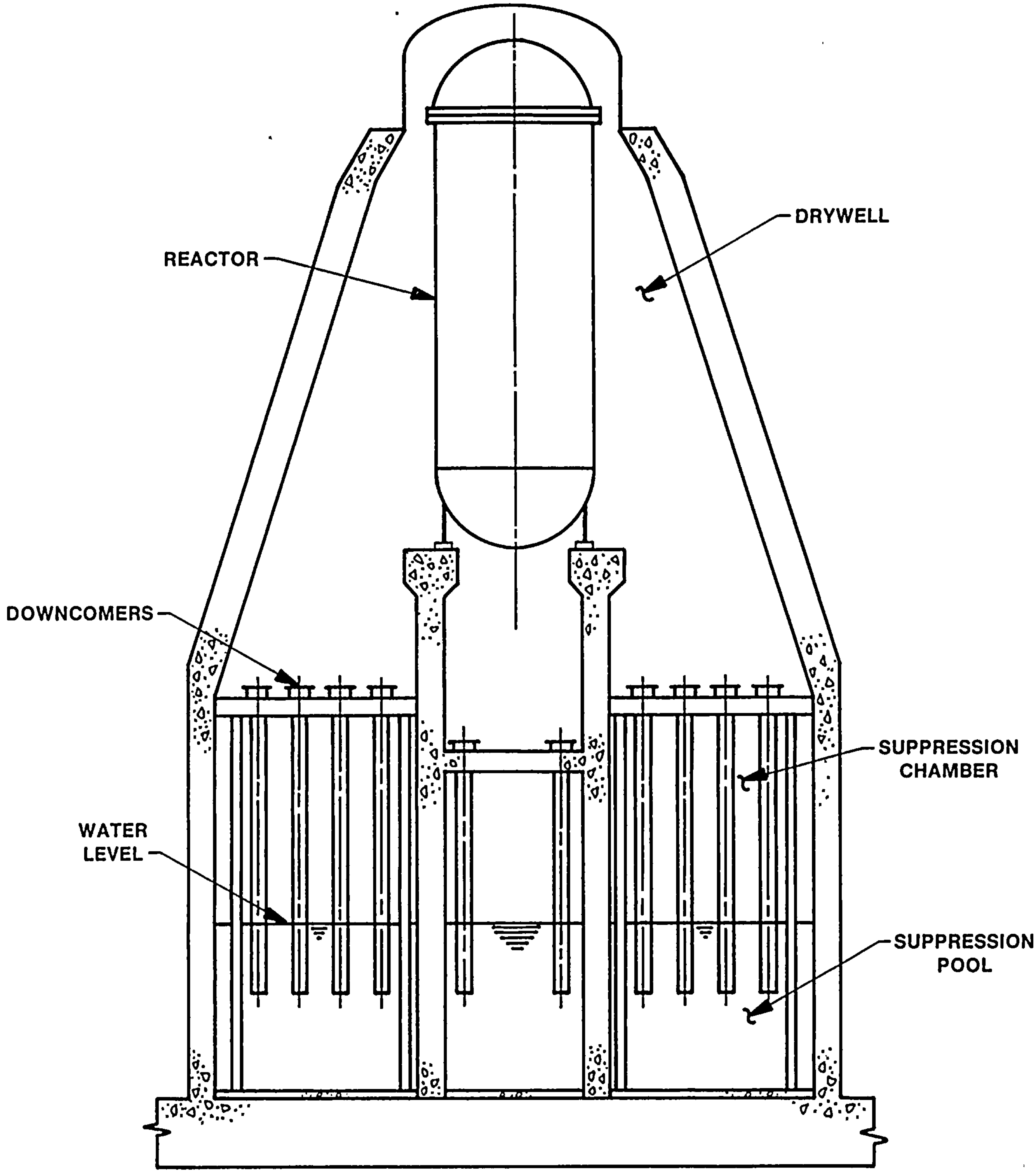


FIGURE 7A.4-1

MARK II
PRIMARY CONTAINMENT

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS

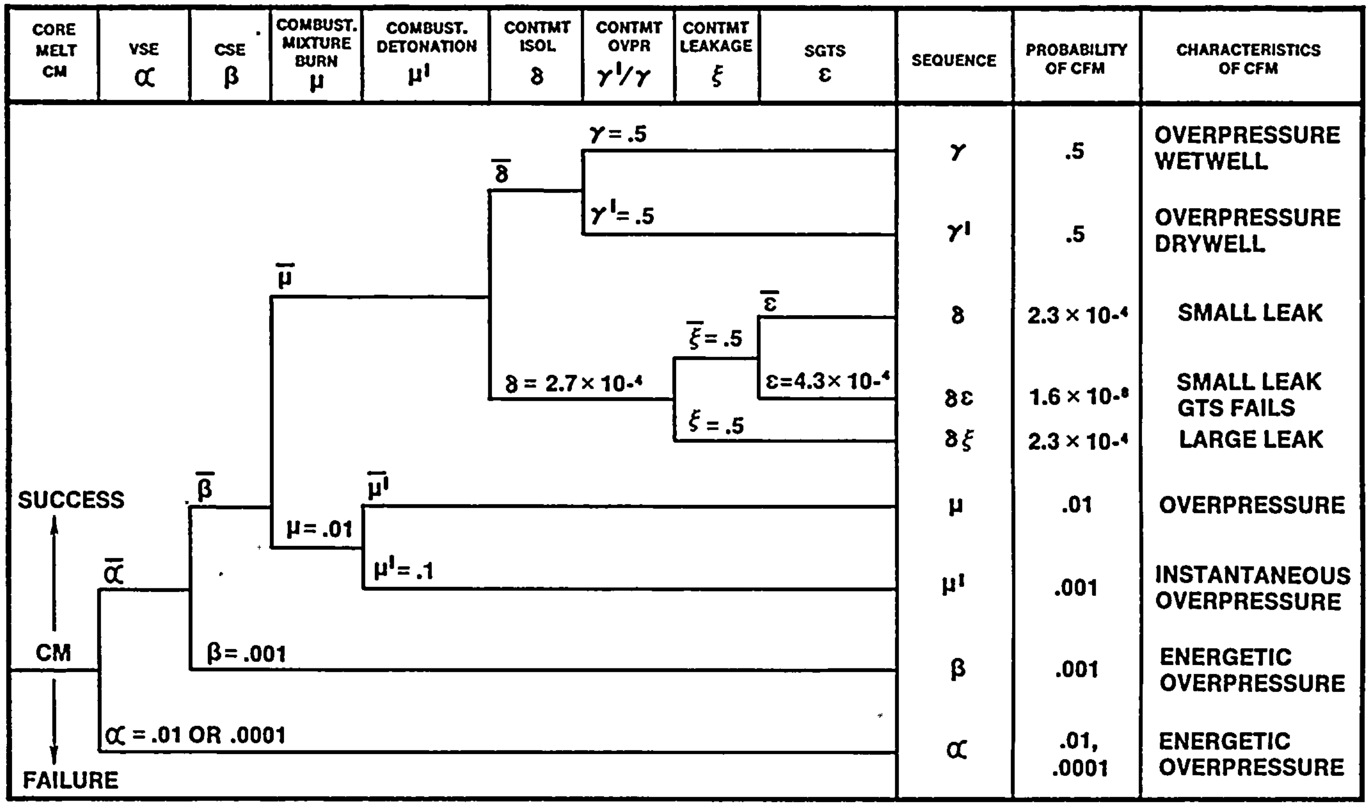


FIGURE 7A.4-2

CONTAINMENT EVENT TREE

NIAGARA MOHAWK POWER CORPORATION

NINE MILE POINT-UNIT 2

ENVIRONMENTAL REPORT-OLS

7A.5 RELEASE CATEGORIES

7A.5.1 Definition of Release Categories

RSS BWR Core Melt Release Categories 1, 2, 3, and 4 are used for the Unit 2 analysis. The RSS, GG1, and Limerick studies were used as guidance for assigning accident sequences to the release categories. These categories are defined as follows.

BWR Release Category 1

This release category is representative of a core meltdown followed by a steam explosion in the reactor vessel and simultaneous breach of containment integrity. The latter would cause the release of a substantial quantity of radioactive material to the atmosphere. The total release is assumed to contain approximately 40 percent of the iodines and alkali metals present in the core at the time of containment failure. Most of the release would occur over a 1/2-hr period. Because of the energy generated in the steam explosion, this category would be characterized by a relatively high rate of energy release to the atmosphere. This category also includes certain sequences that involve overpressure failure of the containment prior to the occurrence of core melting and a steam explosion. In these sequences, the rate of energy release would be somewhat smaller than for those previously discussed, although it would still be relatively high.

BWR Release Category 2

This release category is representative of a core meltdown resulting from a transient event in which decay heat removal systems are assumed to fail. Containment overpressure failure would result, and core melting would follow. Most of the release would occur over a period of about 3 hr. The containment failure would be such that radioactivity would be released directly to the atmosphere without significant retention of fission products. This category involves a relatively high rate of energy release due to the sweeping action of the gases generated by the interaction of water and concrete with the molten mass. Approximately 90 percent of the iodines and 50 percent of the alkali metals present in the core would be released to the atmosphere.

BWR Release Category 3

This release category represents a core meltdown caused by a transient event accompanied by a failure to scram or failure

to remove decay heat. Containment failure would occur either before core melt or as a result of gases generated during the interaction of the molten fuel with concrete after reactor vessel melt-through. Some fission product retention would occur either in the suppression pool or the reactor building prior to release to the atmosphere. Most of the release occurs over a period of about 3 hr and is postulated to comprise 10 percent of the iodines and 10 percent of the alkali metals. For those sequences in which the containment would fail due to overpressure after core melt, the rate of energy release to the atmosphere would be relatively high. For those sequences in which overpressure failure would occur before core melt, the energy release rate would be somewhat smaller, although still moderately high.

BWR Release Category 4

This release category is representative of a core meltdown with enough containment leakage to the reactor building to prevent containment failure by overpressure. The quantity of radioactivity released to the atmosphere would be significantly reduced by normal ventilation paths in the reactor building and potential mitigation by the secondary containment filter systems (SGTS). Condensation in the containment and the action of the SGTS on the releases would also lead to a low rate of energy release. The radioactive material would be released from the reactor building or the stack at an elevated level. Most of the release would occur over a 2-hr period and is assumed to contain approximately 0.08 percent of the iodines and 0.5 percent of the alkali metals.

7A.5.2 Combined Dominant Accident Sequence Probabilities

The dominant accident sequences for Unit 2 have been quantified and are listed in Table 7A.5-1. The probability of any accident sequence was calculated by multiplying the core melt sequence probability (from Section 7A.3.3) by its containment failure mode probability, e.g., probability of sequence T_1PQE- would be $(2.4x10^{-8}) \times (0.012) = 2.9x10^{-10}$ per reactor-year. The release category frequencies were found by summing the probabilities of the dominant accident sequences for each release category. Release category totals were not smoothed as was done in the RSS. See the RSS, Appendix V, Section 4.1.2 for a more detailed example of smoothing release category probabilities.

TABLE 7A.5-1

DOMINANT CORE MELT ACCIDENT SEQUENCE PROBABILITIES

Sequence	Release Category Probabilities (per reactor-year) 1	2	3	4
T_1PQI		$2.9x10^{-10}$	$2.9x10^{-10}$	$1.3x10^{-13}$
$T_{23}PQI$		$1.6x10^{-6}$	$1.6x10^{-6}$	$7.4x10^{-10}$
T_1PQE	$2.9x10^{-10}$			$5.5x10^{-12}$
$T_{23}PQE$	$2.5x10^{-8}$			$4.8x10^{-10}$
SI		$5.0x10^{-7}$	$5.0x10^{-7}$	$2.3x10^{-10}$
T_1QW		$1.8x10^{-9}$	$1.8x10^{-9}$	$8.1x10^{-13}$
$T_{23}QW$		$5.5x10^{-6}$	$5.5x10^{-6}$	$2.5x10^{-9}$
T_1QUV	$6.5x10^{-10}$			$7.1x10^{-11}$
$T_{23}C$	$5.4x10^{-10}$	$2.7x10^{-6}$	$2.7x10^{-6}$	$1.2x10^{-9}$
Total	$2.6x10^{-8}$	$1.0x10^{-5}$	$1.0x10^{-5}$	$5.2x10^{-9}$

Total Release Frequency: $2.0x10^{-5}$/reactor-year

7A.6 CONSEQUENCE ANALYSIS

7A.6.1 Description of the CRAC2 Computer Code

The consequences to public health and safety, and the regional economy are evaluated using the CRAC2 computer code[5]. The first version of CRAC (Calculation of Reactor Accident Consequences) was developed to support WASH-1400. Sandia National Laboratories has updated the code to its present version.

CRAC2 computations begin with a postulated accident (or accidents if grouped into release categories) which includes a breach of containment. The resultant release of radioactivity is described in terms of its probability of occurrence, isotopic release quantities, heat release quantity, time and duration of release, and warning time.

Meteorological data is processed using the bin sampling technique developed specifically for CRAC2. An entire
year's worth of hourly weather observations from one
location (8,760 data points) which include wind direction 2
and speed, atmospheric stability, and precipitation rate are grouped into sequences or bins with given characteristics. Examples are: it begins to rain at a certain distance from the site; a wind slowdown occurs at a certain distance from the site; or a certain combination of wind speed and
stability class occurs. Twenty-nine bins are defined and 2
prioritized by CRAC2 and the subsequent bin sampling is
carried out so that each bin is taken into account. This ensures that important weather types are neither ignored nor given excessive weight, so that peak consequences produced by certain weather situations are not missed. This technique has provided an improvement in meteorological sampling over the CRAC code which was used in the RSS.

Weather conditions from each of the 29 bins are then applied
to a straight line Gaussian Plume model to calculate the 2
atmospheric dispersion term X/Q. Special effects which modify the basic Gaussian model, such as radioactive decay, duration of release, building wakes, inversion lids, and
plume rise, are factored into the analysis for each hour of
plume travel. Additionally, the effects of both wet and dry 2
deposition are taken into account. The resultant X/Q values and deposition processes define air and ground radioactivity concentrations at each spatial interval from the site.

Air and ground concentration levels are used to calculate
potential radiation doses that would be received by 2
individuals. A spatial grid consisting of sixteen

2 22.5-degree sectors and 24 radii out to 80 km (50 mi) is used to perform the dose calculations. A habitable land fraction and population value (1980 census projected to year 2000) are assigned for each area element in this grid. For calculating early health effects, the most important exposure pathways are:

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1. Inhalation from the passing radioactive cloud.

2. External exposure from the passing cloud.

3. External exposure (short-term) from deposited ground contamination.

For estimating latent health effects, the pathways of interest are:

1. External exposure from deposited ground contamination (long- and short-term).

2. Inhalation of radioactivity from the passing cloud and from the resuspension of deposited ground contamination.

3. Ingestion of contaminated foods, milk, and milk products.

2 Early or acute effects are defined as those which occur within 1 yr following exposure. These include both fatalities and injuries. Latent effects usually manifest themselves in the form of cancer later in life. Health physics data such as organ dose conversion factors; milk consumption rates; threshold doses for fatalities, injuries, and various cancer types; timing data for computing lifetime doses; isotope weathering/decay data; and inhalation/ingestion factors are supplied to the code in order to allow public radiation health effects to be computed. Table 7A.6-1 provides information on which isotopes are important for each exposure pathway.

The effects of mitigative actions taken to reduce public exposure such as evacuation and sheltering are taken into account. Evacuation parameters such as distance traveled, delay time, effective evacuation speed, exposure duration, sheltering factors, and radius of evacuation for the region are supplied to the code. These evacuation and sheltering scenarios are used to compute the dose reduction achieved by the emergency action.

Regional economic impact is also calculated by CRAC2. Agricultural and economic data including farm and dairy production; farm, business, and residential property values; and relocation and evacuation costs are supplied to the code and the impact is calculated in terms of food, crop, and dairy losses; interdiction costs; decontamination costs; and relocation and evacuation costs.

The final results of the CRAC2 consequence model are displayed as a set of complementary cumulative distribution functions (CCDFs). A CCDF is defined as the probability that the consequences will exceed a given magnitude. CRAC2 determines the final CCDFs by accounting for all consequences produced for each trial and the associated probability of occurrence. A trial is defined as one combination of accident release parameters, weather conditions, and downwind population. The curves produced from the CRAC2 CCDF output may be then used to evaluate the health and economic risks to the public from a large scale core melt accident in a given region surrounding the plant.

Figure 7A.6.1 provides an overall view of the site region. Figure 7A.6-2 shows a schematic of the CRAC2 consequence model.

Table 7A.6-2 provides identification of the sources for the input parameters to CRAC2 for Unit 2. 3

Tables 7A.6-3 through 7A.6-7 provide the CRAC2 input for Unit 2 for the isotopes, release parameters, evacuation, population, and meteorological data requirements, respectively.

7A.6.2 Discussion of Health and Economic Impacts

The results of CRAC2 computations are presented in Figures 7A.6-3 through 7A.6-8. CCDFs representing acute fatalities, acute injuries, latent fatalities, latent thyroid cancers, total whole-body man-Rem, and property damage, within 80 km (50 mi) of Unit 2 are provided. Table 7A.6-8 shows the sensitivity of early effects (acute fatalities and injuries), late effects (latent fatalities and thyroid cancers), and economic effects (property damage) to various parameters.

Acute fatalities are dominated by the high probability of Release Category 2 (Section 7A.5). Release Category 1, although possessing rather rapid timing and a large quantity of released activity is not as consequential a release as Category 2. Release Category 3 has a relatively high probability but a lower amount of released activity. Category 4 is characterized by releases through the SGTS, therefore the activity released is much lower. Category 4 does not contribute to acute fatality consequences.

Acute injuries are dominated by Categories 2 and 3 due to their relatively high probability of occurrence and higher release fractions. The lower activity magnitude of Release Category 3 is not quite as important for injuries as it is for fatalities because of the lower dose thresholds for

injuries. Release Category 4 makes a small but essentially negligible contribution to acute injuries. The Oswego County, New York Radiological Emergency Response Plan (RERP) outlines six evacuation scenarios covering the various combinations of season and time of day. No one evacuation model dominated early effects. The difference in early effect consequences among the 6 models differed by no more than 10 percent.

Latent fatalities and thyroid cancers result from lower doses than those that produce acute fatalities. These are
2 integral effects over large areas and long time periods, and are extrapolated from the radiogenic cancer effects observed following exposure to higher doses such as the Japanese atomic bomb survivors. Because of the affinity of the human thyroid for halogens such as iodine, thyroid cancer is most sensitive to the amount of iodine released. According to the Committee of the Biological Effects of Ionizing Radiation (BEIR)[6], solid tumors may take as long as 30 yr to develop, whereas leukemia can occur within 5 yr. Release Categories 2 and 3 with their higher probabilities of occurrence, dominate the latent fatality CCDFs. Release Category 2, with its higher iodine release, dominates the thyroid cancer CCDFs. The thyroid cancer results include both malignant and benign radiogenic tumors.

Economic impact is assessed in terms of the cost to all
2 affected property and includes both evacuation and relocation costs. As with latent effects, property damage CCDFs are dominated by Release Categories 2 and 3.

Figure 7A.6-7 provides the CCDFs for total cost with and without decontamination. When decontamination procedures are carried out, this adds cost; however, the decontamination restores property to economic use, and the
2 interdiction costs are reduced. Although decontamination is expensive, it is a one-time cost, whereas interdiction of property, particularly farm property, has a long-term effect and hence creates greater economic loss and hardship. This is reflected in the CCDFs in Figure 7A.6-7. The probability of a given dollar loss is greater when decontamination is not performed. This reflects the higher (long-term) interdiction costs.

The demography and annual wind rose frequencies for the
2 Unit 2 site are such that approximately 55 percent of the time the wind blows out over Lake Ontario including sectors containing both land and lake. Only 9 percent of the total 80-km (50-mi) regional population resides in sectors which border Lake Ontario, and one-half of these people live

beyond 72 km (45 mi) where there is essentially zero risk of early fatality. Therefore, there is roughly 50 percent 2
probability that a release will be blown toward an unpopulated or sparsely populated area. There is little doubt that releases blown in these directions will result in considerably lower health consequences due to the deposition mechanisms and the lack of people liable to exposure.

Exposure pathways could result from the ingestion of fish caught from the lake, ingestion of drinking water from the lake, and direct exposure from contaminated beaches and nearshore land. Interdicting these pathways is entirely possible; however, the socioeconomic impact of such action

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is difficult to assess. A liquid pathway consequence analysis is not within the scope of this study; however, the economic effect of the loss of drinking water supply and recreational areas would be temporarily felt. Some beaches and recreational areas might suffer permanent closure or abandonment by the public. Commercial fishing does take place on Lake Ontario. However, it is concentrated in the far northeast corner of the lake and does not constitute a major industry. Nearly 90 percent of all fish commercially caught in the lake are landed by Canadian fishermen. Some of these fish could be temporarily affected by a release from Unit 2.

For the Unit 2 site, the CRAC2 results revealed that fatalities would most likely occur within 32 km (20 mi) of the plant and in no case would fatalities occur beyond 72 km (45 mi). Injuries would most likely occur within 56 km (35 mi) of the plant. Although the risk of injury exists beyond 80 km (50 mi); the probability of occurence is very low.

For comparison purposes, the CCDFs for acute and latent early fatalities for GG1, Limerick, PB2 (rebaselined RSS results), Perry, and Fermi 2 have been plotted against the Unit 2 results. These comparisons are shown on Figures 7A.6-9 and 7A.6-10. Because of the uncertainty bands associated with each curve, the CCDFs for acute and latent fatalities for the six plants may be considered consistent. 2

7A.6.3 Risk Due to External Causes

The foregoing analysis has confined itself to event sequences generated by inplant failures (with the exception of loss of offsite power). However, the possibility exists that some large external event could initiate an accident or adversely affect the plant's response to an internal initiating event.

The Unit 2 plant is not considered singularly vulnerable to external initiators. It is located in an area of low seismic activity, far away from a large body of seawater, and in an area of relatively low tornado probability. Therefore, earthquakes, hurricanes, tidal waves, and tornadoes are not expected to be high probability events. Man-made hazards such as aircraft impact, accidents at nearby industrial or military facilities, and pipeline accidents are not considered viable because the site is located at least 32 km (20 mi) from any major air traffic lane and 64 km (40 mi) from the nearest major airport (Syracuse, New York). Also, there are no large industrial

military facilities or pipelines near the site. The risk from transportation accidents exists only from dangerous materials on vehicular and rail traffic destined to/from the site itself. There are no major highways or rail lines carrying dangerous materials near the site. Single rail spurs and access roads provide egress routes from the three plants on site including Unit 2. The hazards due to flooding from Lake Ontario, flooding from internal sources, fires, chemical hazards, turbine missile hazards, and sabotage exist at about the same probability as at any U.S. nuclear power plant and are taken into account in the basic design criteria of the plant.

The following FSAR sections provide an indepth treatment of these topics:

	Title	FSAR Section
	Fire Protection	9.5.1, Appendix 9A
	Flooding	3.4
	Turbine Missiles	3.5.1.3
1	Chemical Hazards	2.2, 9.4.1
	Security	13.6
	Seismic Design	3.7, 3.8
	Tornado Design	3.3

Some external events will affect only one accident sequence while some external events will affect all accident sequences. With external causes taken into account, it is expected that the event sequence probabilities and hence the release category probabilities will increase slightly. However, because Unit 2 is less than or equal to most U.S. sites with respect to external vulnerability, it is anticipated that external events will not be significant contributors to risk at Unit 2.

7A.6.4 Limitations and Sources of Uncertainties

7A.6.4.1 Limitations

The following limitations are identified in this study:

1. Following the RSSMAP methodology, full fault trees were not developed for the Unit 2 systems analysis.

The survey and analysis technique employed in the GG1 study was used. This method, however, truncated the system unavailability analysis at the major component level. Small, but possibly sensitive components are covered by the failure rates for the parent equipment. Also, components were considered generically from system to system; ie., HPCS control circuits were assumed to have the same failure probability as diesel control circuitry; all motor-operated valves were assumed to have the same failure contributors, and each contributor was assumed to exhibit the same failure rate. This will not significantly alter the final results. However, a plant and/or manufacturer specific research of equipment operating histories might reveal slightly different failure rate information. Human error data was taken directly from the RSS and the GG1 study. A thorough human reliability analysis including a comprehensive review of plant operating and casualty procedures might also slightly alter the data.

2. The success criteria for ECCS operation during transients and LOCAs was taken as the same as GG1 (BWR 6).

3. Because Unit 2 is still under construction, as-built plant information is not available. The FSAR, PSAR, ER-CPS, Standard Technical Specifications for BWR 5[7], and design P&IDs were used in lieu of the as-built drawings, technical specifications, and actual plant operating/ emergency procedures.

4. The containment analysis consisted of comparing the Unit 2 Mark II containment with containments of plants where a full PRA had been performed (particularly Limerick) and adopting their results to Unit 2.

7A.6.4.2 Sources of Uncertainties

The specific sources of uncertainty in this study have been enumerated in the previous section. It should be noted that the RSS methodology used to analyze Unit 2 has been found to be sound based upon the results of the Lewis Committee review[8]. In the RSS, the uncertainties were found to fall into two groups: dispersion-dosimetric model (accident release source terms, probabilities, physical characteristics of the accident, and atmospheric dispersion)

and the dose-response model (health physics and cost parameters).

Early fatalities are most sensitive to the dispersion-dosimetric model uncertainties. This report has utilized theoretical accident source term information as an input to the risk analysis contained herein. Based upon recently generated information[9-17] regarding the accuracy of this source term information, there appears to be sound reasons to believe that it is significantly more conservative than originally assumed. Therefore, the consequences described in this study may be significantly overestimated. It is possible that a reduction in the
2 iodine and particulate fission product release fractions by a factor of 10 might likely result in zero acute fatalities being predicted[18].

The other consequences, latent fatalities and property damage, are less sensitive to the uncertainties in the dispersion-dosimetric model than early effects. Total population and cost parameters tend to have a greater effect on these results because the effects are integrated over large areas and long time periods and the accident characteristics become less important. The dose response
2 models used in CRAC2 and this study are based upon the 1980 BEIR Committee findings and are a central estimate of the three BEIR3 dose response models. It is closest to the linear-quadratic model in BEIR3. These findings are generally considered as an improvement over the previous (1972 BEIR) models; however, the lack of information available regarding the dose effectiveness of low dose rates is indicative of the uncertainties still present regarding the risk of radiation induced cancer.

7A.6.5 Conclusions

The preceding sections have considered the potential environmental impacts of core melt accident releases into the atmosphere. The impacts which have been analyzed include possible exposures to individuals and to the surrounding population as a whole, the near- and long-term consequences of such exposure, and the socioeconomic effects of property contamination.

2 Figures 7A.6-11, 7A.6-12, and 7A.6-13 provide comparisons of risk of acute fatality and property damage from the Unit 2 reactor versus risk of acute fatality and property damage from man-caused events, naturally-occurring events, and 100 nuclear power plants (overall U.S. nuclear risk). From these figures, it can be seen that the operation of Unit 2 will not contribute measurably to the overall acute fatality or property damage risks from either man-caused or

naturally-occurring events, including other nuclear power plant operations. It should be noted that the curve representing 100 nuclear power plants is not site specific and is provided as an order of magnitude comparison. 2

Table 7A.6-9 provides comparison data in the area of early illness and latent fatalities. The contribution to these consequences from the operation of Unit 2 is negligible.

In order for the consequences of a potential core melt accident at Unit 2 to be significant, the release parameters, weather conditions, and downwind population must be at their worst conditions. The probability of this occurring is extremely low. For even modest consequences to occur, the trial values must be well above average in severity. The probability of these conditions existing simultaneously is still quite low. Since the three components of a trial (release parameters, weather conditions, and downwind population density) are completely independent of each other, accidents with even modest environmental impact at Unit 2 are considered highly unlikely.

TABLE 7A.6-1

EXPOSURE IMPACT OF VARIOUS ISOTOPES

Exposure Pathway/Effect	Most Contributing Radionuclides
Cloudshine	Kr-88, Te-132, I-132, I-133, I-131, I-135
Inhalation (early effects)	Te-132, I-131, Cs-134, Ba-140
Inhalation (leukemia)	Sr-90
Inhalation (bone cancer)	Sr-90, Pu-241, Pu-238
Inhalation (lung cancer)	Ru-106, Ce-144
Groundshine (early effects)	Te-132, I-131, I-132, I-133, I-135
Thyroid dose	I-131, I-132, I-135
Milk ingestion	I-131, I-133
Long-term groundshine	Cs-137

NOTE: Radionuclides which have a negligible effect on health are: Co-58, Co-60, Kr-85, Kr-85m, Kr-87, Rb-86, Y-90, Nb-95, Tc-99m, Ru-105, Rh-105, Te-127, Te-129, Ce-143, Pr-143, Nd-147, Am-241 (Reference 19).

SOURCE: NUREG/CR-2300 (Reference 19)

TABLE 7A.6-2

CRAC2 DATA SOURCES

Data	Source (Reference Number)	
Isotopic inventory	1, 20	
(list of isotopes in Table 7A.6-3)		2
Release parameters		
Timing data	4	
Release fractions	1	
Evacuation strategies		
Timing and distance data	21, 22, 23	
Sheltering factors	19	
Population distributions		
U.S.	24, 25, 26	
Canadian	27	
Meteorological data		
Weather data	site measurements (Jan 1, 1979 - Dec 31, 1979)	
Atmospheric mixing heights	28	
Economic data	1, 29	

TABLE 7A.6-3

CRAC2 COMPUTER CODE ISOTOPES

Element	Isotopes
Cobalt	Co-58*, Co-60*
Krypton	Kr-85, Kr-85m, Kr-87, Kr-88
Rubidium	Rb-86
Strontium	Sr-89, Sr-90, Sr-91
Yttrium	Y-90, Y-91
Zirconium	Zr-95, Zr-97
Niobium	Nb-95
Molybdenum	Mo-99
Technetium	Tc-99m
Ruthenium	Ru-103, Ru-105, Ru-106
Rhodium	Rh-105
Tellurium	Te-127, Te-127m, Te-129, Te-131m, Te-132
Antimony	Sb-127, Sb-129
Iodine	I-131, I-132, I-133, I-134, I-135
Xenon	Xe-133, Xe-135
Cesium	Cs-134, Cs-136, Cs-137
Barium	Ba-140
Lathanum	La-140
Cerium	Ce-141, Ce-143, Ce-144
Praseodymium	Pr-143
Neodymium	Nd-147

TABLE 7A.6-3 (Cont)

Element	Isotopes
Neptunium	Np-239*
Plutonium	Pu-238*, Pu-239*, Pu-240*, Pu-241*
Americium	Am-241*
Curium	Cm-242*, Cm-244*

*RSS data corrected to values consistent with an end-of-cycle 3,489-MWt BWR. BWR 5-specific data from GE was not available for these isotopes.

TABLE 7A.6-4

CRAC2 RELEASE PARAMETERS

RSS Release Category	Probability/ Reactor-year	Time of Release (hr)	Duration of Release (hr)	Warning Time for Evacuation (hr)	Elevation of Release (m)	Heat Released (cal/sec)	Fraction of Core Inventory Released						
							Xe-Kr	I	Cs-Rb	Te-Sb	Ba-Sr	Ru[1]	La[2]
BWR 1	3.5×10^{-6}	2.6	0.5	1.3	45	2.80×10^{6}	1.0	0.4	0.4	0.7	0.05	0.5	5×10^{-3}
BWR 2	1.1×10^{-5}	39.0	2.0	7.0	45	2.10×10^{5}	1.0	0.9	0.5	0.3	0.1	0.03	4×10^{-3}
BWR 3	1.1×10^{-5}	39.0	2.0	7.0	45	2.10×10^{5}	1.0	0.1	0.1	0.3	0.01	0.02	3×10^{-3}
BWR 4	5.6×10^{-9}	5.0	2.0	2.0	45	0	0.6	8×10^{-4}	5×10^{-3}	4×10^{-3}	6×10^{-4}	6×10^{-4}	1×10^{-4}

[1]Includes Mo, Rh, Tc, Co.
[2]Includes Nd, Y, Ce, Pr, La, Nb, Am, Cm, Pu, Np, Zr.

TABLE 7A.6-5

CRAC2 EVACUATION STRATEGIES

Strategy	Probability of Strategy (%)	Time Delay Before Evacuation (hr)	Evacuation Speed (mph)	Maximum Distance from Site Evacuated (mi)	Maximum Distance Moved by Evacuees (mi)	Sheltering Radius (mi)
Weekday (school in session)	18	3.0	.79	10	20	10
Weekday (school not in session)	17	2.0	.73	10	20	10
Weekend/holiday (summer daytime)	5	2.0	1.15	10	20	10
Weekend/holiday (winter daytime)	10	2.0	1.48	10	20	10
Evening	17	1.5	1.18	10	20	10
Night	33	1.0	1.38	10	20	10

NOTE: Models correspond to the six typical evacuation periods outlined in the Nine Mile Point Nuclear Station Site Emergency Plan, New York State Radiological Emergency Preparedness Plan, and the Radiological Emergency Response Plan for Oswego County, NY (References 21 through 23).

TABLE 7A.6-6

CRAC2 POPULATION DISTRIBUTION DATA
(2000 Projected)

Direction	0.0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0	5.0-6.0	6.0-7.0	7.0-8.5	8.5-10.0	10.0-12.5	12.5-15.0	15.0-17.5	17.5-20.0	20.0-25.0	25.0-30.0	30.0-35.0	35.0-40.0	40.0-45.0	45.0-50.0	Sector Totals	
	Distance (mi)																									
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	361	1,862	30,460	32,708	
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44	1,014	817	2,506	4,881	2,970	2,972	15,204	
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	76	493	767	2,026	4,104	2,333	22,364	16,341	7,378	55,882	
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	315	3,100	1,440	2,888	1,150	549	289	199	1,240	6,334	17,504	
E	0	0	4	28	41	18	0	71	184	173	131	0	572	299	954	1,824	991	1,031	1,890	1,019	479	664	1,188	2,074	13,635	
ESE	0	0	11	33	75	18	101	131	161	167	494	214	262	2,197	1,392	1,451	1,645	1,196	2,104	2,583	3,658	5,125	11,340	22,833	57,191	
SE	0	0	0	61	68	111	87	89	18	59	268	107	178	244	1,221	1,562	2,553	3,150	8,676	8,756	11,714	12,231	24,172	21,893	97,218	
SSE	0	0	0	34	137	118	23	148	338	150	157	144	259	239	1,687	1,857	2,683	3,646	31,719	56,769	155,897	165,485	24,225	8,371	454,086	2
S	0	0	0	10	62	30	110	179	81	76	239	288	311	294	2,099	19,104	3,684	3,404	9,956	17,848	26,460	18,985	27,539	5,226	135,985	
SSW	0	0	11	5	49	101	200	198	266	244	592	234	1,031	2,468	2,292	1,905	2,568	1,635	2,203	3,743	6,763	6,677	20,597	20,236	74,018	
SW	0	0	60	51	43	38	69	171	217	370	3,944	12,167	9,616	2,398	2,012	1,615	891	984	3,531	4,905	4,288	8,583	11,511	21,979	89,443	
WSW	0	0	0	22	3	11	0	11	5	0	4	667	5,601	1,296	20	0	0	0	0	37	1,700	5,189	7,865	12,479	34,910	
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	177	349	526	
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	253	1,321	7,890	9,464	
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	225	2,983	3,208	
Interval Totals	0	0	86	244	478	445	590	998	1,270	1,239	5,829	13,821	17,830	9,435	11,992	32,494	16,948	18,745	64,269	101,130	216,112	250,997	152,573	173,457	1,090,982	

NOTES: 1. Figures are based on the 1980 census projected to 2000. 2
2. Figures include a small portion of the Province of Ontario, Canada, which is cut by the 80-km (50-mi) around the site.
3. Sector designations correspond to those used in Table 7A.6-7

TABLE 7A.6-7

CRAC2 METEOROLOGICAL BIN DATA SUMMARY

WIND DIRECTION

METBIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total	Percent
1 R 0	42	6	15	23	24	16	18	8	1	5	28	18	21	36	59	28	348	3.9726
2 R 5	5	3	0	1	3	1	1	7	0	1	5	6	14	8	8	7	70	0.7991
3 R 10	21	10	4	4	3	3	2	3	0	4	6	6	8	11	21	18	124	1.4155
4 R 15	13	11	5	7	3	2	4	5	0	5	4	5	5	13	17	17	116	1.3242
5 R 20	21	4	0	9	6	3	4	4	0	0	4	3	9	7	16	13	103	1.1758
6 R 25	10	6	5	4	6	4	4	2	0	1	2	3	8	6	8	16	85	0.9703
7 R 30	19	3	1	4	7	5	6	1	0	2	5	5	4	9	13	15	99	1.1301
8 S 10	7	5	4	11	10	9	9	6	1	0	0	0	0	2	8	2	74	0.8447
9 S 15	7	2	1	8	3	4	7	3	0	1	0	0	0	2	7	2	47	0.5365
10 S 20	4	1	3	13	7	7	13	3	0	0	2	0	1	1	0	4	59	0.6735
11 S 25	6	5	1	3	5	4	6	2	0	0	0	0	0	3	5	2	42	0.4795
12 S 30	7	6	4	9	5	6	7	3	0	0	0	0	3	3	7	4	64	0.7306
13 C 3	38	7	1	1	11	9	43	28	15	71	48	22	7	2	13	24	340	3.8813
14 C 4	44	6	3	28	99	109	148	55	2	7	3	1	1	6	41	46	599	6.8379
15 D 1	10	1	1	6	9	8	19	26	8	26	34	27	33	13	12	10	243	2.7740
16 D 2	74	7	5	9	17	3	24	21	4	31	48	19	11	16	17	28	334	3.8128
17 D 3	57	16	8	10	22	11	21	30	0	34	33	9	6	13	17	21	308	3.5160
18 D 4	106	48	49	61	64	42	70	71	5	21	36	4	1	28	71	47	724	8.2648
19 D 5	8	8	57	152	255	281	209	49	1	0	1	0	1	10	28	11	1071	12.2260
20 E 1	32	16	19	21	15	12	27	34	13	40	65	38	68	40	37	27	504	5.7534
21 E 2	94	43	23	21	21	10	8	17	4	24	35	26	22	29	53	50	480	5.4795
22 E 3	104	39	28	20	23	7	11	6	1	7	9	8	4	39	95	83	484	5.5251
23 E 4	195	82	44	48	20	18	14	11	3	1	7	0	1	21	135	133	733	8.3676
24 E 5	30	5	34	37	65	49	40	7	3	0	1	0	0	4	50	37	352	4.0183
25 F 1	95	15	16	29	23	16	30	16	9	12	16	12	91	51	85	90	606	6.9178
26 F 2	110	19	10	6	10	3	2	10	4	7	7	2	14	24	96	120	44	5.0685
27 F 3	79	11	7	5	6	6	2	3	0	9	3	5	0	4	41	35	216	2.4658
28 F 4	13	1	1	24	6	1	6	4	2	0	0	0	0	0	5	10	73	0.8333
29 F 5	0	0	3	12	2	0	0	1	0	0	0	0	0	0	0	0	18	0.2055
All	1251	386	353	586	750	649	755	436	76	309	402	219	333	401	965	890	8760	100.0

2

TABLE 7A.6-7 (Cont)

KEY TO METBIN DESCRIPTION:

R = Rain within intervals (mi); e.g., R 5 means rain within 5 mi of the site.
S = Wind slowdowns within intervals (mi); e.g., S 10 means a wind slowdown within 10 mi of the site.
C, D, E, F = Stability Categories
1 (0-1), 2 (1-2), 3 (2-3), 4 (3-5), 5 (>5) = Wind speed intervals (m/sec) used in combination with stability categories.

NOTES:

1. This table represents the number of hours that the weather conditions described by each bin occurred with the wind blowing toward each sector. 2
2. This table is based upon site hourly measurements made from January 1, 1979, through December 31, 1979.
3. Wind directions are given by sector numbers. Each sector is 22 1/2 deg in arc and is centered on the 16 compass points. Sector 1 is centered on north and sector 2 is immediately clockwise (NNE). Wind speeds were measured at a height of 10 m.
4. The metbin categorizations are made automatically by the CRAC2 code.

TABLE 7A.6-8

CRAC2 RESULT SENSITIVITIES

Parameter[1]	CCDF Sensitivities[2] Early Effects	Late Effects	Economic Effects
Release category probability	Major	Major	Major
Magnitude of released activity	Major	Major	Major
Release timing (beginning warning, duration)	Major	Low	Low
Magnitude of heat released	Moderate to Major	Low	Low
Weather conditions (wind direction, wind speed, rainfall, deposition, and dispersion conditions)	Major	Moderate	Moderate
Evacuation timing (warning and delay)	Major	Low	Low
Evacuation parameters (speed, radius evacuated, sheltering models)	Moderate	Low	Low

[1] Other parameters such as dose conversion factors, dose threshold data, and other health physics parameters can also have major or moderate effects upon CCDFs. However, these parameters are not plant- or site-dependent and are the same data that was used in the RSS. The parameters listed in this table are all plant or site specific.

[2] The above sensitivites (major, moderate, low) are qualitative in nature.

SOURCE: NUREG/CR-2300 (Reference 19)

TABLE 7A.6-9

COMPARISON OF EARLY INJURY AND LATENT FATALITIES BETWEEN UNIT 2 AND OVERALL U.S.

Early Illness

Probability of individual early illness (per reactor-year):

U.S. overall[1]: 3.6×10^{-2}

Unit 2[2]: 2.39×10^{-9} 4

Latent Fatality

Probability of individual latent cancer fatality:

U.S. Overall[3]: 5.47×10^{-3} per year 4

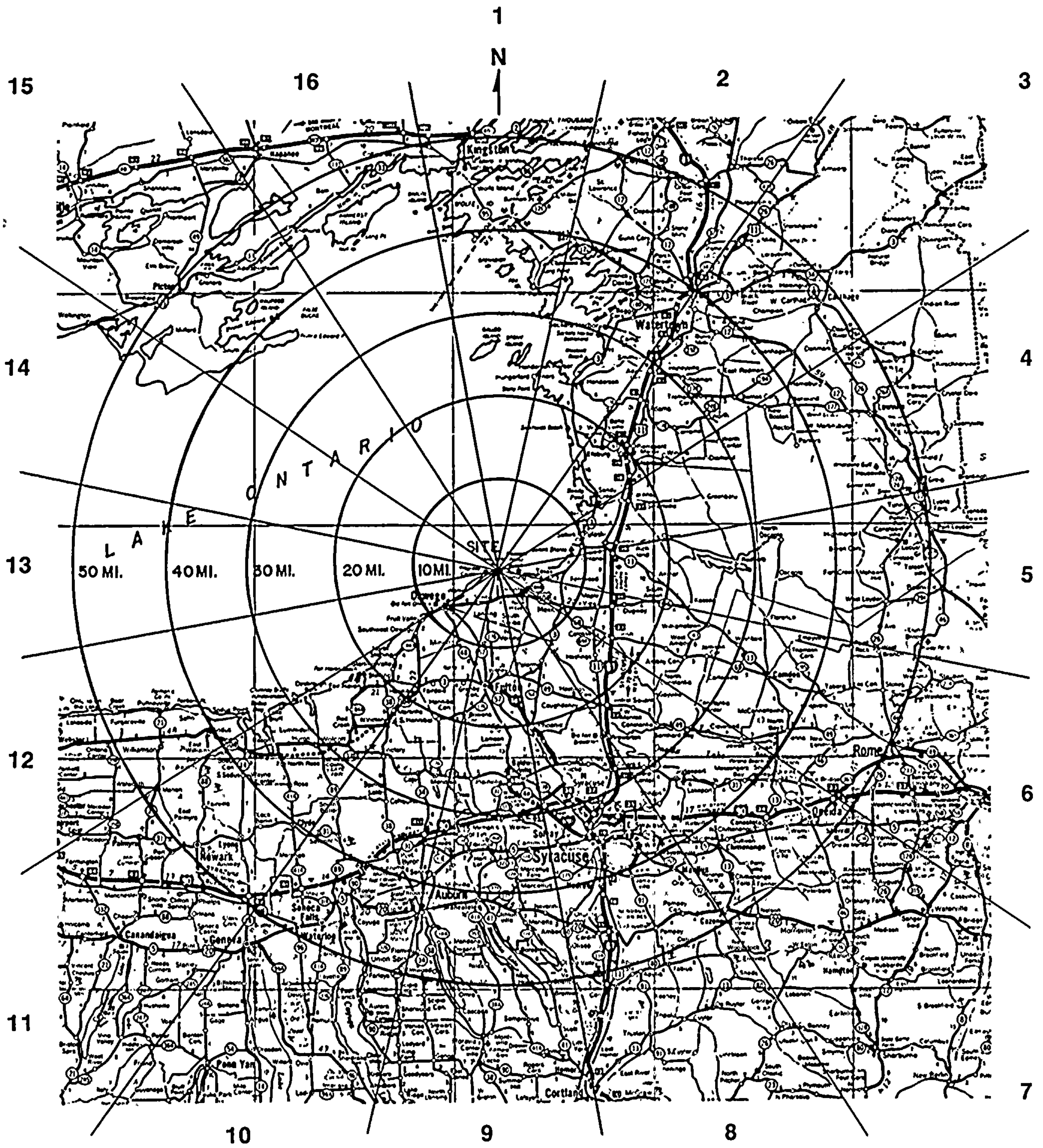
Unit 2[4]: 3.39×10^{-9} per reactor-year

(1) Based on RSS data of 8 million injuries per year from all accidents. The population of the U.S. is assumed to be 225 million.

(2) Based on 2.61×10^{-3} mean number of acute injuries within 50 mi of Unit 2 divided by the population within 50 mi of Unit 2. This represents only the incremental contribution to acute injury due to reactor accidents.

(3) Based on the individual lifetime risk of cancer mortality from all causes of 16.4 percent from BEIR III (Reference 6), divided by the assumed average remaining lifetime of 30 yr. 4

(4) Based on 3.69×10^{-3} mean number of cancer fatalities within 50 mi of Unit 2 per reactor year divided by the population within 50 mi of Unit 2. This represents only the incremental contribution to latent fatality due to reactor accidents.



NOTES:

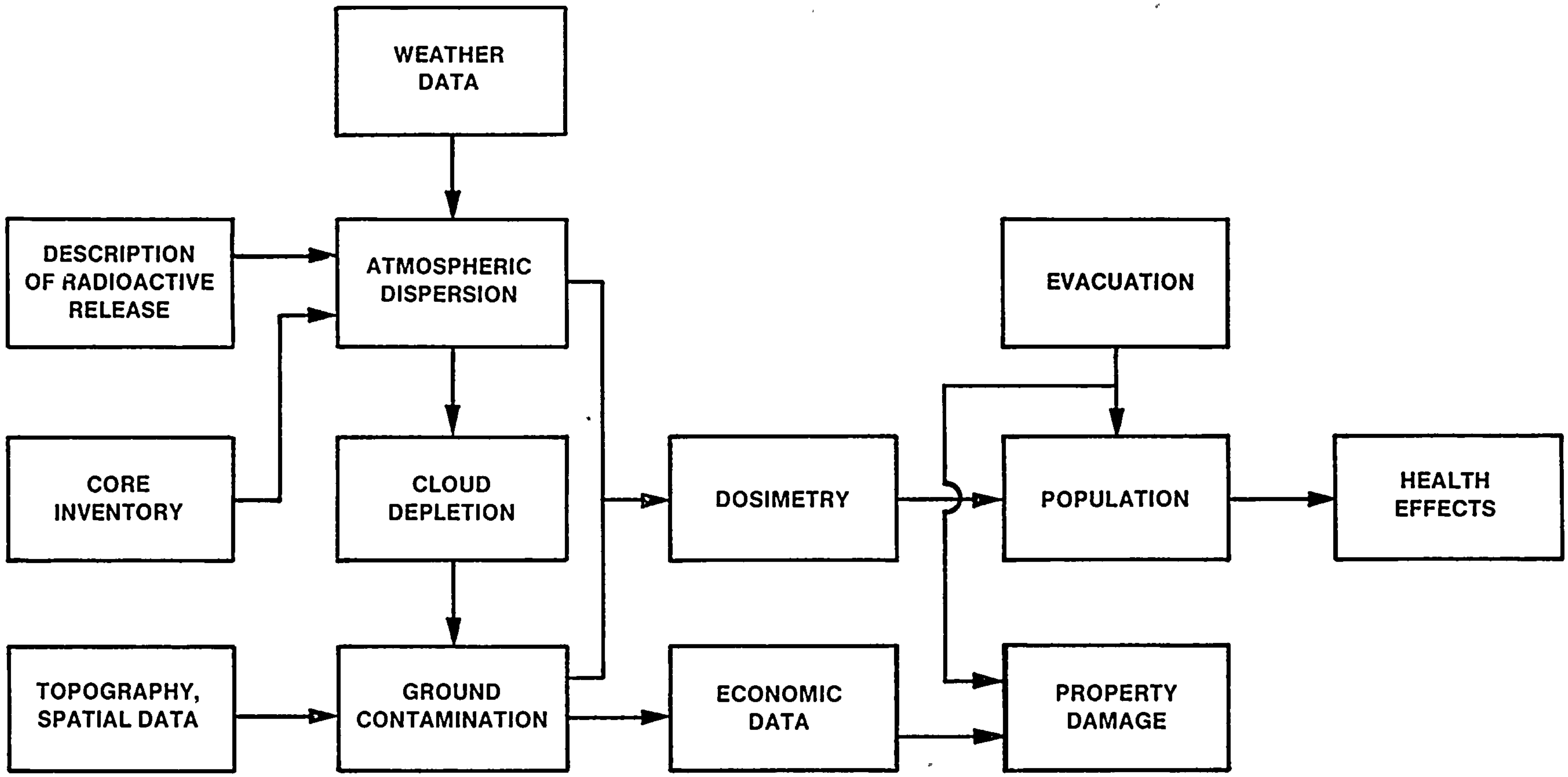
1. EACH SECTOR IS 22½ DEGREES WIDE. SECTOR 1 IS CENTERED ON NORTH AND EACH SECTOR FOLLOWS COUNTER-CLOCKWISE AS SHOWN.
2. FOR CLARITY ONLY 10 MI. INCREMENTAL RADII ARE SHOWN. THE ACTUAL ANALYSIS USES A MUCH CLOSER SPACING.

SOURCE:
Reference 31

FIGURE 7A.6-1

AREA MAP

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS



ADAPTED FROM: — NUREG 0340 (REFERENCE 32)

FIGURE 7A.6-2

CRAC2 CONSEQUENCE MODEL SCHEMATIC

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS

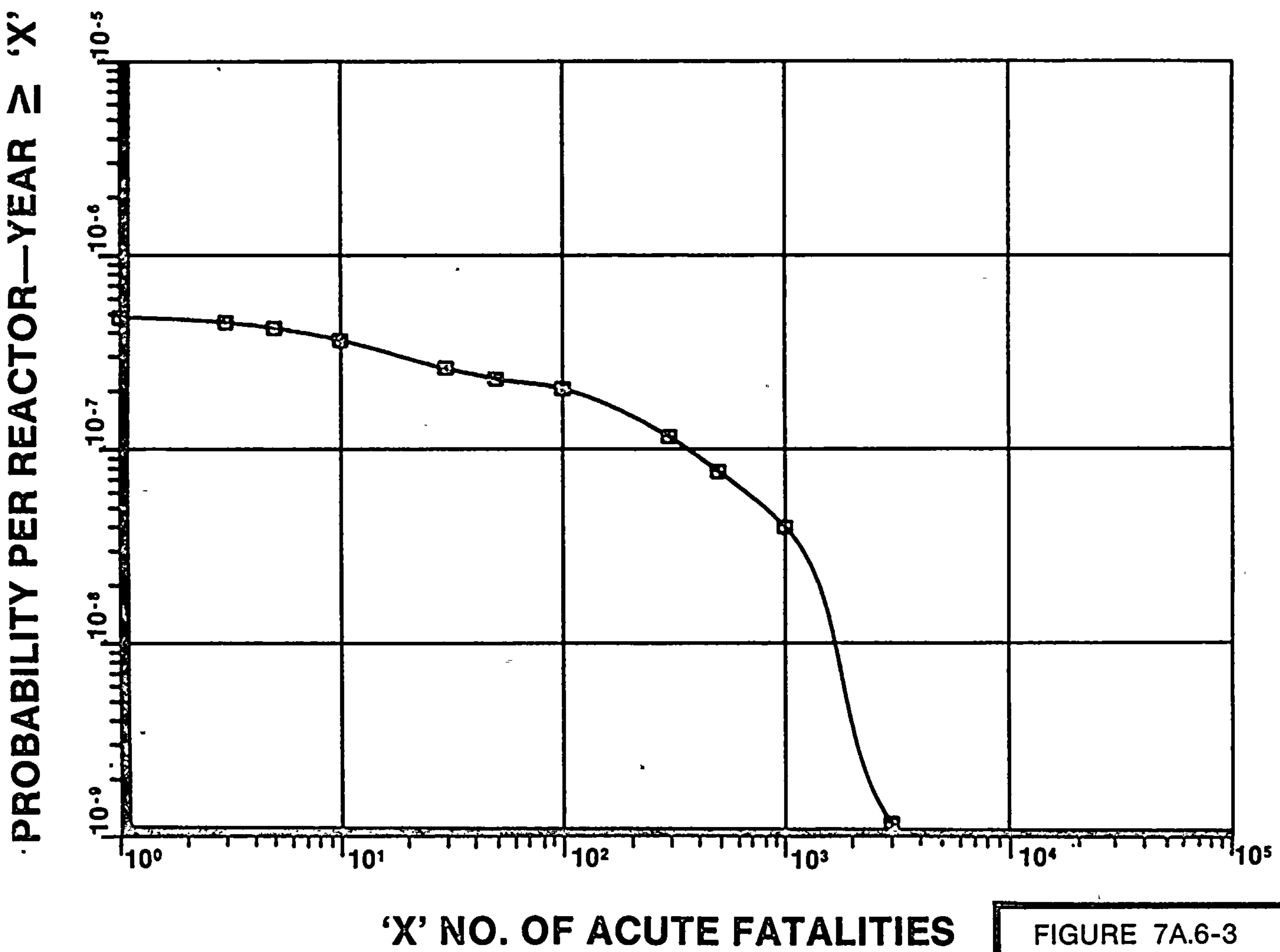


FIGURE 7A.6-3

ACUTE FATALITIES

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS

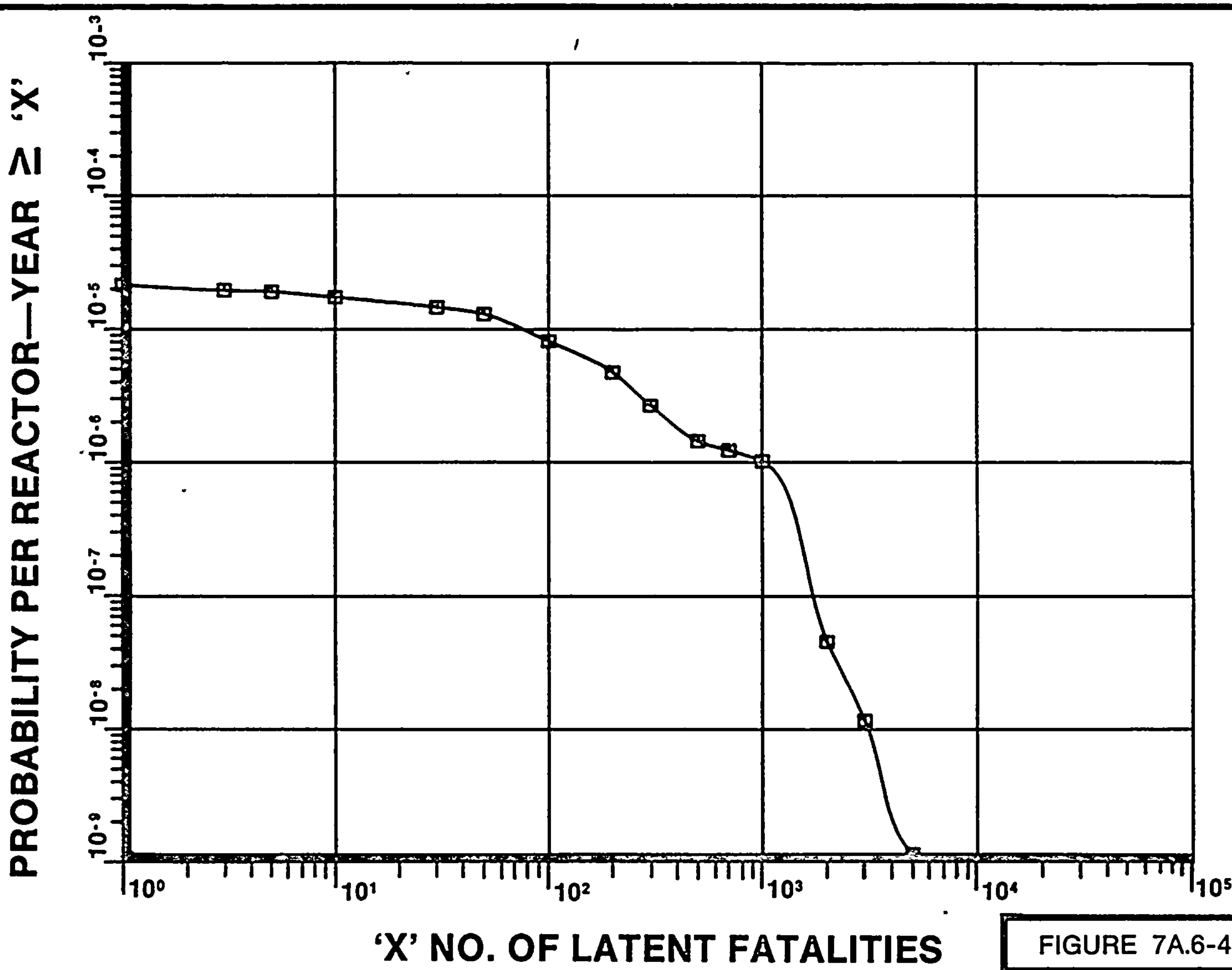


FIGURE 7A.6-4

LATENT FATALITIES

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS

SUPPLEMENT 2 JUNE 1983

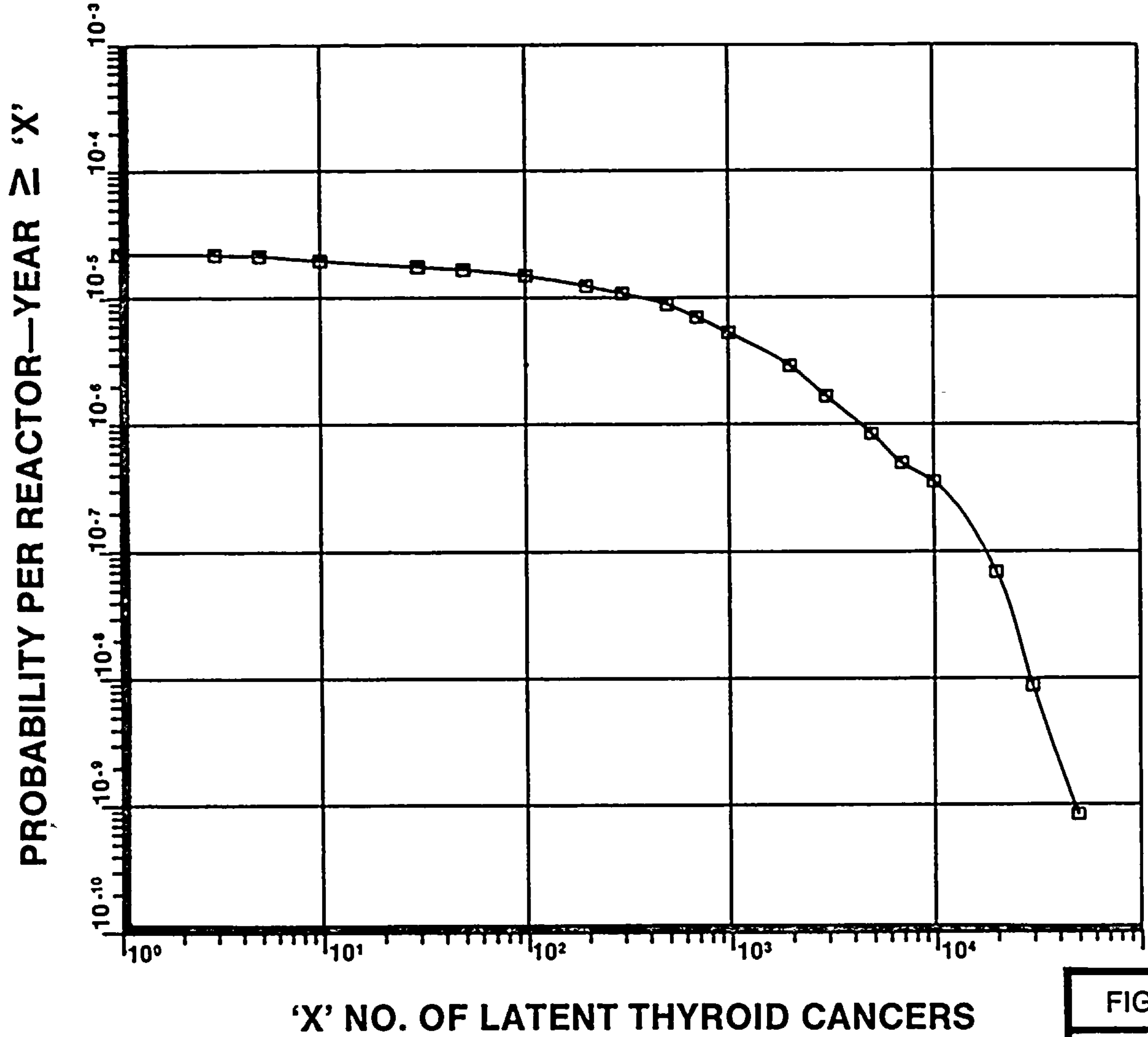


FIGURE 7A.6-5

LATENT THYROID CANCERS

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS

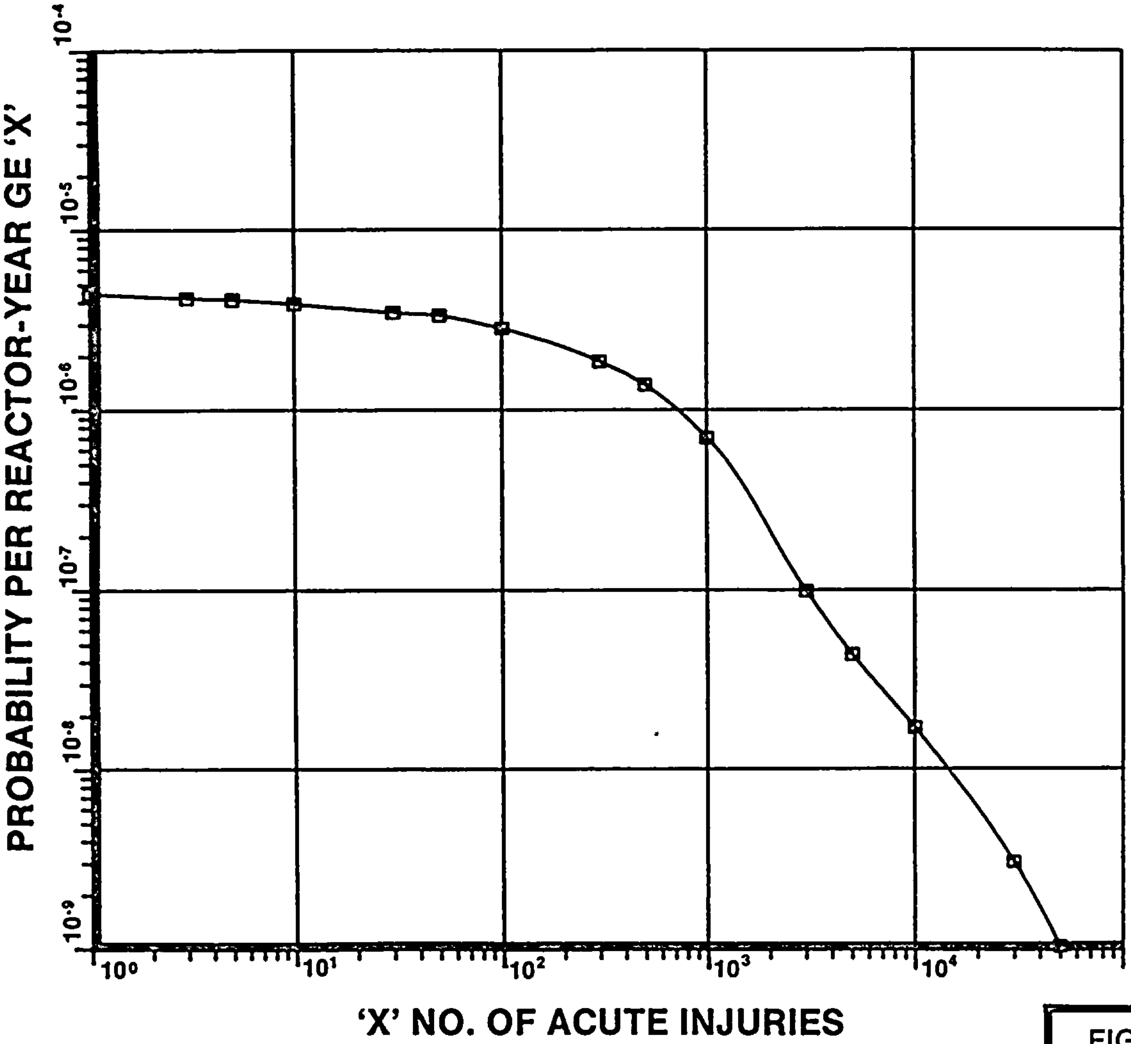


FIGURE 7A.6-6

ACUTE INJURIES

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS

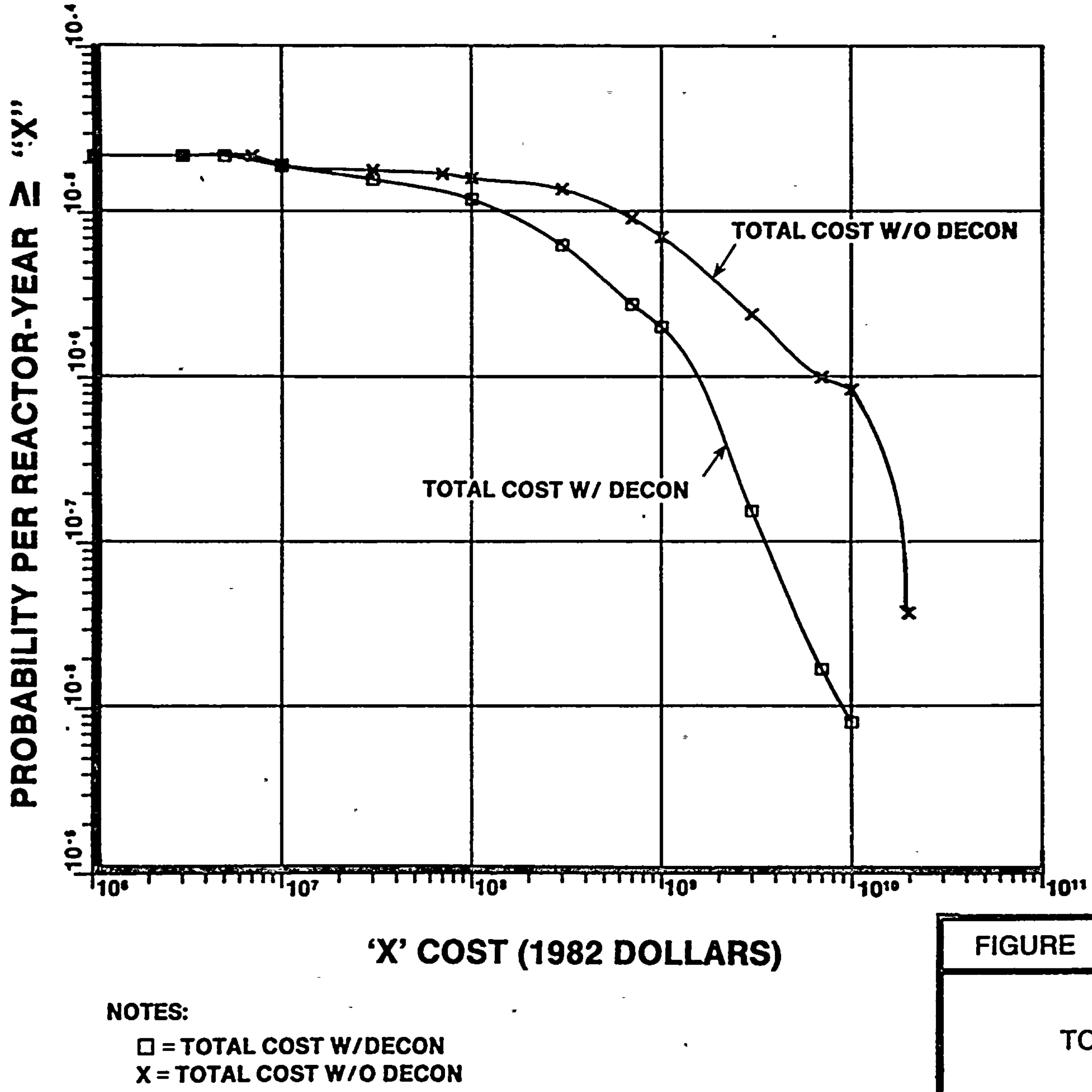
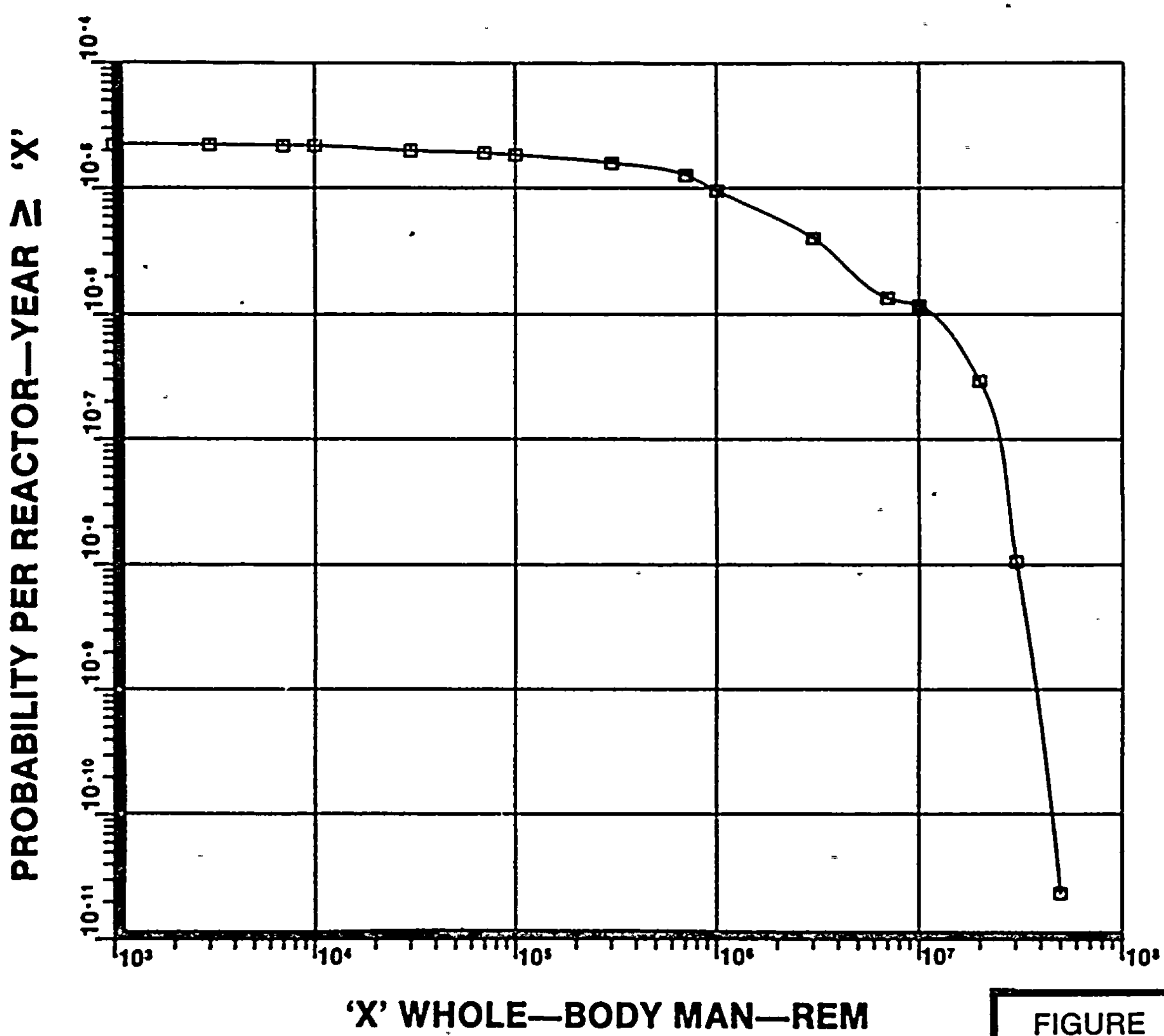


FIGURE 7A.6-7

TOTAL COST (1982 DOLLARS)

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS

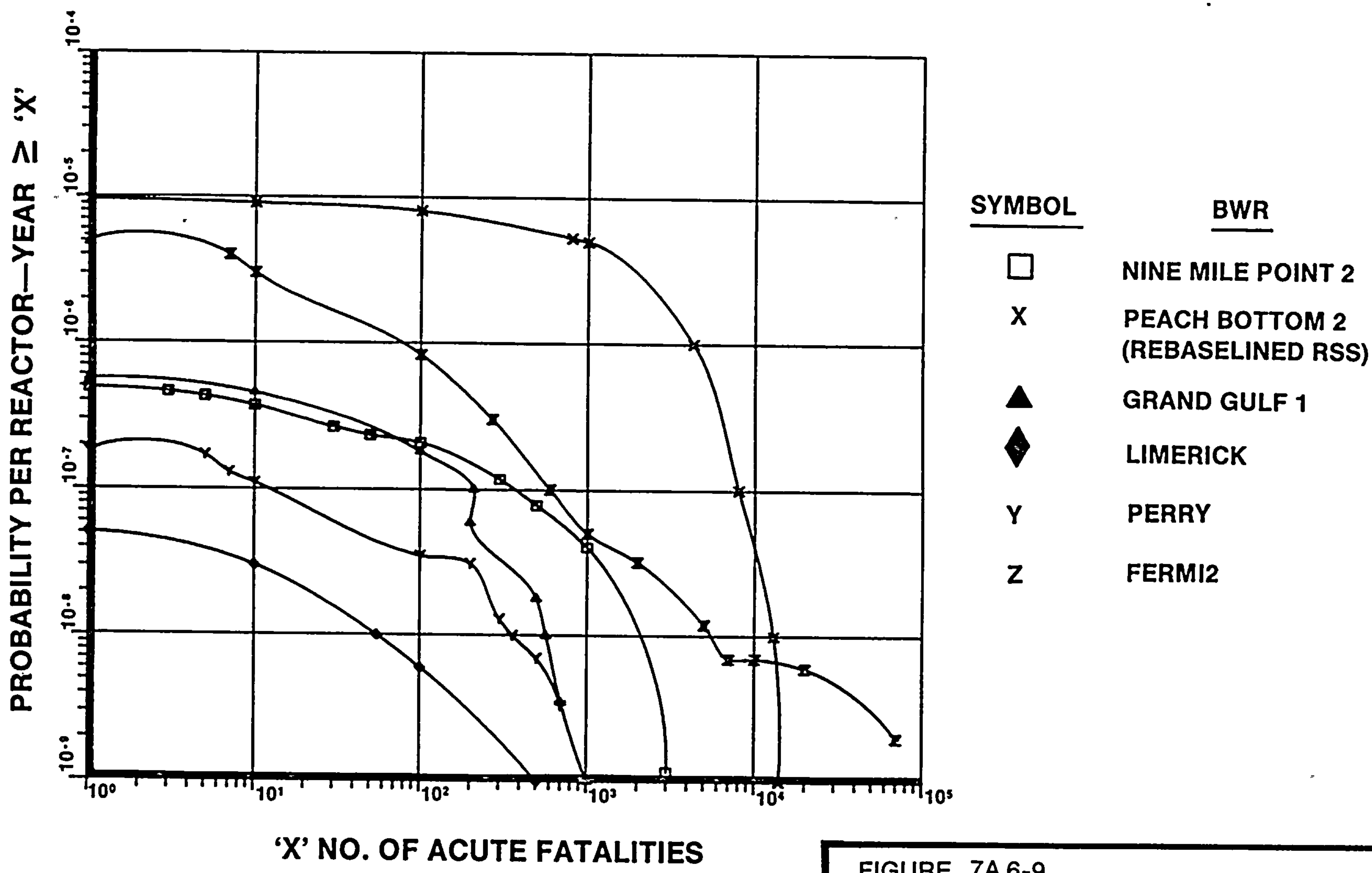


NOTES: 1. THIS CURVE DOES NOT INCLUDE EXPOSURE TO THOSE PERSONS COUNTED AS ACUTE FATALITIES.

FIGURE 7A.6-8

TOTAL WHOLE-BODY MAN-REM

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS



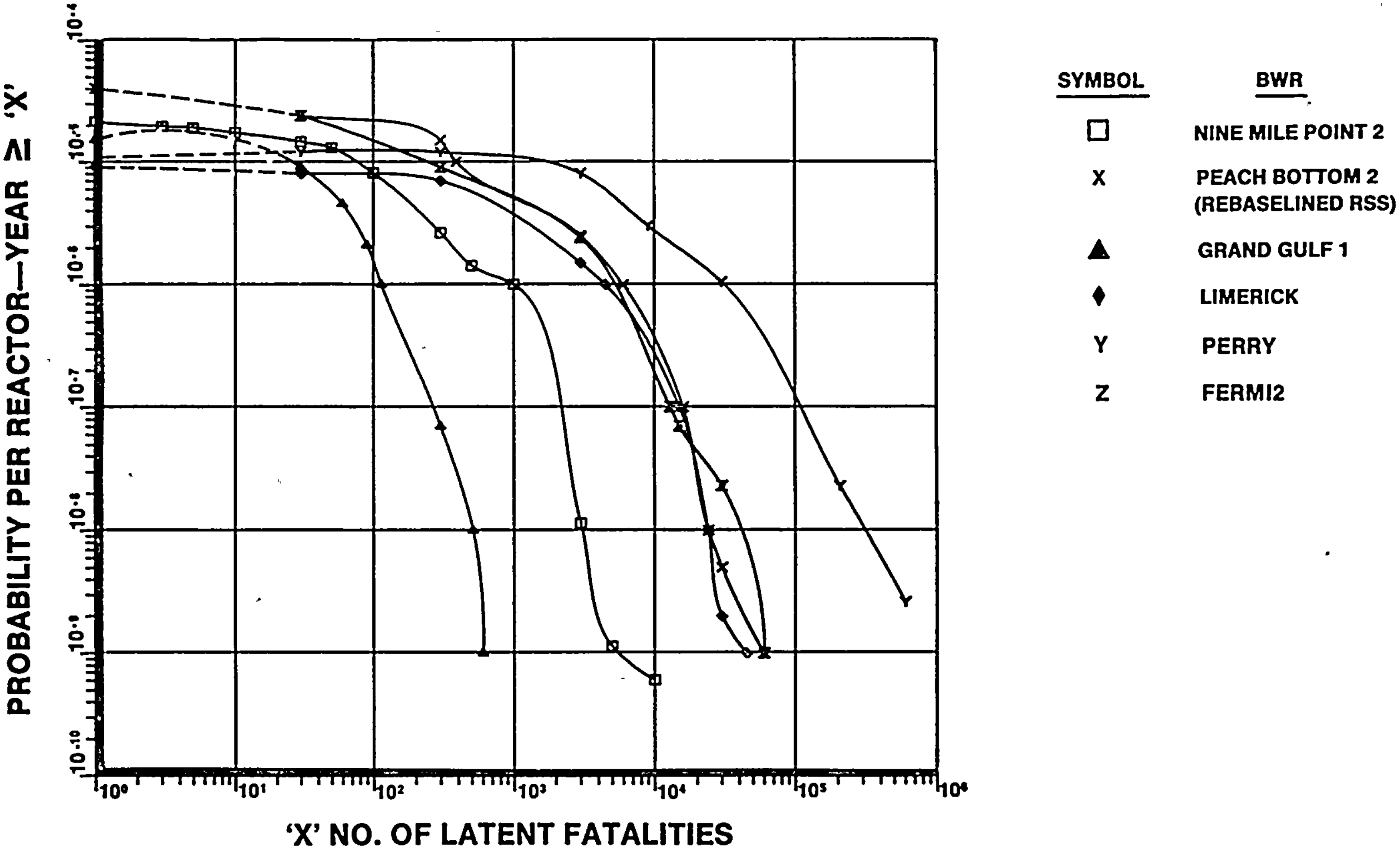
NOTES: 1. THE SOURCES FOR THE LIMERICK,PB2, GG1, PERRY, AND FERMI2 CURVES ARE REFERENCES 4, 33, 34, 35, and 36 RESPECTIVELY.

NOTES: 2. THE Y-AXIS UNITS FOR THE LIMERICK CURVES ARE: FREQUENCY (EVENTS/YEAR) ≥ 'X'.

FIGURE 7A.6-9

ACUTE FATALITIES-BWR COMPARISON

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS



NOTES: 1. THE SOURCES FOR THE LIMERICK, PB2, GG1, PERRY, AND FERMI2 CURVES ARE REFERENCES 4, 33, 34, 35, AND 36 RESPECTIVELY.

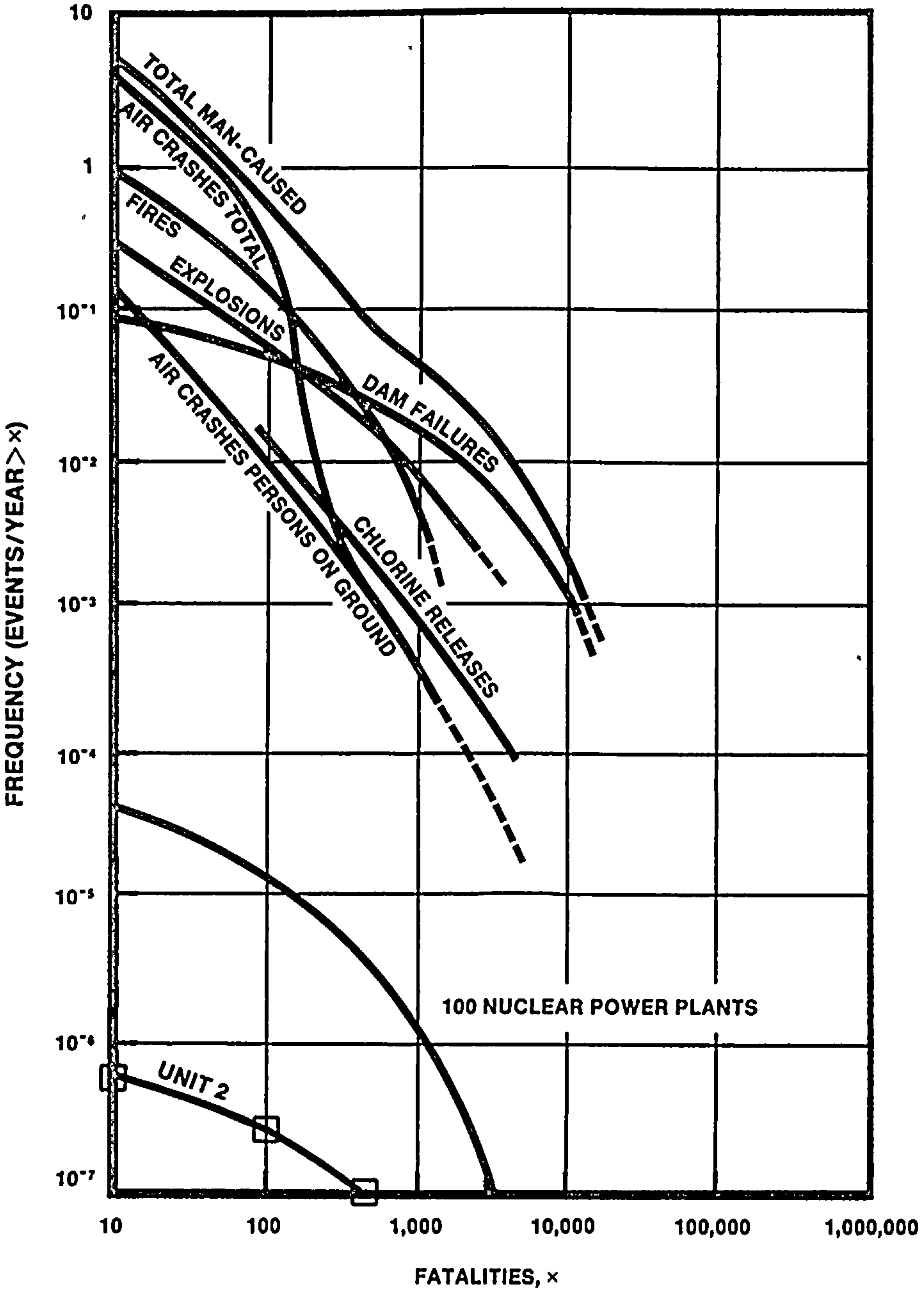
NOTES: 2. THE Y-AXIS UNITS FOR THE LIMERICK CURVES ARE: FREQUENCY (EVENTS/YEAR) 'X'

NOTES: 3. THE LATENT FATALITY CCDF'S FOR GG1, LIMERICK, PB2, PERRY, AND FERMI2 WERE GENERATED USING THE CRAC CODE, CRAC CALCULATED CANCER DEATHS USING A 30 YEAR LATENCY PERIOD AND THE RESULTS WERE ALL NORMALIZED TO 1 YEAR BY DIVIDING BY 30. THE UNIT 2 LATENT FATALITY CCDF'S ARE NOT NORMALIZED TO ONE YEAR, THEREFORE, THE GG1, LIMERICK, PB2, PERRY, AND FERMI2 LATENT FATALITY RESULTS HAVE BEEN MULTIPLIED BY 30 TO PROVIDE A COMMON BASE FOR COMPARISON. THE CURVES FOR THESE 5 PLANTS HAVE BEEN EXTRAPOLATED IN THE 1 TO 30 MAGNITUDE RANGE (SHOWN AS DASHED LINES.)

FIGURE 7A.6-10

LATENT FATALITIES-BWR COMPARISON

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS



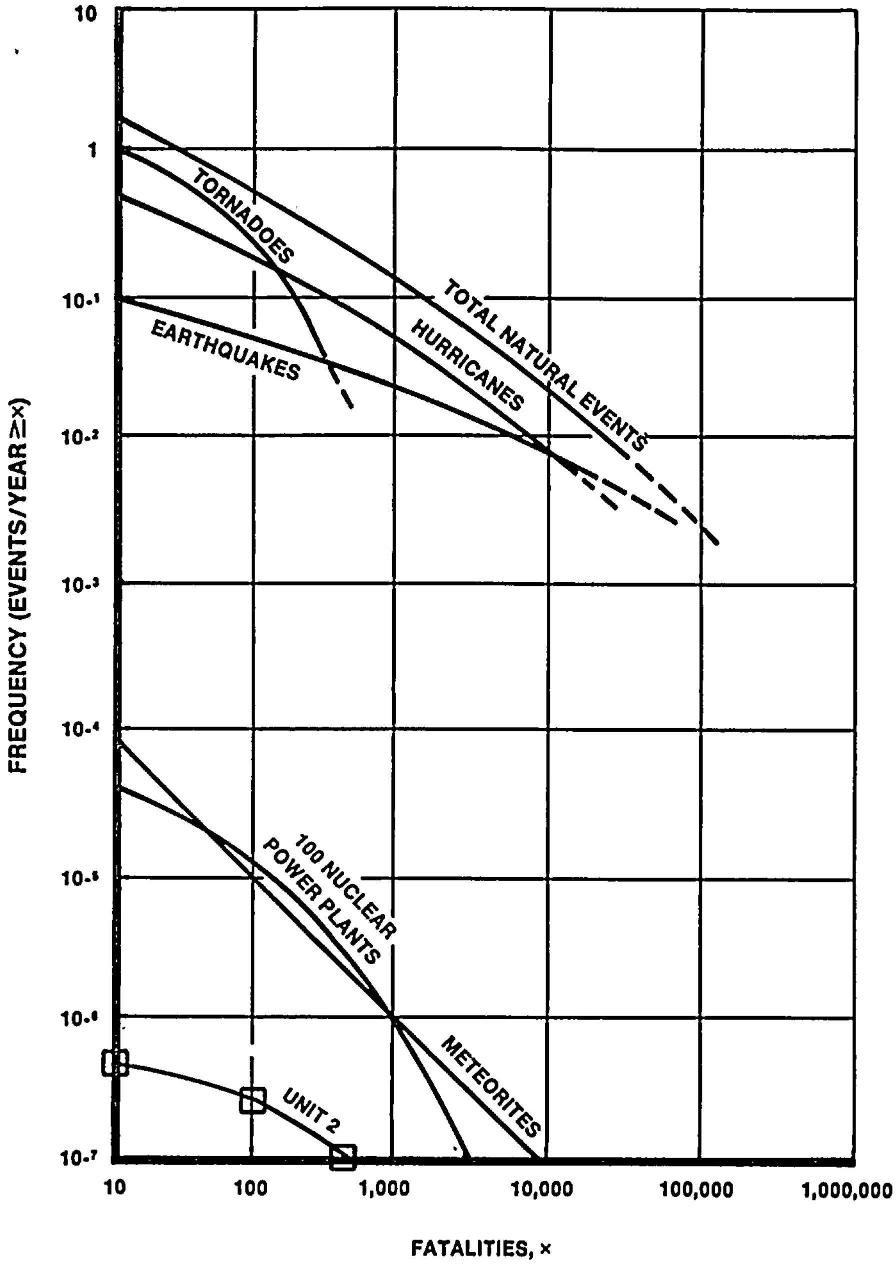
SOURCE: WASH - 1400 (RSS) (REFERENCE 1)

NOTE 1: FATALITIES DUE TO AUTO ACCIDENTS ARE NOT SHOWN BECAUSE DATA ARE NOT AVAILABLE FOR LARGE CONSEQUENCE ACCIDENTS. AUTO ACCIDENTS CAUSE ABOUT 50,000 FATALITIES PER YEAR IN THE U.S.

FIGURE 7A.6-11

CCDF'S COMPARISON OF UNIT 2 VERSUS OVERALL U.S. MAN-CAUSED FATALITIES RISK

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS



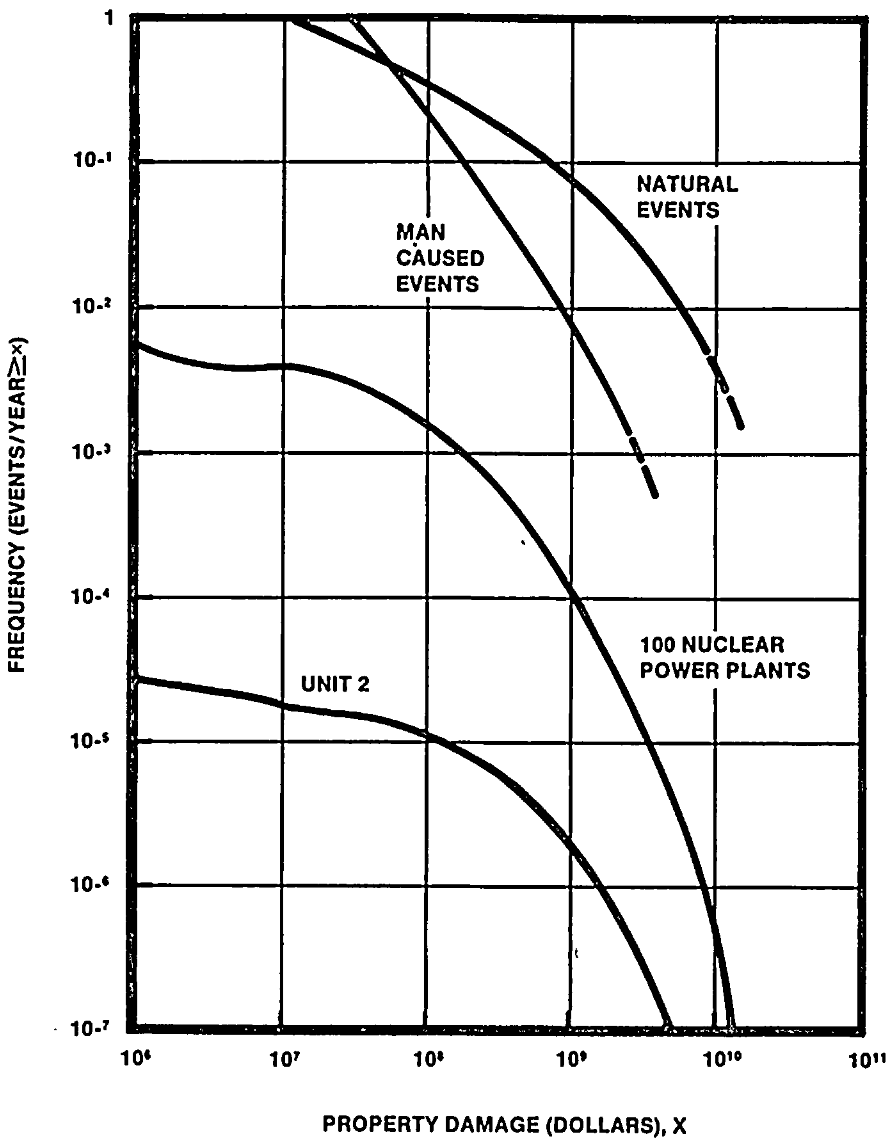
SOURCE: WASH — 1400 (RSS)

NOTE: 1. DATA FOR HURRICANES, TORNADOES, AND EARTHQUAKES ARE BASED ON THE AVERAGE U.S. VALUES FOR EVENTS DURING 1900-1972, 1953-1971, AND 1906-1971, RESPECTIVELY. DATA ARE TAKEN AS PRESENTED IN THE RSS.

FIGURE 7A.6-12

CCDFs COMPARISON OF UNIT 2 VERSUS OVERALL U.S. NATURALLY OCCURRING EVENT FATALITIES RISK

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS



SOURCE: WASH - 1400 (RSS)

NOTE 1: PROPERTY DAMAGE DUE TO AUTO ACCIDENTS IS NOT INCLUDED BECAUSE DATA ARE NOT AVAILABLE FOR LOW PROBABILITY EVENTS. AUTO ACCIDENTS CAUSE ABOUT $15 BILLION DAMAGE EACH YEAR.

FIGURE 7A.6-13

CCDFs COMPARISON OF UNIT 2 VERSUS OVERALL U.S. PROPERTY DAMAGE RISK

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS

7A.7 REFERENCES

1. Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants (WASH-1400). NUREG-75/014, Nuclear Regulatory Commission, Washington, DC, October 1975.

2. Reactor Safety Study Methodology Applications Program: Grand Gulf Unit 1 BWR Power Plant. NUREG/CR-1659/ 4 of 4, Nuclear Regulatory Commission and Sandia National Laboratories, Washington, DC, October 1981.

3. Industry Degraded Core Rulemaking Program, Technical Report 3.1, Atomic Industrial Forum/Technology for Energy Corporation, June 1982.

4. Probabilistic Risk Assessment, Limerick Generating Station. Docket Nos. 50-352 and 50-353, Philadelphia Electric Company, Philadelphia, PA, March 1981.

5. Calculations of Reactor Accidents Consequences - Version 2 (CRAC2) Computer Code Users' Manual. NUREG/CR-2326, Nuclear Regulatory Commission and Sandia National Laboratories, Washington, DC, March 1982

6. The Effects on Populations of Exposures to Low Levels of Ionizing Radiation: 1980 Committee on the Biological Effects of Ionizing Radiation (BEIR III). National Academy of Sciences, Washington, DC, 1980.

7. Standard Technical Specifications for BWR 5. NUREG-0123, Revision 3, Nuclear Regulatory Commission and General Electric Company, Washington, DC, Fall 1980.

8. Risk Assessment Review Group Report to the U.S. Nuclear Regulatory Commission. NUREG/CR-0400, USNRC, September 1978.

9. Letter from W.R. Stratton, A.P. Malinauskas, and D.O. Campbell to NRC Chairman J. Ahearne dated August 14, 1980.

10. Letter from Chauncey Starr to NRC Commissioner J. Hendrie dated September 20, 1980.

11. Levenson, M. and Rahn, F. Realistic Estimates of the Consequences of Nuclear Accidents, Nuclear Technology, Vol 53, May 1981.

2 12. Morewitz, H. Fission Product Releases from Degraded Core Accidents, Nuclear Technology, Vol 53, May 1981.

13. Mendosa, Z.T.; Stevens, G.A.; and Ritzmann, R.L. Radiation Release from the SL-1 Accident. Nuclear Technology, Vol 53, May 1981.

14. Letter from Nuclear Safety Oversight Committee to President Jimmy Carter dated December 21, 1980.

15. Campbell, D.O.; Malinauskas, A.P.; and Stratton, W.R. The Chemical Behavior of Fission Product Iodine in Tight Water Reactor Accidents, Nuclear Technology, Vol 53, May 1981.

16. Bunz, H.; Schikarski, W.; and Schock, W. The Role of Aerosol Behaviour in Light Water Reactor Core Melt Accidents. Nuclear Technology, Vol 53, May 1981.

17. Recommended Source Term of Environmental Releases from Major LWR Accidents, NSA 81/008. Rodger, Walter A. and Trepathi, R.R., Nuclear Safety Associates, September 1981.

18. Source Terms: An Investigation of Uncertainties, Magnitudes, and Recommendations for Research, NUS Corporation and Sandia National Laboratories, NUS-3808/ALO-1008, March 1982.

19. PRA Procedures Guide. NUREG/CR-2300, Nuclear Regulatory Commission, American Nuclear Society, and Institute of Electrical and Electronics Engineers, Washington, DC, April 1982.

2 20. NMP2 Core Inventory, GE letter NMP2-4788 dated February 4, 1983.

21. New York State Radiological Emergency Preparedness Plan. State of New York, July 1981.

22. Oswego County Radiological Emergency Response Plan. Oswego County, NY, July 1981.

23. Nine Mile Point Nuclear Station Site Emergency Plan. Niagara Mohawk Power Corporation, Revision 9, March 5, 1982.

24. U.S. Department of Commerce, Bureau of the Census, 1980 Census.

25. New York Department of Commerce, 1978 Official Population Projections by Age and Sex for New York State Counties, 1979.

26. Envirodata Corporation, Digitized Census Maps of Area Within 50 Miles of Nine Mile Point, NY, 1982.

27. Government of Canada, Statistics Canada Interim Population Counts for Census Divisions and Census Subdivisions, 1981.

28. Holzworth, G. C. Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States. Environmental Protection Agency, Publication No. AP-101, Washington, DC, 1972.

29. U.S. Department of Commerce, Consumer's Price Index.

30. Cancer Facts and Figures, American Cancer Society, 1982.

31. Preliminary Safety Analysis Report, Nine Mile Point Nuclear Station - Unit 2. NRC Docket No. 50-410, Niagara Mohawk Power Corporation, June 1972.

32. Wall, I.B., et al. Overview of the Reactor Safety Study Consequence Model. NUREG-0340, Nuclear Regulatory Commission, Washington, DC, 1977.

33. Task Force Report on the Interim Operation of Indian Point. NUREG-0715, USNRC, August 1980.

34. Final Environmental Impact Statement related to the operation of Grand Gulf Nuclear Station, Units 1 and 2. NUREG-0777, Docket Nos. 50-416 and 50-417, USNRC, September 1981.

35. Final Environmental Impact Statement Related to the Operation of Perry Nuclear Power Plant Units 1 and 2. NUREG-0884, Docket Nos. 50-440 and 50-441, USNRC, December 1982. 2

36. Final Environmental Impact Statement Related to the Operation of Enrico Fermi Atomic Power Plant, Unit 2, NUREG-0769, Docket No. 50-341, USNRC, August 1981.

APPENDIX 7B

MAIN STACK AND COMBINED RADWASTE AND REACTOR BUILDING VENT ANNUAL AND GRAZING SEASON X/Q AND D/Q AT GROUND LEVEL FOR LOCATIONS OF MILK ANIMALS, MEAT ANIMALS, VEGETABLE GARDENS AND RESIDENCES BY SECTOR

AND

MAIN STACK X/Q AND D/Q AT GROUND LEVEL, LONG-TERM (ROUTINE) GASEOUS RELEASES FOR MECHANICAL VACUUM RELEASES AT LOCATIONS OF MILK ANIMALS, MEAT ANIMALS, VEGETABLE GARDENS AND RESIDENCES BY SECTOR 7

APPENDIX 7B

LIST OF TABLES

LIST OF TABLES (Cont)

7

TABLE 7B-1

MAIN STACK X/Q AND D/Q AT GROUND LEVEL
LONG TERM (ROUTINE) AND GRAZING SEASON GASEOUS RELEASES
LOCATIONS OF MILK ANIMALS BY SECTOR

Sector Bearing	Distance (m)	Annual X/Q (sec/m³)	Annual D/Q (1/m²)	Grazing Season X/Q (sec/m³)	Grazing Season D/Q (1/m²)
ESE	2,366	9.39E-09	8.75E-10	8.84E-09	5.88E-10
	4,855	1.26E-08	3.83E-10	1.13E-08	2.57E-10
SSE	2,592	6.13E-09	4.22E-10	4.40E-09	2.93E-10
	3,931	1.17E-08	2.66E-10	8.99E-09	1.72E-10
	4,001	1.16E-08	2.61E-10	8.95E-09	1.68E-10
	5,925	1.10E-08	1.50E-10	9.85E-09	9.46E-11
SW	2,700	4.40E-09	2.57E-10	4.18E-09	1.88E-10

7

TABLE 7B-2

MAIN STACK X/Q AND D/Q AT GROUND LEVEL
LONG TERM (ROUTINE) AND GRAZING SEASON GASEOUS RELEASES
LOCATIONS OF MEAT ANIMALS BY SECTOR

Sector Bearing	Distance (m)	Annual X/Q (sec/m^3)	Annual D/Q (1/m^2)	Grazing Season X/Q (sec/m^3)	Grazing Season D/Q (1/m^2)	
E	1,711	8.50E-09	1.33E-09	1.04E-08	1.36E-09	
ESE	2,554	9.62E-09	8.01E-10	8.92E-09	5.39E-10	
	2,743	1.05E-08	7.46E-10	9.56E-09	5.01E-10	
	3,051	1.15E-08	6.72E-10	1.03E-08	4.51E-10	
	3,200	1.16E-08	6.42E-10	1.04E-08	4.31E-10	
	3,240	1.17E-08	6.35E-10	1.04E-08	4.26E-10	7
	3,399	1.17E-08	6.07E-10	1.04E-08	4.07E-10	
	3,668	1.18E-08	5.66E-10	1.05E-08	3.80E-10	
	3,857	1.18E-08	5.41E-10	1.05E-08	3.63E-10	
	4,545	1.22E-08	4.25E-10	1.09E-08	2.85E-10	
	4,855	1.26E-08	3.83E-10	1.13E-08	2.57E-10	
	5,044	1.24E-08	3.60E-10	1.12E-08	2.42E-10	
	5,234	1.22E-08	3.39E-10	1.10E-08	2.28E-10	
SE	2,892	1.03E-08	6.33E-10	6.67E-09	3.18E-10	
	3,120	1.03E-08	5.83E-10	6.69E-09	2.93E-10	
	3,925	1.94E-08	4.83E-10	1.39E-08	2.37E-10	
	4,074	1.89E-08	4.60E-10	1.37E-08	2.26E-10	
	4,771	1.81E-08	3.89E-10	1.38E-08	1.92E-10	
	4,961	1.77E-08	3.64E-10	1.37E-08	1.80E-10	

TABLE 7B-2 (Cont)

Sector Bearing	Distance (m)	Annual X/Q (sec/m³)	Annual D/Q (1/m²)	Grazing Season X/Q (sec/m³)	Grazing Season D/Q (1/m²)
	5,340	1.65E-08	3.22E-10	1.29E-08	1.59E-10
SSE	3,008	6.44E-09	3.51E-10	4.50E-09	2.40E-10
	3,971	1.16E-08	2.63E-10	8.97E-09	1.70E-10
	4,001	1.16E-08	2.61E-10	8.95E-09	1.68E-10
SSW	4,140	8.94E-09	2.02E-10	8.33E-09	1.62E-10
	4,409	8.85E-09	1.82E-10	8.32E-09	1.46E-10
	4,709	8.72E-09	1.64E-10	8.27E-09	1.32E-10
	4,819	8.66E-09	1.58E-10	8.24E-09	1.27E-10
	5,788	1.16E-08	1.26E-10	1.18E-08	9.97E-11
	5,908	1.20E-08	1.28E-10	1.23E-08	1.00E-10
	6,207	1.14E-08	1.18E-10	1.18E-08	9.24E-11
SW	2,700	4.40E-09	2.57E-10	4.18E-09	1.88E-10
	3,200	5.52E-09	2.22E-10	5.06E-09	1.60E-10

7

TABLE 7B-3

MAIN STACK X/Q AND D/Q AT GROUND LEVEL LONG TERM (ROUTINE) AND GRAZING SEASON GASEOUS RELEASES LOCATIONS OF VEGETABLE GARDENS BY SECTOR

Sector Bearing	Distance (m)	Annual X/Q (sec/m³)	Annual D/Q (1/m²)	Grazing Season X/Q (sec/m³)	Grazing Season D/Q (1/m²)
E	1,940	8.84E-09	1.22E-09	1.07E-08	1.24E-09
	2,129	9.21E-09	1.15E-09	1.12E-08	1.17E-09
	2,936	1.29E-08	8.65E-10	1.55E-08	8.86E-10
ESE	2,554	9.62E-09	8.01E-10	8.92E-09	5.39E-10
	2,743	1.05E-08	7.46E-10	9.56E-09	5.01E-10
	2,862	1.06E-08	7.15E-10	9.62E-09	4.80E-10
	3,011	1.08E-08	6.81E-10	9.69E-09	4.57E-10
	3,091	1.16E-08	6.64E-10	1.03E-08	4.46E-10
	3,160	1.16E-08	6.50E-10	1.04E-08	4.36E-10
	3,200	1.16E-08	6.42E-10	1.04E-08	4.31E-10
	3,469	1.18E-08	5.95E-10	1.04E-08	4.00E-10
	3,658	1.18E-08	5.67E-10	1.05E-08	3.81E-10
	3,857	1.18E-08	5.41E-10	1.05E-08	3.63E-10
	4,545	1.22E-08	4.25E-10	1.09E-08	2.85E-10
	4,855	1.26E-08	3.83E-10	1.13E-08	2.57E-10
	5,084	1.24E-08	3.55E-10	1.12E-08	2.39E-10
SE	2,397	9.45E-09	7.91E-10	6.33E-09	3.97E-10
	2,892	1.03E-08	6.33E-10	6.67E-09	3.18E-10
	3,011	1.03E-08	6.06E-10	6.68E-09	3.05E-10

7

TABLE 7B-3 (Cont)

Sector Bearing	Distance (m)	Annual X/Q (sec/m³)	Annual D/Q (1/m²)	Grazing Season X/Q (sec/m³)	Grazing Season D/Q (1/m²)
SE	3,080	1.03E-08	5.91E-10	6.69E-09	2.97E-10
	3,120	1.03E-08	5.83E-10	6.69E-09	2.93E-10
	3,239	1.03E-08	5.60E-10	6.70E-09	2.82E-10
	3,279	1.03E-08	5.53E-10	6.71E-09	2.78E-10
	3,308	1.03E-08	5.48E-10	6.71E-09	2.76E-10
	3,388	1.23E-08	5.35E-10	8.02E-09	2.69E-10
	3,577	1.62E-08	5.05E-10	1.09E-08	2.54E-10
	3,616	1.61E-08	5.00E-10	1.09E-08	2.52E-10
	3,915	1.79E-08	4.61E-10	1.26E-08	2.32E-10
	3,965	1.93E-08	4.77E-10	1.38E-08	2.35E-10
	4,074	1.89E-08	4.60E-10	1.37E-08	2.26E-10
	4,303	1.97E-08	4.62E-10	1.46E-08	2.28E-10
	4,383	1.94E-08	4.48E-10	1.45E-08	2.21E-10
	4,731	1.82E-08	3.94E-10	1.39E-08	1.95E-10
	4,961	1.77E-08	3.64E-10	1.37E-08	1.80E-10
	5,300	1.66E-08	3.26E-10	1.30E-08	1.61E-10
SSE	2,582	6.13E-09	4.24E-10	4.40E-09	2.94E-10
	2,938	6.44E-09	3.62E-10	4.51E-09	2.47E-10
	3,047	6.43E-09	3.46E-10	4.50E-09	2.35E-10
	3,852	1.18E-08	2.73E-10	9.02E-09	1.77E-10
	3,931	1.17E-08	2.66E-10	8.99E-09	1.72E-10

7

TABLE 7B-3 (Cont)

Sector Bearing	Distance (m)	Annual X/Q (sec/m³)	Annual D/Q (1/m²)	Grazing Season X/Q (sec/m³)	Grazing Season D/Q (1/m²)
SSE	4,001	1.16E-08	2.61E-10	8.95E-09	1.68E-10
	4,041	1.15E-08	2.57E-10	8.94E-09	1.66E-10
	4,270	1.22E-08	2.52E-10	9.82E-09	1.59E-10
	4,349	1.21E-08	2.44E-10	9.76E-09	1.55E-10
	4,429	1.20E-08	2.37E-10	9.70E-09	1.50E-10
	4,658	1.16E-08	2.18E-10	9.51E-09	1.38E-10
S	2,809	7.73E-09	4.10E-10	7.31E-09	3.76E-10
	3,306	8.18E-09	3.40E-10	7.60E-09	3.07E-10
	3,913	1.43E-08	2.90E-10	1.39E-08	2.59E-10
	4,102	1.48E-08	2.81E-10	1.46E-08	2.50E-10
	5,109	1.41E-08	2.10E-10	1.47E-08	1.82E-10
	5,209	1.39E-08	2.04E-10	1.45E-08	1.76E-10
	5,259	1.38E-08	2.00E-10	1.44E-08	1.74E-10
SSW	4,559	8.79E-09	1.73E-10	8.29E-09	1.39E-10
	4,639	8.75E-09	1.68E-10	8.28E-09	1.35E-10
	4,709	8.72E-09	1.64E-10	8.27E-09	1.32E-10
	4,789	8.68E-09	1.60E-10	8.25E-09	1.28E-10
	4,869	8.64E-09	1.55E-10	8.23E-09	1.25E-10
	5,558	1.20E-08	1.35E-10	1.22E-08	1.07E-10
	5,788	1.16E-08	1.26E-10	1.18E-08	9.97E-11
	5,978	1.18E-08	1.26E-10	1.21E-08	9.84E-11

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TABLE 7B-3 (Cont)

Sector Bearing	Distance (m)	Annual X/Q (sec/m³)	Annual D/Q (1/m²)	Grazing Season X/Q (sec/m³)	Grazing Season D/Q (1/m²)
SSW	6,058	1.17E-08	1.23E-10	1.20E-08	9.62E-11
	6,137	1.06E-08	1.11E-10	1.07E-08	8.86E-10
SW	2,270	3.82E-09	3.04E-10	3.85E-09	2.25E-10
	2,311	3.84E-09	2.99E-10	3.85E-09	2.21E-10
	2,351	3.87E-09	2.94E-10	3.86E-09	2.17E-10
	2,700	4.40E-09	2.57E-10	4.18E-09	1.88E-10
	3,080	5.42E-09	2.29E-10	4.98E-09	1.66E-10
	3,430	5.69E-09	2.09E-10	5.20E-09	1.51E-10
	3,770	5.88E-09	1.93E-10	5.40E-09	1.39E-10
	4,010	5.99E-09	1.83E-10	5.52E-09	1.31E-10
	5,699	6.28E-09	1.04E-10	6.05E-09	7.46E-11
	6,039	7.18E-09	9.51E-11	7.08E-09	6.80E-11
	6,309	7.89E-09	8.87E-11	7.92E-09	6.34E-11

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TABLE 7B-4

MAIN STACK X/Q AND D/Q AT GROUND LEVEL
LONG TERM (ROUTINE) AND GRAZING SEASON GASEOUS RELEASES
LOCATIONS OF RESIDENCES BY SECTOR

Sector Bearing	Distance (m)	Annual X/Q (sec/m³)	Annual D/Q (1/m²)	Grazing Season X/Q (sec/m³)	Grazing Season D/Q (1/m²)
E	1,711	8.50E-09	1.33E-09	1.04E-08	1.36E-09
	1,820	8.65E-09	1.28E-09	1.05E-08	1.30E-09
	1,940	8.84E-09	1.22E-09	1.07E-08	1.24E-09
	2,129	9.21E-09	1.15E-09	1.12E-08	1.17E-09
	2,208	9.39E-09	1.11E-09	1.14E-08	1.14E-09
	2,746	1.24E-08	9.15E-10	1.49E-08	9.37E-10
	2,856	1.27E-08	8.85E-10	1.53E-08	9.06E-10
	2,936	1.29E-08	8.65E-10	1.55E-08	8.86E-10
	4,124	1.55E-08	6.41E-10	1.89E-08	6.58E-10
	4,154	1.55E-08	6.33E-10	1.89E-08	6.51E-10
ESE	2,554	9.62E-09	8.01E-10	8.92E-09	5.39E-10
	2,743	1.05E-08	7.46E-10	9.56E-09	5.01E-10
	2,862	1.06E-08	7.15E-10	9.62E-09	4.80E-10
	3,011	1.08E-08	6.81E-10	9.69E-09	4.57E-10
	3,091	1.16E-08	6.64E-10	1.03E-08	4.46E-10
	3,160	1.16E-08	6.50E-10	1.04E-08	4.36E-10
	3,200	1.16E-08	6.42E-10	1.04E-08	4.31E-10
	3,240	1.17E-08	6.35E-10	1.04E-08	4.26E-10
	3,359	1.17E-08	6.13E-10	1.04E-08	4.12E-10

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TABLE 7B-4 (Cont)

Sector Bearing	Distance (m)	Annual X/Q (sec/m³)	Annual D/Q (1/m²)	Grazing Season X/Q (sec/m³)	Grazing Season D/Q (1/m²)
	3,399	1.17E-08	6.07E-10	1.04E-08	4.07E-10
	3,429	1.17E-08	6.02E-10	1.04E-08	4.04E-10
	3,469	1.18E-08	5.95E-10	1.04E-08	4.00E-10
	3,588	1.18E-08	5.77E-10	1.05E-08	3.88E-10
	3,658	1.18E-08	5.67E-10	1.05E-08	3.81E-10
	3,698	1.18E-08	5.62E-10	1.05E-08	3.77E-10
	3,857	1.18E-08	5.41E-10	1.05E-08	3.63E-10
	4,506	1.22E-08	4.31E-10	1.09E-08	2.89E-10
	4,545	1.22E-08	4.25E-10	1.09E-08	2.85E-10
	4,585	1.22E-08	4.19E-10	1.09E-08	2.81E-10
	4,625	1.22E-08	4.14E-10	1.09E-08	2.78E-10
	4,735	1.27E-08	3.98E-10	1.14E-08	2.67E-10
	4,765	1.27E-08	3.94E-10	1.14E-08	2.65E-10
	4,855	1.26E-08	3.83E-10	1.13E-08	2.57E-10
	4,895	1.26E-08	3.78E-10	1.13E-08	2.53E-10
	5,044	1.24E-08	3.60E-10	1.12E-08	2.42E-10
	5,084	1.24E-08	3.55E-10	1.12E-08	2.39E-10
	5,124	1.23E-08	3.51E-10	1.11E-08	2.36E-10
	5,234	1.22E-08	3.39E-10	1.10E-08	2.28E-10
SE	2,397	9.45E-09	7.91E-10	6.33E-09	3.97E-10
	2,555	9.52E-09	7.27E-10	6.31E-09	3.65E-10

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TABLE 7B-4 (Cont)

Sector Bearing	Distance (m)	Annual X/Q (sec/m³)	Annual D/Q (1/m²)	Grazing Season X/Q (sec/m³)	Grazing Season D/Q (1/m²)	
	2,892	1.03E-08	6.33E-10	6.67E-09	3.18E-10	
	2,921	1.03E-08	6.26E-10	6.68E-09	3.15E-10	
	3,011	1.03E-08	6.06E-10	6.68E-09	3.05E-10	
	3,050	1.03E-08	5.98E-10	6.69E-09	3.00E-10	
	3,080	1.03E-08	5.91E-10	6.69E-09	2.97E-10	
	3,120	1.03E-08	5.83E-10	6.69E-09	2.93E-10	
	3,159	1.03E-08	5.76E-10	6.70E-09	2.89E-10	
	3,199	1.03E-08	5.68E-10	6.70E-09	2.86E-10	
	3,239	1.03E-08	5.60E-10	6.70E-09	2.82E-10	
	3,279	1.03E-08	5.53E-10	6.71E-09	2.78E-10	7
	3,308	1.03E-08	5.48E-10	6.71E-09	2.76E-10	
	3,348	1.23E-08	5.41E-10	8.02E-09	2.72E-10	
	3,388	1.23E-08	5.35E-10	8.02E-09	2.69E-10	
	3,577	1.62E-08	5.05E-10	1.09E-08	2.54E-10	
	3,616	1.61E-08	5.00E-10	1.09E-08	2.52E-10	
	3,805	1.81E-08	4.75E-10	1.27E-08	2.39E-10	
	3,815	1.81E-08	4.73E-10	1.27E-08	2.38E-10	
	3,915	1.79E-08	4.61E-10	1.26E-08	2.32E-10	
	3,925	1.94E-08	4.83E-10	1.39E-08	2.37E-10	
	3,965	1.93E-08	4.77E-10	1.38E-08	2.35E-10	
	4,074	1.89E-08	4.60E-10	1.37E-08	2.26E-10	
	4,154	2.02E-08	4.90E-10	1.49E-08	2.42E-10	

TABLE 7B-4 (Cont)

Sector Bearing	Distance (m)	Annual X/Q (sec/m³)	Annual D/Q (1/m²)	Grazing Season X/Q (sec/m³)	Grazing Season D/Q (1/m²)	
	4,303	1.97E-08	4.62E-10	1.46E-08	2.28E-10	
	4,383	1.94E-08	4.48E-10	1.45E-08	2.21E-10	
	4,652	1.85E-08	4.06E-10	1.40E-08	2.00E-10	
	4,731	1.82E-08	3.94E-10	1.39E-08	1.95E-10	
	4,771	1.81E-08	3.89E-10	1.38E-08	1.92E-10	
	4,961	1.77E-08	3.64E-10	1.37E-08	1.80E-10	
	5,230	1.68E-08	3.34E-10	1.32E-08	1.65E-10	
	5,300	1.66E-08	3.26E-10	1.30E-08	1.61E-10	
	5,539	1.59E-08	3.03E-10	1.26E-08	1.50E-10	
SSE	2,582	6.13E-09	4.24E-10	4.40E-09	2.94E-10	7
	2,819	6.45E-09	3.80E-10	4.53E-09	2.61E-10	
	2,938	6.44E-09	3.62E-10	4.51E-09	2.47E-10	
	3,047	6.43E-09	3.46E-10	4.50E-09	2.34E-10	
	3,812	1.19E-08	2.76E-10	9.04E-09	1.79E-10	
	3,852	1.18E-08	2.73E-10	9.02E-09	1.77E-10	
	3,931	1.17E-08	2.66E-10	8.99E-09	1.72E-10	
	3,961	1.17E-08	2.64E-10	8.97E-09	1.70E-10	
	3,971	1.16E-08	2.63E-10	8.97E-09	1.70E-10	
	4,001	1.16E-08	2.61E-10	8.95E-09	1.68E-10	
	4,041	1.15E-08	2.57E-10	8.94E-09	1.66E-10	
	4,120	1.25E-08	2.67E-10	9.93E-09	1.69E-10	

TABLE 7B-4 (Cont)

Sector Bearing	Distance (m)	Annual X/Q (sec/m³)	Annual D/Q (1/m²)	Grazing Season X/Q (sec/m³)	Grazing Season D/Q (1/m²)
	4,270	1.22E-08	2.52E-10	9.82E-09	1.59E-10
	4,349	1.21E-08	3.44E-10	9.76E-09	1.55E-10
	4,429	1.20E-08	2.37E-10	9.70E-09	1.50E-10
	4,658	1.16E-08	2.18E-10	9.51E-09	1.38E-10
	5,196	1.08E-08	1.82E-10	9.18E-09	1.16E-10
	5,226	1.08E-08	1.80E-10	9.14E-09	1.15E-10
	5,496	1.08E-08	1.70E-10	9.34E-09	1.07E-10
	5,885	1.10E-08	1.52E-10	9.91E-09	9.57E-11
	5,925	1.10E-08	1.50E-10	9.85E-09	9.46E-11
	5,994	1.08E-08	1.47E-10	9.76E-09	9.28E-11
S	2,809	7.73E-09	4.10E-10	7.31E-09	3.76E-10
	3,306	8.18E-09	3.40E-10	7.60E-09	3.07E-10
	3,873	1.44E-08	2.94E-10	1.40E-08	2.62E-10
	3,913	1.43E-08	2.90E-10	1.39E-08	2.59E-10
	3,953	1.43E-08	2.87E-10	1.39E-08	2.56E-10
	3,993	1.50E-08	2.93E-10	1.47E-08	2.60E-10
	4,033	1.49E-08	2.89E-10	1.47E-08	2.57E-10
	4,072	1.49E-08	2.85E-10	1.46E-08	2.53E-10
	4,102	1.48E-08	2.81E-10	1.46E-08	2.50E-10
	4,990	1.44E-08	2.19E-10	1.50E-08	1.89E-10
	5,109	1.41E-08	2.10E-10	1.47E-08	1.82E-10

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TABLE 7B-4 (Cont)

Sector Bearing	Distance (m)	Annual X/Q (sec/m³)	Annual D/Q (1/m²)	Grazing Season X/Q (sec/m³)	Grazing Season D/Q (1/m²)
	5,139	1.41E-08	2.08E-10	1.47E-08	1.80E-10
	5,169	1.40E-08	2.06E-10	1.46E-08	1.79E-10
	5,179	1.40E-08	2.06E-10	1.46E-08	1.78E-10
	5,209	1.39E-08	2.04E-10	1.45E-08	1.76E-10
	5,259	1.38E-08	2.00E-10	1.44E-08	1.74E-10
	5,449	1.34E-08	1.89E-10	1.40E-08	1.64E-10
SSW	4,210	8.92E-09	1.96E-10	8.33E-09	1.58E-10
	4,319	8.88E-09	1.88E-10	8.33E-09	1.51E-10
	4,409	8.85E-09	1.82E-10	8.32E-09	1.46E-10
	4,559	8.79E-09	1.73E-10	8.29E-09	1.39E-10
	4,639	8.75E-09	1.68E-10	8.28E-09	1.35E-10
	4,709	8.72E-09	1.64E-10	8.27E-09	1.32E-10
	4,789	8.68E-09	1.60E-10	8.25E-09	1.28E-10
	4,869	8.64E-09	1.55E-10	8.23E-09	1.25E-10
	4,909	9.61E-09	1.53E-10	9.27E-09	1.23E-10
	4,979	1.01E-08	1.50E-10	9.81E-09	1.20E-10
	5,368	1.18E-08	1.39E-10	1.18E-08	1.10E-10
	5,448	1.16E-08	1.35E-10	1.17E-08	1.08E-10
	5,558	1.20E-08	1.35E-10	1.22E-08	1.07E-10
	5,638	1.19E-08	1.32E-10	1.21E-08	1.04E-10
	5,678	1.18E-08	1.30E-10	1.20E-08	1.03E-10

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TABLE 7B-4 (Cont)

Sector Bearing	Distance (m)	Annual X/Q (sec/m³)	Annual D/Q (1/m²)	Grazing Season X/Q (sec/m³)	Grazing Season D/Q (1/m²)
	5,748	1.17E-08	1.28E-10	1.19E-08	1.01E-10
	5,788	1.16E-08	1.26E-10	1.18E-08	9.97E-11
	5,818	1.21E-08	1.32E-10	1.24E-08	1.03E-10
	5,868	1.20E-08	1.30E-10	1.23E-08	1.01E-10
	5,908	1.20E-08	1.28E-10	1.23E-08	1.00E-10
	5,918	1.19E-08	1.28E-10	1.22E-08	1.00E-10
	5,978	1.18E-08	1.26E-10	1.21E-08	9.84E-11
	6,018	1.18E-08	1.24E-10	1.21E-08	9.73E-11
	6,058	1.17E-08	1.23E-10	1.20E-08	9.62E-11
	6,098	1.16E-08	1.22E-10	1.19E-08	9.52E-11
	6,137	1.16E-08	1.20E-10	1.19E-08	9.42E-11
	6,207	1.14E-08	1.18E-10	1.18E-08	9.24E-11
SW	1,971	3.70E-09	3.39E-10	3.88E-09	2.53E-10
	2,240	3.80E-09	3.07E-10	3.85E-09	2.28E-10
	2,270	3.82E-09	3.04E-10	3.85E-09	2.25E-10
	2,311	3.84E-09	2.99E-10	3.85E-09	2.21E-10
	2,351	3.87E-09	2.94E-10	3.86E-09	2.17E-10
	2,471	3.94E-09	2.82E-10	3.88E-09	2.07E-10
	2,580	4.30E-09	2.68E-10	4.14E-09	1.97E-10
	2,700	4.40E-09	2.57E-10	4.18E-09	1.88E-10
	2,810	4.49E-09	2.48E-10	4.23E-09	1.81E-10

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TABLE 7B-4 (Cont)

Sector Bearing	Distance (m)	Annual X/Q (sec/m³)	Annual D/Q (1/m²)	Grazing Season X/Q (sec/m³)	Grazing Season D/Q (1/m²)
	2,930	4.92E-09	2.39E-10	4.57E-09	1.74E-10
	3,080	5.42E-09	2.29E-10	4.98E-09	1.66E-10
	3,160	5.49E-09	2.24E-10	5.03E-09	1.62E-10
	3,200	5.52E-09	2.22E-10	5.06E-09	1.60E-10
	3,240	5.55E-09	2.19E-10	5.08E-09	1.59E-10
	3,380	5.65E-09	2.12E-10	5.17E-09	1.53E-10
	3,430	5.69E-09	2.09E-10	5.20E-09	1.51E-10
	3,620	5.80E-09	2.00E-10	5.31E-09	1.44E-10
	3,740	5.87E-09	1.95E-10	5.38E-09	1.40E-10
	3,770	5.88E-09	1.93E-10	5.40E-09	1.39E-10
	3,810	5.90E-09	1.92E-10	5.42E-09	1.37E-10
	4,010	5.99E-09	1.83E-10	5.52E-09	1.31E-10
	4,270	6.08E-09	1.65E-10	5.63E-09	1.18E-10
	4,310	6.09E-09	1.63E-10	5.65E-09	1.17E-10
	4,350	6.10E-09	1.61E-10	5.66E-09	1.15E-10
	4,430	6.12E-09	1.56E-10	5.69E-09	1.12E-10
	4,930	6.18E-09	1.32E-10	5.84E-09	9.40E-11
	5,120	6.15E-09	1.24E-10	5.83E-09	8.85E-11
	5,160	6.50E-09	1.22E-10	6.20E-09	8.74E-11
	5,659	6.30E-09	1.06E-10	6.06E-09	7.54E-11
	5,699	6.28E-09	1.04E-10	6.05E-09	7.46E-11
	5,769	6.60E-09	1.02E-10	6.40E-09	7.31E-11

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TABLE 7B-4 (Cont)

Sector Bearing	Distance (m)	Annual X/Q (sec/m³)	Annual D/Q (1/m²)	Grazing Season X/Q (sec/m³)	Grazing Season D/Q (1/m²)
	5,929	7.25E-09	9.79E-11	7.13E-09	7.00E-11
	6,039	7.18E-09	9.51E-11	7.08E-09	6.80E-11
	6,309	7.89E-09	8.87E-11	7.92E-09	6.34E-11
	8,039	6.70E-09	6.02E-11	6.89E-09	4.30E-11
	8,239	6.58E-09	5.79E-11	6.78E-09	4.14E-11
	8,309	6.54E-09	5.71E-11	6.75E-09	4.08E-11
	8,349	6.52E-09	5.67E-11	6.72E-09	4.05E-11
	8,659	7.16E-09	5.35E-11	7.53E-09	3.82E-11
	8,809	7.64E-09	5.20E-11	8.13E-09	3.72E-11
	9,039	7.46E-09	4.99E-11	7.96E-09	3.57E-11
	9,079	7.43E-09	4.96E-11	7.93E-09	3.54E-11
	9,279	7.29E-09	4.79E-11	7.78E-09	3.42E-11
WSW	4,126	2.46E-09	5.96E-11	2.00E-09	3.76E-11

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TABLE 7B-5

COMBINED RADWASTE AND REACTOR BUILDING VENT X/Q AND D/Q AT GROUND LEVEL, LONG-TERM (ROUTINE) AND GRAZING SEASON GASEOUS RELEASES, LOCATIONS OF MILK ANIMALS BY SECTOR

Sector Bearing	Distance (m)	Annual X/Q (sec/m^3)	Annual D/Q ($1/m^2$)	Grazing Season X/Q (sec/m^3)	Grazing Season D/Q ($1/m^2$)
ESE	2,417	7.32E-08	1.54E-09	5.44E-08	9.52E-10
	4,915	4.03E-08	5.19E-10	3.65E-08	3.37E-10
SSE	2,475	3.06E-08	6.52E-10	2.31E-08	4.33E-10
	3,822	4.10E-08	3.61E-10	4.10E-08	2.35E-10
	3,892	4.01E-08	3.50E-10	4.03E-08	2.28E-10
	5,820	2.99E-08	2.23E-10	3.38E-08	1.69E-10
SW	2,485	3.36E-08	4.90E-10	3.10E-08	3.55E-10

TABLE 7B-6

COMBINED RADWASTE AND REACTOR BUILDING VENT X/Q AND D/Q AT GROUND LEVEL, LONG-TERM (ROUTINE) AND GRAZING SEASON GASEOUS RELEASES, LOCATIONS OF MEAT ANIMALS BY SECTOR

Sector Bearing	Distance (m)	Annual X/Q (sec/m^3)	Annual D/Q ($1/m^2$)	Grazing Season X/Q (sec/m^3)	Grazing Season D/Q ($1/m^2$)
E	1,842	1.42E-07	2.90E-09	1.42E-07	2.58E-09
ESE	2,607	7.06E-08	1.37E-09	5.40E-08	8.49E-10
	2,797	6.59E-08	1.23E-09	5.12E-08	7.66E-10
	3,106	5.94E-08	1.05E-09	4.73E-08	6.58E-10
	3,256	5.88E-08	9.77E-10	4.79E-08	6.15E-10
	3,296	5.81E-08	9.59E-10	4.74E-08	6.04E-10
	3,456	5.53E-08	8.93E-10	4.56E-08	5.64E-10
	3,726	5.11E-08	7.97E-10	4.28E-08	5.07E-10
	3,916	4.85E-08	7.40E-10	4.11E-08	4.73E-10
	4,605	4.20E-08	5.80E-10	3.71E-08	3.76E-10
	4,915	4.03E-08	5.19E-10	3.65E-08	3.37E-10
	5,105	3.86E-08	4.86E-10	3.51E-08	3.16E-10
	5,295	3.70E-08	4.57E-10	3.38E-08	2.97E-10
SE	2,857	5.04E-08	9.93E-10	3.30E-08	4.80E-10
	3,087	4.66E-08	8.80E-10	3.12E-08	4.27E-10
	3,896	5.84E-08	6.44E-10	5.17E-08	3.19E-10
	4,046	5.56E-08	6.04E-10	4.95E-08	3.00E-10
	4,745	4.81E-08	4.60E-10	4.54E-08	2.31E-10
	4,935	4.62E-08	4.31E-10	4.41E-08	2.18E-10
	5,315	4.18E-08	3.80E-10	4.03E-08	1.93E-10

TABLE 7B-6 (Cont)

Sector Bearing	Distance (m)	Annual X/Q (sec/m^3)	Annual D/Q (1/m^2)	Grazing Season X/Q (sec/m^3)	Grazing Season D/Q (1/m^2)
SSE	2,893	2.98E-08	5.32E-10	2.35E-08	3.46E-10
	3,862	4.05E-08	3.55E-10	4.06E-08	2.31E-10
	3,892	4.01E-08	3.50E-10	4.03E-08	2.28E-10
SSW	3,932	3.69E-08	3.06E-10	3.95E-08	2.48E-10
	4,202	3.44E-08	2.76E-10	3.71E-08	2.24E-10
	4,502	3.19E-08	2.46E-10	3.47E-08	2.00E-10
	4,611	3.11E-08	2.36E-10	3.39E-08	1.92E-10
	5,581	3.35E-08	1.84E-10	3.97E-08	1.54E-10
	5,701	3.27E-08	1.78E-10	3.87E-08	1.49E-10
	6,001	3.06E-08	1.64E-10	3.64E-08	1.39E-10
SW	2,485	3.36E-08	4.90E-10	3.10E-08	3.55E-10
	2,985	3.52E-08	3.75E-10	3.43E-08	2.73E-10

TABLE 7B-7

COMBINED RADWASTE AND REACTOR BUILDING VENT X/Q AND D/Q AT GROUND LEVEL, LONG-TERM (ROUTINE) AND GRAZING SEASON GASEOUS RELEASES, LOCATIONS OF VEGETABLE GARDENS BY SECTOR

Sector Bearing	Distance (m)	Annual X/Q (sec/m^3)	Annual D/Q (1/m^2)	Grazing Season X/Q (sec/m^3)	Grazing Season D/Q (1/m^2)
E	2,072	1.26E-07	2.46E-09	1.29E-07	2.21E-09
	2,262	1.16E-07	2.15E-09	1.20E-07	1.96E-09
	3,072	8.97E-08	1.44E-09	9.91E-08	1.37E-09
ESE	2,607	7.06E-08	1.37E-09	5.40E-08	8.49E-10
	2,796	6.59E-08	1.23E-09	5.12E-08	7.66E-10
	2,916	6.33E-08	1.16E-09	4.96E-08	7.21E-10
	3,066	6.02E-08	1.07E-09	4.78E-08	6.70E-10
	3,146	6.09E-08	1.03E-09	4.92E-08	6.46E-10
	3,216	5.95E-08	9.95E-10	4.83E-08	6.26E-10
	3,256	5.88E-08	9.77E-10	4.79E-08	6.15E-10
	3,526	5.41E-08	8.66E-10	4.49E-08	5.49E-10
	3,716	5.12E-08	8.00E-10	4.29E-08	5.09E-10
	3,916	4.85E-08	7.40E-10	4.11E-08	4.73E-10
	4,605	4.20E-08	5.80E-10	3.71E-08	3.76E-10
	4,915	4.03E-08	5.19E-10	3.65E-08	3.37E-10
	5,145	3.82E-08	4.80E-10	3.48E-08	3.12E-10
SE	2,358	5.82E-08	1.29E-09	3.60E-08	6.15E-10
	2,857	5.04E-08	9.93E-10	3.30E-08	4.80E-10
	2,977	4.84E-08	9.31E-10	3.20E-08	4.51E-10
	3,047	4.73E-08	8.98E-10	3.15E-08	4.36E-10
	3,087	4.66E-08	8.80E-10	3.12E-08	4.27E-10
	3,356	4.81E-08	7.75E-10	3.43E-08	3.78E-10

TABLE 7B-7 (Cont)

Sector Bearing	Distance (m)	Annual X/Q (sec/m^3)	Annual D/Q (1/m^2)	Grazing Season X/Q (sec/m^3)	Grazing Season D/Q (1/m^2)
SE	3,207	4.48E-08	8.30E-10	3.03E-08	4.03E-10
	3,276	4.94E-08	8.05E-10	3.50E-08	3.92E-10
	3,247	4.98E-08	8.16E-10	3.53E-08	3.97E-10
	3,546	5.58E-08	7.27E-10	4.45E-08	3.57E-10
	3,586	5.50E-08	7.13E-10	4.40E-08	3.57E-10
	3,886	5.47E-08	6.25E-10	4.67E-08	3.09E-10
	3,936	5.77E-08	6.33E-10	5.11E-08	3.14E-10
	4,046	5.56E-08	6.04E-10	4.95E-08	3.00E-10
	4,275	5.54E-08	5.50E-10	5.14E-08	2.74E-10
	4,355	5.40E-08	5.32E-10	5.03E-08	2.66E-10
	4,705	4.87E-08	4.67E-10	4.58E-08	2.34E-10
	4,935	4.62E-08	4.31E-10	4.41E-08	2.18E-10
	5,275	4.23E-08	3.85E-10	4.06E-08	1.96E-10
SSE	2,465	3.23E-08	6.85E-10	2.45E-08	4.46E-10
	2,824	3.04E-08	5.52E-10	2.39E-08	3.59E-10
	2,933	2.95E-08	5.21E-10	2.33E-08	3.38E-10
	3,742	4.21E-08	3.74E-10	4.20E-08	2.43E-10
	3,822	4.10E-08	3.61E-10	4.10E-08	2.35E-10
	3,892	4.01E-08	3.50E-10	4.03E-08	2.28E-10
	3,931	3.97E-08	3.44E-10	3.98E-08	2.24E-10
	4,161	4.02E-08	3.13E-10	4.18E-08	2.05E-10
	4,241	3.92E-08	3.03E-10	4.09E-08	1.98E-10
	4,321	3.83E-08	2.94E-10	4.01E-08	1.92E-10
	4,551	3.59E-08	2.69E-10	3.78E-08	1.77E-10
S	2,633	3.91E-08	6.63E-10	3.88E-08	6.01E-10
	3,132	3.58E-08	5.09E-10	3.65E-08	4.60E-10

TABLE 7B-7 (Cont)

Sector Bearing	Distance (m)	Annual X/Q (sec/m^3)	Annual D/Q (1/m^2)	Grazing Season X/Q (sec/m^3)	Grazing Season D/Q (1/m^2)
S	3,741	5.31E-08	4.08E-10	6.18E-08	3.68E-10
	3,931	5.29E-08	3.76E-10	6.26E-08	3.39E-10
	4,940	4.34E-08	2.82E-10	5.35E-08	2.71E-10
	5,040	4.23E-08	2.73E-10	5.21E-08	2.62E-10
	5,090	4.18E-08	2.69E-10	5.15E-08	2.58E-10
SSW	4,352	3.31E-08	2.60E-10	3.58E-08	2.11E-10
	4,432	3.25E-08	2.53E-10	3.53E-08	2.05E-10
	4,502	3.19E-08	2.46E-10	3.47E-08	2.00E-10
	4,581	3.13E-08	2.39E-10	3.41E-08	1.94E-10
	4,661	3.07E-08	2.32E-10	3.35E-08	1.88E-10
	5,351	3.53E-08	1.96E-10	4.18E-08	1.64E-10
	5,581	3.35E-08	1.84E-10	3.97E-08	1.54E-10
	5,771	3.22E-08	1.74E-10	3.82E-08	1.47E-10
	5,851	3.16E-08	1.71E-10	3.76E-08	1.44E-10
	5,931	3.11E-08	1.67E-10	3.70E-08	1.41E-10
SW	2,056	3.82E-08	6.44E-10	3.44E-08	4.64E-10
	2,096	3.77E-08	6.26E-10	3.40E-08	4.52E-10
	2,136	3.72E-08	6.09E-10	3.36E-08	4.40E-10
	2,485	3.36E-08	4.90E-10	3.10E-08	3.55E-10
	2,865	3.23E-08	3.98E-10	3.07E-08	2.89E-10
	3,215	3.34E-08	3.38E-10	3.30E-08	2.46E-10
	3,555	3.11E-08	2.94E-10	3.12E-08	2.15E-10
	3,795	2.96E-08	2.69E-10	3.00E-08	1.97E-10
	5,484	2.56E-08	1.53E-10	2.80E-08	1.12E-10
	5,824	2.40E-08	1.38E-10	2.64E-08	1.01E-10
	6,094	2.29E-08	1.28E-10	2.52E-08	9.38E-11

TABLE 7B-8

COMBINED RADWASTE AND REACTOR BUILDING VENT X/Q AND D/Q AT GROUND LEVEL, LONG-TERM (ROUTINE) AND GRAZING SEASON GASEOUS RELEASES, LOCATIONS OF RESIDENCES BY SECTOR

Sector Bearing	Distance (m)	Annual X/Q (sec/m^3)	Annual D/Q (1/m^2)	Grazing Season X/Q (sec/m^3)	Grazing Season D/Q (1/m^2)
E	1,842	1.42E-07	2.90E-09	1.42E-07	2.58E-09
	1,952	1.34E-07	2.68E-09	1.35E-07	2.40E-09
	2,072	1.26E-07	2.46E-09	1.29E-07	2.21E-09
	2,262	1.16E-07	2.15E-09	1.20E-07	1.96E-09
	2,342	1.12E-07	2.04E-09	1.17E-07	1.86E-09
	2,882	9.53E-08	1.59E-09	1.04E-07	1.50E-09
	2,992	9.20E-08	1.50E-09	1.01E-07	1.42E-09
	3,072	8.97E-08	1.44E-09	9.91E-08	1.37E-09
	4,261	7.00E-08	8.80E-10	8.28E-08	8.56E-10
	4,291	6.95E-08	8.69E-10	8.23E-08	8.46E-10
ESE	2,607	7.06E-08	1.37E-09	5.40E-08	8.49E-10
	2,796	6.59E-08	1.23E-09	5.12E-08	7.66E-10
	2,916	6.33E-08	1.16E-09	4.96E-08	7.21E-10
	3,066	6.02E-08	1.07E-09	4.78E-08	6.70E-10
	3,146	6.09E-08	1.03E-09	4.92E-08	6.46E-10
	3,216	5.95E-08	9.95E-10	4.83E-08	6.26E-10
	3,256	5.88E-08	9.77E-10	4.79E-08	6.15E-10
	3,296	5.81E-08	9.59E-10	4.74E-08	6.04E-10
	3,416	5.60E-08	9.09E-10	4.60E-08	5.74E-10
	3,456	5.53E-08	8.93E-10	4.56E-08	5.64E-10
	3,486	5.48E-08	8.81E-10	4.53E-08	5.58E-10
	3,526	5.41E-08	8.66E-10	4.49E-08	5.49E-10
	3,646	5.23E-08	8.24E-10	4.36E-08	5.23E-10

TABLE 7B-8 (Cont)

Sector Bearing	Distance (m)	Annual X/Q (sec/m3)	Annual D/Q (1/m2)	Grazing Season X/Q (sec/m3)	Grazing Season D/Q (1/m2)
ESE	3,716	5.12E-08	8.00E-10	4.29E-08	5.09E-10
	3,756	5.07E-08	7.88E-10	4.25E-08	5.02E-10
	3,916	4.85E-08	7.40E-10	4.11E-08	4.73E-10
	4,565	4.24E-08	5.89E-10	3.74E-08	3.82E-10
	4,605	4.20E-08	5.80E-10	3.71E-08	3.76E-10
	4,645	4.16E-08	5.71E-10	3.68E-08	3.71E-10
	4,685	4.12E-08	5.63E-10	3.66E-08	3.65E-10
	4,795	4.01E-08	5.41E-10	3.58E-08	3.51E-10
	4,825	3.98E-08	5.35E-10	3.56E-08	3.48E-10
	4,915	4.03E-08	5.19E-10	3.65E-08	3.37E-10
	4,955	3.99E-08	5.12E-10	3.62E-08	3.32E-10
	5,105	3.86E-08	4.86E-10	3.51E-08	3.16E-10
	5,145	3.82E-08	4.80E-10	3.48E-08	3.12E-10
	5,185	3.79E-08	4.73E-10	3.45E-08	3.08E-10
	5,295	3.70E-08	4.57E-10	3.38E-08	2.97E-10
SE	2,358	5.82E-08	1.29E-09	3.60E-08	6.15E-10
	2,518	5.71E-08	1.21E-09	3.63E-08	5.80E-10
	2,857	5.04E-08	9.93E-10	3.30E-08	4.80E-10
	2,887	4.99E-08	9.77E-10	3.28E-08	4.72E-10
	2,977	4.84E-08	9.31E-10	3.20E-08	4.51E-10
	3,017	4.77E-08	9.12E-10	3.17E-08	4.42E-10
	3,047	4.73E-08	8.98E-10	3.15E-08	4.36E-10
	3,087	4.66E-08	8.80E-10	3.12E-08	4.27E-10
	3,127	4.60E-08	8.63E-10	3.09E-08	4.19E-10
	3,167	4.54E-08	8.46E-10	3.06E-08	4.11E-10

TABLE 7B-8 (Cont)

Sector Bearing	Distance (m)	Annual X/Q (sec/m³)	Annual D/Q (1/m²)	Grazing Season X/Q (sec/m³)	Grazing Season D/Q (1/m²)
SE	3,207	4.48E-08	8.30E-10	3.03E-08	4.03E-10
	3,247	4.98E-08	8.16E-10	3.53E-08	3.97E-10
	3,276	4.94E-08	8.05E-10	3.50E-08	3.92E-10
	3,316	4.87E-08	7.90E-10	3.47E-08	3.85E-10
	3,356	4.81E-08	7.75E-10	3.43E-08	3.78E-10
	3,546	5.58E-08	7.27E-10	4.45E-08	3.57E-10
	3,586	5.50E-08	7.13E-10	4.40E-08	3.57E-10
	3,776	5.30E-08	6.55E-10	4.34E-08	3.23E-10
	3,786	5.28E-08	6.52E-10	4.33E-08	3.22E-10
	3,886	5.47E-08	6.25E-10	4.67E-08	3.09E-10
	3,936	5.77E-08	6.33E-10	5.11E-08	3.14E-10
	4,046	5.56E-08	6.04E-10	4.95E-08	3.00E-10
	4,126	5.42E-08	5.84E-10	4.84E-08	2.91E-10
	4,275	5.54E-08	5.50E-10	5.14E-08	2.74E-10
	4,355	5.40E-08	5.32E-10	5.03E-08	2.66E-10
	4,625	4.98E-08	4.80E-10	4.68E-08	2.41E-10
	4,705	4.87E-08	4.67E-10	4.58E-08	2.34E-10
	4,745	4.81E-08	4.60E-10	4.54E-08	2.31E-10
	4,935	4.62E-08	4.31E-10	4.41E-08	2.18E-10
	5,205	4.30E-08	3.94E-10	4.13E-08	2.00E-10
	5,275	4.23E-08	3.85E-10	4.06E-08	1.96E-10
	5,515	3.99E-08	3.57E-10	3.85E-08	1.82E-10
SSE	2,465	3.23E-08	6.85E-10	2.45E-08	4.46E-10
	2,704	3.15E-08	5.91E-10	2.46E-08	3.84E-10
	2,824	3.04E-08	5.52E-10	2.39E-08	3.59E-10
	2,933	2.95E-08	5.21E-10	2.33E-08	3.38E-10
	3,702	4.26E-08	3.81E-10	4.24E-08	2.47E-10

TABLE 7B-8 (Cont)

Sector Bearing	Distance (m)	Annual X/Q (sec/m^3)	Annual D/Q (1/m^2)	Grazing Season X/Q (sec/m^3)	Grazing Season D/Q (1/m^2)
SSE	3,742	4.21E-08	3.74E-10	4.20E-08	2.43E-10
	3,822	4.10E-08	3.61E-10	4.10E-08	2.35E-10
	3,852	4.06E-08	3.56E-10	4.07E-08	2.32E-10
	3,862	4.05E-08	3.55E-10	4.06E-08	2.31E-10
	3,892	4.01E-08	3.50E-10	4.03E-08	2.28E-10
	3,931	3.97E-08	3.44E-10	3.98E-08	2.24E-10
	4,011	3.87E-08	3.33E-10	3.90E-08	2.17E-10
	4,161	4.02E-08	3.13E-10	4.18E-08	2.05E-10
	4,241	3.92E-08	3.03E-10	4.09E-08	1.98E-10
	4,321	3.83E-08	2.94E-10	4.01E-08	1.92E-10
	4,551	3.59E-08	2.69E-10	3.78E-08	1.77E-10
	5,090	3.15E-08	2.24E-10	3.38E-08	1.49E-10
	5,120	3.13E-08	2.22E-10	3.36E-08	1.48E-10
	5,390	2.93E-08	2.04E-10	3.17E-08	1.37E-10
	5,780	3.01E-08	2.26E-10	3.41E-08	1.71E-10
	5,820	2.99E-08	2.23E-10	3.38E-08	1.69E-10
	5,890	2.94E-08	2.19E-10	3.33E-08	1.66E-10
S	2,633	3.91E-08	6.63E-10	3.88E-08	6.01E-10
	3,132	3.58E-08	5.09E-10	3.65E-08	4.60E-10
	3,701	5.38E-08	4.16E-10	6.26E-08	3.74E-10
	3,741	5.31E-08	4.08E-10	6.18E-08	3.68E-10
	3,781	5.25E-08	4.01E-10	6.11E-08	3.61E-10
	3,821	5.47E-08	3.94E-10	6.46E-08	3.55E-10
	3,861	5.40E-08	3.87E-10	6.39E-08	3.49E-10
	3,901	5.34E-08	3.81E-10	6.31E-08	3.43E-10
	3,931	5.29E-08	3.76E-10	6.26E-08	3.39E-10
	4,820	4.49E-08	2.94E-10	5.52E-08	2.82E-10

TABLE 7B-8 (Cont)

Sector Bearing	Distance (m)	Annual X/Q (sec/m^3)	Annual D/Q (1/m^2)	Grazing Season X/Q (sec/m^3)	Grazing Season D/Q (1/m^2)
S	4,940	4.34E-08	2.82E-10	5.35E-08	2.71E-10
	4,970	4.31E-08	2.80E-10	5.31E-08	2.68E-10
	5,000	4.27E-08	2.77E-10	5.27E-08	2.65E-10
	5,010	4.26E-08	2.76E-10	5.25E-08	2.64E-10
	5,040	4.23E-08	2.73E-10	5.21E-08	2.62E-10
	5,090	4.18E-08	2.69E-10	5.15E-08	2.58E-10
	5,280	3.99E-08	2.53E-10	4.93E-08	2.43E-10
SSW	4,002	3.62E-08	3.00E-10	3.88E-08	2.43E-10
	4,112	3.52E-08	2.86E-10	3.78E-08	2.32E-10
	4,202	3.44E-08	2.76E-10	3.71E-08	2.24E-10
	4,352	3.31E-08	2.60E-10	3.58E-08	2.11E-10
	4,432	3.25E-08	2.53E-10	3.53E-08	2.05E-10
	4,502	3.19E-08	2.46E-10	3.47E-08	2.00E-10
	4,581	3.13E-08	2.39E-10	3.41E-08	1.94E-10
	4,661	3.07E-08	2.32E-10	3.35E-08	1.88E-10
	4,701	3.63E-08	2.31E-10	4.12E-08	1.89E-10
	4,771	3.57E-08	2.26E-10	4.05E-08	1.85E-10
	5,161	3.64E-08	2.08E-10	4.28E-08	1.73E-10
	5,241	3.57E-08	2.03E-10	4.20E-08	1.69E-10
	5,351	3.53E-08	1.96E-10	4.18E-08	1.64E-10
	5,431	3.47E-08	1.92E-10	4.10E-08	1.60E-10
	5,471	3.44E-08	1.90E-10	4.07E-08	1.58E-10
	5,541	3.38E-08	1.86E-10	4.01E-08	1.56E-10
	5,581	3.35E-08	1.84E-10	3.97E-08	1.54E-10
	5,611	3.33E-08	1.82E-10	3.95E-08	1.53E-10
	5,661	3.29E-08	1.80E-10	3.91E-08	1.51E-10
	5,701	3.27E-08	1.78E-10	3.87E-08	1.49E-10

TABLE 7B-8 (Cont)

Sector Bearing	Distance (m)	Annual X/Q (sec/m³)	Annual D/Q (1/m²)	Grazing Season X/Q (sec/m³)	Grazing Season D/Q (1/m²)
SSW	5,711	3.26E-08	1.77E-10	3.87E-08	1.49E-10
	5,771	3.22E-08	1.74E-10	3.82E-08	1.47E-10
	5,811	3.19E-08	1.73E-10	3.79E-08	1.45E-10
	5,851	3.16E-08	1.71E-10	3.76E-08	1.44E-10
	5,891	3.14E-08	1.69E-10	3.73E-08	1.43E-10
	5,931	3.11E-08	1.67E-10	3.70E-08	1.41E-10
	6,001	3.06E-08	1.64E-10	3.64E-08	1.39E-10
SW	1,756	4.30E-08	7.91E-10	3.83E-08	5.69E-10
	2,026	3.86E-08	6.58E-10	3.47E-08	4.74E-10
	2,056	3.82E-08	6.44E-10	3.44E-08	4.64E-10
	2,096	3.77E-08	6.26E-10	3.40E-08	4.52E-10
	2,136	3.72E-08	6.09E-10	3.36E-08	4.40E-10
	2,256	3.58E-08	5.63E-10	3.26E-08	4.07E-10
	2,365	3.65E-08	5.26E-10	3.37E-08	3.81E-10
	2,485	3.36E-08	4.90E-10	3.10E-08	3.55E-10
	2,595	3.44E-08	4.59E-10	3.22E-08	3.32E-10
	2,715	3.34E-08	4.30E-10	3.15E-08	3.12E-10
	2,865	3.23E-08	3.98E-10	3.07E-08	2.89E-10
	2,945	3.55E-08	3.83E-10	3.45E-08	2.78E-10
	2,985	3.52E-08	3.75E-10	3.43E-08	2.73E-10
	3,025	3.49E-08	3.68E-10	3.41E-08	2.68E-10
	3,165	3.38E-08	3.46E-10	3.33E-08	2.52E-10
	3.215	3.34E-08	3.38E-10	3.30E-08	2.46E-10
	3,405	3.21E-08	3.12E-10	3.20E-08	2.28E-10
	3,525	3.13E-08	2.97E-10	3.14E-08	2.17E-10
	3,555	3.11E-08	2.94E-10	3.12E-08	2.15E-10

TABLE 7B-8 (Cont)

Sector Bearing	Distance (m)	Annual X/Q (sec/m³)	Annual D/Q (1/m²)	Grazing Season X/Q (sec/m³)	Grazing Season D/Q (1/m²)
SW	3,595	3.08E-08	2.89E-10	3.10E-08	2.12E-10
	3,795	2.96E-08	2.69E-10	3.00E-08	1.97E-10
	4,054	2.81E-08	2.46E-10	2.88E-08	1.80E-10
	4,094	2.79E-08	2.42E-10	2.86E-08	1.77E-10
	4,134	2.77E-08	2.38E-10	2.84E-08	1.74E-10
	4,214	2.72E-08	2.30E-10	2.81E-08	1.69E-10
	4,714	2.48E-08	1.91E-10	2.59E-08	1.40E-10
	4,904	2.39E-08	1.79E-10	2.52E-08	1.31E-10
	4,944	2.38E-08	1.76E-10	2.50E-08	1.29E-10
	5,444	2.57E-08	1.55E-10	2.82E-08	1.13E-10
	5,484	2.56E-08	1.53E-10	2.80E-08	1.12E-10
	5,554	2.52E-08	1.49E-10	2.76E-08	1.10E-10
	5,714	2.45E-08	1.42E-10	2.69E-08	1.04E-10
	5,824	2.40E-08	1.38E-10	2.64E-08	1.01E-10
	6,094	2.29E-08	1.28E-10	2.52E-08	9.38E-11
	7,824	2.08E-08	9.80E-11	2.41E-08	8.05E-11
	8,024	2.07E-08	9.66E-11	2.43E-08	8.11E-11
	8,094	2.05E-08	9.55E-11	2.40E-08	8.04E-11
	8,134	2.26E-08	9.85E-11	2.70E-08	8.47E-11
	8,444	2.16E-08	9.42E-11	2.59E-08	8.19E-11
	8,594	2.11E-08	9.23E-11	2.54E-08	8.06E-11
	8,824	2.05E-08	8.96E-11	2.46E-08	7.89E-11
	8,864	2.03E-08	8.91E-11	2.45E-08	7.86E-11
	9,064	1.98E-08	8.70E-11	2.39E-08	7.72E-11
WSW	3,931	1.33E-08	8.04E-11	1.34E-08	5.23E-11

TABLE 7B-9

MAIN STACK X/Q AND D/Q AT GROUND LEVEL
LONG-TERM (ROUTINE) GASEOUS RELEASES
FOR MECHANICAL VACUUM RELEASES
LOCATIONS OF MILK ANIMAL BY SECTOR

Sector Bearing	Distance (m)	X/Q (sec/m^3)	D/Q ($1/m^2$)
ESE	2,366	5.97E-08	3.13E-09
	4,855	7.65E-08	1.53E-09
SSE	2,592	5.31E-08	2.00E-09
	3,931	1.11E-07	1.62E-09
	4,001	1.09E-07	1.61E-09
	5,925	9.38E-08	8.59E-10
SW	2,700	4.44E-08	1.26E-09

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TABLE 7B-10

MAIN STACK X/Q AND D/Q AT GROUND LEVEL
LONG TERM (ROUTINE) GASEOUS RELEASES
FOR MECHANICAL VACUUM RELEASES
LOCATIONS OF MEAT ANIMALS BY SECTOR

Sector Bearing	Distance (m)	X/Q (sec/m³)	D/Q (1/m²)
E	1,711	4.14E-08	3.82E-09
ESE	2,554	6.18E-08	2.89E-09
	2,743	6.70E-08	2.67E-09
	3,051	7.65E-08	2.54E-09
	3,200	7.63E-08	2.44E-09
	3,240	7.66E-08	2.42E-09
	3,399	7.65E-08	2.33E-09
	3,668	7.61E-08	2.20E-09
	3,857	7.77E-08	2.18E-09
	4,545	7.56E-08	1.69E-09
	4,855	7.65E-08	1.53E-09
	5,044	7.56E-08	1.46E-09
	5,234	7.43E-08	1.39E-09
SE	2,892	7.28E-08	2.56E-09
	3,120	7.38E-08	2.42E-09
	3,925	1.38E-07	2.49E-09
	4,074	1.32E-07	2.37E-09
	4,771	1.21E-07	1.84E-09
	4,961	1.18E-07	1.74E-09

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TABLE 7B-10 (Cont)

Sector Bearing	Distance (m)	X/Q (sec/m³)	D/Q (1/m²)
	5,340	1.07E-07	1.51E-09
SSE	3,008	5.78E-08	1.72E-09
	3,971	1.10E-07	1.61E-09
	4,001	1.09E-07	1.61E-09
SSW	4,140	8.10E-08	1.04E-09
	4,409	7.70E-08	9.22E-10
	4,709	7.50E-08	8.42E-10
	4,819	7.40E-08	8.18E-10
	5,788	9.48E-08	7.58E-10
	5,908	9.81E-08	7.40E-10
	6,207		
SW	2,700	4.44E-08	1.26E-09
	3,200	5.57E-08	1.10E-09

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TABLE 7B-11

MAIN STACK X/Q AND D/Q AT GROUND LEVEL
LONG-TERM (ROUTINE) GASEOUS RELEASES
FOR MECHANICAL VACUUM RELEASES
LOCATIONS OF VEGETABLE GARDENS BY SECTOR

Sector Bearing	Distance (m)	X/Q (sec/m^3)	D/Q ($1/m^2$)
E	1,940	4.66E-08	3.62E-09
	2,129	5.06E-08	3.48E-09
	2,936	7.61E-08	2.80E-09
ESE	2,554	6.18E-08	2.89E-09
	2,743	6.70E-08	2.67E-09
	2,862	7.07E-08	2.69E-09
	3,011	7.07E-08	2.56E-09
	3,091	7.65E-08	2.51E-09
	3,160	7.63E-08	2.47E-09
	3,200	7.63E-08	2.44E-09
	3,469	7.45E-08	2.24E-09
	3,658	7.61E-08	2.20E-09
	3,857	7.77E-08	2.18E-09
	4,545	7.56E-08	1.69E-09
	4,855	7.65E-08	1.53E-09
	5,084	7.53E-08	1.44E-09
SE	2,397	6.42E-08	3.04E-09
	2,892	7.28E-08	2.56E-09
	3,011	7.38E-08	2.50E-09

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TABLE 7B-11 (Cont)

Sector Bearing	Distance (m)	X/Q (sec/m³)	D/Q (1/m²)
SE	3,080	7.38E-08	2.45E-09
	3,120	7.38E-08	2.42E-09
	3,239	7.33E-08	2.33E-09
	3,279	7.30E-08	2.29E-09
	3,308	7.30E-08	2.29E-09
	3,388	8.84E-08	2.27E-09
	3,577	1.04E-07	2.45E-09
	3,616	1.15E-07	2.69E-09
	3,915	1.26E-07	2.46E-09
	3,965	1.34E-07	2.40E-09
	4,074	1.32E-07	2.37E-09
	4,303	1.33E-07	2.15E-09
	4,383	1.31E-07	2.10E-09
	4,731	1.24E-07	1.90E-09
	4,961	1.18E-07	1.74E-09
	5,300	1.08E-07	1.53E-09
SSE	2,582	5.26E-08	1.99E-09
	2,938	5.81E-09	1.77E-09
	3,047	5.78E-08	1.69E-09
	3,852	1.14E-07	1.69E-09
	3,931	1.11E-07	1.62E-09
	4,001	1.09E-07	1.61E-09

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TABLE 7B-11 (Cont)

Sector Bearing	Distance (m)	X/Q (sec/m³)	D/Q (1/m²)
SSE	4,270	1.13E-07	1.45E-09
	4,349	1.12E-07	1.42E-09
	4,429	1.08E-07	1.36E-09
	4,658	1.05E-07	1.28E-09
S	2,809	6.59E-08	1.85E-09
	3,306	7.21E-08	1.62E-09
	3,913	1.30E-07	1.72E-09
	4,102	1.31E-07	1.61E-09
	5,109	1.19E-07	1.15E-09
	5,209	1.16E-07	1.11E-09
	5,259	1.15E-07	1.09E-09
SSW	4,559	7.60E-08	8.82E-10
	4,639	7.53E-08	8.61E-10
	4,709	7.50E-08	8.42E-10
	4,789	7.44E-08	8.27E-10
	4,869	7.37E-08	8.04E-10
	5,558	9.94E-08	8.15E-10
	5,788	9.48E-08	7.58E-10
	5,978	9.70E-08	7.33E-10
	6,058	9.44E-08	7.05E-10
	6,137	9.34E-08	6.94E-10

TABLE 7B-11 (Cont)

Sector Bearing	Distance (m)	X/Q (sec/m³)	D/Q (1/m²)
SW	2,270	3.63E-08	1.45E-09
	2,311	3.65E-08	1.42E-09
	2,351	3.75E-08	1.42E-09
	2,700	4.44E-08	1.26E-09
	3,080	5.51E-08	1.14E-09
	3,430	5.57E-08	1.04E-09
	3,770	5.57E-08	9.60E-10
	4,010	5.59E-08	9.13E-10
	5,699	5.24E-08	5.34E-10
	6,039	6.23E-08	5.20E-10
	6,309	6.91E-08	4.98E-10

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TABLE 7B-12

MAIN STACK X/Q AND D/Q AT GROUND LEVEL
LONG-TERM (ROUTINE) GASEOUS RELEASES
FOR MECHANICAL VACUUM RELEASES
LOCATIONS OF RESIDENCES BY SECTOR

Sector Bearing	Distance (m)	X/Q (sec/m^3)	D/Q ($1/m^2$)	
E	1,711	4.14E-08	3.82E-09	
	1,820	4.30E-08	3.67E-09	
	1,940	4.66E-08	3.62E-09	
	2,129	5.06E-08	3.48E-09	
	2,208	5.26E-08	3.39E-09	
	2,746	7.32E-08	2.91E-09	
	2,856	7.52E-08	2.86E-09	
	2,936	7.61E-08	2.80E-09	7
	4,124	8.64E-08	2.18E-09	
	4,154	8.85E-08	2.21E-09	
ESE	2,554	6.18E-08	2.89E-09	
	2,743	6.70E-08	2.67E-09	
	2,862	7.07E-08	2.69E-09	
	3,011	7.07E-08	2.56E-09	
	3,091	7.65E-08	2.51E-09	
	3,160	7.63E-08	2.47E-09	
	3,200	7.63E-08	2.44E-09	
	3,240	7.66E-08	2.42E-09	
	3,359	7.57E-08	2.32E-09	

TABLE 7B-12 (Cont)

Sector Bearing	Distance (m)	X/Q (sec/m³)	D/Q (1/m²)
ESE	3,399	7.65E-08	2.33E-09
	3,429	7.47E-08	2.26E-09
	3,469	7.45E-08	2.24E-09
	3,588	7.60E-08	2.23E-09
	3,658	7.61E-08	2.20E-09
	3,698	7.55E-08	2.18E-09
	3,857	7.77E-08	2.18E-09
	4,506	7.60E-08	1.72E-09
	4,545	7.56E-08	1.69E-09
	4,585	7.57E-08	1.68E-09
	4,625	7.51E-08	1.65E-09
	4,735	7.79E-08	1.60E-09
	4,765	7.79E-08	1.58E-09
	4,855	7.65E-08	1.53E-09
	4,895	7.63E-08	1.52E-09
	5,044	7.56E-08	1.46E-09
	5,084	7.53E-08	1.44E-09
	5,124	7.41E-08	1.41E-09
	5,234	7.43E-08	1.39E-09
SE	2,397	6.42E-08	3.04E-09
	2,555	6.54E-08	2.83E-09
	2,892	7.28E-08	2.56E-09

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TABLE 7B-12 (Cont)

Sector Bearing	Distance (m)	X/Q (sec/m³)	D/Q (1/m²)	
SE	2,921	7.40E-08	2.57E-09	
	3,011	7.38E-08	2.50E-09	
	3,050	7.41E-08	2.48E-09	
	3,080	7.38E-08	2.45E-09	
	3,120	7.38E-08	2.42E-09	
	3,159	7.35E-08	2.39E-09	
	3,199	7.35E-08	2.36E-09	
	3,239	7.33E-08	2.33E-09	
	3,279	7.30E-08	2.29E-09	
	3,308	7.30E-08	2.29E-09	
	3,348	8.86E-08	2.28E-09	7
	3,388	8.84E-08	2.27E-09	
	3,577	1.04E-07	2.45E-09	
	3,616	1.15E-07	2.69E-09	
	3,805	1.28E-07	2.54E-09	
	3,815	1.28E-07	2.53E-09	
	3,915	1.26E-07	2.46E-09	
	3,925	1.38E-07	2.49E-09	
	3,965	1.34E-07	2.40E-09	
	4,074	1.32E-07	2.37E-09	
	4,154	1.39E-07	2.29E-09	
	4,303	1.33E-07	2.15E-09	
	4,383	1.31E-07	2.10E-09	

TABLE 7B-12 (Cont)

Sector Bearing	Distance (m)	X/Q (sec/m^3)	D/Q (1/m^2)
SE	4,652	1.23E-07	1.90E-09
	4,731	1.24E-07	1.90E-09
	4,771	1.21E-07	1.84E-09
	4,961	1.18E-07	1.74E-09
	5,230	1.09E-07	1.56E-09
	5,300	1.08E-07	1.53E-09
	5,539	1.04E-07	1.44E-09
SSE	2,582	5.26E-08	1.99E-09
	2,819	5.84E-08	1.85E-09
	2,938	5.81E-09	1.77E-09
	3,047	5.78E-08	1.69E-09
	3,812	1.14E-07	1.71E-09
	3,852	1.14E-07	1.69E-09
	3,931	1.11E-07	1.62E-09
	3,961	1.10E-07	1.61E-09
	3,971	1.10E-07	1.61E-09
	4,001	1.09E-07	1.61E-09
	4,041	1.09E-07	1.59E-09
SSE	4,120	1.16E-07	1.54E-09
	4,270	1.13E-07	1.45E-09
	4,349	1.12E-07	1.42E-09
	4,429	1.08E-07	1.36E-09

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TABLE 7B-12 (Cont)

Sector Bearing	Distance (m)	X/Q (sec/m³)	D/Q (1/m²)
SSE	4,658	1.05E-07	1.28E-09
	5,196	9.49E-08	1.07E-09
	5,226	9.45E-08	1.06E-10
	5,496	9.38E-08	9.72E-10
	5,885	9.42E-08	8.64E-10
	5,925	9.38E-08	8.59E-10
	5,994	9.31E-08	8.46E-10
S	2,809	6.59E-08	1.85E-09
	3,306	7.21E-08	1.62E-09
	3,873	1.31E-07	1.74E-09
	3,913	1.30E-07	1.72E-09
	3,953	1.30E-07	1.71E-09
	3,993	1.33E-07	1.65E-09
	4,033	1.33E-07	1.66E-09
	4,072	1.32E-07	1.64E-09
	4,102	1.31E-07	1.61E-09
	4,990	1.21E-07	1.18E-09
	5,109	1.19E-07	1.15E-09
	5,139	1.19E-07	1.14E-09
	5,169	1.18E-07	1.13E-09
	5,179	1.16E-07	1.11E-09
	5,209	1.16E-07	1.11E-09

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TABLE 7B-12 (Cont)

Sector Bearing	Distance (m)	X/Q (sec/m³)	D/Q (1/m²)
S	5,259	1.15E-07	1.09E-09
	5,449	1.10E-07	1.03E-09
SSW	4,210	8.04E-08	1.01E-09
	4,319	7.76E-08	9.47E-10
	4,409	7.70E-08	9.22E-10
	4,559	7.60E-08	8.82E-10
	4,639	7.53E-08	8.61E-10
	4,709	7.50E-08	8.42E-10
	4,789	7.44E-08	8.27E-10
	4,869	7.37E-08	8.04E-10
	4,909	8.47E-08	8.25E-10
	4,979	8.48E-08	9.42E-10
	5,368	9.52E-08	8.32E-10
	5,448	9.42E-08	8.16E-10
	5,558	9.94E-08	8.15E-10
	5,638	9.65E-08	7.88E-10
	5,678	9.61E-08	7.78E-10
	5,748	9.55E-08	7.66E-10
	5,788	9.48E-08	7.58E-10
	5,818	9.91E-08	7.57E-10
	5,868	9.84E-08	7.49E-10
	5,908	9.81E-08	7.40E-10

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TABLE 7B-12 (Cont)

Sector Bearing	Distance (m)	X/Q (sec/m^3)	D/Q (1/m^2)
SSW	5,918	9.81E-08	7.40E-10
	5,978	9.70E-08	7.33E-10
	6,018	9.67E-08	7.24E-10
	6,058	9.44E-08	7.05E-10
	6,098	9.41E-08	6.96E-10
	6,137	9.34E-08	6.94E-10
	6,207	9.27E-08	6.86E-10
SW	1,971	3.07E-08	1.48E-09
	2,240	3.61E-08	1.46E-09
	2,270	3.63E-08	1.45E-09
	2,311	3.65E-08	1.42E-09
	2,351	3.75E-08	1.42E-09
	2,471	3.88E-08	1.37E-09
	2,580	4.34E-08	1.31E-09
	2,700	4.44E-08	1.26E-09
	2,810	4.51E-08	1.21E-09
	2,930	5.02E-08	1.19E-09
	3,080	5.51E-08	1.14E-09
	3,160	5.57E-08	1.11E-09
	3,200	5.57E-08	1.10E-09
	3,240	5.57E-08	1.09E-09
	3,380	5.57E-08	1.05E-09

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TABLE 7B-12 (Cont)

Sector Bearing	Distance (m)	X/Q (sec/m³)	D/Q (1/m²)	
SW	3,430	5.57E-08	1.04E-09	
	3,620	5.62E-08	9.95E-10	
	3,740	5.57E-08	9.70E-10	
	3,770	5.57E-08	9.60E-10	
	3,810	5.57E-08	9.55E-10	
	4,010	5.59E-08	9.13E-10	
	4,270	5.65E-08	8.47E-10	
	4,310	5.63E-08	8.34E-10	
	4,350	5.65E-08	8.27E-10	
	4,430	5.65E-08	8.01E-10	
	4,930	5.54E-08	6.90E-10	
	5,120	5.46E-08	6.51E-10	7
	5,160	5.64E-08	6.31E-10	
	5,659	5.28E-08	5.43E-10	
	5,699	5.24E-08	5.34E-10	
	5,769	5.43E-08	5.18E-10	
	5,929	6.30E-08	5.32E-10	
	6,039	6.23E-08	5.20E-10	
	6,309	6.91E-08	4.98E-10	
	8,039	5.29E-08	3.26E-10	
	8,239	5.21E-08	3.16E-10	
	8,309	5.18E-08	3.12E-10	
	8,349	5.16E-08	3.10E-10	

TABLE 7B-12 (Cont)

Sector Bearing	Distance (m)	X/Q (sec/m³)	D/Q (1/m²)
SW	8,659	5.62E-08	3.45E-10
	8,809	6.19E-08	3.48E-10
	9,039	6.08E-08	3.37E-10
	9,079	6.08E-08	3.34E-10
	9,279	5.97E-08	3.25E-10
WSW	4,126	3.73E-08	3.94E-10

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APPENDIX 7C

POPULATION DISTRIBUTION - CLASS 9 ACCIDENTS

APPENDIX 7C

LIST OF TABLES

APPENDIX 7C

LIST OF TABLES (Cont)

APPENDIX 7C

LIST OF FIGURES

APPENDIX 7C

POPULATION DISTRIBUTION - CLASS 9 ACCIDENTS

Population distribution within an 80-km (50-mi) radius of Nine Mile Point Unit 2 is listed by distance and direction in Tables 7C-1 through 7C-7. Population densities are listed in Tables 7C-8 and 7C-9. 5 Figures 7C-1 and 7C-2 show the 16- and 80-km (10- and 50-mi) areas with sector overlays corresponding to the tables.

Population distribution between 0 and 6 km (0-3.7 mi) was determined through a door-to-door survey conducted by Stone & Webster Engineering Corporation on May 9 through 13, 1982.

Population distribution beyond 6 km (3.7 mi) was calculated using the same methods as those described in Section 2.5.1. Data from the 1980 U.S. Census of Population and the 1981 Canadian Census of Population provided the basis for the estimates.

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Bibliography

1. Bureau of the Census. 1980 Census of Population, Advance Reports, U.S. Department of Commerce, New York, 1981.

2. New York Department of Commerce. 1978 Official Population Projections by Age and Sex for New York State Counties, September 1980.

3. Statistics Canada. Interim Population Counts for Census Divisions and Census Subdivisions, 1981, Ottawa, Canada, 1982.

4. Statistics Canada. Population: Geographic Distributions. 1976 Census, Census Divisions and Subdivisions: Ontario, Ottawa, Canada, June 1977.

5. Envirodata Corp. Digitized Maps of Area Within 50 Miles of Nine Mile Point, 1982.

6. Ministry of Treasury and Economics, Central Statistical
5 Services, Ontario: Population Projections by Regions and Counties for Years 1981, 1986, 1996, 2001. Toronto, Canada, February, 1979.

7. Ministry of Treasury and Economics, Central Statistical Services, Ontario: Population Projections for Counties of 10,000 Population and Over (in 1976) 1981, 1986, 1991, 1996, 2001 (Concluded). Toronto, Canada, April 1980.

8. Statistics Canada, 1976 Final Population, 1981 Population and Dwellings, Canada, Provinces, Census Divisions and Subdivisions. Ottawa, Canada, 1982.

TABLE 7C-1

POPULATION DISTRIBUTION FOR 1980
0- TO 50-MILE RADIUS 5

Direction	Distance (mi) 0.0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0	5.0-6.0	6.0-7.0	7.0-8.5	8.5-10.0	Total	
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
E	0	0	3	21	30	13	0	53	136	127	96	0	421	220	1,120	
ESE	0	0	8	24	55	13	74	96	118	123	364	158	193	1,618	2,844	
SE	0	0	0	45	50	82	65	66	13	44	197	79	131	180	952	
SSE	0	0	0	25	101	87	17	109	249	110	115	107	191	176	1,287	
S	0	0	0	7	45	22	81	132	60	56	176	212	229	217	1,237	
SSW	0	0	8	4	36	75	147	146	196	180	436	172	758	1,817	3,975	
SW	0	0	44	38	32	28	51	126	160	272	2,904	8,959	7,081	1,765	21,460	
WSW	0	0	0	16	2	8	0	8	4	0	3	491	1,106	954	2,592	5
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	0	0	63	180	351	328	435	736	936	912	4,291	10,178	10,110	6,947	35,467	5

TABLE 7C-1 (Cont)

Direction	Distance (mi) 10.0-12.5	12.5-15.0	15.0-17.5	17.5-20.0	20.0-25.0	25.0-30.0	30.0-35.0	35.0-40.0	40.0-45.0	45.0-50.0	Total 0-50.0
N	0	0	0	0	0	0	24	341	1,699	25,985	28,049
NNE	0	0	0	42	956	771	2364	4,604	2,799	2,801	14,337
NE	0	56	396	711	1,911	3,872	2,199	21,085	15,349	6,910	52,489
ENE	232	2,282	1,061	2,130	879	449	242	176	1,086	5,554	14,091
E	703	1,343	729	760	1,393	758	421	615	1,086	1,895	10,823
ESE	1,024	1,069	1,210	881	1,549	1,976	3,518	5,103	11,287	22,726	53,187
SE	899	1,151	1,880	2,320	6,489	7,246	9,746	10,058	19,254	17,549	77,544
SSE	1,242	1,368	1,976	2,698	26,358	48,390	132,885	141,059	20,648	7,100	385,011
S	1,546	14,068	2,712	2,511	8,470	15,181	22,645	16,621	25,329	4,750	115,070
SSW	1,687	1,403	1,891	1,259	2,060	3,347	6,201	6,165	19,616	20,648	68,252
SW	1,482	1,234	767	929	3,121	4,062	3,541	7,089	9,583	18,091	71,359
WSW	15	0	0	0	0	31	1,404	4,286	6,496	10,308	25,132
W	0	0	0	0	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0	0	164	323	487
NW	0	0	0	0	0	0	0	233	1,221	7,309	8,763
NNW	0	0	0	0	0	0	0	0	211	2,819	3,030
Totals	8,830	23,974	12,622	14,241	53,186	86,083	185,190	217,435	135,828	154,768	927,624

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TABLE 7C-2

POPULATION DISTRIBUTION FOR 1986
0- TO 50-MILE RADIUS | 5

Direction	Distance (mi) 0.0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0	5.0-6.0	6.0-7.0	7.0-8.5	8.5-10.0	Total	
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
E	0	0	3	23	33	15	0	58	150	141	107	0	467	244	1,241	
ESE	0	0	9	27	61	14	82	107	131	136	403	175	214	1,791	3,150	
SE	0	0	0	50	56	89	72	73	15	49	218	87	146	199	1,054	
SSE	0	0	0	27	112	96	18	120	276	122	128	118	211	194	1,422	
S	0	0	0	8	50	24	90	146	66	62	195	235	254	240	1,370	
SSW	0	0	9	4	40	83	163	162	217	199	483	191	840	2,012	4,403	
SW	0	0	49	42	35	31	56	140	177	302	3,216	9,923	7,842	1,956	23,769	
WSW	0	0	0	18	2	9	0	9	4	0	3	544	1,224	1,057	2,870	5
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	0	0	70	199	389	361	481	815	1,036	1,011	4,753	11,273	11,198	7,693	39,279	5

TABLE 7C-2 (Cont)

Direction	Distance (mi) 10.0-12.5	12.5-15.0	15.0-17.5	17.5-20.0	20.0-25.0	25.0-30.0	30.0-35.0	35.0-40.0	40.0-45.0	45.0-50.0	Total 0-50.0
N	0	0	0	0	0	0	24	352	1,762	26,337	28,475
NNE	0	0	0	43	990	797	2,443	4,760	2,895	2,895	14,823
NE	0	62	428	739	1,976	4,002	2,274	21,798	15,890	7,162	54,331
ENE	257	2,528	1,173	2,359	963	482	259	185	1,155	5,898	15,259
E	778	1,489	809	841	1,542	836	440	635	1,130	1,972	11,713
ESE	1,135	1,183	1,341	977	1,715	2,157	3,556	5,103	11,293	22,738	54,348
SE	995	1,275	2,082	2,569	7,141	7,648	10,274	10,679	20,778	18,925	83,420
SSE	1,376	1,515	2,188	2,983	27,775	50,483	138,635	147,163	21,544	7,426	402,510
S	1,712	15,581	3,005	2,780	8,837	15,827	23,593	17,204	25,850	4,863	120,622
SSW	1,869	1,554	2,094	1,371	2,092	3,393	6,317	6,281	19,807	20,319	69,500
SW	1,641	1,346	802	942	3,220	4,270	3,727	7,459	10,058	19,090	76,324
WSW	16	0	0	0	0	32	1,478	4,510	6,837	10,849	26,592
W	0	0	0	0	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0	0	168	331	499
NW	0	0	0	0	0	0	0	240	1,253	7,504	8,997
NNW	0	0	0	0	0	0	0	0	216	2,904	3,120
Totals	9,779	26,533	13,922	15,604	56,251	89,927	193,020	226,369	140,636	159,213	970,533

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TABLE 7C-3

POPULATION DISTRIBUTION FOR 1990
0- TO 50-MILE RADIUS 5

	Distance (mi)														
Direction	0.0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0	5.0-6.0	6.0-7.0	7.0-8.5	8.5-10.0	Total
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E	0	0	4	25	36	16	0	63	162	151	115	0	501	261	1,334
ESE	0	0	10	29	65	15	88	115	141	146	432	188	230	1,924	3,383
SE	0	0	0	53	60	97	77	78	16	52	234	94	156	214	1,131
SSE	0	0	0	29	120	103	20	129	297	131	137	127	228	209	1,530
S	0	0	0	8	54	26	96	157	71	67	209	252	273	258	1,471
SSW	0	0	10	5	43	89	175	173	233	214	519	205	903	2,161	4,730
SW	0	0	52	45	38	33	60	150	190	323	3,454	10,657	8,423	2,100	25,525
WSW	0	0	0	19	2	10	0	10	5	0	3	584	1,315	1,135	3,083 5
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	76	213	418	389	516	875	1,115	1,084	5,103	12,107	12,029	8,262	46,187 5

TABLE 7C-3 (Cont)

Direction	Distance (miles)										Total	
	10.0-12.5	12.5-15.0	15.0-17.5	17.5-20.0	20.0-25.0	25.0-30.0	30.0-35.0	35.0-40.0	40.0-45.0	45.0-50.0	0-50.0	
N	0	0	0	0	0	0	25	363	1,811	27,176	29,375	
NNE	0	0	0	44	1,017	820	2,513	4,893	2,977	2,978	15,242	
NE	0	67	453	761	2,032	4,115	2,340	22,416	16,352	7,373	55,909	
ENE	277	2,715	1,261	2,532	1,027	508	273	195	1,205	6,151	16,144	
E	836	1,599	869	903	1,657	896	458	655	1,166	2,037	12,410	
ESE	1,218	1,271	1,439	1,047	1,842	2,299	3,626	5,169	11,437	23,030	55,761	
SE	1,069	1,370	2,236	2,760	7,645	8,025	10,777	11,259	22,117	20,130	88,519	
SSE	1,478	1,627	2,350	3,200	29,117	52,652	144,589	153,485	22,468	7,755	420,251	
S	1,839	16,735	3,228	2,984	9,214	16,493	24,570	17,783	26,283	4,965	125,565	5
SSW	2,007	1,669	2,249	1,455	2,113	3,423	6,396	6,363	19,927	20,148	70,480	
SW	1,762	1,433	827	949	3,294	4,435	3,871	7,748	10,432	19,869	80,145	
WSW	17	0	0	0	0	34	1,536	4,685	7,103	11,271	27,729	
W	0	0	0	0	0	0	0	0	0	0	0	
WNW	0	0	0	0	0	0	0	0	170	335	505	
NW	0	0	0	0	0	0	0	242	1,265	7,572	9,079	
NNW	0	0	0	0	0	0	0	0	219	2,912	3,131	
Totals	10,503	28,486	14,912	16,635	58,958	93,700	200,974	235,256	144,932	163,702	1,010,245	

TABLE 7C-4

POPULATION DISTRIBUTION FOR 2000
0- TO 50-MILE RADIUS 5

	Distance (mi)															
Direction	0.0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0	5.0-6.0	6.0-7.0	7.0-8.5	8.5-10.0	Total	
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
E	0	0	4	28	41	18	0	71	184	173	131	0	572	299	1,521	
ESE	0	0	11	33	75	18	101	131	161	167	494	214	262	2,197	3,864	
SE	0	0	0	61	68	111	87	89	18	59	268	107	178	244	1,290	
SSE	0	0	0	34	137	118	23	148	338	150	157	144	259	239	1,747	
S	0	0	0	10	62	30	110	179	81	76	239	288	311	294	1,680	
SSW	0	0	11	5	49	101	200	198	266	244	592	234	1,031	2,468	5,399	
SW	0	0	60	51	43	38	69	171	217	370	3,944	12,167	9,616	2,398	29,144	
WSW	0	0	0	22	3	11	0	11	5	0	4	667	1,501	1,296	3,520	5
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	0	0	86	244	478	445	590	998	1,270	1,239	5,829	13,821	13,730	9,435	48,165	5

TABLE 7C-4 (Cont)

Direction	Distance (mi) 10.0-12.5	12.5-15.0	15.0-17.5	17.5-20.0	20.0-25.0	25.0-30.0	30.0-35.0	35.0-40.0	40.0-45.0	45.0-50.0	Total 0-50.0	
N	0	0	0	0	0	0	25	361	1,824	27,272	29,482	
NNE	0	0	0	44	1,014	817	2,506	4,881	2,970	2,971	15,203	
NE	0	76	493	767	2,026	4,104	2,333	22,364	16,341	7,378	55,882	
ENE	315	3,100	1,440	2,888	1,150	549	289	199	1,240	6,334	17,504	
E	954	1,824	991	1,031	1,890	1,019	479	664	1,188	2,074	13,635	
ESE	1,392	1,451	1,645	1,196	2,104	2,583	3,658	5,125	11,340	22,833	57,191	
SE	1,221	1,562	2,553	3,150	8,676	8,756	11,714	12,231	24,172	21,893	97,218	
SSE	1,687	1,857	2,683	3,646	31,719	56,769	155,897	165,485	24,225	8,371	454,086	
S	2,099	19,104	3,684	3,404	9,936	17,765	26,447	18,985	27,539	5,226	135,869	
SSW	2,292	1,905	2,568	1,635	2,199	3,559	6,703	6,677	20,597	20,236	73,770	5
SW	2,012	1,615	891	984	3,531	4,905	4,288	8,583	11,511	21,979	89,443	
WSW	20	0	0	0	0	37	1,700	5,189	7,865	12,479	30,810	
W	0	0	0	0	0	0	0	0	0	0	0	
WNW	0	0	0	0	0	0	0	0	170	336	506	
NW	0	0	0	0	0	0	0	243	1,271	7,607	9,121	
NNW	0	0	0	0	0	0	0	0	219	2,926	3,145	
Totals	11,992	32,494	16,948	18,745	64,245	100,863	216,039	250,987	152,472	169,915	1,082,865	

TABLE 7C-5

POPULATION DISTRIBUTION FOR 2010
0- TO 50-MILE RADIUS | 5

Direction	0.0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0	5.0-6.0	6.0-7.0	7.0-8.5	8.5-10.0	Total	
	Distance (mi)															
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
E	0	0	5	33	47	21	0	83	214	200	152	0	665	347	1,767	
ESE	0	0	13	38	87	21	117	152	187	194	574	249	304	2,552	4,488	
SE	0	0	0	71	79	128	101	104	21	69	311	124	207	284	1,499	
SSE	0	0	0	40	160	137	27	172	393	174	181	169	301	278	2,032	
S	0	0	0	11	71	35	128	208	95	88	278	334	362	342	1,952	
SSW	0	0	13	6	57	118	232	231	309	284	688	271	1,197	2,867	6,273	
SW	0	0	69	60	51	44	80	198	252	429	4,581	14,135	11,173	2,786	33,858	
WSW	0	0	0	25	3	13	0	13	6	0	4	775	1,744	1,505	4,088	5
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	0	0	100	284	555	517	685	1,161	1,477	1,438	6,769	16,057	15,953	10,961	55,957	5

TABLE 7C-5 (Cont)

	Distance (miles)										
Direction	10.0-12.5	12.5-15.0	15.0-17.5	17.5-20.0	20.0-25.0	25.0-30.0	30.0-35.0	35.0-40.0	40.0-45.0	45.0-50.0	Total 0-50.0
N	0	0	0	0	0	0	26	373	1,875	30,382	32,656
NNE	0	0	0	45	1,043	841	2,580	5,024	3,056	3,058	15,647
NE	0	89	552	798	2,085	4,225	2,401	23,022	16,833	7,607	57,612
ENE	366	3,600	1,673	3,353	1,314	609	316	209	1,297	6,632	19,369
E	1,110	2,121	1,152	1,198	2,196	1,181	522	697	1,246	2,176	15,366
ESE	1,617	1,686	1,909	1,389	2,442	2,971	3,902	5,400	11,948	24,056	61,808
SE	1,418	1,816	2,966	3,661	10,061	10,026	13,394	14,025	27,827	25,092	111,785
SSE	1,960	2,157	3,117	4,234	36,299	64,745	177,797	188,734	27,627	9,555	518,257
S	2,439	22,195	4,281	3,953	11,306	20,219	30,043	21,142	29,246	5,616	152,392
SSW	2,662	2,214	2,984	1,864	2,281	3,686	7,020	7,014	21,233	20,558	77,789
SW	2,337	1,849	967	1,018	3,808	5,493	4,809	9,627	12,873	24,655	101,294
WSW	23	0	0	0	0	42	1,908	5,821	8,823	13,999	34,704
W	0	0	0	0	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0	0	165	325	490
NW	0	0	0	0	0	0	0	235	1,231	7,331	8,797
NNW	0	0	0	0	0	0	0	0	207	2,706	2,913
Totals	13,932	37,727	19,601	21,513	72,835	114,038	244,718	281,323	165,487	183,748	1,210,879

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TABLE 7C-6

POPULATION DISTRIBUTION FOR 2020
0- TO 50-MILE RADIUS | 5

Direction	Distance (mi) 0.0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0	5.0-6.0	6.0-7.0	7.0-8.5	8.5-10.0	Total	
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
E	0	0	5	38	55	24	0	96	247	231	175	0	767	401	2,039	
ESE	0	0	15	44	101	24	135	175	215	223	662	287	351	2,945	5,177	
SE	0	0	0	82	91	148	118	120	24	80	359	143	239	327	1,731	
SSE	0	0	0	46	184	158	31	199	453	201	210	194	348	320	2,344	
S	0	0	0	13	82	40	147	240	109	102	320	386	417	395	2,251	
SSW	0	0	15	7	66	136	268	266	357	328	793	313	1,380	3,307	7,236	
SW	0	0	80	69	58	51	93	229	291	495	5,285	16,304	12,886	3,212	39,053	
WSW	0	0	0	29	4	15	0	15	7	0	5	894	2,012	1,736	4,717	5
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	0	0	115	328	641	596	792	1,340	1,703	1,660	7,809	18,521	18,400	12,643	64,548	5

TABLE 7C-6 (Cont)

Direction	Distance (mi) 10.0-12.5	12.5-15.0	15.0-17.5	17.5-20.0	20.0-25.0	25.0-30.0	30.0-35.0	35.0-40.0	40.0-45.0	45.0-50.0	Total 0-50.0
N	0	0	0	0	0	0	26	381	1,910	34,863	37,180
NNE	0	0	0	47	1,068	861	2,639	5,140	3,127	3,128	16,010
NE	0	102	616	824	2,133	4,323	2,457	23,552	17,227	7,788	59,022
ENE	422	4,153	1,930	3,866	1,494	674	344	215	1,336	6,829	21,263
E	1,279	2,444	1,328	1,382	2,533	1,360	571	732	1,302	2,274	17,244
ESE	1,864	1,945	2,204	1,602	2,819	3,402	4,249	5,821	12,879	25,933	67,895
SE	1,635	2,095	3,421	4,222	11,608	11,601	15,482	16,219	32,117	28,821	128,952
SSE	2,261	2,489	3,595	4,885	42,005	74,977	205,894	218,560	31,994	11,064	600,068
S	2,813	25,601	4,938	4,558	13,061	23,364	34,654	23,884	31,342	6,101	172,567 5
SSW	3,071	2,553	3,441	2,118	2,375	3,831	7,387	7,409	21,992	21,252	82,665
SW	2,696	2,108	1,051	1,056	4,135	6,194	5,431	10,868	14,498	27,801	114,891
WSW	27	0	0	0	0	47	2,154	6,569	9,959	15,804	39,277
W	0	0	0	0	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0	0	154	304	458
NW	0	0	0	0	0	0	0	220	1,148	6,780	8,148
NNW	0	0	0	0	0	0	0	0	183	2,314	2,497
Totals	16,068	43,490	22,524	24,560	83,231	130,634	281,288	319,570	181,168	201,056	1,368,137

TABLE 7C-7

POPULATION DISTRIBUTION FOR 2030
0- TO 50-MILE RADIUS | 5

Direction	Distance (mi) 0.0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0	5.0-6.0	6.0-7.0	7.0-8.5	8.5-10.0	Total	
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
E	0	0	6	44	63	28	0	110	284	265	201	0	880	460	2,341	
ESE	0	0	17	50	115	27	155	201	247	256	759	329	402	3,380	5,938	
SE	0	0	0	94	105	171	135	137	27	91	412	165	274	375	1,986	
SSE	0	0	0	52	211	182	35	228	520	230	240	222	399	367	2,686	
S	0	0	0	15	94	46	169	276	125	117	368	443	478	453	2,584	
SSW	0	0	17	8	75	157	307	305	409	376	911	359	1,585	3,795	8,304	
SW	0	0	92	79	67	58	106	264	334	568	6,067	18,715	14,793	3,688	44,831	
WSW	0	0	0	33	4	17	0	17	8	0	5	1,026	2,309	1,993	5,412	5
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	0	0	132	375	734	686	907	1,538	1,954	1,903	8,963	21,259	21,120	14,511	74,082	5

TABLE 7C-7 (Cont)

Direction	Distance (mi) 10.0-12.5	12.5-15.0	15.0-17.5	17.5-20.0	20.0-25.0	25.0-30.0	30.0-35.0	35.0-40.0	40.0-45.0	45.0-50.0	Total 0-50.0
N	0	0	0	0	0	0	27	390	1,938	40,990	43,345
NNE	0	0	0	48	1,093	881	2,699	5,257	3,198	3,199	16,375
NE	0	118	686	853	2,182	4,421	2,513	24,095	17,621	7,965	60,454
ENE	485	4,768	2,215	4,435	1,696	744	374	219	1,361	6,965	23,262
E	1,468	2,806	1,525	1,587	2,909	1,560	631	772	1,364	2,378	19,341
ESE	2,139	2,233	2,529	1,840	3,235	3,891	4,712	6,417	14,201	28,594	75,729
SE	1,877	2,404	3,926	4,846	13,351	13,518	18,034	18,883	37,203	33,237	149,265
SSE	2,595	2,856	4,127	5,610	48,978	87,730	240,924	255,743	37,436	12,937	701,622
S	3,229	29,388	5,667	5,230	15,243	27,281	40,395	27,277	33,841	6,686	196,821
SSW	3,526	2,930	3,951	2,401	2,477	3,992	7,799	7,856	22,848	22,302	88,386
SW	3,095	2,394	1,144	1,096	4,508	7,006	6,150	12,307	16,389	31,433	130,353
WSW	31	0	0	0	0	53	2,438	7,441	11,278	17,897	44,550
W	0	0	0	0	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0	0	137	270	407
NW	0	0	0	0	0	0	0	196	1,023	5,943	7,162
NNW	0	0	0	0	0	0	0	0	148	1,737	1,885
Totals	18,445	49,897	25,770	27,946	95,672	151,077	326,696	366,853	199,986	222,533	1,558,957

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TABLE 7C-8

POPULATION DENSITY FOR 1986
0- TO 50-MILE RADIUS

	Distance (mi)														
Direction	0.0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0	5.0-6.0	6.0-7.0	7.0-8.5	8.5-10.0	Average
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E	0	0	13	81	115	138	0	3,412	7,500	1,226	451	0	160	52	139
ESE	0	0	37	79	138	26	130	146	158	146	187	69	47	329	162
SE	0	0	0	146	127	165	113	99	18	53	101	34	32	37	55
SSE	0	0	0	79	254	178	28	163	331	131	119	99	46	36	85
S	0	0	0	23	113	44	141	198	79	66	90	92	56	44	71
SSW	0	0	37	12	91	154	255	220	260	213	224	75	184	369	227
SW	0	0	200	122	79	57	88	190	212	333	1,495	4,339	1,718	359	1,242
WSW	0	0	0	126	15	49	0	50	73	0	150	4,000	1,819	972	1,099
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average	0	0	72	80	127	102	126	177	204	178	392	815	361	200	315

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TABLE 7C-8 (Cont)

	Distance (mi)										
Direction	10.0-12.5	12.5-15.0	15.0-17.5	17.5-20.0	20.0-25.0	25.0-30.0	30.0-35.0	35.0-40.0	40.0-45.0	45.0-50.0	Average 0-50.0
N	0	0	0	0	0	0	21	20	39	626	268
NNE	0	0	0	34	34	38	65	95	37	37	50
NE	0	55	45	44	45	74	36	296	190	77	124
ENE	70	200	74	128	22	11	4	3	14	65	35
E	72	110	51	48	37	17	7	9	14	21	25
ESE	103	88	84	58	51	40	56	73	139	246	115
SE	90	95	131	140	178	233	322	222	262	208	208
SSE	125	112	137	162	653	977	2,308	2,018	259	80	840
S	159	1,247	189	154	221	309	370	234	352	61	263
SSW	169	115	131	74	47	64	108	87	274	241	150
SW	152	104	63	78	97	86	63	101	121	205	166
WSW	148	0	0	0	0	57	473	178	162	195	205
W	0	0	0	0	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0	0	32	34	33
NW	0	0	0	0	0	0	0	27	29	97	70
NNW	0	0	0	0	0	0	0	0	19	58	51
Totals	122	249	104	100	143	195	339	312	149	142	201

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TABLE 7C-9

POPULATION DENSITY FOR 2030
0- TO 50-MILE RADIUS

	Distance (mi)															
Direction	0.0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0	5.0-6.0	6.0-7.0	7.0-8.5	8.5-10.0	Average	
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
E	0	0	25	155	219	257	0	6,471	14,200	2,304	848	0	302	98	262	
ESE	0	0	69	146	260	50	246	275	297	274	351	129	88	620	306	
SE	0	0	0	274	238	317	212	186	32	98	191	65	60	69	103	
SSE	0	0	0	151	478	337	55	310	623	247	223	185	87	67	160	
S	0	0	0	44	213	85	265	375	150	125	170	174	105	83	135	5
SSW	0	0	69	23	170	291	481	414	490	403	422	141	347	696	427	
SW	0	0	375	230	152	107	166	359	400	626	2,821	8,183	3,240	677	2,342	
WSW	0	0	0	231	29	93	0	95	145	0	250	7,544	3,431	1,832	2,072	
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Average	0	0	136	151	239	194	237	334	385	335	739	1,537	682	377	594	

TABLE 7C-9 (Cont)

Direction	10.0-12.5	12.5-15.0	15.0-17.5	17.5-20.0	20.0-25.0	25.0-30.0	30.0-35.0	35.0-40.0	40.0-45.0	45.0-50.0	Average 0-50.0
	Distance (mi)										
N	0	0	0	0	0	0	24	23	42	975	409
NNE	0	0	0	37	37	42	72	105	41	41	56
NE	0	104	72	51	49	82	39	327	211	86	138
ENE	132	377	139	241	38	17	6	3	17	77	53
E	135	208	96	90	70	31	10	10	16	25	41
ESE	194	165	159	109	95	72	75	92	174	310	161
SE	170	179	246	263	333	411	566	393	469	365	372
SSE	235	212	259	305	1,151	1,698	4,011	3,506	450	139	1,464
S	301	2,352	357	290	381	535	633	371	460	83	429
SSW	319	217	248	130	56	79	133	108	316	265	191
SW	286	186	90	91	135	142	103	167	196	337	283
WSW	288	0	0	0	0	94	780	294	268	322	344
W	0	0	0	0	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0	0	26	28	27
NW	0	0	0	0	0	0	0	22	24	77	56
NNW	0	0	0	0	0	0	0	0	13	35	31
Average	229	468	192	179	243	328	575	505	211	198	323

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TABLE 7C-10

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TABLE 7C-11

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TABLE 7C-21

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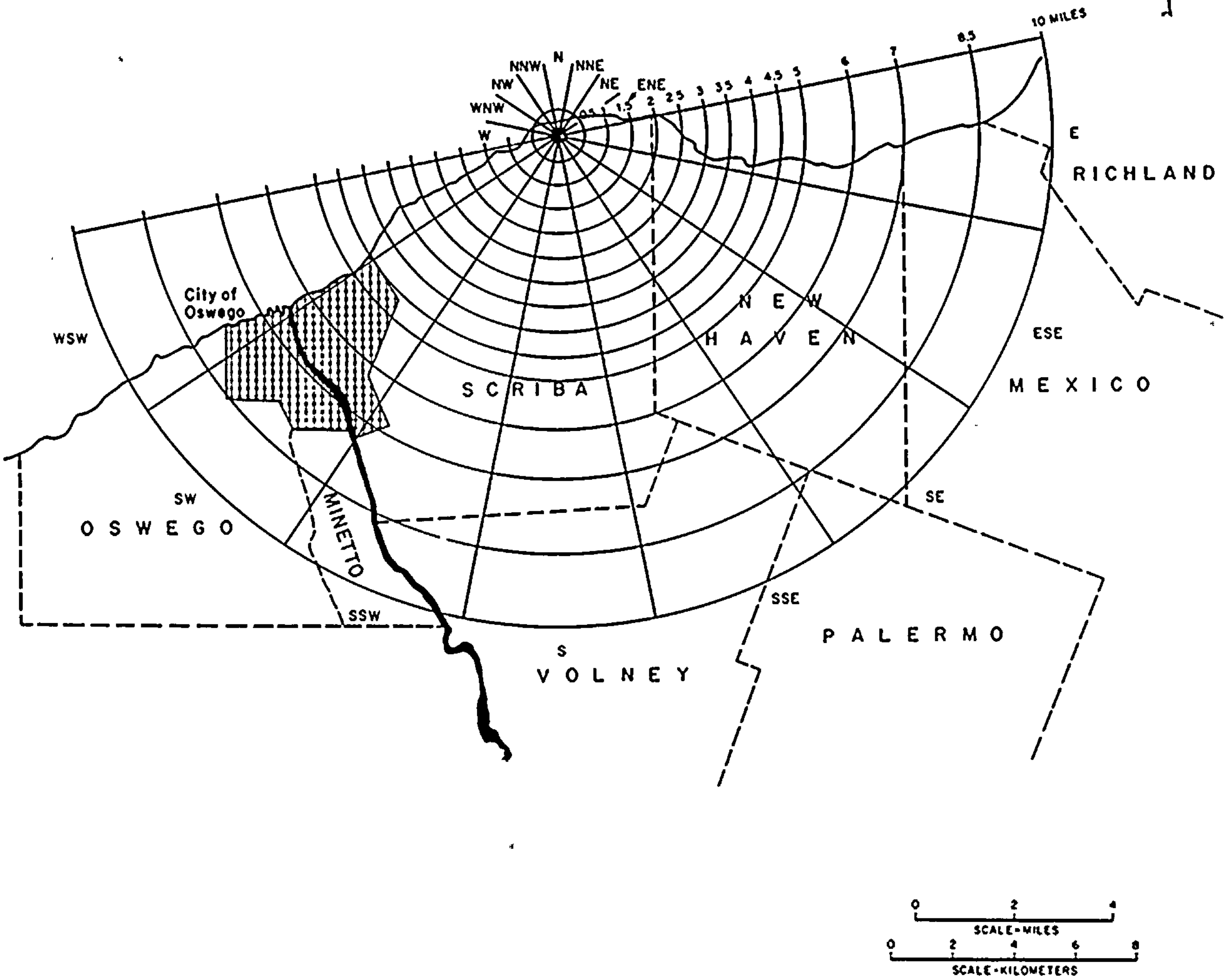

FIGURE 7C-1

0-10 MILE POPULATION ROSE

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS

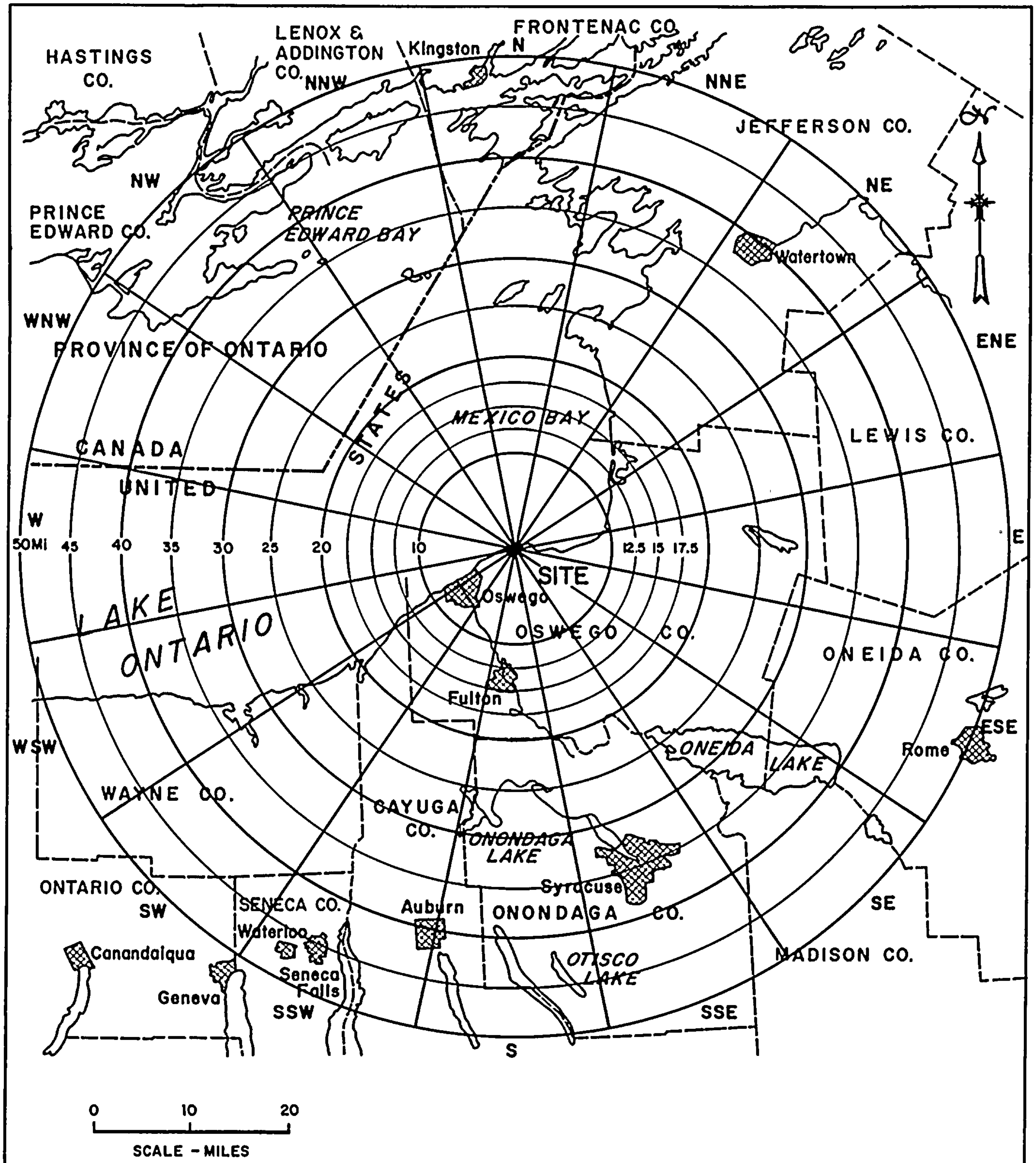

FIGURE 7C-2

50 MILE POPULATION ROSE

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT - UNIT 2
ENVIRONMENTAL REPORT - OLS

APPENDIX 7D

LIQUID PATHWAY CONSEQUENCE ANALYSIS

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APPENDIX 7D

LIQUID PATHWAY CONSEQUENCE ANALYSIS

7D.1 INTRODUCTION

In this appendix, the potential environmental impact of a release of radioactivity to the hydrosphere due to a core melt (Class 9) accident is analyzed. The Unit 2 plant systems and structures have been designed to specifically preclude this type of release; however, in the unlikely event that such a severe accident occurs, the station is fully equipped with a complement of emergency safety features which are designed to prevent and mitigate the effects and consequences of such an event. In order for such a release to represent a potential hazard, the radioactivity must penetrate the underlying plant structure of the reactor building, travel through the groundwater to the nearest surface waterbody, in this case Lake Ontario, and then disperse and enter the drinking water and food chain pathways.

7D.2 GENERAL APPROACH AND SCOPE OF ANALYSIS

The Liquid Pathway Generic Study[1] (LPGS) provides a detailed hydrospheric transport and dose model for severe accident releases into the groundwater and surface waterbodies adjacent to commercial nuclear power plants. Five types of surface waterbody sites were analyzed: large free-flowing river, small river with dammed reservoirs, Great Lakes, estuary, and ocean. Both land-based and floating nuclear power plants were analyzed. In this analysis the key Unit 2 hydrologic, geological, and environmental parameters affecting releases of radioactivity to the hydrosphere will be compared with the same parameters for the LPGS land-based plant sited on a Great Lake. In this manner, scaling factors for the LPGS Great Lakes site population doses can be calculated, and a comparison of the LPGS Great Lakes doses with the estimated Unit 2 doses can be made. The parameters which will be compared are listed as follows: 6

1. Distance from reactor to surface waterbody

2. Reactor thermal power

3. Groundwater/Containment velocity

4. Retention factors (retardation) for ion exchange in soil/rock

5. Lake flowrate

6. Lake volume

7. Sedimentation rate

8. Equilibrium coefficient for Cs-137 and Sr-90 in the surface waterbody

9. Affected drinking water population

10. Lake fish catch

11. Lake/shoreline usage

Because of the typically long travel times involved in reaching the surface waterbody, the only two isotopes of interest are Cs-137 and Sr-90. These isotopes have half-lives of 30.1 and 29.0 years respectively. Because of the effects of retardation (due to ion exchange), all other radionuclides are assumed to have decayed to negligible activities by the time the contamination reaches the surface waterbody.

7D.3 HYDROSPHERIC DESCRIPTION OF THE SITE

In the Unit 2 plant vicinity, groundwater is available from
6 an unconfined aquifer and deep confined aquifers. The unconfined aquifer is composed of glacial till and fill material and the Oswego sandstone beneath the soil. The unconsolidated deposits are connected to the Oswego sandstone through a fractured zone at the top of the rock. As the depth increases into the sandstone, the number of fractures decreases, and the sandstone becomes relatively impermeable after approximately 20 ft. The local water table varies from 261 ft to the lake level (244 ft) with annual variations of approximately 2 ft. The average gradient is north-northwest toward Lake Ontario. The deeper, confined aquifers are within the Pulaski and Whetstone Gulf formations. The local groundwater systems are more fully described in FSAR Section 2.4.13.

The analysis of groundwater flow in this study does not account for the effects of rock fractures in the Pulaski B sandstone formation. Secondary porosities due to fissures have not been estimated; however, the porosity and permeability data used are derived from pumping tests performed during construction excavations. These tests, while not absolute indicators of medium fissure effects, do for the purposes of this study provide reasonable data that

are representative of the general conditions found in the Pulaski B formation.

The surface waterbody of interest is Lake Ontario, the easternmost of the Great Lakes and the St. Lawrence River as far downstream as Quebec. Unit 2 is located on the western portion of the Nine Mile Point promontory, approximately 600 ft from the southeastern shore of Lake Ontario. The grade elevation of the site varies between 256 ft and 265 ft while the mean lake level is 246 ft. A more detailed description of Lake Ontario and the site hydrology may be found in Section 2.3.1.1 and FSAR Section 2.4.1.2.

7D.4 DETERMINATION OF UNIT 2 KEY PARAMETERS

7D.4.1 Distance to Surface Waterbody

The distance from the reactor building centerline to the lake is 600 feet.

7D.4.2 Retention Factor (Retardation) for Ion Exchange in Subsurface Material

As the radionuclides travel through the porous subsurface medium, chemical adsorption phenomena will tend to retard their progress. In order for the geochemical adsorption to be effective, the contaminants must physically contact the subsurface material. Therefore, the degree of retardation 6
is governed by the various physical properties such as bulk density, aquifer porosity, and species equilibrium distribution coefficient. The retardation factors for Cs-137 and Sr-90 are calculated using the following formula[2]:

$$R_d = 1 + \frac{\rho_d K_d}{\eta_e}$$

Where:

R_d = Retardation factor, dimensionless

η_d = Bulk density of the medium = 165.43 lb/ft^3 [3,4]

K_d = Distribution coefficient for Cs-137 and Sr-90 = 1.602 ft^3/lb and 0.320 ft^3/lb, respectively[5,6,7,8]

n_e = Effective aquifer porosity. This value is 6 percent and is an average calculated from various transition zone test results. See FSAR Section 2.4.13.2.2.

The equilibrium distribution coefficients (K_d) used to calculate the retardation factors were derived from an extensive literature search and are at the low end of the range of values given by Isherwood[9].

R_d(Cs-137) = 4418

R_d(Sr-90) = 884

7D.4.3 Groundwater/Contaminant Velocity

Without accounting for the effects of subsurface retardation of Cs-137 and Sr-90, the groundwater/contaminant velocity to Lake Ontario is 0.173 ft/day.

This value is calculated using the following formulation proposed by Codell[10]. The solution for the lake/aquifer interface concentration from a 1 curie instantaneous release in a finite thickness aquifer is:

$$C_i = \frac{1}{n_e R_d} X_1 Y_1 Z_1$$

6

$$X_1 = \frac{1}{\sqrt{4\pi E_x t/R_d}} \exp \left[\frac{-(x - ut/R_d)^2}{4 E_x t/R_d} - \lambda t \right]$$

$$Y_1 = \frac{1}{\sqrt{4\pi E_y t/R_d}} \exp \left[\frac{y^2}{4 E_y t/R_d} \right]$$

$$Z_1 = \left[\frac{1}{h} 1 + 2 \sum_{m=1}^{\infty} \exp \left(- \frac{m^2 \pi^2 E_z t}{H^2 R_d} \right) \cos m\pi \frac{z_s}{n} \cos m\pi \frac{z}{n} \right]$$

This general formula can be simplified by making the following assumptions:

1. Since the travel times are characteristically long, the Σ term will approach zero.

2. The contaminant is carried only in the principal direction towards the lake, i.e., the vertical (z) and lateral (y) components may be ignored (y=z=0).

The solution for the time of maximum concentration is:

$$t = \frac{-2E_x + \sqrt{4E_x^2 + u^2x^2}}{u^2}$$

Where:

t = travel time to Lake Ontario, sec.

x = Horizontal distance to Lake Ontario, ft. This distance is 600 ft[11].

E_x = Horizontal dispersion coefficient, ft^2/sec

u = Seepage velocity, ft/sec

$R_d = 1$

The average seepage velocity, u, is calculated from Darcy's
Law[10,12] as follows: 6

$$u = \frac{Ki}{n_e}$$

Where:

u = Average seepage velocity, ft/sec

K = Average medium permeability, ft/sec. This value is 7×10^{-6} ft/sec and is based upon measured transmissivity data accumulated during construction excavations. See FSAR Section 2.4.13.2.2.

i = Hydraulic gradient, dimensionless. The hydraulic gradient is the vertical difference between the groundwater elevation underneath the reactor building (prior to pumping-assuming dewater pumps turned-off) and the lake surface divided by the horizontal travel distance. The vertical height difference is 11 ft (255 ft-244 ft) and the horizontal travel distance is 600 ft.

η_e = Medium primary porosity, dimensionless. This value is 6 percent and is an average calculated from various transition zone test results. See FSAR Section 2.4.13.2.2.

Substituting values for K, i, and η_e:

$$u = 2.0 \times 10^{-6} \text{ ft/sec}$$

The horizontal dispersion coefficient, E_x, is calculated as follows:[1]

$$E_x = \sigma_x u$$

Where:

E = Dispersion coefficient in the principal flow direction, ft^2/sec.

σ_x = Medium dispersivity, ft. This value is not
available for the Unit 2 site; therefore,
σ_x will be calculated by multiplying a
known aquifer dispersivity by the ratio of
6 the known aquifer porosity to the Unit 2
Pulaski B Formation porosity. In this
case, the Snake River dispersivity (197 ft)
and porosity (10 percent) will be used[13].

Therefore,

$$\sigma_x = 197 \text{ ft}\left(\frac{0.10}{0.06}\right) = 328 \text{ ft.}$$

and,

$$E_x = (328 \text{ ft}) (2\times10^{-6} \text{ ft/sec}) = 7\times10^{-4} \text{ ft}^2 \text{ ft/sec}$$

The final substitution of x, u, and E_x yields the following solution for time of maximum concentration:

$$t = 2.99 \times 10^{8} \text{ sec or } 9.5 \text{ years}$$

This value of groundwater travel time is calculated with no ion exchange (adsorption) taken into account (i.e., R_d = 1.0). Knowing the travel distance and time, accordingly; the average groundwater/contaminant velocity is 2×10^{-6} ft/sec or 1.7×10^{-1} ft/day.

The groundwater/contaminant travel times will be used to calculate the exponential decay of Cs-137 and Sr-90 during the period when these isotopes are traveling through the aquifer to the lake. The radioactive decay factor (RDF) will be expressed as follows:

$$RDF = \frac{N}{N_o} = \exp(-\lambda t)$$

where:

RDF = Radioactive decay factor

N = Amount of each isotope remaining after time t

N_o = Initial amount of each isotope

λ = Radioactive decay constant for each isotope (equal to 0.693/isotope half-life)

t = Groundwater travel time

7D.4.4 Lake Physical Parameters 6

In the Great Lakes, water movement and, hence, any contaminants transported by the water, occurs on several scales. Nearshore, the currents generally move parallel to the coastline in one direction for several days and then mixing occurs with the offshore water, followed by a reversal of the alongshore current. The bulk lake-wide currents are counterclockwise in direction. Twice a year, except for Lake Erie, seasonal turnover occurs in which the upper 50-75 ft of lake volume mixes with the remainder of the lake. The large volumes and small inlet/outlet flows of the Great Lakes result in long flushing times (approximately 8 years for Lake Ontario). Contaminants deposited in the Great Lakes are substantially diluted quickly due to current action; however, the natural removal due to flushing is relatively slow. Consequently, contaminants will exhibit low concentrations, but will persist for long residence times.

Sedimentation effects are present in the Great Lakes; however, the sedimentation rate is slow. Therefore, removal of radionuclides from solution will be slow. Permanent removal (burial) in bottom sediments will occur for strongly adsorbed radionuclides, such as Cs-137; however, less

strongly interacting species such as Sr-90 will reenter the water column via diffusion out of the sediment layer.

The important lake parameters are: lake volume, flowrate through the lake, sedimentation rate, and equilibrium distribution coefficient for Cs-137 and Sr-90. These parameters for Lake Ontario are listed below along with their references.

Parameter	Value	Reference
Volume	5.78×10^{13} cu ft	FSAR, Section 2.4.1.2
Flowrate	241,000 cfs	FSAR, Section 2.4.1.2
Sedimentation rate	0.02 in/yr	LPGS
Equilibrium Distribution Coefficient for Cs-137, Sr-90	27,000 cc/g(Cs-137) 2400 cc/g(Sr-90)	LPGS

7D.4.5 Affected Drinking Water Population

6 The population affected by the liquid pathway release are those persons who receive drinking water from Lake Ontario and downstream from the St. Lawrence River.

This exposed population group consists of both U.S. and Canadian components. The population values that follow are taken from NUREG/CR-1956[14].

	Persons
U.S. from Lake Ontario	1.66×10^6
Canadian from Lake Ontario	3.0×10^6
Canadian from St. Lawrence River	3.0×10^6
Total	7.66×10^6

The U.S. value includes a factor which accounts for the fact that 83 percent of the U.S. population in the Great Lakes Water Resources Region receives its drinking water from surface water supplies[14]. The Canadian values include Toronto and its surrounding region and the St. Lawrence River downstream to Quebec. Below Quebec, the St. Lawrence is considered esturarial.

7D.4.6 Fish Catch

Tables 2.3-7 and 2.3-16 present the respective U.S. and Canadian total commercial fish harvests landed in Lake Ontario. Sandia National Laboratories (SNL) states that the fraction of the commercial catch eventually consumed by humans is 0.14 for the Great Lakes[14].

Tables 2.3-8 and 2.3-10 present the corresponding U.S. and Canadian data for recreational fish catches in Lake Ontario. The U.S. recreational data are for the 2-year period of 1976-1977, while the Canadian recreational data represent the single-year harvest for 1980. Section 2.3.2.3.2 states that approximately 56 percent of the recreational harvest is eventually eaten.

The following is an annual summary by weight of the U.S. and Canadian fish harvests in Lake Ontario.

Type of Harvest	Total Harvest (kg)	Amount Consumed by Humans (kg)
U.S. Commercial	79,962	11,195
Canadian Commercial	1,014,816	142,074
U.S. Recreational	1,057,554	592,230
Canadian Recreational	2,732,897	1,200,341
Total		1,945,840

6

The above data includes only finfish catches. Shellfish are not caught in measurable quantities in the Great Lakes.

7D.4.7 Lake/Shoreline Usage

The Great Lakes are heavily used for recreational purposes, particularly on Lake Ontario in New York State. Boating, fishing, and swimming are all frequent summertime activities on Lake Ontario which bring persons directly into contact with lake water. SNL provides the following data with respect to shoreline usage and immersion for Lake Ontario[14]:

Pathway	Usage (10^6 man-hours/year)
Shoreline (boating, fishing)	160
Immersion (swimming)	78

These values include estimates for Canadian users of the lake.

7D.4.8 Reactor Thermal Power

The rated thermal power output of the Unit 2 plant is 3323 MWt. This parameter will be used to adjust the source term in the LPGS. The curie content of the Unit 2 core is based on ratioing the LPGS core curie content with respect to power level.

7D.5 COMPARISON AND SCALING OF LPGS AND UNIT 2 PARAMETERS

Table 7D-1 provides a comparison of LPGS Great Lakes site and Unit 2 parameters which are most important to severe accident releases to the hydrosphere.

Without the effects of ion exchange, the travel time to the lake is 9.5 years for Cs-137 and Sr-90. This compares with an average travel time of 0.61 years in the LPGS. Therefore, without soil retardation, the time that it takes for activity to migrate to the surface waterbody is 15.6 times longer at the Unit 2 site than at the LPGS Great Lakes site. For Unit 2, when the effects of retardation are incorporated, these travel times are increased markedly to 42,028 years for Cs-137 and 8,409 years for Sr-90. The travel times with retardation in the LPGS are 51 years for
6 Cs-137 and 5.1 years for Sr-90. Without retardation, the travel time for Cs-137 and Sr-90 represents approximately 0.32 half-lives. At the Unit 2 site, with retardation, the travel time for Cs-137 represents 1,401 half-lives, while the travel time for Sr-90 represents 290 half-lives. Therefore, with retardation accounted for, negligible amounts of Cs-137 or Sr-90 will reach the lake. This assumes half-lives of 30 years and 29 years for Cs-137 and Sr-90, respectively.

Since the LPGS utilized the properties of Lake Ontario to represent the generic Great Lakes, the properties used in this analysis are essentially the same. The volume and flowrate given in the LPGS are nearly identical to those shown in FSAR, Section 2.4.1.2. The sedimentation rate used in the LPGS is 0.02 in/yr. The actual measured sedimentation rate at Nine Mile Point is not available; however, SNL has stated that the Great Lakes exhibit sedimentation rates in the range of 0.01 in/yr to 0.03 in/yr, with an average value of 0.02 in/yr[14]. This is consistent with the value used for calculations in the LPGS; therefore, the same value will be assumed here for the Unit 2 site. The equilibrium distribution coefficients (K_d) for Cs-137 and Sr-90 used in the LPGS are 27,000 cc/g and 2,400 cc/g, respectively. Again, actual data are not

available for the Nine Mile Point region of Lake Ontario; however, SNL has stated that average Great Lakes K_d values are 10,000 cc/g and 1,000 cc/g for Cs-137 and Sr-90, respectively, and that these values are at the low end of their possible ranges and are therefore conservative. Therefore, the LPGS values appear to be acceptable and will be used in this analysis.

Because all of the properties for Lake Ontario used here are identical to those assumed in the LPGS, except for a slight variation in flowrate, the effects of dilution changes in Lake Ontario for Unit 2 dose calculations will be ignored. The same hydrologic dispersion/retention of radioactive contaminants in the lake that was calculated in the LPGS will be utilized in this analysis.

The affected drinking water population downstream of the Unit 2 site is assumed to be 7.66 million persons. The LPGS Great Lakes population value is 2.0 million. Therefore, an accident at Unit 2 will expose 3.83 times as many people as the LPGS release.

The thermal power of the Unit 2 plant is 1.038 times the thermal power rating of the LPGS reactor, which is the generic 3200-MWt PWR used in the Reactor Safety Study (WASH-1400)[15]. Therefore, a severe accident release at Unit 2 starts with 3.8 percent more radioactivity than the LPGS initial core inventory.

The annual fish catch in Lake Ontario is 1.95 million kg/yr. 6
This value is 16 percent of the LPGS value. The Unit 2 value includes only finfish and accounts for both U.S. and Canadian commercial and recreational harvests. The LPGS value also includes commercial and recreational finfish catches for both U.S. and Canadian fisheries.

The shoreline and immersion usage of Lake Ontario is assessed at 160 million and 78 million user-hours per year, respectively. These user-hours compare with 440 million and 120 million user-hours per year for the same activities used in the LPGS. Therefore, a liquid pathway release to Lake Ontario would expose 36 percent of the persons exposed at the Great Lakes LPGS site via the shoreline use pathway, and 65 percent of the persons exposed in the LPGS via the swimming pathway.

The scaling factor for the drinking water pathway, SF_{dw}, is defined as the multiplication of Unit 2 key drinking water exposure parameters to LPGS key drinking water exposure parameters. Numerically, it is calculated as follows:

$$SF_{dw} = \frac{\text{Unit 2 radioactive decay factor}}{\text{LPGS radioactive decay factor}} \times \frac{\text{LPGS dilution factor}}{\text{Unit 2 dilution factor}}$$

$$\times \frac{\text{Unit 2 drinking water population}}{\text{LPGS drinking water population}} \times \frac{\text{Unit 2 thermal power}}{\text{LPGS plant thermal power}}$$

For the aquatic food pathway, the scaling factor SF_{aq} is defined in the same manner, except that those parameters important to aquatic food ingestion are used. Numerically, SF_{aq} is defined as:

$$SF_{aq} = \frac{\text{Unit 2 radioactive decay factor}}{\text{LPGS radioactive decay factor}} \times \frac{\text{LPGS dilution factor}}{\text{Unit 2 dilution factor}}$$

$$\times \frac{\text{Unit 2 aquatic food harvest}}{\text{LPGS aquatic food harvest}} \times \frac{\text{Unit 2 thermal power}}{\text{LPGS plant thermal power}}$$

For the shoreline use and immersion pathways, the scaling
6 factors SF_{su} and SF_{im} are defined in the same manner, except that those parameters important to shoreline use and immersion are used. Numerically, SF_{su} and SF_{im} are defined as:

$$SF_{su} = \frac{\text{Unit 2 radioactive decay factor}}{\text{LPGS radioactive decay factor}}$$

$$\times \frac{\text{LPGS dilution factor}}{\text{Unit 2 dilution factor}} \times \frac{\text{Unit 2 thermal power}}{\text{LPGS plant thermal power}}$$

$$\times \frac{\text{Unit 2 shoreline user-hr/yr}}{\text{LPGS shoreline user-hr/yr}}$$

$$SF_{im} = \frac{\text{Unit 2 radioactive decay factor}}{\text{LPGS radioactive decay factor}} \times \frac{\text{Unit 2 thermal power}}{\text{LPGS thermal power}}$$

$$\times \frac{\text{LPGS dilution factor}}{\text{Unit 2 dilution factor}} \times \frac{\text{Unit 2 swimming hr/yr}}{\text{LPGS swimming hr/yr}}$$

NOTE: All dilution factor ratios are equal to unity.

For Cs-137 and Sr-90 without retardation, SF_{dw}, SF_{aq}, SF_{su}, and SF_{im} are calculated as follows:

$$SF_{dw} = \frac{\exp[-(0.693/30\ yr)(9.5\ yr)]}{\exp[-(0.693/30\ yr)(0.61\ yr)]}$$

$$\times \frac{7.66 \times 10^6\ persons}{2.0 \times 10^6\ persons} \times \frac{3323\ MWt}{3200\ MWt}$$

$$= 3.22$$

$$SF_{aq} = \frac{\exp[-(0.693/30\ yr)(9.5\ yr)]}{\exp[-(0.693/30\ yr)(0.61\ yr)]}$$

$$\times \frac{1.95 \times 10^6\ kg}{1.21 \times 10^7\ kg} \times \frac{3323\ MWt}{3200\ MWt}$$

$$= 0.14$$

$$SF_{su} = \frac{\exp[-(0.693/30\ yr)(9.5\ yr)]}{\exp[-(0.693/30\ yr)(0.61\ yr)]} \times \frac{3323\ MWt}{3200\ MWt}$$

$$\times \frac{160 \times 10^6\ hr}{440 \times 10^6\ hr}$$

$$= 0.31$$

$$SF_{im} = \frac{\exp[-(0.693/30\ yr)(9.5\ yr)]}{\exp[-(0.693/30\ yr)(0.61\ yr)]} \times \frac{3323\ MWt}{3200\ MWt}$$

$$\times \frac{78 \times 10^6\ hr}{120 \times 10^6\ hr}$$

6

$$= 0.55$$

With retardation incorporated, SF_{dw} and SF_{aq} are calculated as follows for Cs-137 and Sr-90:

$$SF_{dw}\ (CS\text{-}137) = \frac{\exp[-(0.693/30\ yr)(42028\ yr)]}{\exp[-(0.693/30\ yr)(51\ yr)]}$$

$$\times \frac{7.66 \times 10^6\ persons}{2.0 \times 10^6\ persons} \times \frac{3323\ MWt}{3200\ MWt}$$

$$= 0$$

$$SF_{dw}\,(Sr\text{-}90) = \frac{\exp[-(0.693/29\ yr)(8409\ yr)]}{\exp[-(0.693/29\ yr)(5.7\ yr)]}$$

$$\times \frac{7.66 \times 10^6\ persons}{2.0 \times 10^6\ persons} \times \frac{3323\ MWt}{3200\ MWt}$$

$$= 0$$

$$SF_{aq}\,(Cs\text{-}137) = \frac{\exp[-(0.693)/30\ yr)(42028\ yr)]}{\exp[-(0.693/30\ yr)(51\ yr)]}$$

$$\times \frac{1.95 \times 10^6\ kg}{1.21 \times 10^7\ kg} \times \frac{3328\ MWt}{3200\ MWt}$$

$$= 0$$

$$SF_{aq}\,(Sr\text{-}90) = \frac{\exp[-(0.693/29\ yr)(8409\ yr)]}{\exp[-(0.693/29\ yr)(5.7\ yr)]}$$

$$\times \frac{1.95 \times 10^6\ kg}{1.21 \times 10^7\ kg} \times \frac{3323\ MWt}{3200\ MWt}$$

$$= 0$$

6

$$SF_{su}\,(Cs\text{-}137) = \frac{\exp[-(0.693/30\ yr)(42028\ yr)]}{\exp[-(0.693/30\ yr)(51\ yr)]} \times \frac{3323\ MWt}{3200\ MWt}$$

$$\times \frac{160 \times 10^6\ hr}{440 \times 10^6\ hr}$$

$$= 0$$

$$SF_{su}\,(Sr\text{-}90) = \frac{\exp[-(0.693/29\ yr)(42028\ yr)]}{\exp[-(0.693/29\ yr)(5.7\ yr)]} \times \frac{3323\ Mwt}{3200\ MWt}$$

$$\times \frac{160 \times 10^6\ hr}{440 \times 10^6\ hr}$$

$$= 0$$

$$SF_{im}\,(Cs\text{-}137) = \frac{\exp[-(0.693/30\ yr)(42028\ yr)]}{\exp[-(0.693/30\ yr)(51\ yr)]} \times \frac{3323\ MWt}{3200\ MWt}$$

$$\times \frac{28 \times 10^6\ hr}{120 \times 10^6\ hr}$$

$$= 0$$

$$SF_{im}(\text{Sr-90}) = \frac{\exp[-(0.693/29\ \text{yr})(8409\ \text{yr})]}{\exp[-(0.693/29\ \text{yr})(5.7\ \text{yr})]} \times \frac{3323\ \text{MWt}}{3200\ \text{MWt}} \times \frac{78 \times 10^6\ \text{hr}}{120 \times 10^6\ \text{hr}} = 0$$

The scaling factors are summarized in Table 7D-2.

7D.6 CONCLUSIONS

The scaling factors calculated in Section 7D.5 indicate that with retardation effects, the doses due to a Class 9 accident release to the Unit 2 hydrosphere will be far less than the core melt release doses calculated in the LPGS for a land-based nuclear power plant situated on a large lake. Therefore, the same conclusions reached in the LPGS regarding the health and environmental impacts of severe accident releases to the hydrosphere also apply to the Unit 2 site. These conclusions are:

1. Both source and pathway interdiction are possible. Although such actions could incur large costs and possibly cause some socioeconomic effects (such as restricting fishing, recreation, and marine traffic temporarily), they would be effective in containing the impacts to limited and controllable areas. 6

2. Liquid pathways are not nearly as significant contributors to risk as the atmospheric pathway. Doses predicted for liquid pathways are much lower than those predicted for atmospheric releases.

3. No acute fatalities are expected for hydrospheric releases, even when the same source term used in the Reactor Safety Study is used, and interdiction of the source and exposure pathways is not undertaken. The radiological threat to public health is characterized by small increases in exposure above natural background levels, which would create slight statistical increases in the normal occurrences of latent effects such as cancer. Interdiction, with its attendant costs of either the source or pathways, would be quite effective in reducing the number of predicted latent effects such that the increases due to hydrospheric releases would be statistically indistinguishable from the yearly variations in the normal cancer rate due to all other sources.

4. Effects on biotic ecosystems, both marine and agrarian, are expected to be minor. Recovery of these ecosystems is expected to take place within several years of exposure. Interdiction will limit the exposure of surrounding biota to small definable areas which can easily be monitored.

5. The socioeconomic impacts of uninterdicted releases to Lake Ontario could be extensive. However, the impacts are not expected to be as great as would be predicted for plants along the Eastern Seaboard where local economies rely heavily on seasonal recreational activities such as swimming, boating, fishing, and tourism.

6 Since the estimated doses from severe accident releases to the hydrosphere at Unit 2 are less than those calculated in the LPGS for a similar site, the contribution from liquid pathway releases to the overall severe accident environmental risk is small. The overall risk due to severe accidents is dominated by atmospheric releases, and this risk has been shown to be several orders of magnitude less than the risk due to other man-made and naturally occurring hazards. Accordingly, the contribution to overall environmental risk due to severe accident releases to the Unit 2 site hydrosphere is extremely low.

7D.7 REFERENCES

1. Liquid Pathway Generic Study - Impacts of Accidental Radioactive Releases to the Hydrosphere from Floating and Land-Based Nuclear Power Plants, NUREG-0440, U.S. Nuclear Regulatory Commission, February 1978.

2. American Society of Civil Engineers (1981), Notes for Geotechnical Lecture Series for 1981; Groundwater Hydrology.

3. Compaction Test Reports, Nine Mile Point Nuclear Station Unit, Stone & Webster Engineering Corporation, Document 12177-W-1-10, June 25, 1973.

4. Report of Test Results, Dynamic Laboratory Soil Testing Program for NMP2; Goldberg, Zoino, Dunnicliff, and Associates, Inc., April 1977.

5. Glove, D. B. A Method to Describe the Flow of Radioactive Ions in Groundwater, Final Report, December 1, 1966, through June 30, 1968, Aerospace Safety TID-4500, 54th Edition, Category U-36(150), SC-CR-70-6139.

6. Inone, Y. and Monisawa, S. On the Selection of a Ground Disposal Site for Radioactive Waste; An Approach to Its Safety Evaluation, Health Physics, Pergamon Press, Volume 26, 1974. 6

7. Fenske, P. R. Prediction of Radionuclide Migration in Groundwater. Chapter 6 of Technical Discussions of Offsite Safety Programs for Underground Nuclear Detonations, U.S. Atomic Energy Commission, Nevada Operations Office, Reynolds Electrical and Engineering Co., Inc., Mercury, NV, December 1968.

8. Inone, Y. and Kaufman, W. Production of Movement of Radionuclides in Solution Through Porous Media, Health Physics, Pergamon Press, Volume 9, 1963.

9. Isherwood, D. Geoscience Data Base Handbook for Modeling a Nuclear Water Repository, NUREG/CR-0912, Volume 1, U.S. Nuclear Regulatory Commission and Lawrence Livermore Laboratory, January 1981.

10. Codell, R. B. A Collection of Mathematical Models for Dispersion in Surface Water and Groundwater, NUREG-0868, U. S. Nuclear Regulatory Commission, June 1982.

11. Stone & Webster Engineering Corporation, Drawing 12177-EB-1C-11.

12. Chow, V. T. Handbook of Applied Hydrology, Chapter 13, McGraw-Hill, 1964.

13. Robertson, J. B. Digital Modeling of Radioactive and Chemical Waste Transport in the Snake River Plain Aquifer at the National Reactor Testing Station, Idaho. USGS Open File Report No. IDO-22054, Water Resources Division, Idaho Falls, ID, 1974.

6

14. The Consequences From Liquid Pathways After a Reactor Meltdown Accident. NUREG/CR-1956. Sandia National Laboratories and U. S. Nuclear Regulatory Commission, June 1981.

15. Reactor Safety Study - An Assessment of The Accident Risks in U. S. Commercial Nuclear Power Plants. WASH-1400. NUREG-7S/014. U. S. Nuclear Regulatory Commission, October 1975.

TABLE 7D-1

KEY HYDROLOGICAL, GEOLOGICAL, AND ENVIRONMENTAL PARAMETERS FOR THE UNIT 2 SITE AND THE LPGS GREAT LAKES SITE

Parameter	LPGS Value	Unit 2 Value	
Distance from reactor centerline to surface waterbody	1500 ft	600 ft	
Groundwater/Contaminant velocity(1)	6.7 ft/day	0.173 ft/day	
Retention factors for ion exchange	83 (Cs-137) 9.2 (Sr-90)	4418 (Cs-137) 884 (Sr-90)	
Lake flowrate	2.34×10^5 cfs	2.41×10^5 cfs	
Lake volume	5.78×10^{13} cu ft	5.78×10^{13} cu ft	
Sedimentation rate	0.02 in/yr	0.02 in/yr	
Equilibrium distribution coefficient (K_d) for Cs-137 and Sr-90 in surface waterbody	27,000 cc/gram (Cs-137) 2,400 cc/gram (Sr-90)	27,000 cc/gram (Cs-137) 2,400 cc/gram (Sr-90)	6
Drinking water population	2.0×10^6	7.66×10^6	
Reactor thermal power	3200 MWt	3323 MWt	
Fish harvest(2)	1.21×10^7 kg/yr	1.95×10^6 lb/yr	
Shoreline/lake usage	120×10^6 user-hr swimming 440×10^6 user-hr other activities	78×10^6 user-hr swimming 160×10^6 user-hr other activities	

(1) Groundwater velocities shown are without effects of retardation due to ion exchange.

(2) Fish harvest values include commercial and recreational finfish for both U.S. and Canadian landings. Values are given in kg per year.

TABLE 7D-2

SUMMARY OF DOSE SCALING FACTORS[1]

Pathway	Scaling Factor		
	No Retardation	Cs-137[2]	Sr-90[2]
Drinking Water	3.22	Note 3	Note 3
Aquatic Food	0.14	Note 3	Note 3
Shoreline Usage	0.31	Note 3	Note 3
Immersion	0.55	Note 3	Note 3

6

[1] The following scaling factors represent the estimated ratio of Unit 2 pathway doses to LPGS Great Lakes site pathway doses.
[2] The values for Cs-137 and Sr-90 include ion exchange retardation effects. 6
[3] Due to the extremely long radioactive decay times, Cs-137 and Sr-90 are not detectable in each pathway.

CHAPTER 8

THE NEED FOR THE PLANT

The need for the power to be generated by Unit 2 was assessed in detail in the construction permit stage[1].

The relevant sections of the ER-CPS which address this topic are as follows:

Reference	Title
Section 1.2	Need for Locating the Power Station at the Site
Section 8	Alternatives to the Proposed Power Station
Section 9	Benefit Cost Analysis

The discussion of the need for the plant and the need for power pertains specifically to CPS review. These issues are not addressed in this report in accordance with a 10CFR51 rule change as presented in 47FR12940, which provides for the deletion of this discussion in the ER-OLS[2].

References

1. Nine Mile Point Nuclear Station Unit 2, Applicant's Environmental Report - Construction Permit Stage, NRC Docket No. 50-410, Niagara Mohawk Power Corporation, June 1972.

2. Office of the Federal Register. Need for Power and Alternative Energy Issues in Operation License Proceedings. 47FR12940, General Services Administration, Washington, DC, March 26, 1982.

CHAPTER 9

ALTERNATIVES TO THE PROJECT

Alternative energy sources and sites and alternative station designs were evaluated in the construction permit stage[1].

The relevant sections of the ER-CPS which address this topic are as follows:

Reference	Title
Section 8	Alternatives to the Proposed Power Station
Section 9	Benefit Cost Analysis

These issues are not addressed in this report in accordance with the amendment to 10CFR51 as cited in 47FR12940, which provides for the deletion of this discussion in the ER-OLS[2].

References

1. Nine Mile Point Nuclear Station Unit 2, Applicant's Environmental Report - Construction Permit Stage. NRC Docket No. 50-410, Niagara Mohawk Power Corporation, June 1972.

2. Office of the Federal Register. Need for Power and Alternative Energy Issues in Operating License Proceedings. 47FR12940, General Services Administration, Washington, DC, March 26, 1982.

CHAPTER 10

EVALUATION OF THE PROPOSED ACTION

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CHAPTER 10

EVALUATION OF THE PROPOSED ACTION

10.1 SUMMARY OF UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

10.1.1 Impacts of Construction

The impacts of construction were addressed in the Environmental Report - Construction Permit Stage and are not addressed here.

10.1.2 Impacts of Operation

The impacts associated with the operation of Unit 2 are identified and discussed in Chapter 5. The measures and controls utilized to limit adverse operational impacts are discussed in Section 5.10. Many features of the design and operation of Unit 2 act to limit environmental impacts. The estimated impacts that remain, while relatively minor, can be considered adverse and unavoidable. These impacts are summarized in Table 10.1-1.

TABLE 10.1-1

SUMMARY OF UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

Category	Unavoidable Adverse Impacts
Hydrological and Water Use (Sections 5.2 and 5.3)	Relatively low generation of effluent from two waste streams: combined plant discharge (i.e., cooling tower blowdown, water treatment system discharge, liquid radwaste, and service water discharge) and sanitary effluents, with impact limited to a small area of Lake Ontario. A small volume of water will be removed from Lake Ontario for plant operation. Similarly, a relatively small volume of heated water will be returned to the lake.
Ecological (Section 5.3)	
Terrestrial	Minimal impact to plants or animals is expected due to plant operation. Projected impact is limited to loss of a small number of birds resulting from collisions with transmission towers and lines and the power plant cooling tower, stack, and buildings.
Aquatic	The small volume of water utilized for plant operations and the incorporation of a fish diversion system as part of the plant design are anticipated to result in undetectable impacts to Lake Ontario aquatic populations. The transmission system maintenance program has been designed so that there will be little or no impact on the few aquatic habitats crossed by the transmission line corridor.
Socioeconomic (Section 5.8)	Limited impact will result from visibility of cooling tower and plume under certain meteorological conditions.

TABLE 10.1-1 (Cont)

Category	Unavoidable Adverse Impacts
Radiological (Section 5.4)	Small quantities of radionuclides will be released to the environment during routine operation of the station. These releases result in doses lower than the design objectives established in Appendix I of 10CFR50 and thereby meet the as-low-as-is-reasonably-achievable philosophy.
Atmospheric and Meteorological (Section 5.3)	Limited shadowing and cloud cover modification due to the visible plume will result from operation of the natural-draft cooling tower.

10.2 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

10.2.1 Irreversible Resource Commitments

The commitment of an environmental resource in such a manner that the resource cannot return in the future to its original state is considered irreversible. On this basis, the only resource committed in a manner considered irreversible is a portion of land at the site that contains the substation switchyard and transmission corridors, which may remain in Niagara Mohawk Power Corporation's electrical grid (Section 5.9.2). These areas total 1.9 ha (4.6 acres), or less than 1 percent of the 364-ha (900-acre) site (Section 5.1.1).

10.2.2 Irretrievable Resource Commitments

The commitment of a material resource in such a manner that, after its use by Unit 2, it cannot be recycled or restored by practical (or economical) means for another function is termed irretrievable. These commitments are identified in Table 10.2-1.

TABLE 10.2-1

ESTIMATED QUANTITIES OF MATERIALS IRRETRIEVABLY COMMITTED TO THE CONSTRUCTION AND OPERATION OF UNIT 2

Material	Quantities Used	Resources
Cement	9.4×10^4 metric tons (1.03×10^5 short tons)	U.S. production of cement (1980): 6.97×10^7 metric tons (7.68×10^7 short tons)[1]
Structural steel	1.60×10^4 metric tons (1.76×10^4 tons)	U.S. raw steel production (1980): 1.01×10^8 metric tons (1.12×10^8 tons)[1]
Electrical cable	1.98×10^6 lin m (6.35×10^6 lin ft)	NA
Sulfuric acid	11.01 metric tons/day maximum (12.14 short tons/day)	U.S. production (1979): 3.9×10^7 metric tons (4.3×10^7 short tons)[1]
Sodium hydroxide	0.76 metric tons/day maximum (0.84 short tons/day)	U.S. production (1979): 1.16×10^7 metric tons (1.28×10^7 short tons)[1]
Petroleum products[2]		U.S. proved reserves of crude petroleum (1979): 4.30×10^{12} l (1.14×10^{12} gal)[1]
Diesel fuel	5.08×10^6 l (1.34×10^6 gal)	
Gasoline	2.55×10^6 l (6.75×10^5 gal)	
Fuel oil	3.31×10^5 l (8.75×10^4 gal)	

TABLE 10.2-1 (Cont)

Material	Quantities Used	Resources
Uranium[2]	6.73×10^3 metric tons (7.41×10^3 short tons)	Free world production of U_3O_8 (1980): 5.14×10^4 metric tons (5.67×10^4 short tons)[1]

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[1] Source: Bureau of the Census. Statistical Abstract of the United States - 1981, U.S. Department of Commerce.

[2] Based on one half of the totals estimated for River Bend Station, Units 1 and 2. Environmental Report - Operating License Stage, Section 10.2.

10.3 RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY OF MAN'S ENVIRONMENT

The local use of man's environment by the project can be summarized in terms of the unavoidable adverse environmental impacts of operation discussed in Section 10.1 and the irreversible and irretrievable commitments of resources discussed in Section 10.2. Except for the consumption of depletable resources resulting from plant construction and operation, these uses may be classified as short term (i.e., over the life of the plant). The principal short-term benefit of the plant is the production of electrical energy. When used for this purpose, the economic productivity of the site will be extremely large compared with the productivity from agriculture or other probable uses.

The maximum long-term impact to productivity will result from the permanent removal of 1.9 ha (4.6 acres) of land that will not be available for any other use after decommissioning (Section 10.2.1). However, the short-term enhancement of regional productivity resulting from the electrical energy produced by the plant is expected to result in a correspondingly large increase in regional long-term productivity that probably would not be equaled by any other long-term use of the site. Most long-term impacts resulting from land-use preemption will be eliminated by conversion of the site to other uses following Unit 2 decommissioning (Section 5.9.2).

Thus, the negative aspects of plant construction and operation as they affect man's environment are outweighed by the positive, long-term increase in regional productivity caused by short-term enhancement of productivity resulting from the generation of electrical energy.

10.4 BENEFIT-COST BALANCE

10.4.1 Benefits

10.4.1.1 Direct Benefits

The primary benefit of Unit 2 is the generation of electric power to meet the growing demand in the co-owner electric system. The approximately 7.13 billion kWh/yr of energy that Unit 2 will produce will go to residential, industrial, and commercial customers throughout the service area.

10.4.1.2 Indirect Benefits

Indirect benefits associated with the construction and operation of Unit 2 (described in detail in Section 5.8.2) are primarily economic in nature and include tax payments, increased employment, and expenditures for engineering, materials, and fuel processing which will be made in New York State as well as other parts of the country. Additional benefits incident to the construction and operation of Unit 2 include the extensive studies of the ecology, geology, hydrology, archeology, and meteorology of the area which have contributed significantly to man's knowledge of the environment. Finally, the Energy Information Center, presently operated at the Nine Mile Point site by Niagara Mohawk Power Corporation and the Power Authority of the State of New York, will continue to provide educational and recreational benefits for thousands of visitors annually.

10.4.2 Costs

10.4.2.1 Direct Costs

The cost to construct Unit 2 is estimated to be $3.7 billion. The estimated annual cost to operate Unit 2 for the first full year of operation (1987), including fixed charges, fuel costs, operation and maintenance costs, overhead, insurance costs, and decommissioning costs, is $890 million. Total operating costs over the lifetime of the plant are estimated to be $42 billion.

10.4.2.2 Indirect Costs

The indirect costs of Unit 2 anticipated to result from the environmental impacts summarized in previous sections of this chapter, while difficult to quantify, have been investigated and are believed to be minor relative to the benefits derived from the project.

CHAPTER 11

SUMMARY OF ACTIONS TAKEN

During the construction permit stage, several commitments were made and requirements were imposed to protect the environment during the construction and operation of Unit 2. These commitments/requirements are described in the Unit 2 Environmental Report-Construction Permit Stage (ER-CPS), Final Environmental Statement (FES), and the Construction Permit. Environmental commitments and requirements pertinent to the operation of Unit 2 are summarized in this chapter. The following summaries provide a reference to the source(s) of the commitment/requirement, identify the nature of the commitment/requirement, and describe the action taken by NMPC to satisfy the commitment/requirement:

1. As Low As Practicable (ALAP) Discharge Criteria.
2. Landscaping Program.
3. Dike.
4. Planting Along Transmission Line Corridor.
5. Equipment Cleaning.
6. Aquatic Monitoring and Impact Assessment Programs.
7. Thermal Monitoring Program.
8. Radiological Monitoring Program.
9. Liquid Discharges Containing Oil.
10. Permit to Operate Standby Diesel Generators.
11. Disposal of Miscellaneous Solid Waste.
12. Meteorology Data.
13. Water Quality of Discharge During Operation.

1. As Low As Practicable (ALAP) Discharge Criteria

References: FES Section 3.5

Commitment Requirement/Action Taken:

The radwaste system as designed will utilize the equipment described in Section 3.5 of the FES to meet the ALAP discharge criteria, which will be described in the appropriate technical specifications. See ER-OLS Section 3.5 and FSAR Chapter 11 for a description of the Unit 2 radwaste systems.

2. Landscaping Program

References: FES Section 4.1

Commitment Requirement/Action Taken:

A landscaping program shall be implemented after construction is complete, as discussed in ER-OLS Section 3.1.

3. Dike

References: FES Section 4.1 and ER-CPS Section 4.4

Commitment Requirement/Action Taken:

A dike shall be constructed to prevent shoreline erosion and advancing wave runup. Details of the revetment-ditch (dike) system are presented in FSAR Section 2.4.2.

4. Planting Along Transmission Line Corridor

References: FES Section 4.1, 4.12

Commitment Requirement/Action Taken:

Baseline environmental studies conducted along the Unit 2-Volney 345-kV transmission line corridor are described in ER-OLS Sections 2.4.1.2, 2.4.2.2, and 6.5.1 and in NMPC's Article VII Application to the New York State Public Service Commission. Measures that NMPC proposes to employ to avoid or minimize adverse environmental effects during transmission line operation and maintenance are

identified in ER-OLS Sections 3.7, 5.1.2, 5.6.1, and the Article VII application.

5. Equipment Cleaning

References: FES Section 4.2 and ER-CPS Section 3.8

Commitment Requirement/Action Taken:

Chemicals used for cleaning equipment will be handled in accordance with the SPDES permit requirements.

6. Aquatic Monitoring and Impact Assessment Programs

References: FES Sections 5.5.2 and 6.1 and ER-CPS Sections 5.1.1, 5.5.6.1, 5.5.6.2, and the Construction Permit.

Commitment Requirement/Action Taken:

Aquatic Monitoring Program

Preoperational aquatic monitoring programs were conducted for Unit 2 to determine the taxonomic composition of the biota and to characterize the temporal/spatial abundance and distribution of major groups and selected species in the Nine Mile Point vicinity of Lake Ontario. The biotic groups studied include phytoplankton, microzooplankton, macrozooplankton, icthyoplankton, benthic invertebrates, periphyton, and nekton (fish). The methodologies employed during these monitoring programs and the results of the studies are presented in ER-OLS Sections 6.5.2.1 and 2.4.2.1, respectively.

Entrainment Effects

Fish eggs and larvae were collected offshore of the site and at the intake and discharge of Unit 1. In 1972, a program was conducted to measure fish collected on trash racks and traveling screens. The studies are discussed in ER-OLS Sections 5.3.1.2 and 6.5.2.1.

Impingement Survey

Monitoring was performed to determine the number, species, and size of fish impinged at Unit 1 and the James A. FitzPatrick plant. The results of this study and its relevance to the Unit 2 intake design and field sampling

program are discussed in ER-OLS Sections 2.4.2.1, 3.4, 5.3.1.2, and 6.5.2.1.

Screenwell Fish Removal and Diversion System

The screenwell for Unit 2 allows for the installation of fish removal equipment which will remove fish from in front of the traveling screens. The screenwell also contains a fish diversion system, returning the fish to the lake. The fish diversion system is described in ER-OLS Section 5.3.1.2.

7. Thermal Monitoring Program

References: FES Section 6.2 and ER-CPS Sections 5.5.6.4 and 5.5.6.5.

Commitment Requirement/Action Taken:

Field investigations of the thermal plumes from Unit 1 and the James A. FitzPatrick plant were conducted in order to correlate the data obtained from the aquatic environment program. The field investigations, which were carried out during different seasons using a variety of measuring techniques, are reported in ER-OLS Sections 2.3.1 and 6.1.1.

Field investigations of temperature and current patterns were also performed at the location of the Unit 1 intake and discharge. These investigations were conducted to verify modeling predictions and are reported in ER-OLS Sections 2.3.1, 6.1.1, 6.3.1, and 6.3.2.

A comprehensive preoperational water quality monitoring program was conducted in the Nine Mile Point vicinity. The methodologies associated with the monitoring program and the results of the studies are reported in ER-OLS Sections 6.6.2 and 2.3.3, respectively.

8. Radiological Monitoring Program

References: FES Section 6.3, ER-CPS Section 5.5.6.7, and the Construction Permit.

Commitment Requirement/Action Taken:

The preoperational radiological monitoring program will be supplemented to be usable for operational monitoring. Details are provided in ER-OLS Section 6.2.

9. Liquid Discharges Containing Oil

References: ER-CPS Section 3.7.1

Commitment Requirement/Action Taken:

Unit 2 operational discharges which may potentially contain oil, such as those from the main and reserve station transformer area and the diesel generator building drains, will be routed to an oil/water separator prior to discharge. See ER-OLS Section 3.6.3 for additional details.

10. Permit to Operate Standby Diesel Generators

References: ER-CPS Section 3.8

Commitment Requirement/Action Taken:

The New York State Department of Environmental Conservation (NYSDEC), by letter dated January 7, 1982, notified NMPC that the standby diesel generators (emergency diesels) are exempt from the permitting process.

11. Disposal of Miscellaneous Solid Waste

References: ER-CPS Section 5.4.7

Commitment Requirement/Action Taken:

Solid waste generated onsite, such as lunchroom waste, office wastepaper, machine shop scraps, and trash collected on the cooling water inlet trash racks, will be hauled offsite for disposal at an approved landfill site.

12. Meteorology Data

References: ER-CPS Section 5.5.6

Commitment Requirement/Action Taken:

Meteorological data have been routinely collected at the Nine Mile Point site since 1974. The meteorological monitoring program is described in ER-OLS Section 6.4. Meteorological data for the periods January 1974 through December 1976 and November 1978 through October 1980 were used to assess operational impacts related to Unit 2. These

data are presented in ER-OLS Section 2.7 and FSAR Section 2.3.

13. Water Quality of Discharge During Operation

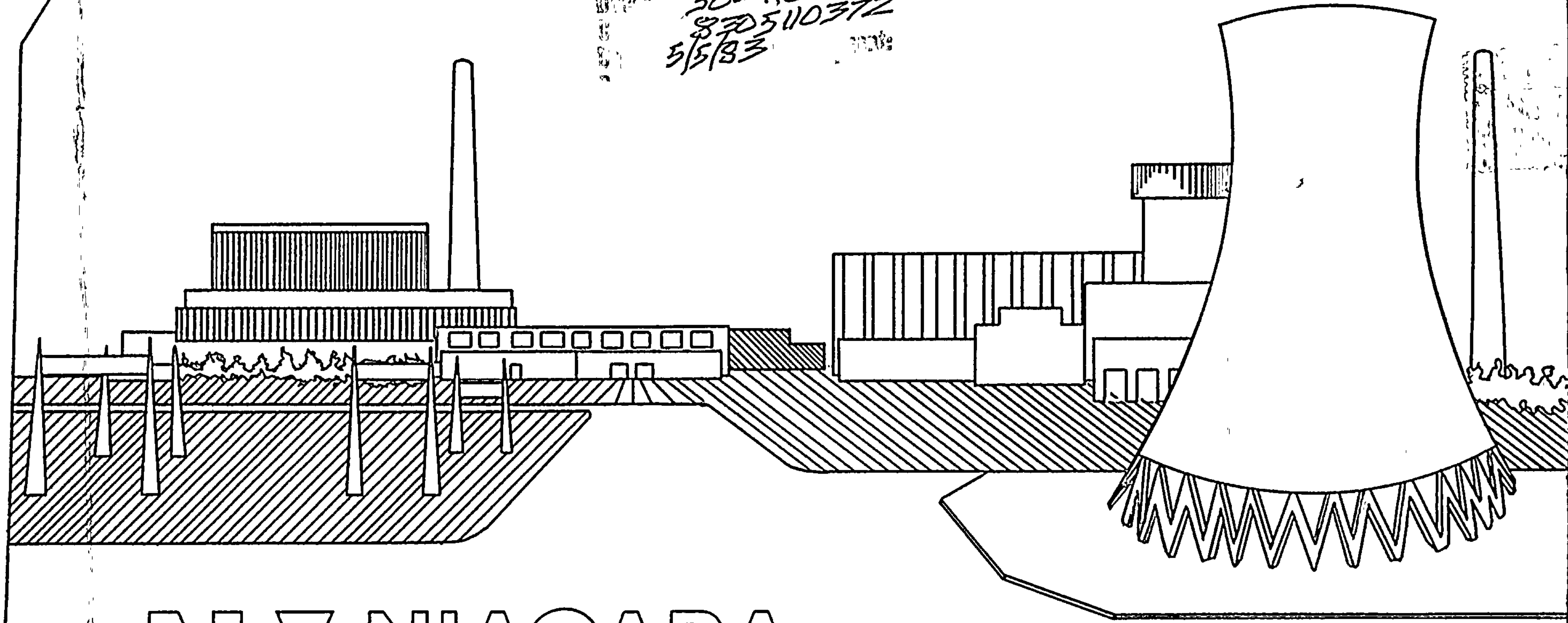
References: Construction Permit

Commitment Requirement/Action Taken:

NMPC will comply with the water quality standards, effluent limitations, monitoring and reporting requirements pursuant to the requirements of the NYSDEC 401 Water Quality Certification and SPDES permit issued for Unit 2. Copies of these documents are included in ER-OLS Chapter 1. A further discussion of compliance with water quality standards and effluent limitations is presented in ER-OLS Section 5.5.2.1.

ER-OLS QUESTIONS AND RESPONSES

NINE MILE POINT NUCLEAR STATION — UNIT 2



NIAGARA MOHAWK

QUESTIONS AND RESPONSES

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LIST OF NRC QUESTIONS

QUESTION E240.1 (3.3)

Update the water use data (including temperature in Table 3.3-1) to include historical meteorologic and hydrologic data recorded up to calendar year 1982 (or for as recently as available data will permit).

RESPONSE

Table 3.3-1 has been revised to incorporate updated meteorological and hydrological data. Lake temperature data recorded at Unit 1 over the last 5 years (1978-1982) are included. The best available period of record for relative humidity data (1972-1976) is also included.

Table parameters E through O (service water intake flow, fish system flow, tempering flow, cooling tower evaporation, total lake intake, service water discharge flow and ΔT, blowdown flow and ΔT, combined plant flow and ΔT) were calculated based on the input values of wet-bulb temperature, relative humidity, lake temperature, and lake level. These parameters are also influenced by the maintenance of a minimum cooling tower basin temperature of 44°F during winter operation. 6

In order to determine the extreme maximum and minimum values of temperature differential and flow rate, the following combinations of parameters were used in the calculation. Maximum temperature differentials (i.e., combined plant and cooling tower blowdown) were calculated using the maximum wet-bulb temperature in conjunction with the minimum lake water temperature. This combination results in minimum combined plant discharge flows. Minimum temperature differentials were calculated using the minimum wet-bulb temperature in conjunction with the maximum lake water temperature. This combination yields maximum combined plant discharge flows.

QUESTION E240.2 (2.3.1)

a. Provide more detailed estimates of current velocities (including direction) and their frequency of occurrence. These may be based on wind frequency and direction data and an appropriate mathematical model. Correlations with observed measurements should be discussed.

b. Discuss sediment movement in the vicinity of the intake and discharge structures. Specifically address the possibility of the intake being affected by sediment deposition. Also, address the potential role of sediment movement in transporting radionuclides.

RESPONSE

a. The response to this question is found in revised ER-OLS Section 2.3.1.1.2

b. A discussion of the minimal effect of sedimentation in the vicinity of the intake and discharge structures can be found in FSAR Section 9.2.5.3.1. Other references to design criteria and procedures aimed at minimizing the effect of sedimentation on the safe operation of the plant are as follows:

   1. ER-OLS Section 3.4.2.1 and FSAR Section 9.2.5.2.1 - A sediment trap in the intake screenwell provides a means of removing sedimentation entering the intake structure.

   2. FSAR Section 9.2.1 - An in-line filter is provided in the service water system to further remove suspended solids. An alarm is installed to indicate a high differential pressure across the filter.

The exposure to radionuclides in the sediment is presented in Section 5.4. The maximum calculated sediment exposure pathway dose contributes less than 0.1% of the total body and/or organ doses to man via all liquid pathways. Therefore the role of sediment movement and radionuclide transport is not considered to represent a significant exposure source.

QUESTION E240.3 (3.4)

Discuss the effect of ice on the intake structure and the likelihood of the plant being shutdown in winter months due to ice damage to or ice blockage of the intake structure.

RESPONSE

Discussions of how the plant design minimizes the probability of ice formation on and in the vicinity of the intake structures are provided in FSAR Sections 2.4.7 and 9.2.5.3.1.

QUESTION E240.4 (7.1)

Calculate the radiological consequences of a liquid pathway release from a postulated core melt accident. The analysis should assume, unless otherwise justified, that there has been a penetration of the reactor basement by the molten core mass, and that a substantial portion of radioactively contaminated suppression pool water was released to the ground. Doses should be compared to those calculated in the Liquid Pathway Generic Study (NUREG-0440, 1978). Provide a summary of your analysis procedures and the values of parameters used (such as permeabilities, gradients, populations affected, water use). It is suggested that meetings with the staff of the Hydrologic Engineering Section be arranged so that we may share with you the body of information necessary to perform this analysis.

RESPONSE

See revised Section 7.1.3 and Appendix 7D. 7

QUESTION E240.5 (5.6)

Descriptions of floodplains, as required by Executive Order 11988, Floodplain Management, have not been provided. The definition used in the Executive Order is:

Floodplain: The lowland and relatively flat areas adjoining inland and coastal waters including floodprone areas of offshore islands, including minimum that area subject to a one percent or greater changes of flooding in any given year.

a) Provide descriptions of the floodplain adjoining Lake Ontario adjacent to the site and plant facilities. On a suitable scale map(s) provide delineations of those areas that will be flooded during the one percent (100 year) flood both before and after plant construction.

b) Provide details of the methods used to determine the floodplain in response to a) above. Include your assumptions of and basis for the pertinent parameters used in the computation of the water elevations. If studies approved by the Federal Insurance Administration (FIA) are available for the site and other affected areas, the details of the analysis used in the reports need not be supplied. You can, instead, provide the reports from which you obtained the floodplain information.

c) Identify, locate on a map and describe all plant structures and topographic alterations in the floodplains. Indicate the start and completion dates of all such items.

RESPONSE

The response can be found in revised ER-OLS Section 2.3.1.1.7. Six copies of FIA report, "Flood Insurance Study for Scriba, New York," have been provided under separate correspondence to the NRC on August 25, 1983. 3

QUESTION E240.6 (5.6)

a) Discuss the hydrologic effects of all items identified in response to question E240.6C. Discuss the potential for changes in littoral sediment transport due to plant construction.

b) Provide the details of your analysis used in response to a above. The level of detail is similar to that identified in item 240.5b.

RESPONSE

a. As indicated in the response to E240.5c the only plant structures located in the floodplain are the intake/discharge structures and the revetment ditch system. A discussion of the hydrological alterations to Lake Ontario related to these structures can be found in ER-OLS Sections 5.2 and 5.3. Any change to littoral sediment transport is expected to be minor or nonexistent, as discussed in ER-OLS Section 5.2.1.1.

b. Because of the minor hydrologic effects on Lake Ontario expected from plant construction, no detailed mathematical or physical modeling was performed.

QUESTION E290.2

The mapped land use categories in Figure 2.2-2 do not always correspond with the land use categories in Figure 2.2-1. For example, in Figure 2.2-1 there is a large area east of the site classified as agriculture and it is classified as forest in Figure 2.2-2. Other discrepancies occur and should be checked with corrections made.

RESPONSE

See revised ER-OLS Figures 2.2-1 and 2.2-2.

QUESTION E290.3

The mapped land use categories in Figure 2.2-5 do not appear correct. The whole site is classified as "forest/wetland" and the two residential areas described in question E290.1 are classified as commercial/industrial. These discrepancies should be checked and appropriate corrections made.

RESPONSE

Figures 2.2-5 and 2.2-6 were prepared by the Oswego County Planning Board using 1977 data and a categorization criteria different from that used in the ER-OLS description of existing land use. These two figures have been deleted.

QUESTION E290.4

The same comments made in Question E290.2 apply to Figure 2.2-6.

RESPONSE

See the response to Question E290.3.

QUESTION E290.5

A few minor discrepancies occur between Figures 2.2-2 and 2.2-8. For example, a small area in the backward "L" residential area is classified as public facilities in Figure 2.2-8 and as agricultural land in Figure 2.2-2. These discrepancies should be checked and corrections made.

RESPONSE

See revised ER-OLS Figures 2.2-2 and 2.2-8.

QUESTION E291.1 (2.3.2.3)

a) Provide annual commercial fishery harvest estimates for the years 1976 through 1980 for that portion of Lake Ontario within the 80-km radius.

b) Provide estimates of the sport fish harvest by weight and species, similar to the estimates of number of fish presented in Tables 2.3-8, -9, -10. Also provide estimated sport fish harvest by weight for that portion of Lake Ontario within the 80 km radius.

RESPONSE

a) Commercial fishery harvest estimates are not available for only that portion of Lake Ontario within an 80-km radius of Unit 2. No further breakdown of data is available for U.S. waters; however, the U.S. figures in Table 2.3-7 are considered a reasonable estimate of the 80-km radius harvest since most of the U.S. commercial fish harvest is caught in the eastern basin of Lake Ontario (more than half of the catch comes from Chaumont Bay). Major ports of landing are Chaumont and Oswego, both of which are within the 80-km region. While data 3
specific only to the 80 km region is not available for Canadian waters, catch estimates provided in the ER-OLS for an area approximately 80-km have been revised to include only statistical districts (of Lake Ontario and the St. Lawrence River) 3, 4, 5, and 6. Each of these districts is partially within the 80-km region. Commercial fish harvest in kilograms for these combined districts from 1976 through 1981 is listed in Table 2.3-16.

b) Sport fish harvest estimates are not available for areas smaller than those already provided in the ER-OLS; however, Tables 2.3-9 and 2.3-10 have been revised to include estimates of catch weight in kilograms (weight was estimated using average weight per species). No estimates of catch weight can be calculated for New York Anglers' harvest since fish catch numbers are not indicated for each species. The variation in weight of species included in each catch group is too broad to estimate average weight.

QUESTION E291.3

The ER section on ichthyoplankton (2.4.2.1.4), benthic organisms (2.4.2.1.5), and fish (2.4.2.1.6) cite reference numbers 39, 41, and 47 that refer to citations on phytoplankton and crustaceans zooplankton. Please clarify.

RESPONSE

The response to this question is found in revised ER-OLS Section 2.4.2.1.1.

QUESTION E291.4

Provide a copy of reference number 51 by Storr (1977) "Lake Ontario Fish Tag Report Summary 1972-1976" that formed the basis for discussions in the ER on fish movements.

RESPONSE

A copy of ER-OLS Reference Number 51 by Storr was submitted to the NRC on April 19, 1983 (correspondence from G. K. Rhode to D. G. Eisenhut).

QUESTION E291.5 (2.4.2.1.6)

The discussion of endangered species on ER page 2.4-34 cites the Fish and Wildlife Service 1978 list.

a. Provide a current update of threatened or endangered aquatic species in the site vicinity.

b. Provide a listing of any aquatic species listed as threatened or endangered by the State of New York that have been collected or that are believed to be present in the site vicinity.

RESPONSE

See revised ER-OLS Section 2.4.2.1.6.

QUESTION E291.6

(a) Provide a bibliographic listing and reprint copies of all journal and professional conference proceedings publications (by applicant and applicant's consultants) that have resulted from aquatic studies and monitoring of the NMP-JAF site area.

(b) Provide a bibliographic listing of all technical papers that have been prepared by state and federal agencies and private organizations on the aquatic resources associated with the NMP-JAF site area.

RESPONSE

(a) A bibliographic listing and six copies of journal and professional conference proceedings publications (by Niagara Mowhawk and its consultants) resulting from aquatic studies and monitoring of the NMP-JAF site area were submitted to the Commission by separate correspondence dated June 3, 1983.

(b) A bibliographic listing of technical papers related to the aquatic resources of the NMP-JAF site area prepared by state and federal agencies and private organizations was obtained by a computer search of the following data bases:

1. Dissertation Abstracts International (File 35)

2. BIOSIS

3. LC MARC (File 426)

4. Conference Papers Index

5. NTIS

Based on a computer search of these data bases, the following 144 citations were identified:

Growth Dynamics of White Perch, Roccus Americanus, During Colonization of Bay of Quinte, Lake Ontario. Sheri, Ahmad Nadeem, University of Waterloo (Canada), 1969.

The Chlorophyll A Content of the Surface Waters of Lake Ontario, June to November, 1967, Nicholson, H. F., Fisheries Research Board of Canada, 1970.

Annotated Bibliography of Lake Ontario Limnological and Related Studies Prepared for Office of Research and Monitoring, U.S. Environmental Protection Agency. Washington Office of Research and Monitoring, U.S. Environmental Protection Agency, 1973.

Report to the International Joint Commission on the Pollution of Lake Erie, Lake Ontario, and the International Section of the St. Lawrence River. International Lake Erie Water Pollution Board and the International Lake Ontario-St. Lawrence River Water Pollution Board, 1969.

Response of Lake Ontario North America Plankton Entering the International Section of the St. Lawrence River, USA. Mills, E. L.; Forney, J.L. Cornell University Biol. Field Station, Bridgeport, NY, 1982.

Phosphorus Nutrition of 2 Potentially Competing Filamentous Algae Chadophora-glomerata and Stigeolclonium-tenue from Lake Ontario, North America. Rosemarin, A.S. Departmental Fish. Oceans, Ottawa, Ontario, Canada, 1982.

Photo Chromism of 26 Di-Nitrodiphenyl Ethers enhanced in the Presence of a Host Bio Molecule. Cahnmamm, H.J.; Matsuura, T. Dept. Synthetic Chem., Fac. Eng., Kyoto Univ., Kyoto, Japan, 1982.

Changes in Lake Ontario USA Canada total phosphorus concentrations 1976-1978. Fraser, A.S. National Water Research Institute, Canada Cent., Inland Waters, Ontario, Canada, 1980.

The Warm Water Sport Fishery of Eastern Lake Ontario, New York, USA. Panek, F.M. New York State Dept. of Environmental Conservation, Building 40, SUNY, Stony Brook, NY, 1981.

Food of White Perch Morone-americana Rock Bass Ambloplites-Rupestris and Yellow Perch Perca-Flavescens in Eastern Lake Ontario, New York, USA. Elrod, J.H.; Busch, W.-D.N.; Griswold, B. L.; Schneider, C.P.; Wolfert, D.R. U.S. Fish and Wildlife Service, Great Lakes Fishery Laboratory, Ann Arbor, MI. 1981

Comparative Food Selection by Coexisting Subyearling Coho Salmon Oncorhynchus-Kisutch Chinook Salmon Oncorhynchus-Tshawytscha and Rainbow Trout Salmo-Gairdneri in a Tributary of Lake Ontario, USA. Johnson, J. H. New York State Dept. of Environmental Conservation, Albany, NY, 1981.

Food Habits and Dietary Overlap of Perlid Stone-flies Plecoptera in a Tributary of Lake Ontario, NY, USA. Johnson, J. H. Nez Perce Tribe of Idaho, Lapwai, Idaho, 1981.

Reproduction Distribution and Population Size of Largemouth Bass Micropterus-Salmoides in an Oligotrophic Precambrian Shield, Lake Maraldo, D C. Maccrimmon, H. R. Algoma Fish Assessment Unit, Ont. Minist. Mat. Resources, Sault Ste. Marie, Ontario, Canada, 1981.

The Biology and Parasites of Deep Water Sculpin Myoxocephalus-quadricornis-thompsonii in Burchell, Lake Ontario, Canada. Black, G.A.; Lankester, M. W., Dep. Zool., Univ. of Guelph, Ontario, Canada, 1981.

Chlorophyll A Measurements from Lake Ontario Canada and USA, 1974-1979. Kwiatkowski, R.E. Great Lakes Biolimnol. Lab., Canadian Center of Inland Waters, Burlington, Ontario, 1980.

Physical Variability and Phyto Plankton Communities 4. Temporal Changes in the Phyto Plankton Community of a Physically Variable Lake. Harris, G.P.; Piccinin, B.B. Dept. Biol., McMaster Univ., Hamilton, Ontario, Canada, 1980.

Predation on the Eggs of Steelhead Trout Salmo-gairdneri by Stream Salmonids in a New York USA tributary of Lake Ontario. Johnson, J. New York State Dept. of Environmental Conservation, Albany, NY, 1981.

Environmental Changes in a Portion of Lake Ontario Following Pollution Abatement. Judd, J. H.; Boosor, J.G.; Sladecek, V. International Association of Theoretical and Applied Limnology, Winnipeg, Manitoba, Canada, 1974.

Phosphorus Recycle and Chlorophyll in the Great Lakes, USA and Canada. Di Toro, D. M.; Matystik, W.F., Jr. Manhattan College, Bronx, NY, 1979.

Diets of Juvenile Coho Salmon Oncorhynchus-kisutch and Steelhead Trout Salmo-gairdneri Relative to Prey Availability. Johnson,J.H.; Ringler, N. H. New York State Dept. of Environmental Conservation, Albany, NY, 1980.

Availability to Scenedesmus-quadricauda of Different Forms of Phosphorus in Sedimentary Materials from the Great Lakes, USA and Canada. Williams, J. D. H.; Shear, H.; Thomas, R. L., Process Res. Div., Natl. Water Res. Inst., Can. Cent. Inland Waters, Burlington, Ontario, Canada, 1980.

Annotated List of the Fishes of Lake Ontario, Canada USA Watershed. Crossman, E. J.; Van Meter, H.D. Dept. Ichthyol. Herpetol., R. Ont. Mus., Toronto, Ontario, Canada, 1979.

Distribution of Bacteria and Chlorophyll A at a Nearshore Station in Lake Ontario, Canada, Rao, S. S.; Kwiatkowski, R. E.; Jurkovic, A. A. Microbiol. Lab., Appl. Res. Div. Can. Cent. Inland Waters, Burlington, Ontario, Canada, 1979.

Age and Growth of Rock Bass Ambloplites-rupestris in Eastern Lake Ontario, USA. Wolfert, D. R. US Fish. Wildlife Serv., Ann Arbor, MI, 1980.

Predation on Pacific Salmon Eggs by Salmonids in a Tributary of Lake Ontario, USA Canada. Johnson, J. H.; Ringler, N.H. NY State Dept. Environ. Conserv., Albany, NY, 1979.

Diversity as a Measure of Alewife Alosa-pseudoharengus Dominance of Southeastern Lake Ontario, USA. Weinstein, M.P.; Logan, D. T. Dept. Biol., Virginia Commonwealth Univ., Richmond, VA, 1979.

Crustacean Zoo Plankton of Southwestern Lake Ontario, USA, in Spring 1973, and at the Niagara River and Genesee River Mouth Areas in 1972 and Spring 1973. Czaika, S. C. Great Lakes Lab., State Univ. College. Buffalo, NY, 1978.

Ongoing Chlorophyll A Surveillance Plan on Lake Ontario USA Canada for Nonintensive Sampling Years. Kwiatkowski, R. E. Can. Cent. Inland Waters, Ontario, Canada, 1978.

Walleye Stocks in the Great Lakes 1800-1975, Fluctuations and Possible Causes. Schneider, J. C.; Leach, J.H. Mich. Dept. Nat. Res. Inst. Fish. Res., Ann Arbor, Mich. 48109, USA, 1979.

Age, Growth and Food of Northern Pike in Eastern Lake Ontario, Canada USA. Wolfert, D. R.; Miller, T. J. Sandusky Biol. Stn., U.S. Fish Wildlife Serv., Sandusky, OH, USA, 1978.

Hydrology of Lake Ontario. Witherspoon, D. F. Sladecek, V. International Association of Theoretical and Applied Limnology, Copenhagen, Denmark, 1977.

Algal Nutrient Limitation in Lake Ontario and Tributary Waters, Canada USA. Sridharan, N.; Lee, G. F. University of Wisconsin, Madison, WI, 1977.

Carbon Budgets in Lake Ontario. Charlton, M. N. Fish Res. Board, Canada, 1977.

Distribution of MacroBenthic Species in Lake Ontario in Relation to Sources of Pollution and sediment parameters. Nalepha, T. F.; Thomas, N. A., 1976.

Analysis of Cladophora Distribution in Lake Ontario Using Remote Sensing. Wezernak, C. T.; Lyzenga, D. R., 1975.

Phyto Plankton Biomass Species Composition and Primary Production at a Nearshore and a Mid Lake Station of Lake Ontario During International Field Year for the Great Lakes. Munawar, M.; Stadelmann, P.; Munawar, I. F., Proc. Conf. Great Lakes, 1974.

The Abundance of Diatoms in the Southwestern Nearshore Region of Lake Ontario During the Spring Thermal Bar Period. Lorefice, G. J.; Munawar, M. Proc. Conf. Great Lakes, 1974.

Biomass Parameters and Primary Production at a Nearshore and a Mid Lake Station of Lake Ontario During International Field Year for the Great Lakes. Stadelman, P.; Munawar, M. Conf. Great Lakes, 1974.

Phosphorus and Nitrogen Cycle on a Transect in Lake Ontario During the International Field Year 1972-1973, Proc. Conf. Great Lakes, 1974.

Blue-Spotted Sunfish Enneacanthus-Gloriosus New-Record in the Lake Ontario Drainage, New York, USA. Werner, R. G., 1972.

Primary Production in Relation to Temperature Structure Biomass Concentration and Light Conditions at an Inshore and Offshore Station in Lake Ontario. Stadelmann, P.; Moore, J.E.; Pickett, E. Fish Res. Board, Canada, 1974.

Response of Perch and Their Forage to Thermal Discharges in Lake Ontario. Storr, J. F.; Schlenker, G.; Gibbons, Witfield, J.; Sharitz, R. R. United States Atomic Energy Commission, Technical Information Center: Oak Ridge, TN, U.S. Department of Commerce, Springfield, VA, 1974.

Plankton Entrainment by the Condenser Systems of Nuclear Power Stations on Lake Ontario. Storr, J. F. Gibbons, Witfield, J.; Sharitz, R. R. United States Atomic Energy Commission, Technical Information Center, Oak Ridge, TN, 1974.

A Summary and Comparison of Nutrients and Related Water Quality in Lake Erie, Lake Ontario, Lake Huron, and Lake Superior. Dobson, H. F. H.; Gilbertson, M.; Sly, P. G. Fish Res. Board, Canada, 1974.

A Digital Echo Counting System Used in Determining Abundance of Fresh Water Pelagic Fish in Relation to Depth. Kelso, J. R. M.; Pickett, E. E.; Dowd, R.G.J. Fish Res. Board, Canada, 1974.

Diel and Annual Cycles of Net Plankton Photosyntheses in Lake Ontario. Harris, G. P. Fish Res. Board, Canada, 1973.

Power Plant Thermal Effluents in Southeastern Lake Ontario. Chermack, E. E.; Galletta, T. A. Proc. Conf. Great Lakes, 1973.

Changes in Zoo Plankton Populations in Lake Ontario, 1939-1972. McNaught, D. C.; Buzzard, M. Proc. Conf. Great Lakes, 1973.

A Review of the Changes in the Fish Species Composition of Lake Ontario. Christie, W. J. Great Lakes Fish Comm., 1973.

The Commercial Fishery for American Eel Anguilla-rostrata in Lake Ontario. Hurley, D. A. Trans Am Fish Soc 102 (2), 1973.

The Effects of Thermal Effluents upon Secondary Production. McNaught, D. C.; Fenlon, M. W. E. New York, NY, 1972.

Regional Characterizations of the Thermal Properties of Lake Ontario. Lee, A. H. Proc. Conf. Great Lakes, 1972.

The Macro Benthos of Lake Ontario. Kinney, W. L. Proc. Conf. Great Lakes, 1972.

Summer Circulation Patterns Near Nine Mile Point, Lake Ontario. Landsberg, D. R.; Scott, J. T.; Fenlon, M. Proc. Conf. Great Lakes, 1980.

Current and Temperature Surveys in Lake Ontario for James A FitzPatrick Nuclear Power Plant. Gunwaldsen, R. W.; Brodfeld, B.; Hecker, G. E. Proc. Conf. Great Lakes, 1970.

Study of Thermal Effluents in Southeastern Lake Ontario as Monitored by P TN/ONG N Herometer. Chermack, E. E. Proc. Conf. Great Lakes, 1970.

Nutrients in Lake Ontario. Shiomi, M. T.; Chawla, V. K., Proc. Conf. Great Lakes, 1970.

Distribution of Trace Elements and Chlorophyll A in Lake Ontario. Chau, Y. K.; Chawla, V. K.; Nicholson, H. F.; Vollenweider, R. A. Proc. Conf. Great Lakes, 1970.

Winter Circulation in Lake Ontario. Paskausky, D. F. Proc. Conf. Great Lakes, 1971.

An Investigation of Horizontal Diffusion in Lake Ontario. Hamblin, P. F. Proc. Conf. Great Lakes, 1971.

The Compostion and Horizontal Distribution of Phyto Plankton in Lake Ontario During the Year 1970. Munawar, M.; Nauwerck, A. Proc. Conf. Great Lakes, 1971.

Preliminary Bacteriological Investigation of the Lake Ontario Thermal Bar Menon, A. S.; Dutka, B. J.; Jurkovic, A. A. Proc. Conf. Great Lakes, 1971.

Influences of Thermal Effluents upon Aquatic Production in Lake Ontario. Fenlon, M. W.; McNaught, D. C.; Schroder, G. D. Proc. Conf. Great Lakes, 1971.

Planktonic Diatoms of Lake Ontario USA Asterionella-formosa Fragilaria-crotonensis Tabellaris-fenestrata Stephanodiscus-spp. Reinwand, J. F. Great Lakes Fish Comm, 1969.

Lake Ontario USA Phyto Plankton September 1964. Ogawa, R. E. Great Lakes Fish Comm, 1969.

Fishery Survey of USA Waters of Lake Ontario Commercial Fish Species. Wells, L. Great Lakes Fish Comm, 1969.

Chemical Characteristics of Lake Ontario USA Canada. Allen, H. E. Great Lakes Fish Comm, 1969.

Optical Parameters and Their Relation to Chemical and Biological Processes in Lake Ontario. Thompson, K. P. Canada Center for Inland Waters, Burlington, Canada.

Seasonal Species Composition, Vertical Distribution and Diurnal Migration of Lake Ontario Crustacean Zooplankton. Wilson, J.B. University of Guelph, Ontario, 16th Conference on Great Lakes, Research/Internationl Association for Great Lakes Research Annual Meeting, Huron, Ohio, 1973.

Changes in Zooplankton Community Structure in Lake Ontario (1939-1972). McNaught, D. C. SUNY, Albany, NY, 16th

Conference on Great Lakes Research/international Association for Great Lakes Research Annual Meeting, Huron, Ohio, 1973.

Primary Production Measurement Using C14 Technique In Situ at an Inshore and Offshore Station in Lake Ontario 1972-73. Stadelmann, P. O. Canada Center for Inland Waters, Burlington, Canada, 16th Conference on Great Lakes Research/international Association for Great Lakes Research Annual Meeting, Huron, Ohio, 1973.

Summer and Fall Feeding Preference on Selected Fishes from Lake Ontario. Williams, R. W. QLM Lab, Nyack, N.Y. 16th Conference on Great Lakes Research/international Association for Great Lakes Research Annual Meeting, Huron, Ohio, 1973.

Fish Impingment Studies in Power Plants on Southeast Shore of Lake Ontario. Wilenitz, I. O. Ouirk, Lawler and Matusky Engineers, Tappan, N.Y., 16th Conference on Great Lakes Research/international Association for Great Lakes Research Annual Meeting, Huron, Ohio, 1983.

Power Plant Thermal Effluents in Lake Ontario. Chermack, E. E. Lake Ont Envir. Lab, State University, Oswego, N.Y. 16th Conference on Great Lakes Research/international Association for Great Lakes Research Annual Meeting Huron, Ohio, 1973.

Physio-chemical Relationships in a Coastal Region of Lake Ontario. Palmer, M. D. Ministry of the Environment, Toronto, Canada, International Seminar on Water Resources Instrumentation, Chicago, Ill, 1974.

Phytoplankton Population Dynamics in Lake Ontario During IFYGL. Stoermer, E. F. Great Lakes Res. Div., University of Michigan, Ann Arbor, MI, 38th Annual Meeting of the American Society of Limnology and Oceanography, Halifax, Nova Scotia, 1975.

Comparison of 14C Phytoplankton Productivity from Intake and Discharge Forebays of Nine Mile Point Nuclear Station, Lake Ontario. Fraser, J. E. QLM Lab, Oswego, N.Y., 38th Annual Meeting of the American Society of Limnology and Oceanography, Halifax, Nova Scotia, 1975.

Temporal and Spatial Variability of Chlorophyll A and Related Edaphic Parameters in Lake Ontario, 1974. El-Shaarawi, A. International Association for Great Lakes, 19th Conference on Great Lakes Research, Guelph, Canada, 1976.

Study of Effects of Atmospheric Stability and Over-water Fetch on Wind Speeds over Lake Ontario During IFYGL. Almazan, J. A. International Association for Great Lakes, 19th Conference on Great Lakes Research, Guelph, Canada, 1976.

Comparison of Fish Eggs and Larvae Distribution at One Existing and One Proposed Nuclear Power Plant Site on Southern Nearshore of Lake Ontario. Johnson, J. H. International Association for Great Lakes, 19th Conference on Great Lakes Research, Guelph, Canada, 1976.

Importance of Macroinvertebrate Benthos in Lake Ontario Cladophora Mats. Vetterle, P. International Association for Great Lakes, 19th Conference on Great Lakes Research, Guelph, Canada, 1976.

Sampling Lake Ontario Benthos with an Epibenthic Sled. Mozley, S. C. International Association for Great Lakes, 19th Conference on Great Lakes Research, Guelph, Canada, 1976.

Comparison of Benthic Macrofauna of Lake Ontario and Chaumont Bay, N.Y. Judd, J. H. International Association for Great Lakes, 19th Conference on Great Lakes Research, Guelph, Canada, 1976.

Two-yr Comparison of Phytoplankton During Spring Thermal Bar Conditions of Lake Ontario. Whiteaker, J. International Association for Great Lakes, 19th Conference on Great Lakes Research, Guelph, Canada, 1976.

Variations in Phytoplankton Abundance and Composition of Nearshore Southeastern Lake Ontario with Special Reference to Phytoflagellates. Brown, P. L. International Association for Great Lakes, 19th Conference on Great Lakes Research, Guelph, Canada, 1976.

Establishment of Phytoplankton Species Composition Baseline for Continuing Surveillance of Water Quality Conditions of Lake Ontario. Munavar, M. International Association of Theoretical and Applied Limnology (SIL) Congress, Copenhagen, Denmark, 1977.

Status of Fisheries on Lake Ontario During International Field Year for Great Lakes. Christie, W. J. International Association of Theoretical and Applied Limnology (SIL) Congress, Copenhagen, Denmark, 1977.

Time-lapse Camera Records of Nearshore Bottom Disturbance in Lake Ontario. Rukavina, N. A. Canada Center for Inland Waters, Burlington, Ontario. 21st Conference on Great Lakes Research Program, Windsor, Canada, 1978.

An Eleven-Year Record of Phytoplankton at Lake Ontario's Outflow. Nicholls, K. H. Ontario Ministry of Environment, Rexdale, Ontario. 21st Conference on Great Lakes Research Program, Windsor, Canada, 1978.

Occurrence of Red Alga, Bangia Atropurpurea, in Lake Ontario. Damman, K. E. SUNY Brockport, Brockport, N.Y. 21st Conference on Great Lakes Research Program, Windsor, Canada, 1978.

Spatial and Temporal Distributions of Fish Larvae in Southeast Sector of Lake Ontario, 1973-1977. Humphries, E. M. Carthage, N.Y. 21st Conference on Great Lakes Research Program, Windsor, Canada, 1978.

Effects of Five Steam Electric Generating Stations on Aquatic Biota on Southeastern Shore of Lake Ontario. Wyman, R. L; Lawler, Matusky & Skelly Engineering, Pearl River, N.Y. 21st Conference on Great Lakes Research Program, Windsor, Canada, 1978.

Thermal Bar Studies of Lake Ontario Employing Heat Capacity Mapping Mission (HCMM) Satellite Data. Schott, J. R. 24th Conference on Great Lakes Research and Annual Meeting of the International Association for Great Lakes Research, Columbus, OH, 1981.

Sedimentation Rates for an Inshore and an Offshore Station in Lake Ontario. Rosa, F.; Burns, N. M. 25th Anniversary Conference on Great Lakes Research And Annual Meeting Of The International Association for Great Lakes Research, Sault Ste. Marie, Ontario, 1982.

The Nepheloid Layer In Lake Ontario. Sandilands, R. G.; Mudroch, A. 25th Anniversary Conference on Great Lakes Research And Annual Meeting Of The International Association for Great Lakes Research, Sault Ste. Marie, Ontario, 1982.

Sediment Quality of the Lower Niagara River and Selected Lake Ontario Sampling Sites. Pethybridge, A. H., III, 25th Anniversary Conference on Great Lakes Research and Annual Meeting of the International Association For Great Lakes Research, Sault Ste. Marie, Ontario, 1982.

The Ecology Of Natural Reefs In Lake Ontario, II: Diet Selectivity Growth Of Four Warmwater Fishes. Danehy, R. J.; Anderson, J. W. 25th Anniversary Conference On Great Lakes Research And Annual Meeting Of The International Association For Great Lakes Research, Sault Ste. Marie, Ontario, 1982.

Seasonal Changes in Fish Abundance and Species Composition in the Northern Nearshore Waters of Lake Ontario. Balesio, H. 25th Anniversary Conference on Great Lakes Research and Annual Meeting of the International Association for Great Lakes Research, Sault Ste. Marie, Ontario, 1982.

Protection of Lake Ontario Fish at a Power Plant Intake Using Angled Screen Diversion. Edwards, S. J.; Dembeck, J; Pease, T. E.; Skelly, M. J. 25th Anniversary Conference on Great Lakes Research and Annual Meeting of the International Association for Great Lakes Research, 1982.

Winter Thermal Plume Study Off Pickering Nuclear Generating Station, Lake Ontario (1979-1980), Background of Study. Arden, R. S. 25th Anniversary Conference on Great Lakes Research, Sault Ste. Marie, Ontario, 1982.

Climatology and Structure of Coastal Currents at Pickering Nuclear Generating Station, Lake Ontario. Murth, C. R.; Bull, J. A. 25th Anniversary Conference on Great Lakes Research and Annual Meeting of the International Association for Great Lakes Research, Sault Ste. Marie, Ontario, 1982.

Effect of Cold Weather Thermal Plumes from Pickering Nuclear Generating Station on Lake Ontario Water Temperatures, Farooqui, R. 25th Anniversary Conference on Great Lakes Research and Annual Meeting of the International Association for Great Lakes Research, Sault Ste. Marie, Ontario, 1982.

Distribution and Characteristics of Spawning Round Whitefish in Lake Ontario. Haymes, G. T.; Kolenosky, D. P. 25th Anniversary Conference on Great Lakes Research and Annual Meeting of the International Association for Great Lakes Research, Sault Ste. Marie, Ontario, 1982.

Environmental Changes in a Portion of Lake Ontario Following Pollution Abatement, Judd, J. H. 19th Congress of International Association of Limnology, Winnipeg, Canada, 1974.

Suspended Particulate Material in Big Bay, Bay of Qinte, Lake Ontario, Guppy, S. F. Canada Center for Inland Waters, Burlington, Canada. American Society of Limnology and Oceanography, 39th Annual Meeting. Savannah, Georgia, 1976.

Diurnal Variation in Impingement Rates of Several Species of Lake Ontario Fish. Storr, J. F. SUNY at Buffalo, Amherst, N.Y. Northeast Fish and Wildlife Conference, 1978. White Sulphur Springs, West Virginia, 1978.

Entrainment Impact on Lake Ontario Macrobenthos of a Nuclear Generating Station, Goehle, K. H. SUNY at Buffalo, Amherst, N.Y. Northeast Fish and Wildlife Conference, White Sulphur Springs, West Virginia, 1978.

Changes in the Chironomid Fauna of the Bay of Quinte, Lake Ontario, Over the Last 2000 Years, Warnick, W. Freshwater Institute, Winnipeg, 28th Annual Meeting of Entomological Society of Canada, Ottawa, Canada, 1978.

Analysis of Biological Versus Physical Control of Large Gradients Associated with Lake Ontario's Thermal Bar, Scavia, D.; Bennett, J. R. Great Lakes Environmental Research Lab. (NOAA), Ann Arbor, MI, Twenty-Third Conference on Great Lakes Research, Kingston, Canada, 1980.

Mirex Concentrations in Lake Ontario Bottom Sediments, Martin, F. D.; Scrudato, R. J.; Del Prete, A. SUNY Research Center at Oswego, N.Y. 23rd Conference on Great Lakes Research, Kingston, Canada, 1980.

Temporal Contaminant Dynamics in a Demersal and a Pelagic Food Chain of the Kingston Basin (Lake Ontario) and Their Interactions, Fitzsimons, J. D. Great Lakes Biolimnology Laboratory, Canada, Center for Inland Waters, Burlington, Ontario. 23rd Conference on Great Lakes Research, Kingston, Canada, 1980.

Feeding Periodicity and Diel Changes in Diet Composition of Subyearling Coho Salmon (Oncorhynchus Kisutch) and Steelhead Trout (Salmo Gairdneri) in A Tributary of Lake Ontario. Johnson, J. H.; Johnson, E. Z. N.Y. State Department of Environmental Conservation, Albany, N.Y. 23rd Conference on Great Lakes Research, Kingston, Canada, 1980.

Aspects of Nutrition of Two Potentially Competing Filamentous Green Algae, Cladophora Glomerata and Stigeoclonium Tenue, From Lake Ontario. Rosemarin, A. S. Department of Biology, Queen's University, Kingston, Ontario, Canada. 23rd Conference on Great Lakes Research, Canada, 1980.

Acuarioid Nematodes in Larus Delawarensis from Lake Ontario, Canada. Wong, P. L.; Anderson, R. C. Department of Zoology,

University of Guelph, Ontario, Canada, 5th International Congress of Parasitology, Toronto, Canada, 1982.

Atlas of the Spawning and Nursery Areas of Great Lakes Fishes, Volume XI, Lake Ontario (Final Report). Goodyear, Carole D.; Edsall, T. A.; Dempsey, Diane M. Ormsby; Moss, G. D.; Polanski, P. E. Fish and Wildlife Service, Washington, D.C., 1982.

Atlas of the Spawning and Nursery Areas of Great Lakes Fishes, Volume I, Spawning and Nursery Areas of Great Lake Fishes: A Summary by Geographic Area (Final Report). Goodyear, Carole D.; Edsall, T. A.; Dempsey, D. M. Ormsby; Moss, G. D.; Polanski, P. E. Fish and Wildlife Service, Washington, D.C., 1982.

Ecosystem Changes in Lakes Erie and Ontario, Thomas, N. A. Environmental Research Laboratory, Duluth, MN, Proceedings of the Conference on Changes in the Biota of Lakes Erie and Ontario. Bulletin of the Buffalo Society of Natural Sciences, 1981.

Productivity of Great Lakes Zooplankton, Culver, D. A. Ohio State University, Columbus, OH, 1980.

Eastern Lake Ontario and Oswego and Rochester Harbors Chemical and Physical Characteristics Data for 1971 (Data Report). Bell, G. L. National Oceanic and Atmospheric Administration, Ann Arbor, MI, 1980.

Characteristics of the Oswego River Plume and Its Influence on the Nearshore Environment (Technical Memorandum). Bell, G. L. National Oceanic and Atmospheric Administration, Ann Arbor, MI, 1978.

Temperature and Dissolved Oxygen Data for Lake Ontario, 1972 (IFYGL) (Technical Memorandum). Boyd, J. D.; Eadie, B. J. National Oceanic and Atmospheric Administration, Ann Arbor, MI, 1978.

Phytoplankton Associations in Lake Ontario During IFYGL (Special Report). Stoermer, E. F.; Ladewski, T. B. Michigan University, Ann Arbor, MI, Great Lakes Research Division, 1979.

Lake Ontario Atlas: Internal Waves (Monograph No. 5). Landsberg, D. New York Sea Grant Institute, Albany, NY, 1977.

University at Dallas, Richardson, Center for Environmental Studies, 1977.

Algal Nutrient Availability and Limitation in Lake Ontario During IFYGL, Part II, Nitrogen Available in Lake Ontario Tributary Water Samples and Urban Runoff from Madison, WI. (Final Report). Cowen, W. F.; Sirisinha, K.; Lee, G. F. Texas University at Dallas, Richardson. Center for Environmental Studies, 1977.

Lake Ontario Atlas: Lake Temperatures. Chermak, E. New York Sea Grant Institute, Albany, NY, 1977.

An Investigation of the Nearshore Region of Lake Ontario, IFYGL (Final Report). SUNY at Buffalo, Great Lakes Laboratory, Grosse I., Michigan, 1976.

Algal Nutrient Availability and Limitation in Lake Ontario During IFYGL, Appendices to Part I, Available Phosphorus in Urban Runoff and Lake Ontario Tributary Waters (Final Report). Cowen, W. F.; Lee, G. F. Texas University at Dallas, Richardson, Center for Environmental Studies, 1976.

Algal Nutrient Availability and Limitation in Lake Ontario During IFYGL, Appendices to Part III, Algal Nutrient Limitation In Lake Ontario During IFYGL (Final Report). Sridharan, N.; Lee, G. F. Texas University at Dallas, Richardson, Center for Environmental Studies, 1977.

IFYGL Temperature Transects: Temperature Distributions Across Three Sections of Lake Ontario Continuously Traversed Over Four-Day Intervals in July, August, and October 1972 (Final Report). Boyce, F. M.; Mortimer, C. H. Wisconsin University - Milwaukee, Center for Great Lakes Studies, 1976.

Zooplankton Production in Lake Ontario as Influenced by Environmental Perturbations (Final Report). McNaught, D. O.; Bizzard, M.; Levine, S. SUNY at Albany, Department of Biological Sciences, 1975.

Phytoplankton Composition and Abundance in Lake Ontario During IFYGL (Final Report). Stoermer, E. F.; Bowman, M. M.; Kingston, J. C.; Schaedel, A. L. Michigan University, Ann Arbor, MI, 1975.

Phosphorus Uptake and Release by Lake Ontario Sediments (Ecological Research Series (Final), Bannerman, R. T.; Armstrong, D. E.; Harris, R. F.; Holdren, G. C. Wisconsin University, Madison, WI, 1975.

Kingston, J. C.; Schaedel, A. L. Michigan University, Ann Arbor, MI, 1975.

Phosphorus Uptake and Release by Lake Ontario Sediments (Ecological Research Series (Final), Bannerman, R. T.; Armstrong, D. E.; Harris, R. F.; Holdren, G. C. Wisconsin University, Madison, WI, 1975.

Cladophora Distribution in Lake Ontario (IFYGL) (Final Report), Wezernak, C. T.; Lyzenga, D. R.; Polcyn, F. O. Environmental Research Institute of Michigan, Ann Arbor, MI, 1974.

The 1973-75 Salmon Runs: New York's Salmon River Sport Fishery, Angler Activity and Economic Impact. Brown, T. L. New York Sea Grant Institute, Albany, NY, 1976.

Operation of Nine Mile Point Nuclear Station, Unit 1, Niagara Mohawk Power Corporation, Docket No. 50-410 (Final Environmental Impact Statement). Directorage of Licensing (AEC), Washington, D.C., 1973.

Operation of Nine Mile Point Nuclear Station, Unit 1, Niagara Mohawk Power Corporation, Docket No. 50-220 (Final Environmental Impact Statement) Directorate of Licensing (AEC), Washington, D.C., 1974.

The Operation of R. E. Ginna Nuclear Power Plant, Unit 1. Rochester Gas and Electric Corporation, Docket No. 50-244 (Final Environmental Impact Statement) Directorate of Licensing (AEC), Washington, D.C., 1974.

Nine Mile Point Nuclear Station Unit 1, Niagara Mohawk Power Corporation, Docket No. 50-220 (Draft Environmental Impact Statement). Directorate of Licensing (AEC), Washington, D.C., 1973.

The R. E. Ginna Nuclear Power Plant Unit No. 1, Rochester Gas and Electric Corporation, Docket No. 50-244 (Draft Environmental Impact Statement). Director of Licensing (AEC), Washington D.C., 1973.

Operation of James A. FitzPatrick Nuclear Power Plant, Power Authority of the State of New York, Docket No. 50-333 (Final Environmental Impact Statement). Directorate of Licensing (AEC), Washington, D.C., 1973.

Study of Thermal Effluents in Southeastern Lake Ontario as Monitored by an Airborne IR Thermometer. Chermack, E. E. Proc Conf. Great Lakes Res. 13(2) 1970.

Nine Mile Point Nuclear Station, Niagara Mowhawk Power Corporation, Docket No. 50-410 (Final Environmental Impact Statement) Directorate of Licensing (AEC), Washington, DC, 1973.

QUESTION E291.7 (3.4)

Provide, in tabular form, a comparison of all cooling system design specifications and structure locations as they now exist with those that were evaluated in the FES-CP stage.

RESPONSE

The following table summarizes the comparison of the cooling system design evaluated in the FES-CP stage and the ER-OLS.

COMPARISON OF COOLING SYSTEM DESIGN
SPECIFICATIONS AND STRUCTURE LOCATIONS

FES-CP Stage Evaluation	ER-OLS Evaluation
1. Once-through system	1. Closed-loop system - Natural draft cooling tower
2. Intake	2. Intake
535,000 gpm total 503,000 gpm condenser 32,000 gpm service water	53,600 gpm total (average) 38,675 gpm service water 14,925 gpm fish diversion system
Intake Structure	Intake Structure
1,300 ft offshore	Two intake structures approximately 1,000 ft offshore
3. Discharge	3. Discharge
Approximately 535,000 gpm ΔT_{max} 30.7°F	28,755 gpm (average) ΔT_{max} 27.66°F
Discharge Structure	Discharge Structure
1,500 ft offshore	One diffuser with two outlets approximately 1,500 ft offshore

QUESTION E291.8 (5.2.1)

The average rate of water withdrawal from the lake is stated to be 54,605 gpm (on page 5.2-1). Section 3.3 (page 3.3-1) stated the average water withdrawal to be 53,600 gpm. Please clarify.

RESPONSE

See revised Section 5.2.1.1.

QUESTION E291.9 (5.3)

Provide the status of the application for an SPDES permit for operation of Unit 2.

RESPONSE

The final SPDES permit for Units 1 and 2 was issued by NYSDEC on June 6, 1983. A copy of the permit is provided in revised Appendix 1A. 3

QUESTION E291.10 (5.3.1.2.6)

Provide copies of SWEC and OSS Unit 6 studies of fish survival in the diversion system. These are cited as reference numbers 9 and 10 on ER page 5.3-13.

RESPONSE

A copy of References 9 and 10 were submitted to the NRC on April 19, 1983 (correspondence from G. K. Rhode to D. G. Eisenhut).

QUESTION E291.11 (5.3.1)

a. Provide copies of the 316(a) and (b) studies conducted on NMP Unit 1, Fitzpatrick NPP, and Oswego Units 1-6.

b. Also provide a copy of the 1973-1981 NMP aquatic ecology study (cited as reference number 3 on ER page 5.3-49).

RESPONSE

a. Six copies of the following reports were submitted to the Nuclear Regulatory Commission (NMPC correspondence dated April 19, 1983 and May 13, 1983:

1. 316 (a) Demonstration Submission: NPDES Permit NY 0001015: Nine Mile Point Unit 1. Prepared for Niagara Mohawk Power Corporation by Lawler, Matusky and Skelly Engineers, 1975.

2. James A. FitzPatrick Nuclear Power Plant 3 316 (a) Demonstration Submission: Permit NY 0020109. Prepared for Power Authority of the State of New York, 1977.

3. James A. FitzPatrick Nuclear Power Plant 316 (b) Demonstration Submission & Permit NY 0020109. Prepared for Power Authority of the State of New York by Lawler, Matusky and Skelly Engineers, 1977.

4. Oswego Steam Station Units 1-4 316 (a) Demonstration Submission: Permit NY 0002186. Prepared for Niagara Mohawk Power Corporation by Lawler, Matusky and Skelly Engineers, 1976.

5. Oswego Steam Station Units 1-4 Intake Consideration Permit NY 0002186. Prepared for Niagara Mohawk Power Corporation by Lawler, Matusky and Skelly Engineers, 1976.

6. Oswego Unit 5 316 (a) Demonstration Submission: Permit NY 0003213. Prepared for Niagara Mohawk Power Corporation by Lawler, Matusky and Skelly Engineers, 1975.

7. Oswego Unit 5 Intake Considerations: Permit NY 0003212. Prepared for Niagara Mohawk Power Corporation by Lawler, Matusky and Skelly Engineers, 1975.

8. Oswego Unit 6 316 (a) Demonstration Submission: Permit NY 0003221. Prepared for Niagara Mohawk Power Corporation by Lawler, Matusky and Skelly Engineers, 1975.

9. Oswego Unit 6 Intake Considerations: Permit NY 0003221. Prepared for Niagara Mohawk Power Corporation by Lawler, Matusky and Skelly Engineers, 1975.

Niagara Mohawk was not required to prepare a 316 (b) demonstration for Nine Mile Point Unit 1.

b. The 1973-1981 NMP aquatic ecology study was submitted to the NRC (correspondence from C. V. Mangan to D. G. Eisenhut dated June 3, 1983).

QUESTION E291.12

ER Section 2.3.1.1.6 discusses the interaction of existing thermal plumes from NMP Unit 1 and JAF. ER Section 5.3.2 discusses the impacts to biota from interactions of existing plumes and the predicted NMP-2 plume.

a. Provide an analysis of the effects of fish attraction to the existing plumes and the contribution this could have to entrapment at the NMP-2 intakes, when the existing plumes (and their attracted fishes) interact with the NMP-2 intakes.

b. Provide an analysis of the extent to which fishes attracted to the existing thermal plumes (especially alewife and smelt) spawn earlier than normal and the contribution this has to ichythoplankton entrapment when the plumes interact with the cooling water intake structures.

RESPONSE

Section 2.4.2.1.6 discusses the spatial and temporal fish distribution in the Nine Mile Point vicinity and indicates little evidence of fish attraction to the existing Unit 1 or JAF plume. Some residence in the direct near field might occur because of habitat preference, and during specific seasons some species may utilize the plume vicinity as a suitable habitat. However, no long-term trends were identified.

If the plumes (either Unit 1 or JAF) do attract or hold fish populations for a period of time, and if, through the course of changing weather patterns, the plume occasionally interacts with the Unit 2 intake, then the changing weather patterns should be just as likely to move the plumes into a pattern of interaction with the Unit 1 or JAF intakes. If a plume effect exists, the Unit 1 and JAF impingement over the past nine years (Section 5.3.1.2) would reflect the effect (caused either by avoidance or attraction) from both the Unit 1 and JAF plumes. Since this data base was used to estimate Unit 2 impingement, the potential for plume-intake interaction and its resultant effect on impingement has already been factored into the Unit 2 impingement estimate.

As stated above, the existing discharge plumes created no discernible concentrating effect on spawning fish species, particularly alewife and rainbow smelt. The eggs from those individuals that do spawn in the vicinity of the discharge would have minimal interaction with the plume since they are

demersal while the plume is buoyant. There was no distinct east/west distribution of rainbow smelt or alewife larvae that might suggest a higher spawning event occurring close to the discharge (Section 2.4.2.1.4). By using both the Unit 1 and JAF entrainment data for estimating Unit 2 entrainment impact, any potential for plume-intake interraction, resulting from either a higher localized spawning event or an attraction of larval fish, has already been factored into the estimation.

Since the data base is inadequate to determine either fish or larval spatial distribution or concentrations in the area prior to the existence of the discharge plume, it is impossible to factor out the actual effect the plume has on the local distribution. However, by using the extensive data base gathered since Unit 1 went on line, it is reasonable to assume that, over the nine-year period, most plume-intake interactions that will occur at Unit 2 have already been reflected in the Unit 1 data base.

QUESTION E291.13 (6.5.2.2)

Provide the details of the proposed plan of study of 316(a) and (b) monitoring under the SPDES permit.

RESPONSE

In accordance with the provisions of the combined SPDES permit for Units 1 and 2 (see Revised Appendix 1A), NMPC is required to submit a plan of study for verification of the extent of the Unit 2 thermal plume in Lake Ontario to the NYSDEC 180 days prior to the initiation of discharge.

The SPDES permit also requires that existing biological studies in Lake Ontario required by regulatory agencies continue and that such study programs be adjusted as required by regulatory agencies to assess the operating impact of Unit 2. The scope of any adjustments to the biological studies will be negotiated between NMPC and the NYSDEC prior to operation. 3

QUESTION E291.14 (1.2)

Provide the estimated schedule for finalizing the SPDES; include the hearing schedule.

RESPONSE

The final SPDES permit was issued on June 6, 1983 (see revised Appendix 1A). 3

QUESTION E291.15 (2.3.3.2)

Identify the International Joint Commission office with which we can follow up concerns over water quality in Lake Ontario.

RESPONSE

International Joint Commission (IJC) concerns with water quality in Lake Ontario should be discussed with The New York State Department of Environmental Conservation (NYSDEC) representative on The Commission. The primary IJC representative from New York State is Mr. Daniel Barolo. The technical representative is Mr. Russell Mt. Pleasant. Both of these individuals may be contacted at the following address:

New York State Department of Environmental Conservation
Division of Water, Office of Director
50 Wolf Road
Albany, NY 12233
Telephone: (518) 457-6674

QUESTION E291.16 (2.3.3.3)

Provide the state plan for bringing the waters of Lake Ontario into compliance. Provide the state's basis for the water quality standard of 200 mg/l for TDS.

RESPONSE

The NYS Water Quality Standards were reviewed in 1979 and 1980 in accordance with Clean Water Act requirements. No revisions were promulgated as a result of that review. There is no scheduled formal review of these standards now planned by the NYSDEC.

The basis for the 200 mg/l total dissolved solids standard is reflected in the 1972 Great Lakes Water Quality Agreement and its supporting technical reports. The NYSDEC concern for total dissolved solids (TDS) is based on taste for drinking water as Lake Ontario is used for water supply.

QUESTION E291.17 (3.3.2)

Provide the makeup and blowdown flow rates required in order to obviate sulfuric acid usage in the circulating water system. What would be the cost of this relative to the cost of the acid?

RESPONSE

With a once-through cooling system, sulfuric acid addition may not be required. A closed-loop cooling system, however, requires the addition of sulfuric acid to alleviate the buildup of scale on the condenser tubes. This is true regardless of makeup or blowdown rates.

QUESTION E291.18 (5.5.2.1)

Provide the recommendations, objectives, and goals of the International Joint Commission relevant to Nine Mile Point. Will the project impair in any way attainment of goals of the IJC?

RESPONSE

The IJC recommendations, objectives and goals, as adopted by the State of New York, are reflected in "Codes, Rules, and Regulations of the State of New York, 6NYCRR 702.1 - Class A - Special (International Boundary) Waters, 1974." These recommendations and the effect Unit 2 will have on them are discussed in Section 5.5.2.1, of the ER-OLS

QUESTION E291.20

Identify, by means of specific references, all areas of outdated information as indicated in your letter of February 3, 1982 in the NRC report entitled "Evaluation of the Environmental Effects Due to the Change in Cooling Systems at Nine Mile Point, Unit 2, from a Once-Through System to a Closed Cycle System Utilizing a Natural Draft Cooling Tower." References should identify specific items of outdated information in that report and the specific references in the ER or FSAR that contain the correct and updated information.

RESPONSE

Cooling tower design information given in the NRC report entitled, "Evaluation of the Environmental Effects Due to the Change in Cooling Systems at Nine Mile Point, Unit 2, from a Once-Through System to a Closed Cycle System Utilizing a Natural Draft Cooling Tower," which has been updated in the ER-OLS is given below with reference to the applicable ER-OLS sections.

	Item	NRC Report	ER-OLS	Section	
1.	Cooling tower location	Figure 2	Figure 3.1-1	3.1	
2.	Cooling tower height (ft)	500	541	3.4.2.3	
3.	Bottom diameter (ft)	450	405	3.4.2.3	
4.	Top diameter (ft)	220	273	3.4.2.3	
5.	Circulating water flow (gpm)	579,909	580,000	3.4.1.1.2	
6.	Drift rate (% of circulating water flow)	0.002	0.005	3.4.1.1.4	
7.	Maximum evaporation rate (gpm)	12,000	13,800	3.4.1.1.4	
8.	Range (°F)	27	27	5.3.3.2	6

Item	NRC Report	ER-OLS	Section
9. Design condition			
Wet bulb temp (°F)	74	74	5.3.3.2
Relative humidity (%)	50	50	5.3.3.2
10. Salt drift			
6 Maximum (lb/ac/yr)	3 at 7,000 ft NNE	27 at 6,750 ft NW	5.3.3.2.7
Maximum overland	Not mentioned	0.099 lb/ft yr at 3,250 ft WSW	5.3.3.2.7
11. Maximum blowdown rate (gpm)	12,357	20,440 (19,894 approx)	3.3-1

QUESTION E291.21

Provide all data in your possession on the concentration of MIREX in the adjacent waters or sediments of Lake Ontario.

RESPONSE

NMPC does not have any data concerning the concentration of MIREX in the adjacent waters or sediments of Lake Ontario. NMPC is aware, however, that the New York State Department of Environmental Conservation (NYSDEC) has conducted extensive surveys of MIREX concentrations in Lake Ontario over the past several years. Information concerning these surveys can be obtained from:

Mr. Italo Carcich
New York State Department of Environmental Conservation
Room 317
50 Wolf Road
Albany, New York 12233
(518) 457-7470

QUESTION E291.22

Describe procedures for disposal of preoperational cleaning solution wastes.

RESPONSE

During the preliminary startup and testing period various plant systems will be flushed, cleaned, rinsed, and hydrostatically tested. These activities are scheduled to extend from March 1984 through the end of 1985 with peak wastewater flows expected to occur in September 1984. The estimated daily average wastewater flow over this period is 100,000 gal./day. The specific sources, quantities, and characteristics of these wastewaters are described below. Procedures proposed for disposing of the wastewaters, subject to review and approval by NYSDEC, are also described.

Plant piping systems will be flushed using domestic, lake, or demineralized water as necessary to remove foreign material from the systems prior to startup. An estimated 40,000,000 gal. of water will be used to flush and rinse plant piping systems. The wastewater will contain various quantities of suspended solids such as dirt, sand, weld slag, iron oxides, and other construction debris. The flushing and rinsing wastewater will be routed to two 500,000-gal. capacity settling ponds existing at the site for treatment along with other construction wastewaters. The wastewaters will be treated, monitored, and discharged to Lake Ontario in accordance with State Pollutant Discharge Elimination System (SPDES) permit requirements. 6

In addition to the flushing and rinsing of plant piping that will utilize water with no additives, other plant systems will be tested and cleaned using chemicals and other additives. A standing water leak test of the condenser will require approximately 1,000,000 gal. of water containing a 1.0 mg/l concentration of fluorescent dye. Upon completion of the leak test, the condenser will be drained and then rinsed with another 1,000,000 gal. of water to remove any residual dye. The wastewaters from the condenser static head test will be discharged without treatment to Lake Ontario through the west drainage ditch in accordance with SPDES permit provisions.

The condenser and reactor pressure vessel will be cleaned using a 1.0 percent concentration of trisodium phosphate and an antifoaming agent. The condenser and reactor pressure

6 vessel will each require approximately 10,000 gal. of rinse water (20,000 gal. total) containing the cleaning and antifoaming agents to clean the surfaces of the components. Similarly, the auxiliary boilers will be cleaned using a chemical solution containing 0.36 percent by weight trisodium phosphate and 0.06 percent by weight sodium hydroxide. Approximately 8,000 gal. of wastewater will result from this cleaning operation. All of the wastewaters from the condenser, reactor pressure vessel, and auxiliary boiler cleaning operations will be collected and disposed of offsite at an approved industrial waste disposal facility.

QUESTION E310.1

The ad valorum taxes for Unit 2 have been estimated for the first 10 years of operation (Sec. 5.8.2.1). What assumptions have been made in deriving these figures? How will each jurisdiction share in the division of local property taxes (see Table 2.5-24)? Has the applicant filed for an exemption from local taxes resulting from the installation of anti-pollution equipment? To what extent will an exemption affect local tax revenues?

RESPONSE

The real property tax estimates for Unit 2 presented in ER-OLS Section 5.8.2.1 were developed in March 1982, based on estimated plant growth and municipal budget requirements through 1987. The 1988-1995 taxes were estimated by using an inflation rate index of 7.32 percent per year.

ER-OLS Table 2.5-24 is not intended to be an inclusive list of all the towns and cities that will benefit from Unit 2 tax payments. Rather, this table was included to provide information on the tax base of municipalities in the vicinity of Unit 2, i.e., within a 20 km radius of the site. No assessments related to Unit 2 are reflected in the information presented in Table 2.5-24.

From a town tax standpoint, the only town that will be affected by Unit 2 is the town of Scriba. With respect to county taxes, all 22 towns and two cities in Oswego County will be affected by Unit 2, the extent of which depends on the assessed valuation and equalization rates of each jurisdiction. As the town of Scriba's percentage of the county budget increases with the construction of Unit 2, the percentage of all other tax units will decrease.

Niagara Mohawk has filed for exemptions from local property taxes for air and water pollution abatement equipment at Unit 2. The exemption filing was made with the Regional Director of the New York State Department of Environmental Conservation (NYSDEC) on March 11, 1983. Until Niagara Mohawk's exemption request is reviewed and approved by the NYSDEC, the effect on local tax revenues cannot be quantified. However, even assuming that Niagara Mohawk's exemption request is approved in its entirety, the overall impact on local tax revenues will be small considering the large percentage of the total tax load that is presently being paid by Niagara Mohawk facilities in the town of Scriba and the city of Oswego.

QUESTION E310.2

Is the applicant subject to additional state-imposed taxes (e.g., a gross receipts tax)? If the applicant is liable for such taxes, provide an estimate in 1982 dollars.

RESPONSE

In addition to the local property taxes identified in ER-OLS Section 5.8.2.1, Niagara Mohawk is liable for state-imposed revenue taxes consisting of a gross earnings tax and a gross income tax. Estimated 1986 state revenue taxes for Unit 2 (expressed in 1982 dollars) are $19 million.

QUESTION E310.3

The operating staff for Unit 2 is estimated to be approximately 300 employees (Sec. 5.8.2.2). Does this figure include security forces and other employees of contractors who would regularly be found on the Unit 2 site? If not, the applicant should provide such data on employment.

RESPONSE

A revised operating staff estimate for Unit 2 is now available. The new estimate is presented in revised ER-OLS Section 5.8.2.2.

QUESTION E310.4

What is the applicant's estimate of payroll for Unit 2 employees (utility as well as contractor) expressed in 1982 dollars?

RESPONSE

See revised ER-OLS Section 5.8.2.2 for the response to this question.

QUESTION E310.5

The applicant should provide a table showing the mid-year numbers of operating phase workers at the Unit 2 site. These data should reflect utility employees and contractor personnel (e.g., security guards) who would normally be found on the site, but should exclude intermittent or occasional employees, such as those employed in fuel loading. The applicant should provide these data for a period beginning in 1983 and ending when the complement of operating phase staff is on site.

RESPONSE

This request is addressed in revised ER-OLS Section 5.8.2.2.

QUESTION E310.6

Does the applicant anticipate purchasing goods or services from the area within 50 miles of the site during the operating period? If yes, provide an estimate in 1982 dollars of the value of the purchases.

RESPONSE

This question is addressed in revised ER-OLS Section 5.8.2.1.

QUESTION E320.1

Provide the following:

A production cost analysis which shows the difference in system production costs associated with the availability vs. unavailability of the proposed nuclear addition. Note, the resulting cost differential should be limited solely to the variable or incremental costs associated with generating electricity from the proposed nuclear addition and the sources of replacement energy. If, in your analysis, other factors influence the cost differential, explain in detail.

a. The analysis should provide results on an annual basis covering the period from initial operation of the first unit through five full years of operation of the last unit.

b. Where more than one utility shares ownership in the proposed nuclear addition or where the proposed facility is centrally dispatched as part of an interconnected pool, the results of the analysis may be aggregated for all participating systems.

c. The analysis should assume electrical energy requirements grow at (1) the system's latest official forecasted growth rate, and (2) zero growth from the latest actual annual energy requirement.

d. All underlying assumptions should be explicitly identified and explained.

e. For each year (and for each growth rate scenario) the following results should be clearly stated: (1) system production costs with the proposed nuclear addition available as scheduled; (2) system production costs without the proposed nuclear addition available; (3) the capacity factor assumed for the nuclear addition; (4) the average fuel cost and variable O&M for the nuclear addition and the sources of replacement energy (by fuel type) - both expressed in mills per kWh; and (5) the proportion of replacement energy assumed to be provided by coal, oil, gas, etc. (The base year for all costs should be identified.)

RESPONSE

A response to this request has been submitted to the NRC under separate cover on September 9, 1983. 3

QUESTION E320.2

Provide average, present worth fuel and O and M costs for the Nuclear Unit. (This cost should be calculated for both a 30-year and a 40-year operating life.) Provide escalation, discount rates, and all other variables assumed in calculating these costs.

RESPONSE

A response to this request has been submitted to the NRC under separate cover on September 9, 1983. 3

QUESTION E320.3

Provide a brief summary of the methodology used in arriving at the $123 million decommissioning estimate provided in Section 5.9.2.1.

RESPONSE

Based on a review of the design and construction of the unit, the cost for decommissioning Unit 2 is estimated to be $123 million. This cost is net of salvage and assumes shutdown at the end of the plant operating life, followed promptly by defueling, decontamination, removal of the plant, and restoration of the site to essentially pre-construction conditions.

This cost estimate utilized detailed site specific decommissioning cost estimates for five reactors. Differences between Unit 2 and the plant for which a detailed estimate was performed, assessed cost estimates against these differences developed the Unit 2 estimate. Differences due to local wage rates and waste transportation distance were included. The major difference affecting decommissioning costs is associated with site conditions and construction details and include site subsurface conditions, circulating water system, type of containment and site access, and transportation facilities.

QUESTION E450.1

Our examination of Figures 7A.6-6 and 7A.6-12 reveals that the calculation of the monetary cost of potential severe accidents did not include the low-probability accidents that would result in costs greater than $10,000,000. Judging from the RSS and from many recent studies, we have reason to believe that severe accidents could cause much greater economic losses. Please extend the calculation to include the higher costs as a function of probability.

RESPONSE

See revised Figures 7A.6-7 and 7A.6-13 for the response to this question.

QUESTION E450.2

Figure 7A.6-9 includes data from the Grand Gulf Unit 1 Environmental Statement. Comparison of the CCDFs from the two documents indicates that the CCDFs in Figure 7A.6-9 may be for latent fatalities within 50 miles of the plant, and not for all those at risk from cancer. If so, this should be stated. A more complete depiction of latent fatality risk would include all those people who receive a dose that would increase their chances of a cancer fatality.

RESPONSE

Grand Gulf Unit 1 data offered for comparison are taken from Figure 5.6 of NUREG-0777 labeled, "Within 50 Miles - Excluding Thyroid." Therefore, the CCDFs in Figure 7A.6-10, including five other plants, are only for the exposed population within 50 miles. This clarification has been added to Sections 7A.6.1 and 7A.6.2 and applies to all CCDFs calculated for Unit 2. Also, Figure 7A.6-6 depicting CCDFs for thyroid cancer within 50 miles of Unit 2 has been added.

QUESTION E450.3

Figures 7A.6-10 and -11 show that at a 10^{-7} probability, the consequences of Unit 2 accidents are as large as from 100 nuclear power plants. This comparison may make Nine Mile Point look more risky than is realistic. Additional clarification should be provided.

RESPONSE

Figures 7A.6-10 and 7A.6-11 have been updated (and relabeled 7A.6-11 and 7A.6-12).

QUESTION E450.4

Table 7A.6-9 appears to have incorrectly numbered references. Also, the significance of the comparisons made are not clear. It appears that different types of risk (individual and total) are being compared. Clarify this.

RESPONSE

Table 7A.6-9 has been updated to more accurately compare U.S. overall and Unit 2 individual risks from acute injuries and latent fatalities. The references have also been updated to amplify the basis for the values given in the table.

QUESTION E451.1

Hourly data tape with onsite meterological data for Nine Mile Point-2 was submitted on March 4, 1983. Dew point temperatures were not included on this tape. Provide the dew point temperatures from November 1, 1973, through October 31, 1980.

RESPONSE

The meteorological data tape, submitted by Niagara Mohawk in a letter dated March 4, 1983, did not contain the dew point temperatures from November 1, 1978, through October 31, 1980, since these data were not employed in any of the meteorological cooling tower plume or cooling tower drift analyses.

Dry bulb and dew point temperatures, as well as pressure measured at the meteorological installation, have been added to a revised NRC formatted tape that has been submitted with a separate transmittal letter dated April 29, 1983. FSAR Table 2B-52A lists the monthly data recovery for the dew point temperature for the 2-year period. The format of the revised tape is shown in FSAR Table 2B-54. 3

QUESTION E451.2 (2.7.1)

Examination of additional regional meteorological information is necessary to provide a more complete description of the site and surrounding area:

i) Compare the site to other NWS stations in the vicinity of Nine Mile Point, NY:

1) Rochester, NY (43° 07'N 77° 40'W) 547' ASL: Detailed meteorological data and local climatological data summaries prepared annually are available.

2) Oswego East, NY (43° 28'N 76° 30'W) 350' ASL: Daily temperature and precipitation measurements 1951-present; and local climatological data summaries available.

3) Watertown, NY (43° 58'N 75° 52'W) 497' ASL: Daily temperatures and precipitation measurements, 1971-present; and local climatological data summaries are available.

RESPONSE

Additional meteorological information is not considered necessary to provide a description of the site region. The sources referenced in FSAR Section 2.3.1 summarize meteorological data from many National Weather Service (NWS) offices and cooperative stations throughout the region. These stations include historical climatological data collected at the Rochester, Oswego, and Watertown locations. The description of the regional climate given in FSAR Section 2.3.1 includes ranges of climatological parameters as they vary spatially over the region. In addition, the local climatic effects in the immediate Lake Ontario vicinity are discussed in FSAR Section 2.3.1.2.1.

The Syracuse NWS data are chosen to document the regional extremes of the key meteorological parameters since Syracuse is the first order NWS station that is closest to and most representative of the site. The second closest first order NWS station with a complete long-term record is the Rochester station, located approximately 116 km (72 mi) west of Nine Mile Point. A detailed comparison of the Syracuse and Rochester data for the April 1977 through March 1978 period is presented in the New Haven ER-CPS[1]. The New Haven site is located just east of the Nine Mile Point. 2
This study shows that the Syracuse data are generally more

representative of the onsite climatology than the Rochester data.

The Oswego and Watertown sites are not currently being operated as first order NWS stations. They are cooperative locations measuring temperature and precipitation. Long-term records of these parameters have been used in compiling the overall site climatology given in FSAR Section 2.3.1. The Sterling Power Project summarized detailed historical temperature and precipitation data from the Oswego Weather
2 Bureau Station in 1974[2]. Both the mean temperature and precipitation values on a monthly and annual basis are similar to those measured at the site and reported for the region in FSAR Section 2.3.1. However, the site precipitation extremes exceed the historical Oswego data, whereas temperature extremes over a 60-yr period at Oswego resemble the climatological values for the regions.

2

Additional meteorological data from Watertown have been examined in the New Haven ER-CPS for the 1949 through 1964
2 period[1]. These data are clearly no more representative of the Nine Mile Point region than the Syracuse data, and probably less so due to the location of Watertown on the eastern rather than southeastern shore of Lake Ontario. Thus, Lake Ontario influences the temperature and precipitation regime at Watertown during different wind directions than at Oswego, Rochester, Syracuse and the site. The climatological differences are not significant on an annual average basis.

<u>Reference</u>

1. New York State Electric and Gas Corporation: New Haven Nuclear Station, ER-CPS. Docket Nos. STN50-596 and STN50-597, March 1979.

2. Rochester Gas and Electric Corporation: Sterling Power Plant Nuclear Unit 1, ER-CPS. Docket No. STN-50485-21, 1974.

QUESTION E451.3 (2.7.1)

Present a plot of maximum elevation versus distance from the center of the station in each of the sixteen 22 1/2 degrees compass point sectors (i.e., centered on true north, north northeast, northeast, etc.) radiating from the station to a distance of 50 miles.

RESPONSE

See revised FSAR Section 2.3.2.3.7 and FSAR Figures 2.3-42 through 2.3-46.

QUESTION E451.4 (2.7.4)

The description of the atmospheric dispersion model used for calculation of annual average relative concentratrion (X/Q) 2
and relative deposition (D/Q) values requires additional clarification.

i. Describe how recirculation and trapping were considered.

ii. Numerically demonstrate how: "recirculation of onshore flow would decrease X/Q (values) below 2
estimates made for inland locations," as stated in FSAR Section 2.3-54. Can this statement be supported for locations of concern like the site boundary (<1 mi).

iii. Discuss the appropriateness of a straight-line trajectory model for use at the Nine Mile Point site, considering spatial and temporal variations in airflow. Provide adjustments to the straight-line model, if necessary.

RESPONSE

The atmospheric dispersion model used to calculate annual average relative concentration (X/Q) and relative deposition (D/Q) does not need to account for recirculation and/or plume trapping at Nine Mile Point. Therefore, these two factors are not considered. Regulatory Guide 1.111 cites two examples of spatial and temporal variations in airflow: recirculation of airflow during prolonged atmospheric stagnation and lake/land breeze circulation. Both have been considered for dispersion at Nine Mile Point and have been determined to play an insignificant role on the calculated annual concentrations.

The airflow at Nine Mile Point, especially within the first
8 km (5 mi), and in the region surrounding Nine Mile Point 2
is dominated by large-scale weather patterns. Recirculation of air flow that is caused by prolonged periods of atmospheric stagnation is an extremely rare event.

Korshover, in his 40-yr (1936-1975) analysis of stagnation, has shown that in the Nine Mile Point region there is less than one stagnating case (4 days or more) per year with a total of less than 125 days of stagnation over the 40-yr
period[1]. Furthermore, during the 40 yr, there is only one 2
stagnation period of 7 days or more.

Clearly, the annual average X/Q and D/Q calculations will not be significantly changed by using a trajectory model to simulate these rare events. In addition, these stagnation periods do not warrant the adjustment of the straight-line diffusion equation since one is concerned about the annual average based on a representative climatology. The infrequent occurrence of atmospheric stagnation in the region ensures that the 5-year period, which is modeled in the ER-OLS, is representative of the climatology.

The second consideration, according to Regulatory Guide 1.111, is whether or not the lake/land breeze circulation, including plume trapping and fumigation, necessitates an adjustment to the diffusion equation to prevent <u>substantial</u> underestimates of relative concentration and deposition on an annual basis. Since Nine Mile Point, located on the southeastern shore of Lake Ontario, is subject to the meteorological conditions conducive to the formation of lake/land breezes, the frequency and penetration distances of these breezes need to be assessed.

Two field studies conducted in the vicinity of the southeastern shore of Lake Ontario are especially pertinent since both were conducted near Nine Mile Point. Both studies concluded that lake breezes occur on approximately 10 percent of the days in a year and roughly half penetrate inland as far as the Syracuse National Weather Service Station.

Specifically, the Guski and Miller study in the New Haven
site vicinity of April 1, 1977 through March 31, 1979 shows
that 95 percent, 87 percent, and 43 percent of the 79 lake
2 breezes penetrated as far as 3, 8, and 45 km (2, 5, and
28 mi) inland, respectively[2]. The Speiser study conducted
from March 22, 1982 through August 15, 1982 shows that in
the vicinity of Nine Mile Point there were only 21 lake
breeze days[2]. Of these days, 90 percent penetrated at
2 least 16 km (10 mi), with over 65 percent penetrating as far
as the Syracuse National Weather Station, 51 km (32 mi) from
Nine Mile Point.

Therefore, considerably less than 5 percent of the hours per year at the coastline and less frequent farther inland are affected by lake breezes. The direction and speed at the Nine Mile Point meteorological tower are sufficiently similar to those conditions measured inland during lake breezes; therefore, no adjustment is needed to account for any small differences that occur on a case-by-case basis for the annual calculations.

Thus, the relative concentration and deposition estimates are insignificantly affected by changes in wind direction and speed during these lake breeze cases. Stability estimates are based on the tower-temperature difference and may not reflect the true stability at distances significantly inland, but are representative at the site boundary. Considering the small number of lake breeze hours, even if the stability for inland receptors changes from stable to unstable, this change will not significantly increase the average annual X/Q or D/Q for any inland receptor.

The recirculation of the Nine Mile Point Unit 2 plumes back toward the lakeshore during lake breeze hours would increase the concentration that is strictly calculated by the steady-state Gaussian model. However, as supported by the previously mentioned Guski/Miller and Speiser studies, the plume transport will often exceed 50 km (31 mi) before 2
arriving back at the site boundary, and in many cases may exceed 100 km (62 mi). The net increase for these hours at 2
any one location affected by the return flow of the lake breeze will not result in a substantial underestimate of the annual X/Q values.

QUESTION E451.5 (5.3.3.1)

Discuss the validity of a cooling tower drift study done with a large percent (>40%) of missing meteorological input data:

1. Present the periods of missing data, and

2. Show that at least one annual cycle was represented by key meteorological parameters for the period of January 1, 1974 through December 31, 1976.

RESPONSE

The cooling tower drift study presented in ER-OLS Section 5.3.3.1 used a 3-year (January 1, 1974 through December 31, 1976) meteorological data base for the prediction of salt drift deposition rates and airborne concentrations. As a result of the data substitutions described in ER-OLS Section 5.3.3.1 (p 5.3-36), a 95 percent data recovery was acheived in the 1974-1976 data base without significantly altering the predictions. Since the maximum salt drift deposition rates and airborne concentrations reported in ER-OLS Section 5.3.3.1 are far below levels known to cause injury to vegetation (see ER-OLS Section 5.3.3.2.2) the use of a composite data base does not affect the conclusions drawn from this study. The cooling tower drift study was consistent with the analysis presented in "Air Quality Analysis for Permit to Construct Natural Draft Cooling Tower" prepared for the New York State Department of Environmental Conservation (NYSDEC) dated July 1979. The study is based on three complete annual cycles of meteorological conditions with a 95 percent data recovery rather than an approximate 60 percent data recovery implicit in ER-OLS Question 451.5 (5.3.3.1).

QUESTION E451.6 (6.4.2)

The existing onsite meteorological measurements program is described in FSAR Section 2.3.3.1 as a pre-operational program. The relative humidity data recovery did not meet the guideline recovery (90%) stated in Regulatory Guide 1.23.

1. Present in detail the description of the operational meteorological monitoring program. Will supplemental meteorological data be part of the operational program?

RESPONSE

The response to this request is found in revised FSAR Section 2.3.3.2.

QUESTION E451.16(a) (2.7.4, NUREG-0555, 2.3)

Submit for accident consequence assessments one complete representative year (8760 hours) of hour-by-hour meteorological data (wind speed, wind direction, stability, and precipitation) for a ground level release. Include data substitutions for all missing periods.

a) Transmit the data on magnetic tape in the recommended SRP 2.3.3 Appendix A format.

b) Include a description of the method used to substitute for the missing data.

RESPONSE

For accident consequence assessment for a ground-level release, one representative year (1975) of complete hour-by-hour onsite meteorological data (100-percent data recovery) for the lower-level wind, stability and precipitation has been transmitted to the NRC under separate cover (reference letter from C. V. Mangan to D. Eisenhut, dated October 18, 1983). The 1975 data are formatted as shown in Table 451.16-1 on magnetic tape according to the recommendations of the Standard Review Plan, Section 2.3.3, Appendix A.

To achieve 100-percent data recovery, appropriate data substitutions were made from the other onsite tower measurements made in 1975. The 9-m (30-ft) vane is the primary direction measurement. When this direction was missing, the first valid direction from among the 9-m (30-ft), 30-m (100-ft), or 61-m (200-ft) Aerovanes, in sequence, was selected to replace the missing primary direction. When the primary 9-m (30-ft) cup wind speed was missing, the redundant 9-m (30-ft) Aerovane speed was transferred without adjustment. Since the two upper wind speeds were also missing when both 9-m (30-ft) wind speeds were missing (only 24 hr), persistence was conservatively employed to fill in these remaining missing hours, instead of relying on data from distant National Weather Service stations, such as Syracuse. Stability was determined from the temperature difference between the 61-m (200-ft) and 8-m (27-ft) tower levels according to the classification scheme in Regulatory Guide 1.23. Persistence was again employed to replace the missing 13 hr because the 30-8 m (100-27 ft) temperature difference measurements are coincidentally missing. Since only 1 hr of precipitation was missing, persistence from the hour before of 0 mm (0 in) was substituted.

The representativeness of the 1975 onsite meteorological data was shown by the similarity of the 5-yr climatology at the site based on the joint frequency distributions of wind direction (with only the 9-m (30-ft) Aerovane direction substituted) and the temperature difference between the 61-m (200-ft) and 8-m (27-ft) tower levels. This joint frequency distribution of wind direction, speed, and stability is shown in Table 451.16-2. A comparison of the 5-yr climatology with that of 1975 is shown in Table 451.16-3 for direction and Table 451.16-4 for stability. The comparison of precipitation rates and amounts is obtained from FSAR Table 2B-29 for the site and compares with those measured on an annual climatological basis at Syracuse given in FSAR Table 2B-41.

QUESTION E451.16(b) (2.7.4, NUREG-0555, 5.3.3.1)

Submit at least one recent representative annual cycle of meteorological data on magnetic tape in the recommended format with at least 90% joint data recovery for the essential cooling tower modeling input parameters (wind speed 61(m), wind direction 61(m), stability 61-9(m), temperature 9(m), and dew point 9(m)).

a) Include all meteorological parameters measured at the primary tower.

b) If necessary, substitute missing values with local/NWS data to achieve the 90% joint data recovery. Explain the methods used to substitute missing values.

RESPONSE

A representative annual cycle of meteorological data (1974) with at least 90 percent joint data recovery for the essential cooling tower modelling input parameters was submitted to the NRC under separate cover (reference letter C.V. Mangan to D. Eisenhut dated October 18, 1983). The essential cooling tower parameters are the 61-m (200-ft) wind direction and speed, the 61-8 m (200-27 ft) delta temperature, and the 9-m (30-ft) ambient and dew point temperatures. Dew point temperature was calculated from the ambient temperature and 9-m (30-ft) relative humidity. These parameters, along with the other onsite tower measurements, are formatted on the magnetic tape according to the Standard Review Plan Section 2.3.3 Appendix A as specified in Table 451.16-5.

To achieve over 90% joint data recovery, substitution of the key parameters with other onsite tower data was necessary. The substitution included replacement of missing 61-m (200-ft) wind directions by the 30-m (100-ft) wind directions. In addition, for the instances when the 9-m (30-ft) relative humidity was missing (less than 1 percent of the year), it was replaced by the 61-m (200-ft) relative humidity. No substitutions were made to improve data recovery for the ambient and delta temperatures. With the aforementioned substitutions, the onsite meteorological data for 1974 has 93 percent joint data recovery.

To judge the representativeness of the 1974 data, the joint frequency distribution of wind and stability at the 61-m (200-ft) level with the aforementioned substitution is presented in Table 451.16-6. A comparison of this one year frequency distribution with that of the five-year data base

is presented in Table 451.16-7 for direction and Table 451.16-8 for stability. From these two tables, one concludes that 1974 is representative of the site, although minor variations in the frequency distributions occurred as expected.

TABLE 451.16-1

NRC FORMAT OF NINE MILE POINT METEOROLOGICAL DATA TAPE
FOR ACCIDENT ASSESSMENT

January 1975 through December 1975

Data Description	Units	Format	Column
ID number	(000041)	I6	1-6
Year		I2	7-8
Julian day		I3	9-11
Hour		I4	12-15
Blank		70X	16-85
Lower wind height	(m x 10) (91)	I5	86-90
30-ft vane direction	(deg Az x 10)	I5	91-95
30-ft cup speed	(m/sec x 10)	I5	96-100
Blank		20X	101-120
200-27-ft temperature difference	(°C/100 m x 10)	I5	121-125
Blank		10X	126-135
Precipitation	(mm x 10)	I5	136-140
Blank		20X	141-160

Nine Mile Point Unit 2 ER-OLS

TABLE 451.16-2

1975 JOINT DISTRIBUTION OF WIND DIRECTION AND SPEED
LOCATION 30 FT

JAN 75 - DEC 75

DEG C/100M (200-27FT) LAPSE RATE LE-1.9 CLASS A

SPEEDS(MI/HR)

DIRECTION	1-3 SUM	1-3 PERCENT	4-7 SUM	4-7 PERCENT	8-12 SUM	8-12 PERCENT	13-18 SUM	13-18 PERCENT	19-23 SUM	19-23 PERCENT	24 PLUS SUM	24 PLUS PERCENT	SUM	PERCENT
22.5	1	.0	36	.4	23	.3	3	.0	0	0.0	0	0.0	63	.7
45.0	2	.0	8	.1	24	.3	1	.0	0	0.0	0	0.0	35	.4
67.5	0	0.0	1	.0	0	0.0	0	0.0	0	0.0	0	0.0	1	.0
90.0	0	0.0	2	.0	0	0.0	0	0.0	0	0.0	0	0.0	2	.0
112.5	0	0.0	2	.0	1	.0	0	0.0	0	0.0	0	0.0	3	.0
135.0	0	0.0	5	.1	8	.1	6	.1	1	.0	0	0.0	20	.2
157.5	0	0.0	9	.1	9	.1	5	.1	0	0.0	0	0.0	23	.3
180.0	0	0.0	6	.1	9	.1	3	.0	2	.0	0	0.0	20	.2
202.5	0	0.0	4	.0	7	.1	1	.0	0	0.0	0	0.0	12	.1
225.0	0	0.0	0	0.0	1	.0	0	0.0	0	0.0	0	0.0	1	.0
247.5	1	.0	0	0.0	2	.0	1	.0	0	0.0	1	.0	5	.1
270.0	1	.0	0	0.0	0	0.0	0	0.0	0	0.0	11	.1	12	.1
292.5	3	.0	1	.0	4	.0	0	0.0	2	.0	13	.2	23	.3
315.0	9	.1	29	.3	19	.2	32	.4	11	.1	3	.0	103	1.2
337.5	20	.2	33	.4	12	.1	25	.3	4	.0	0	0.0	94	1.1
360.0	13	.2	46	.5	15	.2	8	.1	0	0.0	0	0.0	82	1.0
	50	.6	182	2.1	134	1.6	85	1.0	20	.2	28	.3	499	5.8

MEAN WIND SPEED 10.1

TABLE 451.16-2 (Cont)

JAN 75 - DEC 75

DEG C/100M (200-27FT) LAPSE RATE -1.8/ -1.7 CLASS B

SPEEDS(MI/HR)

DIRECTION	1-3 SUM	1-3 PERCENT	4-7 SUM	4-7 PERCENT	8-12 SUM	8-12 PERCENT	13-18 SUM	13-18 PERCENT	19-23 SUM	19-23 PERCENT	24 PLUS SUM	24 PLUS PERCENT	SUM	PERCENT
22.5	3	.0	6	.1	6	.1	1	.0	0	0.0	0	0.0	16	.2
45.0	1	.0	8	.1	4	.0	3	.0	0	0.0	0	0.0	16	.2
67.5	1	.0	4	.0	0	0.0	0	0.0	0	0.0	0	0.0	5	.1
90.0	0	0.0	2	.0	0	0.0	0	0.0	0	0.0	0	0.0	2	.0
112.5	0	0.0	2	.0	5	.1	0	0.0	0	0.0	0	0.0	7	.1
135.0	0	0.0	2	.0	9	.1	0	0.0	0	0.0	0	0.0	11	.1
157.5	0	0.0	2	.0	3	.0	2	.0	0	0.0	0	0.0	7	.1
180.0	0	0.0	7	.1	3	.0	2	.0	0	0.0	0	0.0	12	.1
202.5	0	0.0	0	0.0	4	.0	0	0.0	0	0.0	0	0.0	4	.0
225.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
247.5	0	0.0	0	0.0	0	0.0	1	.0	2	.0	3	.0	6	.1
270.0	0	0.0	1	.0	0	0.0	0	0.0	2	.0	14	.2	17	.2
292.5	1	.0	1	.0	0	0.0	1	.0	1	.0	15	.2	19	.2
315.0	0	0.0	7	.1	10	.1	9	.1	2	.0	1	.0	29	.3
337.5	0	0.0	1	.0	4	.0	5	.1	0	0.0	0	0.0	10	.1
360.0	3	.0	5	.1	2	.0	2	.0	0	0.0	0	0.0	12	.1
	9	.1	48	.6	50	.6	26	.3	7	.1	33	.4	173	2.0

MEAN WIND SPEED 13.4

TABLE 451.16-2 (Cont)

JAN 75 - DEC 75

DEG C/100M (200-27FT) LAPSE RATE -1.6/ -1.5 CLASS C

SPEEDS(MI/HR)

DIRECTION	1-3 SUM	1-3 PERCENT	4-7 SUM	4-7 PERCENT	8-12 SUM	8-12 PERCENT	13-18 SUM	13-18 PERCENT	19-23 SUM	19-23 PERCENT	24 PLUS SUM	24 PLUS PERCENT	SUM	PERCENT
22.5	8	.1	11	.1	8	.1	1	.0	0	0.0	0	0.0	28	.3
45.0	0	0.0	13	.2	15	.2	3	.0	0	0.0	0	0.0	31	.4
67.5	2	.0	6	.1	0	0.0	0	0.0	0	0.0	0	0.0	8	.1
90.0	0	0.0	2	.0	0	0.0	0	0.0	0	0.0	0	0.0	2	.0
112.5	0	0.0	5	.1	3	.0	0	0.0	0	0.0	0	0.0	8	.1
135.0	1	.0	4	.0	6	.1	1	.0	0	0.0	0	0.0	12	.1
157.5	0	0.0	7	.1	4	.0	4	.0	0	0.0	0	0.0	15	.2
180.0	0	0.0	13	.2	8	.1	6	.1	1	.0	0	0.0	28	.3
202.5	0	0.0	3	.0	7	.1	1	.0	0	0.0	0	0.0	11	.1
225.0	0	0.0	1	.0	1	.0	1	.0	0	0.0	0	0.0	3	.0
247.5	0	0.0	0	0.0	2	.0	6	.1	2	.0	1	.0	11	.1
270.0	1	.0	3	.0	5	.1	16	.2	15	.2	7	.1	47	.5
292.5	4	.0	6	.1	9	.1	11	.1	15	.2	26	.3	71	.8
315.0	3	.0	11	.1	22	.3	25	.3	7	.1	13	.2	81	.9
337.5	2	.0	13	.2	18	.2	17	.2	0	0.0	0	0.0	50	.6
360.0	1	.0	11	.1	15	.2	10	.1	1	.0	0	0.0	38	.4
	22	.3	109	1.3	123	1.4	102	1.2	41	.5	47	.5	444	5.2

MEAN WIND SPEED 12.7

TABLE 451.16-2 (Cont)

JAN 75 - DEC 75

DEG C/100M (200-27FT) LAPSE RATE -1.4/ -0.5 CLASS D

	SPEEDS(MI/HR) 1-3		4-7		8-12		13-18		19-23		24 PLUS		SUM	PERCENT
DIRECTION	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT		
22.5	18	.2	129	1.5	38	.4	3	.0	0	0.0	0	0.0	188	2.2
45.0	34	.4	115	1.3	136	1.6	2	.0	0	0.0	0	0.0	287	3.3
67.5	30	.4	26	.3	0	0.0	0	0.0	0	0.0	0	0.0	56	.7
90.0	26	.3	33	.4	9	.1	0	0.0	0	0.0	0	0.0	68	.8
112.5	18	.2	50	.6	69	.8	15	.2	0	0.0	0	0.0	152	1.8
135.0	14	.2	85	1.0	106	1.2	22	.3	3	.0	0	0.0	230	2.7
157.5	11	.1	74	.9	40	.5	9	.1	0	0.0	0	0.0	134	1.6
180.0	17	.2	96	1.1	106	1.2	38	.4	1	.0	0	0.0	258	3.0
202.5	6	.1	68	.8	36	.4	4	.0	1	.0	0	0.0	115	1.3
225.0	4	.0	34	.4	66	.8	23	.3	5	.1	1	.0	133	1.6
247.5	4	.0	39	.5	162	1.9	119	1.4	35	.4	37	.4	396	4.6
270.0	8	.1	62	.7	143	1.7	199	2.3	107	1.2	77	.9	596	7.0
292.5	4	.0	47	.5	105	1.2	100	1.2	48	.6	36	.4	341	4.0
315.0	15	.2	54	.6	80	.9	76	.9	37	.4	11	.1	273	3.2
337.5	11	.1	42	.5	46	.5	16	.2	1	.0	0	0.0	116	1.4
360.0	16	.2	54	.6	23	.3	1	.0	0	0.0	0	0.0	94	1.1
	236	2.8	1008	11.8	1166	13.6	627	7.3	238	2.8	162	1.9	3437	40.1

MEAN WIND SPEED 10.7

TABLE 451.16-2 (Cont)

JAN 75 - DEC 75

DEG C/100M (200-27FT) LAPSE RATE -0.4/ 1.5 CLASS E

	SPEEDS(MI/HR) 1-3		4-7		8-12		13-18		19-23		24 PLUS		SUM	PERCENT
DIRECTION	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT		
22.5	14	.2	38	.4	0	0.0	1	.0	0	0.0	0	0.0	53	.6
45.0	32	.4	64	.7	2	.0	0	0.0	0	0.0	0	0.0	98	1.1
67.5	37	.4	28	.3	0	0.0	0	0.0	0	0.0	0	0.0	65	.8
90.0	47	.5	56	.7	3	.0	0	0.0	0	0.0	0	0.0	106	1.2
112.5	35	.4	89	1.0	61	.7	8	.1	0	0.0	0	0.0	193	2.3
135.0	28	.3	160	1.9	171	2.0	45	.5	2	.0	0	0.0	406	4.7
157.5	34	.4	119	1.4	94	1.1	19	.2	0	0.0	0	0.0	266	3.1
180.0	25	.3	266	3.1	201	2.3	18	.2	1	.0	0	0.0	511	6.0
202.5	32	.4	124	1.4	55	.6	2	.0	0	0.0	0	0.0	213	2.5
225.0	17	.2	72	.8	85	1.0	31	.4	8	.1	3	.0	216	2.5
247.5	9	.1	54	.6	124	1.4	97	1.1	14	.2	3	.0	301	3.5
270.0	12	.1	35	.4	31	.4	67	.8	25	.3	7	.1	177	2.1
292.5	7	.1	19	.2	24	.3	22	.3	9	.1	3	.0	84	1.0
315.0	17	.2	15	.2	16	.2	2	.0	1	.0	0	0.0	51	.6
337.5	4	.0	8	.1	1	.0	1	.0	0	0.0	0	0.0	14	.2
360.0	9	.1	13	.2	1	.0	0	0.0	0	0.0	0	0.0	23	.3
	359	4.2	1160	13.5	869	10.1	313	3.7	60	.7	16	.2	2777	32.4

MEAN WIND SPEED 7.9

TABLE 451.16-2 (Cont)

JAN 75 - DEC 75

DEG C/100M (200-27FT) LAPSE RATE 1.6 / 4.0 CLASS F

SPEEDS(MI/HR)

DIRECTION	1-3 SUM	1-3 PERCENT	4-7 SUM	4-7 PERCENT	8-12 SUM	8-12 PERCENT	13-18 SUM	13-18 PERCENT	19-23 SUM	19-23 PERCENT	24 PLUS SUM	24 PLUS PERCENT	SUM	PERCENT
22.5	1	.0	7	.1	0	0.0	0	0.0	0	0.0	0	0.0	8	.1
45.0	7	.1	5	.1	0	0.0	0	0.0	0	0.0	0	0.0	12	.1
67.5	14	.2	3	.0	0	0.0	0	0.0	0	0.0	0	0.0	17	.2
90.0	24	.3	12	.1	0	0.0	0	0.0	0	0.0	0	0.0	36	.4
112.5	21	.2	36	.4	1	.0	0	0.0	0	0.0	0	0.0	58	.7
135.0	21	.2	78	.9	5	.1	0	0.0	0	0.0	0	0.0	104	1.2
157.5	37	.4	74	.9	14	.2	0	0.0	0	0.0	0	0.0	125	1.5
180.0	9	.1	131	1.5	13	.2	0	0.0	0	0.0	0	0.0	153	1.8
202.5	10	.1	37	.4	3	.0	0	0.0	0	0.0	0	0.0	50	.6
225.0	6	.1	14	.2	4	.0	0	0.0	0	0.0	0	0.0	24	.3
247.5	6	.1	11	.1	27	.3	16	.2	2	.0	0	0.0	62	.7
270.0	7	.1	17	.2	4	.0	0	0.0	1	.0	0	0.0	29	.3
292.5	3	.0	9	.1	2	.0	1	.0	0	0.0	0	0.0	15	.2
315.0	4	.0	1	.0	1	.0	1	.0	0	0.0	0	0.0	7	.1
337.5	9	.1	10	.1	0	0.0	0	0.0	0	0.0	0	0.0	19	.2
360.0	6	.1	3	.0	0	0.0	0	0.0	0	0.0	0	0.0	9	.1
	185	2.2	448	5.2	74	.9	18	.2	3	.0	0	0.0	728	8.5

MEAN WIND SPEED 5.3

Nine Mile Point Unit 2 ER-OLS

TABLE 451.16-2 (Cont)

JAN 75 - DEC 75

DEG C/100M (200-27FT) LAPSE RATE GT. 4.0 CLASS G

SPEEDS(MI/HR)

DIRECTION	1-3 SUM	1-3 PERCENT	4-7 SUM	4-7 PERCENT	8-12 SUM	8-12 PERCENT	13-18 SUM	13-18 PERCENT	19-23 SUM	19-23 PERCENT	24 PLUS SUM	24 PLUS PERCENT	SUM	PERCENT
22.5	1	.0	2	.0	0	0.0	0	0.0	0	0.0	0	0.0	3	.0
45.0	2	.0	3	.0	0	0.0	0	0.0	0	0.0	0	0.0	5	.1
67.5	2	.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	.0
90.0	28	.3	5	.1	0	0.0	0	0.0	0	0.0	0	0.0	33	.4
112.5	45	.5	29	.3	1	.0	0	0.0	0	0.0	0	0.0	75	.9
135.0	44	.5	54	.6	1	.0	0	0.0	0	0.0	0	0.0	99	1.2
157.5	32	.4	124	1.4	2	.0	0	0.0	0	0.0	0	0.0	158	1.8
180.0	16	.2	65	.8	0	0.0	0	0.0	0	0.0	0	0.0	81	.9
202.5	2	.0	4	.0	1	.0	0	0.0	0	0.0	0	0.0	7	.1
225.0	0	0.0	0	0.0	1	.0	0	0.0	0	0.0	0	0.0	1	.0
247.5	0	0.0	3	.0	9	.1	4	.0	0	0.0	0	0.0	16	.2
270.0	1	.0	6	.1	1	.0	0	0.0	0	0.0	0	0.0	8	.1
292.5	2	.0	0	0.0	1	.0	0	0.0	0	0.0	0	0.0	3	.0
315.0	1	.0	3	.0	0	0.0	0	0.0	0	0.0	0	0.0	4	.0
337.5	1	.0	2	.0	0	0.0	0	0.0	0	0.0	0	0.0	3	.0
360.0	0	0.0	2	.0	0	0.0	0	0.0	0	0.0	0	0.0	2	.0
	177	2.1	302	3.5	17	.2	4	.0	0	0.0	0	0.0	500	5.8

MEAN WIND SPEED 4.2

Nine Mile Point Unit 2 ER-OLS

TABLE 451.16-2 (Cont)

JAN 75 - DEC 75

DEG C/100M (200-27FT) LAPSE RATE ALL STABILITIES

	SPEEDS(MI/HR) 1-3		4-7		8-12		13-18		19-23		24 PLUS			
DIRECTION	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT
22.5	46	.5	229	2.7	75	.9	9	.1	0	0.0	0	0.0	359	4.2
45.0	78	.9	216	2.5	181	2.1	9	.1	0	0.0	0	0.0	484	5.6
67.5	86	1.0	68	.8	0	0.0	0	0.0	0	0.0	0	0.0	154	1.8
90.0	125	1.5	112	1.3	12	.1	0	0.0	0	0.0	0	0.0	249	2.9
112.5	119	1.4	213	2.5	141	1.6	23	.3	0	0.0	0	0.0	496	5.8
135.0	108	1.3	388	4.5	306	3.6	74	.9	6	.1	0	0.0	882	10.3
157.5	114	1.3	409	4.8	166	1.9	39	.5	0	0.0	0	0.0	728	8.5
180.0	67	.8	584	6.8	340	4.0	67	.8	5	.1	0	0.0	1063	12.4
202.5	50	.6	240	2.8	113	1.3	8	.1	1	.0	0	0.0	412	4.8
225.0	27	.3	121	1.4	158	1.8	55	.6	13	.2	4	.0	378	4.4
247.5	20	.2	107	1.2	326	3.8	244	2.8	55	.6	45	.5	797	9.3
270.0	30	.4	124	1.4	184	2.1	282	3.3	150	1.8	116	1.4	886	10.3
292.5	24	.3	83	1.0	146	1.7	135	1.6	75	.9	93	1.1	556	6.5
315.0	49	.6	120	1.4	148	1.7	145	1.7	58	.7	28	.3	548	6.4
337.5	47	.5	109	1.3	81	.9	64	.7	5	.1	0	0.0	306	3.6
360.0	48	.6	134	1.6	56	.7	21	.2	1	.0	0	0.0	260	3.0
	1038	12.1	3257	38.0	2433	28.4	1175	13.7	369	4.3	286	3.3	8558	99.9

MISSING HOURS 190

MEAN WIND SPEED 9.1

TOTAL NUMBER OF CALM HOURS 12 PERCENT .1

TABLE 451.16-2 (Cont)

JAN 75 - DEC 75

DEG C/100M (200-27FT) DIRECTION VS SPEED

	SPEEDS(MI/HR) 1-3		4-7		8-12		13-18		19-23		24 PLUS			
DIRECTION	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT
22.5	46	.5	229	2.7	78	.9	9	.1	0	0.0	0	0.0	362	4.2
45.0	78	.9	216	2.5	181	2.1	9	.1	0	0.0	0	0.0	484	5.6
67.5	86	1.0	68	.8	0	0.0	0	0.0	0	0.0	0	0.0	154	1.8
90.0	125	1.5	112	1.3	12	.1	0	0.0	0	0.0	0	0.0	249	2.9
112.5	119	1.4	213	2.5	143	1.7	23	.3	0	0.0	0	0.0	498	5.8
135.0	108	1.3	391	4.5	306	3.6	76	.9	6	.1	0	0.0	887	10.3
157.5	114	1.3	409	4.8	167	1.9	39	.5	0	0.0	0	0.0	729	8.5
180.0	67	.8	585	6.8	340	4.0	69	.8	5	.1	0	0.0	1066	12.4
202.5	51	.6	240	2.8	115	1.3	8	.1	1	.0	0	0.0	415	4.8
225.0	27	.3	121	1.4	159	1.8	55	.6	13	.2	4	.0	379	4.4
247.5	20	.2	107	1.2	328	3.8	244	2.8	59	.6	45	.5	799	9.3
270.0	30	.3	124	1.4	185	2.2	283	3.3	150	1.7	116	1.3	888	10.3
292.5	24	.3	84	1.0	147	1.7	135	1.6	75	.9	97	1.1	562	6.5
315.0	49	.6	121	1.4	149	1.7	145	1.7	58	.7	28	.3	550	6.4
337.5	47	.5	109	1.3	81	.9	64	.7	5	.1	0	0.0	306	3.6
360.0	48	.6	136	1.6	56	.7	21	.2	1	.0	0	0.0	262	3.0
	1039	12.1	3265	38.0	2447	28.4	1180	13.7	369	4.3	290	3.4	8590	99.9

MISSING HOURS 158

MEAN WIND SPEED 9.1

TOTAL NUMBER OF CALM HOURS 12 PERCENT .1

TABLE 451.16-3

COMPARISON OF ANNUAL ONSITE 9-M (30-FT) WIND DIRECTION FREQUENCY DISTRIBUTIONS

Directional Sector	Jan 1974 through Dec 1976 and Nov 1978 through Oct 1980 (%)	Jan 1975 through Dec 1975 (%)
NNE	3.1	4.2
NE	4.6	5.6
ENE	2.2	1.8
E	3.5	2.9
ESE	6.5	5.8
SE	10.6	10.3
SSE	8.0	8.5
S	10.4	12.4
SSW	4.7	4.8
SW	4.3	4.4
WSW	9.7	9.3
W	11.1	10.3
WNW	7.4	6.5
NW	7.5	6.4
NNW	3.1	3.6
N	3.0	3.0
Calm	0.4	0.1

TABLE 451.16-4

COMPARISON OF ONSITE AND
SYRACUSE NWS STABILITY FREQUENCY DISTRIBUTIONS

Stability Class	1975 Nine Mile Point[1] (%)	5-Yr Concurrent Period[2] Nine Mile Point[1] (%)	5-Yr Concurrent Period[2] Syracuse NWS[3] (%)	10-Yr Period[4] Syracuse NWS[3] (%)
Extremely unstable (A)	5.8	5.2	0.4	0.4
Moderately unstable (B)	2.0	2.6	4.2	4.5
Slightly unstable (C)	5.2	5.2	8.6	8.6
Neutral (D)	40.1	38.0	62.7	61.0
Stable (E, F, G)	46.7	49.0	24.2	25.4

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(1) Stability determined from temperature difference data measured on the site tower.
(2) January 1974 through December 1976 and November 1978 through October 1980.
(3) Stability determined by the STAR program consistent with Turner's method.
(4) January 1955 through December 1964.

TABLE 451.16-5

NRC FORMAT OF NINE MILE POINT METEOROLOGICAL DATA TAPE
FOR COOLING TOWER PLUME MODELING

January 1974 through December 1974

Data Description	Units	Format	Columns
ID number	(000041)	I6	1-6
Year		I2	7-8
Julian day		I3	9-11
Hour		I4	12-15
Upper height	(m x 10) (610)	I5	16-20
200-ft wind direction	(deg Az x 10)	I5	21-25
200-ft wind speed	(m/sec x 10)	I5	26-30
Blank		5X	31-35
Blank		5X	36-40
200-ft relative humidity	(% x 10)	I5	41-45
Blank		5X	46-50
Intermediate wind height	(m x 10) (305)	I5	51-55
100-ft wind direction	(deg Az x 10)	I5	56-60
100-ft wind speed	(m/sec x 10)	I5	61-65
Blank		5X	66-70
Blank		5X	71-75
Blank		5X	76-80
Blank		5X	81-85

TABLE 451.16-5 (Cont)

Data Description	Units	Format	Columns
Lower wind height	(m x 10 (91)	I5	86-90
30-ft vane direction	(deg Az x 10)	I5	91-95
30-ft cup speed	(m/sec x 10)	I5	96-100
Blank		5X	101-105
27-ft ambient temperature	(°C x 10)	I5	106-110
30-ft relative humidity	(% x 10)	I5	111-115
27-ft dew point temperature	(°C x10)	I5	116-120
200-27-ft temperature difference	(°C/100 m x 10)	I5	121-125
Blank		5X	126-130
100-27-ft temperature difference	(°C/100 m x 10)	I5	131-135
Precipitation	(mm x 10)	I5 5X	136-140 141-145
Pressure	(mb x 10)	I5	146-150
30-ft aerovane direction	(deg Az x 10)	I5	151-155
30-ft aerovane speed	(m/sec x 10)	I5	156-160

Nine Mile Point Unit 2 ER-OLS

TABLE 451.16-6

1974 JOINT DISTRIBUTION OF WIND DIRECTION AND SPEED
LOCATION 200 FT

JAN 74 - DEC 74

DEG C/100M (200-27FT) LAPSE RATE LE-1.9 CLASS A

	SPEEDS(MI/HR) 1-3		4-7		8-12		13-18		19-23		24 PLUS		SUM	PERCENT
DIRECTION	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT		
22.5	0	0.0	6	.1	14	.2	20	.2	18	.2	7	.1	65	.8
45.0	0	0.0	6	.1	3	.0	11	.1	10	.1	6	.1	36	.4
67.5	0	0.0	1	.0	0	0.0	0	0.0	0	0.0	0	0.0	1	.0
90.0	1	.0	1	.0	1	.0	0	0.0	0	0.0	0	0.0	3	.0
112.5	0	0.0	1	.0	1	.0	1	.0	0	0.0	0	0.0	3	.0
135.0	0	0.0	2	.0	6	.1	2	.0	2	.0	4	.0	16	.2
157.5	0	0.0	1	.0	8	.1	12	.1	2	.0	3	.0	26	.3
180.0	0	0.0	1	.0	3	.0	11	.1	1	.0	6	.1	22	.3
202.5	0	0.0	0	0.0	4	.0	5	.1	0	0.0	0	0.0	9	.1
225.0	0	0.0	0	0.0	1	.0	1	.0	1	.0	0	0.0	3	.0
247.5	0	0.0	0	0.0	0	0.0	0	0.0	1	.0	0	0.0	1	.0
270.0	0	0.0	3	.0	0	0.0	0	0.0	1	.0	18	.2	22	.3
292.5	0	0.0	1	.0	2	.0	3	.0	5	.1	25	.3	36	.4
315.0	0	0.0	1	.0	17	.2	14	.2	10	.1	31	.4	73	.9
337.5	0	0.0	15	.2	27	.3	29	.3	6	.1	28	.3	105	1.3
360.0	0	0.0	12	.1	30	.4	28	.3	17	.2	13	.2	100	1.2
	1	.0	51	.6	117	1.4	137	1.6	74	.9	141	1.7	521	6.2

MEAN WIND SPEED 18.6

JAN 74 - DEC 74

DEG C/100M (200-27FT) LAPSE RATE -1.8/ -1.7 CLASS B

SPEEDS(MI/HR)

DIRECTION	1-3 SUM	1-3 PERCENT	4-7 SUM	4-7 PERCENT	8-12 SUM	8-12 PERCENT	13-18 SUM	13-18 PERCENT	19-23 SUM	19-23 PERCENT	24 PLUS SUM	24 PLUS PERCENT	SUM	PERCENT
22.5	1	.0	3	.0	2	.0	3	.0	4	.0	2	.0	15	.2
45.0	0	0.0	8	.1	4	.0	0	0.0	1	.0	4	.0	17	.2
67.5	0	0.0	2	.0	1	.0	0	0.0	0	0.0	0	0.0	3	.0
90.0	0	0.0	0	0.0	1	.0	0	0.0	0	0.0	0	0.0	1	.0
112.5	0	0.0	1	.0	1	.0	1	.0	1	.0	0	0.0	4	.0
135.0	0	0.0	1	.0	3	.0	5	.1	0	0.0	0	0.0	9	.1
157.5	0	0.0	1	.0	4	.0	4	.0	1	.0	0	0.0	10	.1
180.0	0	0.0	1	.0	5	.1	2	.0	0	0.0	2	.0	10	.1
202.5	0	0.0	0	0.0	0	0.0	1	.0	0	0.0	0	0.0	1	.0
225.0	0	0.0	0	0.0	0	0.0	1	.0	0	0.0	0	0.0	1	.0
247.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	7	.1	7	.1
270.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	20	.2	20	.2
292.5	2	.0	1	.0	0	0.0	3	.0	1	.0	17	.2	24	.3
315.0	0	0.0	1	.0	3	.0	10	.1	8	.1	7	.1	29	.3
337.5	0	0.0	1	.0	2	.0	1	.0	3	.0	7	.1	14	.2
360.0	0	0.0	1	.0	1	.0	2	.0	3	.0	6	.1	13	.2
	3	.0	21	.3	27	.3	33	.4	22	.3	72	.9	178	2.1

MEAN WIND SPEED 21.0

TABLE 451.16-6 (Cont)

JAN 74 - DEC 74

DEG C/100M (200-27FT) LAPSE RATE -1.6/ -1.5 CLASS C

	SPEEDS(MI/HR) 1-3		4-7		8-12		13-18		19-23		24 PLUS		SUM	PERCENT
DIRECTION	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT		
22.5	0	0.0	2	.0	4	.0	2	.0	3	.0	10	.1	21	.3
45.0	0	0.0	9	.1	7	.1	7	.1	4	.0	11	.1	38	.5
67.5	0	0.0	4	.0	2	.0	0	0.0	0	0.0	0	0.0	6	.1
90.0	0	0.0	1	.0	5	.1	0	0.0	0	0.0	0	0.0	6	.1
112.5	0	0.0	1	.0	2	.0	3	.0	0	0.0	0	0.0	6	.1
135.0	0	0.0	6	.1	4	.0	5	.1	1	.0	0	0.0	16	.2
157.5	0	0.0	3	.0	8	.1	7	.1	0	0.0	2	.0	20	.2
180.0	0	0.0	3	.0	9	.1	7	.1	2	.0	5	.1	26	.3
202.5	0	0.0	1	.0	2	.0	2	.0	1	.0	2	.0	8	.1
225.0	0	0.0	0	0.0	2	.0	1	.0	1	.0	0	0.0	4	.0
247.5	0	0.0	1	.0	0	0.0	5	.1	2	.0	6	.1	14	.2
270.0	0	0.0	0	0.0	5	.1	9	.1	8	.1	19	.2	41	.5
292.5	2	.0	4	.0	4	.0	17	.2	6	.1	37	.4	70	.8
315.0	0	0.0	6	.1	4	.0	27	.3	20	.2	27	.3	84	1.0
337.5	3	.0	4	.0	1	.0	12	.1	17	.2	14	.2	51	.6
360.0	1	.0	6	.1	1	.0	9	.1	6	.1	21	.3	44	.5
	6	.1	51	.6	60	.7	113	1.4	71	.9	154	1.8	455	5.5

MEAN WIND SPEED 19.6

TABLE 451.16-6 (Cont)

JAN 74 - DEC 74

DEG C/100M - (200-27FT) LAPSE RATE -1.4/ -0.5 CLASS D

	SPEEDS(MI/HR) 1-3		4-7		8-12		13-18		19-23		24 PLUS		SUM	PERCENT
DIRECTION	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT		
22.5	4	.0	13	.2	22	.3	56	.7	32	.4	69	.8	196	2.3
45.0	4	.0	19	.2	38	.5	46	.6	35	.4	52	.6	194	2.3
67.5	4	.0	24	.3	20	.2	21	.3	5	.1	2	.0	76	.9
90.0	6	.1	19	.2	24	.3	24	.3	0	0.0	0	0.0	73	.9
112.5	3	.0	35	.4	26	.3	65	.8	23	.3	3	.0	155	1.9
135.0	5	.1	50	.6	67	.8	85	1.0	35	.4	12	.1	254	3.0
157.5	3	.0	23	.3	56	.7	52	.6	17	.2	17	.2	168	2.0
180.0	3	.0	27	.3	107	1.3	93	1.1	39	.5	14	.2	283	3.4
202.5	2	.0	12	.1	44	.5	41	.5	10	.1	4	.0	113	1.4
225.0	3	.0	6	.1	26	.3	54	.6	28	.3	8	.1	125	1.5
247.5	3	.0	16	.2	65	.8	133	1.6	61	.7	53	.6	331	4.0
270.0	3	.0	35	.4	102	1.2	121	1.5	85	1.0	132	1.6	478	5.7
292.5	4	.0	26	.3	57	.7	113	1.4	83	1.0	184	2.2	467	5.6
315.0	1	.0	22	.3	72	.9	74	.9	52	.6	47	.6	268	3.2
337.5	1	.0	12	.1	37	.4	29	.3	22	.3	12	.1	113	1.4
360.0	2	.0	23	.3	37	.4	54	.6	42	.5	30	.4	188	2.3
	51	.6	362	4.3	800	9.6	1061	12.7	569	6.8	639	7.7	3482	41.7

MEAN WIND SPEED 16.4

Nine Mile Point Unit 2 ER-OLS

TABLE 451.16-6 (Cont)

JAN 74 - DEC 74

DEG C/100M (200-27FT) LAPSE RATE -0.4/ 1.5 CLASS E

SPEEDS(MI/HR)

DIRECTION	1-3 SUM	1-3 PERCENT	4-7 SUM	4-7 PERCENT	8-12 SUM	8-12 PERCENT	13-18 SUM	13-18 PERCENT	19-23 SUM	19-23 PERCENT	24 PLUS SUM	24 PLUS PERCENT	SUM	PERCENT
22.5	3	.0	8	.1	9	.1	8	.1	7	.1	4	.0	39	.5
45.0	2	.0	14	.2	20	.2	34	.4	17	.2	3	.0	90	1.1
67.5	4	.0	7	.1	21	.3	14	.2	1	.0	0	0.0	47	.6
90.0	3	.0	9	.1	33	.4	22	.3	1	.0	0	0.0	68	.8
112.5	2	.0	16	.2	44	.5	33	.4	16	.2	14	.2	125	1.5
135.0	2	.0	16	.2	85	1.0	178	2.1	97	1.2	38	.5	416	5.0
157.5	7	.1	11	.1	57	.7	98	1.2	88	1.1	21	.3	282	3.4
180.0	1	.0	20	.2	66	.8	248	3.0	71	.9	9	.1	415	5.0
202.5	3	.0	11	.1	47	.6	111	1.3	17	.2	0	0.0	189	2.3
225.0	5	.1	8	.1	39	.5	76	.9	27	.3	11	.1	166	2.0
247.5	4	.0	24	.3	56	.7	88	1.1	58	.7	78	.9	308	3.7
270.0	0	0.0	17	.2	27	.3	41	.5	38	.5	43	.5	166	2.0
292.5	3	.0	11	.1	10	.1	20	.2	18	.2	18	.2	80	1.0
315.0	2	.0	4	.0	9	.1	12	.1	6	.1	11	.1	44	.5
337.5	0	0.0	3	.0	12	.1	11	.1	4	.0	0	0.0	30	.4
360.0	2	.0	4	.0	12	.1	10	.1	7	.1	6	.1	41	.5
	43	.5	183	2.2	547	6.6	1004	12.0	473	5.7	256	3.1	2506	30.0

MEAN WIND SPEED 15.6

TABLE 451.16-6 (Cont)

JAN 74 - DEC 74

DEG C/100M (200-27FT)   LAPSE RATE 1.6 / 4.0 CLASS F

	SPEEDS(MI/HR) 1-3		4-7		8-12		13-18		19-23		24 PLUS			
DIRECTION	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT
22.5	1	.0	2	.0	1	.0	1	.0	2	.0	0	0.0	7	.1
45.0	1	.0	1	.0	9	.1	1	.0	1	.0	0	0.0	13	.2
67.5	2	.0	6	.1	4	.0	0	0.0	0	0.0	0	0.0	12	.1
90.0	0	0.0	12	.1	17	.2	5	.1	0	0.0	0	0.0	34	.4
112.5	0	0.0	8	.1	22	.3	12	.1	2	.0	0	0.0	44	.5
135.0	3	.0	3	.0	18	.2	43	.5	13	.2	0	0.0	80	1.0
157.5	0	0.0	5	.1	20	.2	47	.6	28	.3	0	0.0	100	1.2
180.0	0	0.0	8	.1	31	.4	57	.7	19	.2	0	0.0	115	1.4
202.5	2	.0	4	.0	20	.2	29	.3	5	.1	0	0.0	60	.7
225.0	3	.0	5	.1	20	.2	33	.4	1	.0	0	0.0	62	.7
247.5	0	0.0	9	.1	21	.3	25	.3	10	.1	6	.1	71	.9
270.0	3	.0	9	.1	12	.1	12	.1	6	.1	6	.1	48	.6
292.5	3	.0	3	.0	1	.0	2	.0	1	.0	3	.0	13	.2
315.0	0	0.0	4	.0	1	.0	6	.1	1	.0	0	0.0	12	.1
337.5	1	.0	3	.0	5	.1	1	.0	0	0.0	0	0.0	10	.1
360.0	3	.0	5	.1	4	.0	8	.1	1	.0	0	0.0	21	.3
	22	.3	87	1.0	206	2.5	282	3.4	90	1.1	15	.2	702	8.4

MEAN WIND SPEED 13.1

Nine Mile Point Unit 2 ER-OLS

TABLE 451.16-6 (Cont)

JAN 74 - DEC 74

DEG C/100M (200-27FT) LAPSE RATE GT. 4.0 CLASS G

DIRECTION	1-3 SUM	1-3 PERCENT	4-7 SUM	4-7 PERCENT	8-12 SUM	8-12 PERCENT	13-18 SUM	13-18 PERCENT	19-23 SUM	19-23 PERCENT	24 PLUS SUM	24 PLUS PERCENT	SUM	PERCENT
					SPEEDS(MI/HR)									
22.5	0	0.0	0	0.0	3	.0	0	0.0	0	0.0	0	0.0	3	.0
45.0	2	.0	6	.1	3	.0	0	0.0	0	0.0	0	0.0	11	.1
67.5	0	0.0	7	.1	5	.1	0	0.0	0	0.0	0	0.0	12	.1
90.0	1	.0	12	.1	25	.3	2	.0	0	0.0	0	0.0	40	.5
112.5	1	.0	11	.1	27	.3	12	.1	2	.0	0	0.0	53	.6
135.0	0	0.0	6	.1	17	.2	14	.2	6	.1	0	0.0	43	.5
157.5	2	.0	7	.1	20	.2	34	.4	5	.1	0	0.0	68	.8
180.0	3	.0	13	.2	37	.4	43	.5	4	.0	1	.0	101	1.2
202.5	3	.0	9	.1	20	.2	9	.1	0	0.0	0	0.0	41	.5
225.0	1	.0	10	.1	8	.1	9	.1	0	0.0	0	0.0	28	.3
247.5	1	.0	10	.1	7	.1	10	.1	3	.0	1	.0	32	.4
270.0	1	.0	8	.1	3	.0	1	.0	1	.0	1	.0	15	.2
292.5	2	.0	1	.0	2	.0	0	0.0	0	0.0	1	.0	6	.1
315.0	1	.0	1	.0	0	0.0	0	0.0	0	0.0	0	0.0	2	.0
337.5	0	0.0	2	.0	2	.0	0	0.0	0	0.0	0	0.0	4	.0
360.0	1	.0	0	0.0	1	.0	1	.0	0	0.0	0	0.0	3	.0
	19	.2	103	1.2	180	2.2	135	1.6	21	.3	4	.0	462	5.5

MEAN WIND SPEED 10.5

JAN 74 - DEC 74

DEG C/100M (200-27FT) LAPSE RATE ALL STABILITIES

SPEEDS(MI/HR)

DIRECTION	1-3 SUM	1-3 PERCENT	4-7 SUM	4-7 PERCENT	8-12 SUM	8-12 PERCENT	13-18 SUM	13-18 PERCENT	19-23 SUM	19-23 PERCENT	24 PLUS SUM	24 PLUS PERCENT	SUM	PERCENT
22.5	9	.1	34	.4	55	.7	90	1.1	66	.8	92	1.1	346	4.1
45.0	9	.1	63	.8	84	1.0	99	1.2	68	.8	76	.9	399	4.8
67.5	10	.1	51	.6	53	.6	35	.4	6	.1	2	.0	157	1.9
90.0	11	.1	54	.6	106	1.3	53	.6	1	.0	0	0.0	225	2.7
112.5	6	.1	73	.9	123	1.5	127	1.5	44	.5	17	.2	390	4.7
135.0	10	.1	84	1.0	200	2.4	332	4.0	154	1.8	54	.6	834	10.0
157.5	12	.1	51	.6	173	2.1	254	3.0	141	1.7	43	.5	674	8.1
180.0	7	.1	73	.9	258	3.1	461	5.5	136	1.6	37	.4	972	11.7
202.5	10	.1	37	.4	137	1.6	198	2.4	33	.4	6	.1	421	5.0
225.0	12	.1	29	.3	96	1.2	175	2.1	58	.7	19	.2	389	4.7
247.5	8	.1	60	.7	149	1.8	261	3.1	135	1.6	151	1.8	764	9.2
270.0	7	.1	72	.9	149	1.8	184	2.2	139	1.7	239	2.9	790	9.5
292.5	16	.2	47	.6	76	.9	158	1.9	114	1.4	285	3.4	696	8.3
315.0	4	.0	39	.5	106	1.3	143	1.7	97	1.2	123	1.5	512	6.1
337.5	5	.1	40	.5	86	1.0	83	1.0	52	.6	61	.7	327	3.9
360.0	9	.1	51	.6	86	1.0	112	1.3	76	.9	76	.9	410	4.9
	145	1.7	858	10.3	1937	23.2	2765	33.1	1320	15.8	1281	15.4	8306	99.6

MISSING HOURS 417

MEAN WIND SPEED 16.0

TOTAL NUMBER OF CALM HOURS 37 PERCENT .4

TABLE 451.16-6 (Cont)

JAN 74 - DEC 74

DEG C/100M
(200-27FT)

DIRECTION VS SPEED

	SPEEDS(MI/HR) 1-3		4-7		8-12		13-18		19-23		24 PLUS			
DIRECTION	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT	SUM	PERCENT
22.5	9	.1	34	.4	55	.7	90	1.1	64	.8	92	1.1	346	4.1
45.0	9	.1	63	.8	84	1.0	99	1.2	68	.8	76	.9	399	4.8
67.5	10	.1	51	.6	53	.6	35	.4	6	.1	2	.0	157	1.9
90.0	11	.1	54	.6	106	1.3	56	.7	1	.0	0	0.0	228	2.7
112.5	6	.1	73	.9	123	1.5	132	1.6	44	.5	17	.2	395	4.7
135.0	10	.1	84	1.0	200	2.4	332	4.0	154	1.8	54	.6	834	10.0
157.5	12	.1	51	.6	173	2.1	254	3.0	141	1.7	43	.5	674	8.1
180.0	7	.1	73	.9	258	3.1	461	5.5	136	1.6	37	.4	972	11.6
202.5	10	.1	37	.4	137	1.6	200	2.4	33	.4	6	.1	423	5.1
225.0	12	.1	29	.3	97	1.2	177	2.1	58	.7	19	.2	392	4.7
247.5	8	.1	60	.7	149	1.8	261	3.1	135	1.6	151	1.8	764	9.1
270.0	7	.1	72	.9	149	1.8	184	2.2	139	1.7	243	2.9	794	9.5
292.5	16	.2	48	.6	77	.9	158	1.9	114	1.4	285	3.4	698	8.3
315.0	4	.0	39	.5	106	1.3	144	1.7	97	1.2	123	1.5	513	6.1
337.5	5	.1	40	.5	86	1.0	83	1.0	52	.6	61	.7	327	3.9
360.0	9	.1	51	.6	88	1.1	112	1.3	76	.9	76	.9	412	4.9
	145	1.7	859	10.3	1941	23.2	2778	33.2	1320	15.8	1285	15.4	8328	99.6

MISSING HOURS 395

MEAN WIND SPEED 16.0

TOTAL NUMBER OF CALM HOURS 37 PERCENT .4

TABLE 451.16-7

COMPARISON OF ANNUAL ONSITE 61-M (200-FT) WIND DIRECTION FREQUENCY DISTRIBUTIONS 7

Directional Sector	Jan 1974 through Dec 1976 and Nov 1978 through Oct 1980 %	Jan 1974 through Dec 1974 %
NNE	4.0	4.1
NE	3.9	4.8
ENE	2.0	1.9
E	2.5	2.7
ESE	4.5	4.7
SE	9.3	10.0
SSE	8.0	8.1
S	9.8	11.6
SSW	5.4	5.1
SW	6.0	4.7
WSW	10.5	9.1
W	11.0	9.5
WNW	7.8	8.3
NW	6.2	6.1
NNW	3.8	3.9
N	4.3	4.9
Calm	0.3	0.4

TABLE 451.16-8

COMPARISON OF ONSITE AND
SYRACUSE NWS STABILITY FREQUENCY DISTRIBUTIONS

Stability Class	1974 Nine Mile Point[1] (%)	5-Yr Concurrent Period[2] Nine Mile Point[1] (%)	5-Yr Concurrent Period[2] Syracuse NWS[3] (%)	10-Yr Period[4] Syracuse NWS[3] (%)
Extremely unstable (A)	6.2	5.2	0.4	0.4
Moderately unstable (B)	2.1	2.6	4.2	4.5
Slightly unstable (C)	5.5	5.2	8.6	8.6
Neutral (D)	41.7	38.0	62.7	61.0
Stable (E, F, G)	43.9	49.0	24.2	25.4

[1]Stability determined from temperature difference data measured on the site tower.
[2]January 1974 through December 1976 and November 1978 through October 1980.
[3]Stability determined by the STAR program consistent with Turner's method.
[4]January 1955 through December 1964.

QUESTION E451.17 (2.7.4)

a) Present the period of record used in Table 2B-40.

b) Indicate which meteorological measurement levels are tabulated in Table 2B-52A.

c) Explain the methodology used to substitute missing hourly relative humidity and dew point temperature measurements in Tables 2B-44 and 2B-51, respectively. Present the relative humidity and dew point temperature data recovery by month for 1974-1976 as shown in Table 2B-52A.

RESPONSE

a) See revised FSAR Table 2B-40.

b) See revised FSAR Table 2B-52A.

c) See revised FSAR Section 2.3.2.2.8.

QUESTION E451.18 (6.8, Regulatory Guide 1.23)

1. Explain what corrective action was taken to resolve the poor data recovery (less than 90%) for measures of atmospheric moisture prior to 1978. What maintenance and calibration procedures are currently being used to insure adequate data recovery?

2. Present the most recent available onsite measurements of atmospheric moisture (dew point) since 1978. The data summaries should show diurnal and monthly averages and extremes, including the data recovery by month.

RESPONSE

Prior to June 1978, relative humidity was measured by Xeritron humidity sensors. Data recovery for these sensors when in service was over 90 percent, as shown in FSAR Table 2B-42A.

In September 1975, the 30-ft instrument was taken out of service and the 200-ft instrument continued to operate at over 90 percent data recovery. At least one sensor remained in service until June 1978, when a chilled mirror system was installed. Subsequently, this instrumentation has been replaced by a new General Eastern chilled mirror system.

The dew point system's recorders are checked once per day, 5
and the electronics are checked once per month. The dew point controller and sensor are calibrated twice a year, assuming normal operations.

If, however, the daily or monthly checks indicate a problem, additional calibration and/or maintenance are performed.

The most recent available onsite summaries of atmospheric moisture content with over 90 percent data recovery are compiled from the 1974 through 1976 tower data.

Monthly data recoveries for the onsite atmospheric moisture measurements from 1978 through October 1980 are listed in Table 2B-52A. After October 1980, no valid moisture measurements have been obtained.

QUESTION E460.25 (ER 3.5)

Provide the input parameter used for the fraction of feedwater processed through the condensate demineralizers to calculate expected annual gaseous and liquid effluent releases (BWR-GALE Code) from Nine Mile Point, Unit No. 2 (NMP-2). For a BWR with pumped forward feedwater heater drain design (such as NMP-2), the BWR-GALE Code executes the ratio of condensate demineralizer flow rate to steam flow rate of 0.18 for iodines and 0.01 for other nuclides. It appears that you have used a ratio value of 1.0 (full flow condensate demineralizers) in the BWR-GALE Code while your actual designed ratio value is approximately 0.7 for which the BWR-GALE Code automatically executes 0.18 and 0.01 instead.

RESPONSE

See revised Section 3.5. The ratio of condensate demineralizer flow rate to steam flow rate of 0.7 is in agreement with the actual designed ratio value. 5

QUESTION E470.1

Indicate whether goats are raised within 50 miles of Nine Mile Point. If so, the fraction of the year the goats are on pasture should be indicated.

RESPONSE

Goats are raised within 50 miles of Nine Mile Point. However, no published statistics concerning goats are available from either the most recent U.S. Census of Agriculture (1978) or the New York State Crop Reporting Service. Based on a radiological receptor survey of the 0-6 km area surrounding Nine Mile Point, which was conducted May 10-14,1982, doe goats are raised within the vicinity of Nine Mile Point Station. Specifically, goats are raised and pastured annually from May through September in the south-southeast sector, approximately 3.85 kilometers from Nine Mile Point. 2

QUESTION E470.2 (6.2)

The Operational Radiological Environmental Monitoring Program should be revised to include the following:

A. Waterborne Pathway

1. Surface - 1 sample downstream of the discharge area.

2. Drinking water - 1 sample of each of 1 to 3 of the nearest water supplies affected by plant discharges and 1 sample from a control location,

B. Ingestion

1 sample of each principal class of food product from any area irrigated by water containing plant discharges.

RESPONSE

The proposed monitoring described in ER-OLS Section 6.2 provides for a surface water sample downstream of the discharge area. Specifically, ER-OLS Table 6.2-1 (page 2 of 3) identifies one sample from the site's most downstream cooling water intake. The site's most downstream intake is the J.A. Fitzpatrick intake which is located downstream of the Unit 2 discharge area.

The nearest domestic water supply intake to Unit 2 is the Metropolitan Water Board intake located approximately 13 km (8 miles) west of the site. This intake is located at a depth of approximately 18 m (59 feet). On the basis that (1) circulation patterns are typically west to east along the south shore of Lake Ontario and (2) plant discharges would be afforded extensive dilution between Unit 2 and the water supply intake, Niagara Mohawk does not consider radiological monitoring to be warranted at this location. This position is consistent with recent negotiations between NRC and NMPC staff concerning the Unit 1 Radiological Effluent Technical Specifications.

The nearest crop irrigation intake to Unit 2 is located approximately 8 km (5 miles) east of the site (Ref. ER-OLS Table 2.3-5). Considering the very low potential radiological dose via this pathway, Niagara Mohawk does not consider monitoring of food products irrigated by water containing plant discharges to be warranted.

QUESTION E470.3 (2.2)

Provide a table of the following:

1. Distance to nearest residence in each compass sector;

2. Distance to nearest garden in each compass sector;

3. Distance to nearest meat cow in each compass sector;

4. Distance to nearest milk cow in each compass sector;

5. Distance to nearest milk goat in each compass sector;

Confirm that this information is based on the most recent land use census. The year of this census should be provided.

RESPONSE

See revised Section 2.2.1.2.

QUESTION E470.4 (2.2)

Provide the approximate shoreline distance to the following list of recreational areas along Lake Ontario. In addition, the type of recreational activity, i.e., boating, swimming or shoreline activities should be specified:

Oswego Beach	Lakeshore Road
Wright's Landing	West Fourth Street
Oswego Marina	East First Street
Shore Grove	off Lake Road, Rte. 1A
Ontario Bible Camp	off Lake Road, Rte. 1A
Nine Mile Point Energy Information Center	off Lake Road, Rte. 1A
Noyes Audubon Sanctuary	off Nine Mile Point Road
Catfish Creek Marina	Catfish Drive, off Rte. 1
Dowie Dale Campground	Dale Road, off Rte. 104B
Mexico Point Boat Launch	Pond Road, off Rte. 104B

RESPONSE

See revised Section 2.2.1.2 for the approximate shoreline distances from Unit 2 to Lakeshore facilities utilized by the public. Note that Shore Grove is a privately owned restaurant located on the shore of Lake Ontario.

QUESTION E470.5 (2.2)

Provide the approximate shoreline distance to the following irrigation intakes:

J. Simplaar	On Lake Ontario between Demster Beach and Hickory Grove Roads
L. Hurlbutt	On the south side of Butterfly Swamp

RESPONSE

See revised Section 2.2.1.2.

QUESTION E470.6 (5A)

Describe how the dilution factors and transit times for Lake Ontario water flow specified in Table 5A-2 were determined.

RESPONSE

With the exception of the dilution factor at the edge of the initial dilution zone, the dilution factors were calculated using Equation 17 in Regulatory Guide 1.113, Revision 1, April 1977, Appendix A.3. This dispersion model simulates a continuous point-source near shore discharge into a lake having a steady longshore current, and the concentrations or dilution factors at downcurrent locations are predicted. Some locations do not share a common shoreline with the discharge point, but dilution factors were calculated with the same model. Since a shoreline restricts dispersion, these results are conservative. At each location of interest the vertical distribution of concentrations was averaged and an average dilution factor reported. In 6
accordance with the procedure cited in Regulatory Guide 1.113, Revision 1, Appendix A.3a(2), the dilution factors have been multiplied by 2.5 if west of the discharge point or by 1.67 if east of the discharge point, in recognition of the approximately bimodal shoreline currents.

The accompanying transit times were calculated by dividing the horizontal distance to each location of interest by the average current speed.

The dilution factor at the edge of the initial dilution zone was conservatively calculated by dividing the annual average discharge temperature rise, 17.64°F, by the maximum allowable surface temperature rise, 3°F. The annual average discharge temperature rise is provided in Table 5.3-8.

The accompanying transit time, being very short, was assumed to be zero.

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[1] 6NYCRR, Part 704, Criteria Governing Thermal Discharges, September 30, 1974.

QUESTION E470.7 (5A)

Describe why the dilution factor for the 0-10 kilometer range in Table 5A-2 is greater, for example, than the 70-80 kilometer range in that same table.

RESPONSE

See revised Table 5A-2. 6