NUREG-1112

Environmental Assessment
for renewal of Special Nuclear Material License No. SNM-368

Docket No. 70-371

UNC Naval Products
Division of UNC Resources, Inc.

U.S. Nuclear Regulatory Commission

Office of Nuclear Material Safety and Safeguards

January 1985

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LIST OF FACTORS FOR CONVERSION OF ENGLISH TO INTERNATIONAL SYSTEM OF UNITS (SI)

The following table gives the factors used in this document for converting conventional English units to the equivalent International System of Units (SI), now being adopted worldwide, or conventional metric units. The conversion factors have been obtained from the ASTM publication "Standard for Metric Practice"* and are used to four-digit accuracy, since most of the values in this document are not known to any more exactness. After conversion, the SI values have been rounded to reflect an accuracy sufficient for the requirements of this document. Most of the values will be presented in SI units with the equivalent English unit following within parentheses.

Conversion of English to SI Units

To Convert From	To	Multiply By
acre	hectare (ha)	0.4047
barrel (bbl)	cubic meter (m^3)	0.1590
cubic feet/min (ft^3/min)	m^3/min	0.02832
feet (ft)	meters (m)	0.3048
cubic feet (ft^3)	cubic meters (m^3)	0.02832
cubic yards ($yards^3$ or yd^3)	m^3	0.7645
gallon (gal)	cubic meters (m^3)	0.003785
gal/min	m^3/min	0.003785
gal/min	m^3/h	0.2271
gal/min	liters/s (L/s)	0.06309
inch (in.)	centimeters (cm)	2.54
inch (in.)	meter (m)	0.0254
mile (statute)	kilometer (km)	1.609
square mile ($mile^2$)	square kilometer (km^2)	2.590
pound (lb)	kilograms (kg)	0.4536
ton (short)	kilograms (kg)	907.2

*American Society for Testing and Materials, Standard E-380, "Standard for Metric Practice," February 1980.

ABBREVIATIONS AND ACRONYMS

AMAD	Activity median aerodynamic diameter
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
DOE	Department of Energy
EIA	Environmental Impact Appraisal
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
NAS	National Academy of Science
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
ORNL	Oak Ridge National Laboratory

1. PURPOSE OF AND NEED FOR ACTION

1.1 Introduction

The UNC Naval Products, Division of UNC Resources, Inc. in Montville, Connecticut, produces fuel assemblies and complete fuel modules for light-water reactors (LWRs) used in the U.S. Navy nuclear propulsion program.

In response to an application by UNC for renewal of Special Nuclear Material (SNM) License No. SNM-368, the U.S. Nuclear Regulatory Commission (NRC), with the technical assistance of the Oak Ridge National Laboratory (ORNL), prepared this environmental assessment pursuant to NRC Regulations (10 CFR Part 51), which implement requirements of the National Environmental Policy Act (NEPA) of 1969 (P.L. 91-190). Part 51 also takes account of the Council on Environmental Quality Regulations (40 CFR Parts 1500-1508) for implementing NEPA. Sections 51.14 and 51.30 of the NRC regulations (10 CFR) defines "Environmental Assessment" as follows:

1. An environmental assessment is a concise public document, for which the NRC is responsible, that serves to

   - briefly provide sufficient evidence and analysis for determining whether to prepare an Environmental Impact Statement (EIS) or a finding of no significant impact,

   - aid the NRC's compliance with NEPA when no EIS is necessary, and

   - facilitate preparation of an EIS when one is necessary.

2. An environmental assessment shall include brief discussions of the need for the proposal, of alternatives as required by Sect. 102(2)(E) of NEPA, and of the environmental impacts of the proposed action and alternatives. It shall also include a listing of agencies and persons consulted.

The UNC facility at Montville has been in operation since 1957. Some modifications to the site and of the production procedures have been made since the last license was issued. No major changes are anticipated during the five-year license renewal period being considered. Modifications to the fuel fabrication plant to reduce the release of environmental pollutants have been completed by UNC. This environmental assessment provides a review of the past five years of operation and an analysis of future impacts.

The UNC plant is located in the town of Montville, New London County, Connecticut. The site contains about 102 ha (251 acres) with only about a 16-ha (40-acre) portion of the site occupied by the UNC fabrication and core assembly plant and associated facilities.

1.2 Summary of the Proposed Action

The proposed action is the renewal of the license necessary for UNC to continue the existing fuel fabrication operation. Principal operations in the fabrication facility include the processing of highly enriched uranium (>90% ^{235}U)

into fuel elements and assembling of the elements into complete reactor cores. The present application for renewal involves no major changes in the current authorization and no new facilities are planned.

1.3 Need For Action

The UNC operation is needed for the fabrication of fuel elements and core assemblies for LWRs for the U.S. Navy propulsion program, including both first fuel loading and subsequent refueling. Denial of license renewal for the fuel-element fabrication activity at the Naval Products Division (NPD) would require that similar activities be undertaken at another site. Although denial of renewal of the SNM license for the UNC NPD is an alternative available to the NRC, it would be considered only if issues of public health and safety cannot be resolved to the satisfaction of the regulatory authorities involved.

1.4 The Scoping Process

The overall UNC operations and impacts were appraised by NRC in January 1974[1]. Because of this previous documentation and the very limited impacts associated with the operation of the UNC, the staff determined that a formal scoping process was unnecessary. In conducting this assessment of the proposed action, the staff met with Connecticut air and water quality specialists on May 18, 1983, toured the site and surrounding area on May 19, 1983, and met with the applicant to discuss items of information related to facility operations and to seek additional information that might be needed for an adequate assessment. The staff used information submitted by UNC[2,3] to assist in the evaluation.

The current operation of the UNC facilities results in the release of radioactive and nonradioactive effluent to the environment. The actual gaseous and liquid pollutants released during normal operation of the plant have been monitored and documented. Because the proposed license renewal for the UNC does not involve an increased scope of activity, the staff concluded that the principal subjects to be addressed in this environmental assessment should include water use, pollutant controls, environmental monitoring, and environmental impact of operation and accidents. Other site factors and plant operations necessary for this assessment will be described, and aspects of insignificant impacts will be identified.

REFERENCES FOR SECTION 1

1. Environmental Impact Appraisal Concerning License SNM-368, Docket No.70-371 - The United Nuclear Corporation, Naval Products Division Montville Plant, Montville, Connecticut, Fuels and Materials, Directorate of Licensing, U.S. Atomic Energy Commission, January 30, 1974.

2. United Nuclear Corporation, "Environmental Information" (provided for the U.S. Nuclear Regulatory Commission), Docket No. 70-371, Jan. 17, 1983.

3. W. F. Kirk, United Nuclear Corporation, letter with additional information to Marc J. Rhodes, U.S. Nuclear Regulatory Commission, Docket No. 70-371, Aug. 17, 1983.

2. ALTERNATIVES, INCLUDING THE PROPOSED ACTION

2.1 The Alternative of No License Renewal

Not granting a license renewal would cause UNC to cease fuel fabrication for the U.S. Navy propulsion program at this site. This alternative would be considered only if issues of public health and safety could not be resolved. The only benefits to be gained by such a course of action would be the cessation of the environmental impacts (as described in Sect. 4), which have been determined to be acceptably small. Since the fuel elements are needed for the naval propulsion program, denial of a license for the UNC would result in the transfer of the environmental impacts to an alternative site.

2.2 The Alternative of License Renewal

This alternative, which is the proposed action, would result in the continued operation of the UNC facility for another 5 years essentially as it has been operated for the past 10 years. A description of the current operation, waste confinement, and effluent control follows.

2.2.1 Description of the Current Operation

The existing UNC operation involves the fabrication of uranium (>90% ^{235}U enrichment) into fuel assemblies and cores for use in naval reactors. The fabrication procedures use classified technology unique to the U.S. Navy program.

In addition, UNC is involved in research on, and development of, improved manufacturing techniques for fuel-element fabrication and in the removal and/or recovery of non-nuclear waste material generated in manufacturing to prevent degradation of the environment.

The physical layout of the UNC facility is shown in Fig. 2.1. The plant buildings are set in the side of the valley with the roof line nearly level with the parking lot on the ridge above Trading Cove. A security fence surrounds the building complex. About 24,400 m^2 (250,000 ft^2) is devoted to manufacturing operations, with the remainder used for offices, pollution control facilities, and storage. The plant buildings are of sturdy construction and are well maintained.

The Montville facility was originally built in 1957-59, with small additions in 1961 and 1966. The original buildings were approximately 58 m (190 ft) by 69 m (225 ft). A major expansion, Building M, completed in 1969 is about 64 m (210 ft) by 73 m (240 ft), and with an attached two story office building. All operation with special nuclear material in these buidings are limited to clad fuel.

Following authorization by the AEC (now NRC) in 1972, UNC constructed four additional buildings. Building A, which is approximately 82 m (270 ft) by 85 m (280 ft) and is contiguous to Building M, was completed in early 1973. Buildings A and M have a general height of 6.4 m (21 ft) except for a penthouse with a height of 11 m (36 ft) and for the process exhaust stacks on the roofs which range from 1 m (3 ft) to 15 m (5 ft) in height. Building B, which

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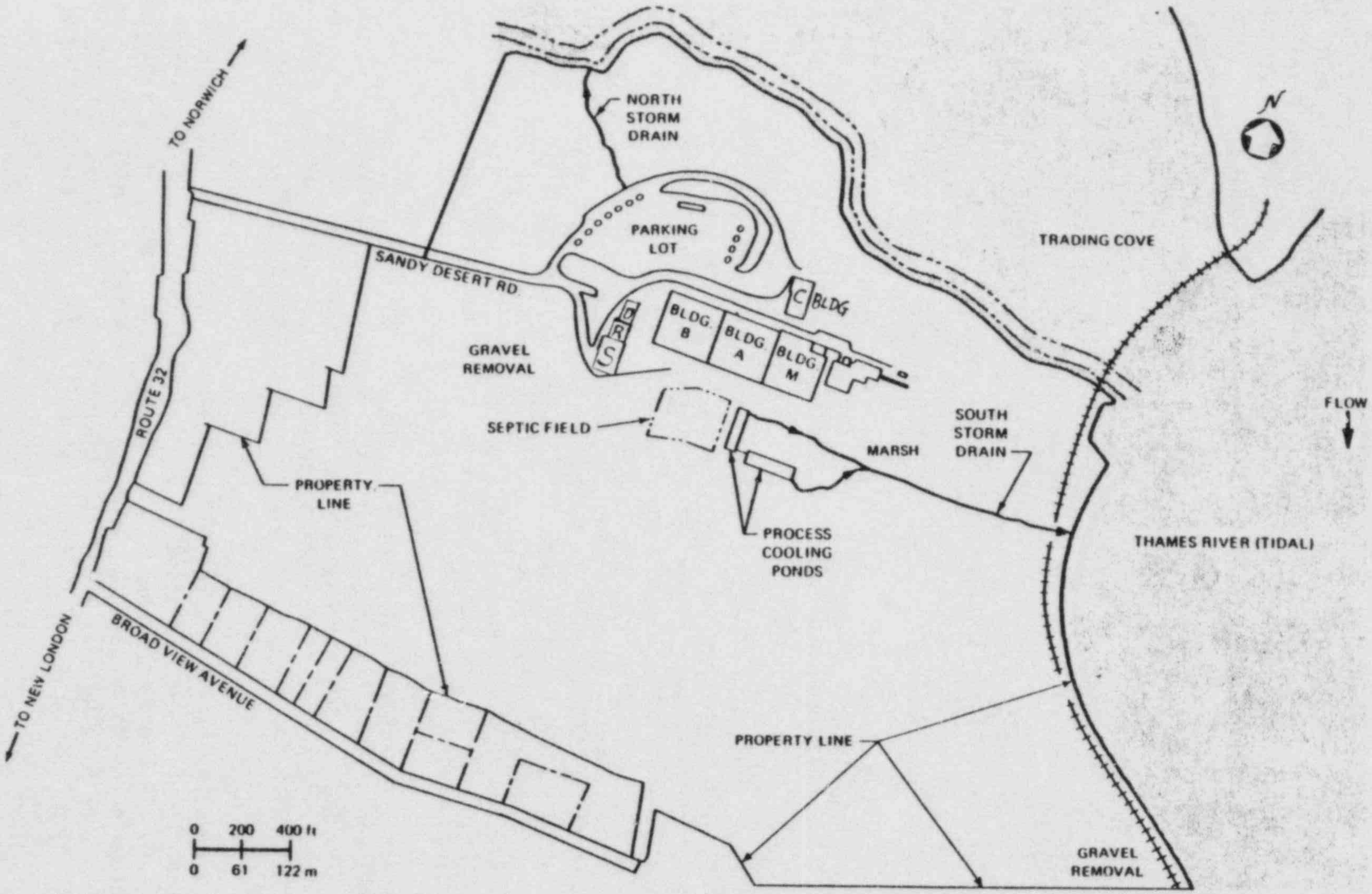

Fig. 2.1. Facility layout of the Naval Products Divisioh complex.

is approximately 82 m (270 ft) by 73 m (240 ft), was completed September 1973, and is used for the initial forming and enclosure of uranium-bearing materials. Building C, which is approximately 73 m (240 ft) by 64 m (210 ft), was completed in May 1973, and contains the main office and clerical functions. Building D, is used for inspection of non-uranium bearing materials, bulk storage of other non-uranium materials and recovery of silver. Building S and R are used for receiving, inspection, and storage of non-uranium materials. Exterior walls of all buildings are a combination of concrete block and insulated metal siding.

In general, the operations performed by UNC at Montville are to produce and assemble unirradiated enriched uranium fuel elements and other components for naval reactor cores. The activities consist of receiving uranium bearing materials, fabrication of uranium fuel fillers, the preparation of clad fuel elements, assembly operations with clad elements, and core assembly operations.

2.2.2 Waste Confinement and Effluent Control[1,2]

2.2.2.1 Gaseous Wastes

There are 26 exhaust stacks from the NPD with potential for either radioactive or nonradioactive gaseous emissions. These stacks are listed in Table 2.1, and their relative locations are shown in the plan view on Fig. 2.2.

Exhausts from operations that could potentially produce radioactive effluents have HEPA filters and/or gas scrubbers. The HEPA filters have an efficiency of about 99.97% for removal of particles >0.3 μm in diameter. Exhausts from HNO_3 pickling operations pass through a caustic fume scrubber that neutralizes and removes most of the nitrogen oxides formed in the pickling process.

Radioactive Emissions

Only the Building B exhausts have potential for radioactive emissions. All of the exhausts have HEPA filters and continuous monitoring for gross alpha with a detection limit of 2.2×10^{-14} μCi/mL. A summary of the release of alpha activity for the years 1978 through 1982 is given in Sect. 4.2.5. The annual emissions averaged 4.42×10^{-5} Ci over the 5-year period and the stack concentrations are far below the 10 CFR Part 20 limits of 4×10^{-12} μCi/mL for insoluble uranium.

Nonradioactive Emissions

Nitrogen oxides are produced during HNO_3 pickling (chemical milling) operations. Most of these oxides and HNO_3 fumes are neutralized and removed from the exhaust by a caustic fume scrubber. It is estimated that 0.21 g/s or 6.7 metric tons/year (7.4 tons/year) of waste calculated as NO_2 is emitted annually at this source point. Ten other pickling exhausts may contain small amounts of nitrogen oxides and HNO_3 vapor together with trace quantities of HF. The 10 untreated exhausts are estimated to emit an additional 0.17 g/s or 5.5 metric tons/year (6 tons/year) of NO_2.

Table 2.1. Stacks evaluated as possible sources of radioactive and nonradioactive emissions[a]

Stack no.	Equivalent diameter (m)	Height (m)	Exhaust rate (m^3/min)	Function
		Building M		
15	0.73	3.04	56.6	Fume Scrubber
17	1.64	1.52	425	Pickle Line
18	1.64	1.52	425	Pickle Line
19	1.45	1.52	340	Pickle Line
20	1.45	1.52	340	Pickle Line
51	1.45	1.52	340	Pickle Line
52	1.45	1.52	340	Pickle Line
		Building A		
1	1.45 x 1.04	2.44	340	Pickle Exhaust
2	1.45 x 1.04	2.44	340	Pickle Exhaust
3	1.45 x 1.04	2.44	340	Pickle Exhaust
4	1.45 x 1.04	2.44	340	Pickle Exhaust
		Building B		
1	1.64	0	299	Chemistry Laboratory
2	0.73	6.7	142	Metallurgy Laboratory
3	0.54	7.0	59.5	Metallurgy Laboratory Hoods
4	0.59	0.61	32.6	Fuel Vault
5	0.64	4.3	62.3	Unit 2 Facility
6	0.68	0.76	80.7	Unit 1 Facility
7	0.82	0.76	119	Decontamination Area
8-1	0.59	0.61	28.3	Unit 1, Clean Room
8-2	0.59	0.61	27.6	Unit 2, Clean Room
13	0.77	0.61	26.7	Unit 2, Change Room
16	0.25	0.61	26.7	Unit 2, Change Room
28	0.64	0	68.0	Health Physics Laboratory
29	1.18	0	136	Radioactive Waste Area
30	0.77	0.61	27.6	Assembly Area
46	0.91	0.61	143	Sectioning

[a]All stacks are vertical except stack nos. 28 and 29, which are horizontal.

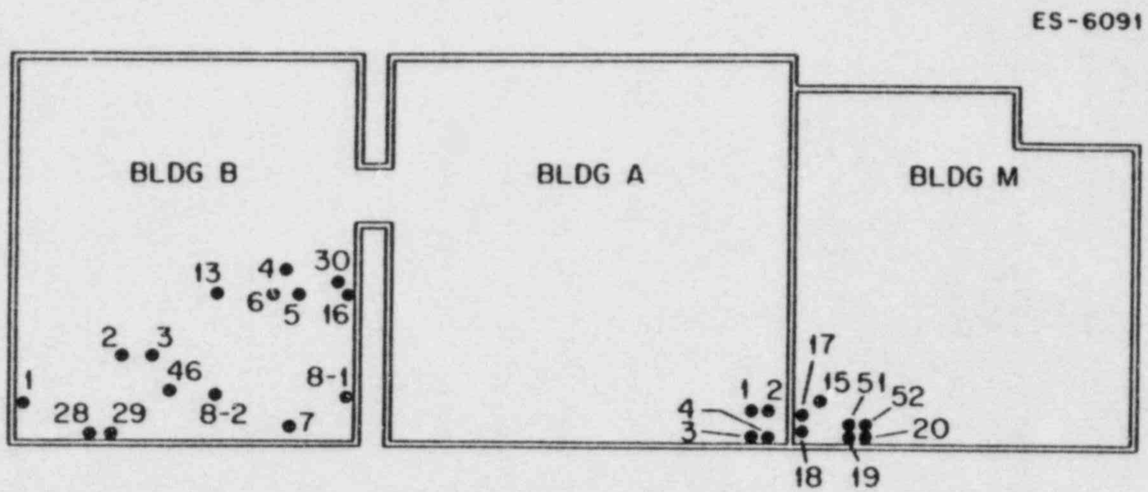

Fig. 2.2. Plan view of exhaust stack locations.

In addition to the above gases, it is estimated that 7.2 metric tons/year of Freon; 3.2 metric tons/year of isopropyl alcohol; 1 metric ton/year of acetone, hexane, and trichlorethylene; and 0.3 metric ton/year of methyl ethyl ketone evaporates within the plant building and are discharged through the exhaust system.

2.2.2.2 Liquid Wastes

The four liquid streams that leave the plant are as follows:

1. An estimated 148 m^3/d (39,000 gpd) of sanitary wastes, which may contain up to 15 m^3/d (4000 gpd) of treated manufacturing process waters containing very low concentrations of uranium are routed to a tile leaching field.

2. The rinse-water stream of about 227 m^3/d (60,000 gpd) is routed to the percolation ponds (process cooling ponds). The percolation ponds effluent feeds into the local groundwater.

3. The south storm drain (Fig. 2.1) carries equipment cooling water at about 1100 m^3/d (290,000 gpd), about 2.8 m^3/d (750 gpd) of rinse waters mixed with neutral NaCl solution from resin regeneration, and overflow from the percolation ponds. The storm drain discharges to the Thames River.

4. The parking area and plant site north of the building complex drains to Trading Cove by way of the north storm drain (Fig. 2.1).

Other liquid wastes on an annual basis are listed as follows:

590 metric tons of spent HF-HNO_3 solution,

154 metric tons of HNO_3 containing iron and copper,

144 metric tons of caustic and detergent solution,

21 metric tons of photographic developer after silver recovery, and

6.3 metric tons of solvents.

All of these wastes are stored on the site until routine pickup for reclamation or disposal by commercial services licensed for such activity by the State of Connecticut.

Radioactive Waste Treatment

All liquids that potentially could contain uranium, the only radioactive material processed at the UNC facility, are piped to collecting tanks in Building B. The liquids from process operations expected to contribute uranium waste are centrifuged and filtered to remove uranium solids before transfer to a 3.8-m^3 (1000-gal) detention tank for sampling. Liquids from change-room showers and the chemical laboratory that could potentially contain uranium are filtered into a separate retention tank for sampling. Six 9.5 m^3 (2500-gal) retention tanks are available with transfer possible between tanks.

Depending on analytical results, the liquids may be given further filtration or passed through an ion exchange column until the uranium concentration is well below 10 CFR Part 20 requirements for unrestricted release. The pH is then adjusted and the liquid discharged into the septic system. Currently, the NRC has established a Branch Technical Position[5] for unrestricted release of soils containing residual amounts of uranium. The staff is concerned that the discharge of liquid wastes containing uranium into the leach field could result in the accumulation of uranium in soil in the long-term exceeding the limit of 30 pci of enriched uranium per gm of soil. The staff has requested that UNC explore other methods of disposal of this liquid waste and a license condition will be imposed requiring UNC to cease the discharge of liquid waste containing uranium to the leachfield by January 1986.

Uranium-containing samples and uranium recovered by ion exchange are shipped to an offsite processing facility for recovery of uranium. No scrap recovery is done at the UNC facility.

Nonradioactive waste treatment

NPD does no onsite treatment of nonradioactive wastes. Chemical wastes are collected onsite in drums or tanks for consignment to State-licensed commercial services.

Sanitary waste treatment

Sanitary waste treatment at the UNC facility includes use of a settling tank for solids removal and a tile leaching field for water dissipation.

Analysis of liquid effluents

In response to an NRC staff request, the applicant obtained an analysis of the surface-water discharge streams to confirm their overall quality.[2] Samples were taken from the drainage ditch above and below the percolation pond outfall and near the river. The percolation pond outfall was also sampled. The samples were analyzed for constituents potentially contributed by UNC operations. The results are given in Section 4.1.1. The quality is such that no detrimental effects would be expected if the water were used.

2.2.2.3 Solid Wastes

Nonradiological

About 137 metric tons of paper, paperboard boxes, and other paper materials are transported to the town dump each year. About 4.5 metric tons of classified or proprietary paper waste is shredded and sent to a local paper mill or incinerated onsite each year.

About 45 metric tons per year of zirconium chips are oxidized (controlled burning) to zirconium oxide and then disposed of as nonhazardous waste. Another 45 metric tons of uncontaminated scrap metal are sold to scrap metal dealers.

Radiological

Scrap uranium wastes are shipped to an offsite processing facility to recover uranium. Sludges generated from the septic tank are shipped to a licensed burial ground or handled as routine sludges by an authorized offsite vendor.

2.3 Decommissioning

At the end of its operating life, the plant must be decontaminated and decommissioned before the site and any plant buildings remaining on the site can be released for unrestricted use. The NRC has prepared a two-volume report[3,4] to provide information on the technology, safety, and costs of decommissioning uranium fuel fabrication plants. This information is intended to contribute background data for uranium fuel fabrication plant owners and for the NRC in the development of decommissioning plans. It also provides the basis for future regulations regarding decommissioning of such facilities.

In accordance with NRC requirements, the applicant prepared and submitted a decommissioning plan, cost estimate, and financial surety dated July 22, 1977, for inclusion in the license application materials. The major guidelines embodied in the plan are as follows:

1. All facilities and grounds are to be decontaminated to levels established for unrestricted use.

2. Current radiological limits are to be adhered to, and available decontamination technology is to be implemented.

3. All process and ancillary equipment in controlled areas is to be cleaned to the maximum extent practicable, packaged, and transported to a licensed disposal facility for burial. If the equipment can be decontaminated to levels established for unrestricted use, it can be released for use in other applications.

4. Any contaminated underground piping is to be removed, cleaned to the maximum extent practicable, packaged, and transported to a licensed disposal facility for burial. The ground surrounding such piping is also to be surveyed and removed for disposal if contaminated beyond established limits.

Decommissioning based on these guidelines and the use of existing prescribed procedures for minimizing radiological and nonradiological contamination should result in insignificant environmental impact during and after the decommissioning operation.

2.4 Safeguards

Current safeguards requirements are set forth in 10 CFR Parts 70 and 73. The regulations in Part 70 provide for material accounting and control requirements with respect to facility organization, material control arrangements, accountability measurements, statistical controls, inventory methods, shipping and receiving procedures, material storage practices, records and reports, and management control.

The NRC's current regulations in 10 CFR Part 73 provide requirements for the physical security and protection of fixed sites and for nuclear material in transit. Physical security requirements for protecting formula quantities of strategic SNM include (1) establishing and training a security organization with armed guards, (2) installing physical barriers, and (3) establishing security response and safeguards contingency plans.

The NRC's regulations in 10 CFR Parts 70 and 73, described briefly above, are applied in the reviews of individual license applications. License conditions are tailored to fit the particular type of plant or facility involved.

The licensee has an approved material control and accounting plan and an approved physical security plan that meet the current requirements. It is concluded, therefore, that the safeguards-related environmental impact of the proposed action is insignificant.

2.5 Staff Evaluation Of The Proposed Action And Alternatives

The staff has concluded that denial of license renewal would provide very little in the way of environmental benefits. The environmental impact associated with the continued operation of the UNC facility has been evaluated and is found to be insignificant. The licensee's method of waste confinement, effluent control and the existing monitoring program are adequate provided that the following additional conditions are included in the renewed license to further protect the environment:

1. The licensee shall cease the discharge of liquid wastes containing uranium to the leach field area by January 1986. (Section 2.2.2).

2. The licensee shall conduct soil profile analysis within the septic field discharge area in accordance with UNC's letter to NRC dated August 19, 1983. (Section 4.1.2.1).

REFERENCES FOR SECTION 2

1. United Nuclear Corporation, "Environmental Information" (provided to the U.S. Nuclear Regulatory Commission), Docket No. 70-371, Jan. 17, 1983.

2. W. F. Kirk, United Nuclear Corporation, letter with additional information to Marc J. Rhodes, U.S. Nuclear Regulatory Commission, Docket No. 70-371, Aug. 19, 1983.

3. H. K. Elder and D. E. Blahnik, "Technology Safety and Costs of Decommissioning a Reference Uranium Fuel Fabrication Plant," NUREG/CR-1266, Vol. 1, prepared by Pacific Northwest Laboratory, October 1980.

4. H. K. Elder and D. E. Blahnik, "Technology Safety and Costs of Decommissioning a Reference Fuel Fabrication Plant," NUREG/CR-1266, Vol. 2, prepared by Pacific Northwest Laboratory, October 1980.

5. W.J. Dircks, U.S. Nuclear Regulatory Commission, "Disposal or Onsite Storage of Residual Thorium or Uranium from Past Operations," Memorandum to the Commissioners, presented as a Branch Technical Position from the Uranium Fuel Licensing Branch, Oct. 5, 1981.

3. THE AFFECTED ENVIRONMENT

3.1 Site Description

The UNC plant is located on a 102-ha (251-acre) site in the town of Montville, New London County, Connecticut. Only a small portion of the site is occupied by the manufacturing facility and the paved parking lot. The Central Vermont Railroad has a right-of-way along the Thames River at the eastern edge of the UNC site. The plant is served by a spur from the railroad and has car and truck access from State Highway 32. The site is bounded on the north by Trading Cove, on the east by the railroad beside the Thames River, and on the south and west by private properties (Fig. 2.1).[1]

The site is an asymmetrical valley flanked by terraces with elevations up to 23 m (70 to 75 ft) above the valley floor. The southern boundary of the valley is a ridge with a maximum elevation of about 46 m (150 ft) above mean sea level (MSL). The northern boundary is a ridge rising to 21 m (70 ft) above MSL. The elevation of the valley floor is about 7.6 m (25 ft) above MSL. The plant buildings are on the valley floor inset into the northern ridge with the parking lot on the northern ridge. The plant exhaust vents are slightly below the level of the northern ridge. The tree-covered ridges surrounding the plant make it difficult to see the facilities from offsite areas. The facilities are surrounded by a security fence and have guard towers that are manned full time.[1,2]

3.2 Meteorology And Climatology

3.2.1 Climatology

Generally, the climate of Connecticut[1] is affected by the continental polar, Artic, and maritime polar and tropical air masses. Occasional thunderstorms, together with more infrequent heavy rains or snows, hurricanes, and ice storms are part of the weather pattern.

The Montville plant site lies in the Thames Valley about 16 km (10 miles) from the Long Island Sound. The climate at the site is more affected by the proximity to Long Island Sound than are the interior portions of the state; however, these maritime influences are variable.

The prevailing winds are west to east. Maritime tropical air masses dominate the Connecticut area during the summer season, causing warm, humid weather and showers. The prevailing low-level winds during the summer are southerly, bringing additional moisture into the area from the Long Island Sound and the Thames River. Continental polar air masses during the autumn and winter seasons cause predominantly northwesterly winds in late fall and winter.

3.2.1.1 Thermal Induced Inversions

In Connecticut, the annual frequency of inversions is a little less than 25% of the time along the southeastern coast as compared to 30% in the northwest area of the state. The seasonal patterns for the state range from 21 to 25% in the spring, 23 to 31% in the summer, and 28 to 36% in the fall. The percentages for these seasons increase from southeast to northwest across the state. However, for the winter, the increase is from 28% in the southwest to 36% in the northeast.

Low-level stability observed along the coast during the daytime at certain times of the year reflects the stabilizing effects of the cold water offshore. At the same time, potential for increased air pollution during these occurrences of low-level stability is offset by higher velocity sea breezes. The net result is that the number of thermal-radiation-induced inversions along the coast is less than in the interior. The average annual lid height for the area, used in this report, is 961 m.[3]

3.2.1.2 Temperature

The New London and Middletown, Connecticut, weather stations are considered to be representative of the Montville area temperature. Highest mean monthly and annual temperatures are shown in Table 3.1 for those weather stations. The mean annual temperature for the area is 13.5°C.

3.2.1.3 Precipitation

Precipitation data for Lake Konomoc, 12 km (7.5 miles) away, would be most representative of the Montville site. Annual normal precipitation for the period 1931-1960 was about 129 cm (51 in.) as shown in Table 3.2. The average annual snowfall on the Montville site was about 97 cm (38 in.) for the period 1941-1961

3.2.1.4 Fog

Heavy or dense fog is observed on an average of 30 d/year in both coastal and inland sections. Along the coastal plains, heavy fog is most common during the late winter and spring seasons but also occurs with considerable frequency in the fall. Cool air drainage into the valleys produces ground fog, and moisture from the rivers produces stream fog. Both may become dense enough to hamper transportation, especially in the early morning.

3.2.1.5 Humidity

The humidity for New Haven and Hartford areas may be considered typical for the Montville area. The humidity data is presented in Table 3.3.

3.2.2 Winds, Tornados, and Storms

High wind conditions in the Montville area are caused primarily by the passage of cyclonic storms-either tropical or extratropical in origin-over southeastern New England. Winds of up to 113 and 142 Km/h (70 and 88 mph) on a recurrence interval of 25 and 100 years, respectively, could occur. However, the buildings are located in the middle of a depression on the site, and thus are shielded from the hurricane winds.

Table 3.1. Highest mean monthly and annual temperature for New London and Middletown, Connecticut (representative of the Montville area)

Month	Temperature (°C)	
	New London (1930-1955)	Middletown (1930-1963)
January	4.0	2.2
February	2.2	2.9
March	7.8	7.9
April	11.3	11.3
May	16.1	17.0
June	21.7	21.9
July	24.8	25.4
August	23.9	24.9
September	20.9	20.1
October	14.9	14.8
November	10.3	9.4
December	3.7	3.9
Annual	13.5	13.5

Source: United Nuclear Corporation, Environmental Report, Montville Site, Naval Products Division, Docket No. 70-371, Sept. 8, 1972.

Table 3.2. Monthly and annual precipitation normals based on 1931-1960 data for Lake Konomac (representative of the Montville area)

Month	Average (cm)
January	11.0
February	9.0
March	12.3
April	11.3
May	10.4
June	8.6
July	10.1
August	11.4
September	11.2
October	10.1
November	12.6
December	11.1
Annual	129.1

Source: United Nuclear Corporation, Environmental Report, Montville Site, Naval Products Division, Docket No. 70-371, Sept. 8, 1972.

Table 3.3. Mean seasonal and annual relative humidity (%) at U.S. Weather Bureau airport stations

Season	Hartford Station[a]		New Haven Station[b]	
	7 a.m.	1 p.m.	7 a.m.	1 p.m.
Winter	76	60	76	64
Spring	75	50	76	63
Summer	82	54	81	67
Fall	86	56	83	66
Annual	80	55	79	65

[a]Data collected over nine years.
[b]Data collected over 20 years.

Although there have been tornados reported in the western part of the state, there have been no recorded tornados in New London County during the period 1682-1971. According to methods for estimating tornado occurrence presented by Thom,[3] the probability of a tornado actually striking the site is about 8×10^{-4} per year, with a recurrence interval of about 1300 years.

3.2.3 Meteorology

Onsite meteorological data currently are not available from the Montville site. In lieu of such information, the staff has decided that the best available data source, representative of the plant site, is the Connecticut Yankee Power Station, located approximately 32 km (20 miles) west of the site. These data, which include the wind direction-speed-stability frequency information, are shown in Tables A.5 and A.6 in Appendix A.

Meteorological dispersion factors (annual χ/Q values) are estimated using the Gaussian plume model and diffusion coefficients for Pasquill-type turbulence.[4,5] The annual average χ/Q values in 16 sectors up to a distance of 80 km (50 miles) from the site are given in Table A.4 of Appendix A.

3.2.4 Air Quality

The Montville site is located in the Eastern Connecticut Intrastate Air Quality Control Region (AQCR #41). In this region, concentrations of particulates do not meet national secondary standards, and concentrations of ozone do not meet national primary standards (40 CFR Part 81, revised as of July 1, 1982). Concentrations of SO_2, CO, and NO_2 are below the national standards or cannot be classified.

3.3 Demography And Socioeconomic Profile

The UNC facility is close to the boundary between the towns of Montville and Norwich and across the Thames River from the town of Preston, as shown on Fig. 3.1. About 300 people live within 0.8 km (0.5 mile) of the UNC site. In 1980, Montville had 16,455 residents; Norwich, 38,074 residents; and Preston, 4,219 residents.[2] The 1980 incremental population within 80 km (50 miles) of UNC is given in Table 3.4 by distance and compass sector. The cumulative population is given in Table 3.5.

Although the local area is rural, it contains much light and heavy manufacturing industry. The UNC facility contributes to area employment but is not a significant factor.

3.4 Land

3.4.1 Site Area

The Montville facilities are located on land that is either gently sloping or level about 9 m (30 ft) above MSL. This land lies in a blind valley that opens to the Thames River on the east and rises to an elevation of 20 m (65 ft) above MSL at the western border of the site. Elevations on the site range from just above MSL at the Thames River to about 60 m (200 ft) above MSL in the southeastern part of the site. Most of the 102-ha (251-acre) site is forestland.

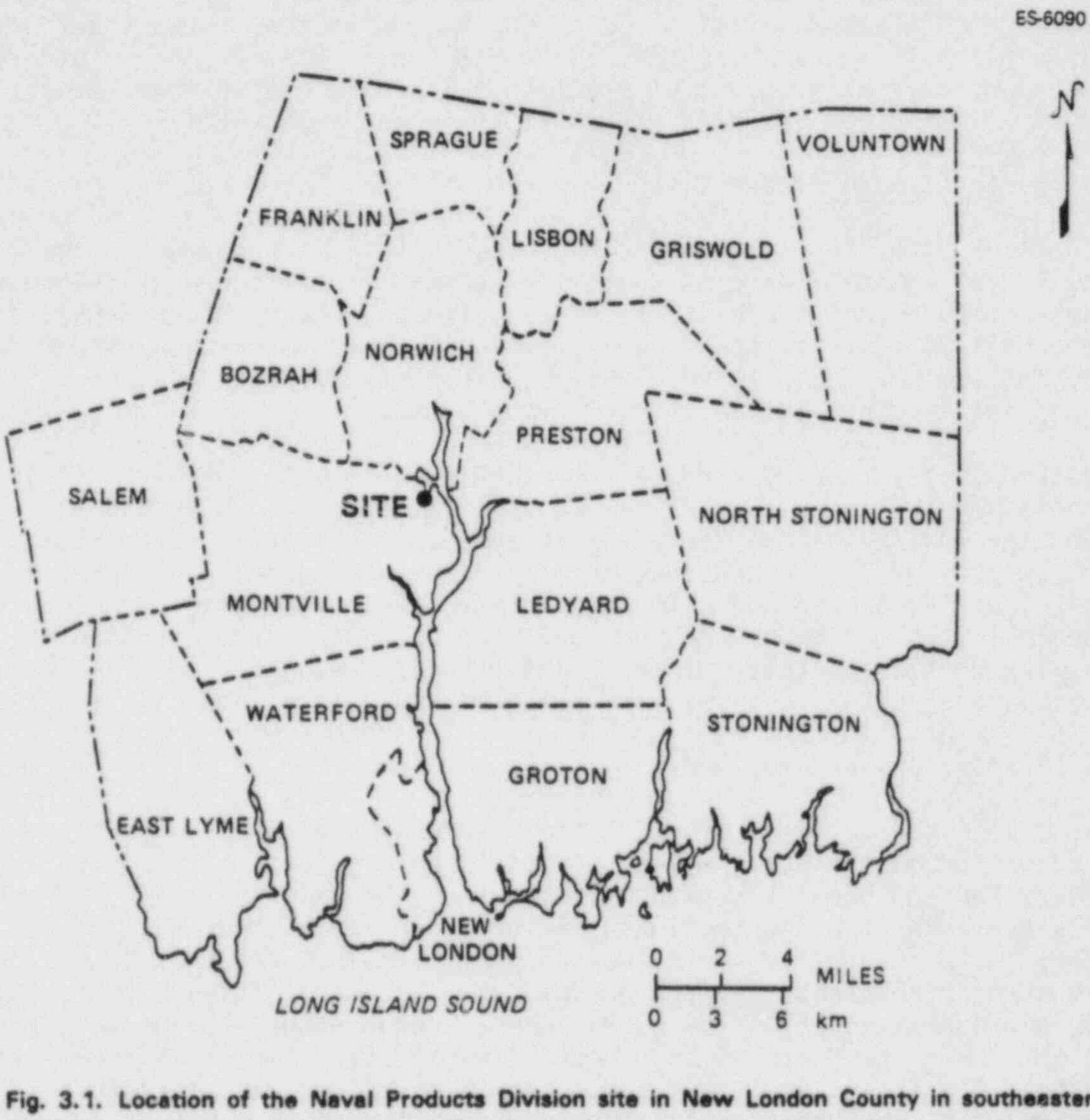

Fig. 3.1. Location of the Naval Products Division site in New London County in southeastern Connecticut.

To the north, a ridge separates the facilities from the Trading Cove, an arm of the Thames River estuary.[1]

About 16 ha (40 acres) of the site are occupied by buildings, parking lots, cooling ponds, and associated clearings surrounding the facilities. Most of the remaining 86 ha (211 acres) are unused forestland.

3.4.2 Adjacent Area

Land uses within a 3.2-km (2-mile) radius of the site include residential, light business, and woodland, including a few farms, two hospitals, and five schools. Residences within this area are located primarily to the south and west. Norwich State Hospital is on the east side of the Thames River about 1.2 km (0.75 mile) from the site. The 74-ha (183-acre) Fort Shantok State Park is located 1.6 km (1 mile) south of the site. The area within 8 km (5 mile) of the site is zoned for residential and light industrial uses.[2]

3.4.3 Historic Significance

The "National Register of Historic Places"[7] lists a large number of historic sites in New London County. Many of these are located in the towns of New London and Norwich. Only one of the historic places, the Raymond Bradford Homestead on Raymond Hill Road, is in the vicinity of Montville. The Pachaug-Great Meadow Swamp, located more than 16 km (10 miles) northeast of the plant site, is the only natural landmark listed in New London County.[8]

Many other sites are recognized at the local level as having historic significance. Several sites in Montville are associated with Indian history. These include the Indian Shantok Fort at Fort Shantok State Park; a Congregational church built in 1831 for Indians; an Indian museum currently operated by Mohegan Indians; and Cochegan Rock, a former retreat of Chief Uncas, who defended his tribe with the help of the English against the Narragansetts in 1645. In addition to these historic Indian sites, several old buildings of historic significance, primarily of colonial style, are located in Montville.[2]

3.4.4 Floodplains and Wetlands

No floodplains or wetlands of significant size or ecological importance are located on the plant site. A few very small (e.g., less than 0.2 ha) wetlands lie along the ephemeral stream downstream from the UNC facilities. No brackish marshes are located along the Thames River shoreline at the eastern site boundary.[1] The shoreline slopes upward rapidly to a level that is unaffected by floods or high tides. At the northwestern boundary of the site, a small floodplain forest about 0.1 ha (0.25 acres) extends from Trading Cove upstream along an intermittent stream for about 12 m (40 ft). Two small ponds are on the site. One is an overflow pond of the Thames River, and the other is a temporary pond. Neither one is a particularly important wetland.

3.5 Hydrology

3.5.1 Surface Water

The UNC site is bordered on the east by the Thames River and to the northeast by Trading Cove, which is connected by a culvert to the Thames River. The

Table 3.4. Incremental 1980 population data within 80 km (50 miles) of the UNC NPD at 41°29'30" latitude and 72°05'30" longitude

Direction	Population distribution at distances given in miles									
	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
N	280	4,324	2,445	986	1,536	3,076	5,875	12,238	13,030	28,962
NNE	0	1,830	5,587	6,757	1,497	7,009	8,461	43,387	35,987	51,206
NE	326	1,528	646	1,685	721	4,146	9,359	13,896	60,808	323,937
ENE	0	742	457	71	403	929	3,185	20,673	220,498	259,077
E	465	3	487	362	249	863	3,940	30,138	36,525	45,886
ESE	0	0	329	341	183	2,848	23,879	8,728	1,983	0
SE	2	283	348	420	284	3,699	14,005	0	517	0
SSE	375	754	473	862	1,619	6,508	11,273	193	1,522	0
S	305	1,195	360	727	1,615	33,354	20,147	0	8,665	141
SSW	0	354	381	578	950	6,628	13,585	4,975	18,962	21,737
SW	326	299	417	373	391	1,732	11,854	24,458	866	17,030
WSW	0	244	244	264	457	2,721	9,591	46,094	38,385	267,825
W	247	208	142	273	548	2,071	4,608	73,164	127,792	201,170
WNW	0	335	201	281	394	1,293	8,952	60,763	381,911	129,119
NW	295	874	361	318	267	1,096	7,918	94,438	161,386	96,081
NNW	0	925	1,093	504	550	1,663	24,763	63,492	27,039	205,293
Total	2,621	13,898	13,971	14,802	11,664	79,636	180,995	496,637	1,135,975	1,647,404

Table 3.5. Cumulative 1980 population data within 80 km (50 miles) of the UNC NPD at 41°29'30" latitude and 72°05'30" longitude

Direction	Population distribution at distances given in miles									
	0-1	0-2	0-3	0-4	0-5	0-10	0-20	0-30	0-40	0-50
N	280	4,694	7,049	8,035	9,571	12,647	18,522	30,760	43,790	72,752
NNE	0	1,830	7,417	14,174	15,671	22,680	31,141	74,529	110,515	101,721
NE	326	1,854	2,500	4,185	4,966	9,052	18,911	32,807	93,615	417,552
ENE	0	742	1,199	1,270	1,673	2,602	5,787	26,460	243,950	506,835
E	465	468	955	1,317	1,566	2,429	6,369	36,507	73,032	110,910
ESE	0	0	329	670	853	3,701	27,500	36,308	30,291	38,291
SE	2	205	633	1,053	1,337	5,036	19,041	19,041	19,558	19,558
SSE	375	1,129	1,602	2,464	4,083	10,591	21,864	22,057	23,579	23,379
S	305	1,500	1,860	2,587	4,202	37,556	57,703	57,703	66,368	66,589
SSW	0	354	735	1,313	2,263	8,891	22,476	27,451	46,413	68,150
SW	326	625	1,042	1,415	1,806	3,538	15,392	39,850	40,716	57,746
WSW	0	244	488	752	1,209	3,930	13,521	59,815	98,000	365,025
W	247	455	597	870	1,418	3,489	8,097	81,261	289,053	410,223
WNW	0	335	536	817	1,211	2,504	18,556	71,319	453,230	582,349
NW	295	1,169	1,530	1,849	2,115	3,211	11,129	105,567	266,953	363,034
NNW	0	925	2,018	2,522	3,072	4,735	29,498	92,990	120,028	325,321
Total	2621	16,519	30,490	45,292	56,956	136,592	317,587	814,224	1,950,099	3,597,563

Thames River drains an area of more than 3500 km^2 (1300 $miles^2$) and is subject to tidal influence[2] in the vicinity of the plant site. Two small ponds occur on the site, in addition to the wastewater ponds.

No perennial streams flow over the site proper, but the drainage courses of numerous intermittent streams discharge to the valley where the UNC facility is located. The intermittent streams carry surface runoff during spring thaws and periods of exceptionally heavy rain. The valley receiving stream drainage formerly was contained by natural levees along the Thames River and consisted partially of a swamp area. This area now drains into the Thames River by a man-made excavation. Because of the well-drained nature of the soils on the site and the depth of the water table, the surface-water flow into the intermittent stream channels and into the river is limited.[1]

The storm drainage from the facility area is discharged at several points to natural channels. Most of this drainage (90-95%) reaches the Thames River.[1]

Water quality of the Thames River generally is good. Levels of nitrate, phosphate, and fluoride are less than 1.0 mg/L; pH levels (6.6) are near neutral.[2]

3.5.2 Groundwater

The groundwater flow system is complicated by the organic material in the valley floor and percolation from the septic field and cooling ponds. Groundwater recharge to the valley comes primarily from Crow Hill. North of the plant buildings, about 120 m (400 ft) from the river, brackish water from Trading Cove intrudes into the freshwater aquifer.

Recharge from Crow Hill is of considerable magnitude since more than half the water used in the plant [over 530 m^3/d (140,000 gpd)] is pumped from onsite wells southeast of the cooling ponds. The well water remains of good quality, and the brackish water from the Thames will appear if the pumping rate exceeds recharge rate.

3.6 Geology, Mineral Resources, and Seismicity

3.6.1 Geology

3.6.1.1 Regional Geology

The geology of eastern Connecticut can be divided into two broad classifications based on physical characteristics: bedrock geology and surficial geology.[1] The bedrock geology consists predominantly of complexly faulted and folded micaceous schists and calc-silicate gneisses that record geologic events that took place primarily during the Paleozoic Age. The surficial geology is characterized by a complex variety of unconsolidated glacial drift deposits of Pleistocene Age.

3.6.1.2 Site Geology

The facility site is underlain by geologic units from both classifications.[1] Crystalline bedrock outcrops appear on the southern flank of the Crow Hill and on the northern shore of Trading Cove. The rock units exposed in these two outcrop areas are believed to be separated by the Honey Hill fault (discussed below). Surficial deposits overlay the crystalline bedrock and can be divided into several categories based on their genesis.

The bedrock underlying the site is a fine-grained to medium-grained, equigranular gneiss. The gneiss is fractured in outcrops on Crow Hill. Outcrops on the northern shore of Trading Cove are not intensely fractured but do display intense folds. The surficial deposits on the site are about 46 m (150 ft) thick beneath the northern ridge and thin out in a southerly direction as they lap on Crow Hill.

Deposits of glacial till, with thicknesses of 3 to 5 m (10 to 15 ft), overlay the gneissic bedrock. These deposits range from moderately sorted, coarse sand to material consisting entirely of very fine sand or soil. Stratified fluvial deposits overlay the general till and form a kame terrace with an elevation of approximately 23 m (75 ft). The kame terrace is part of a geomorphologic feature that extends up the valley of Trading Cove Brook. The deposits range from fine-grained sand to boulder gravel.

The lower part of the valley at the facility site is covered with 5 to 7 m (15 to 20 ft) of dredge spoils from the Thames River that were dumped at the site following the hurricane of September 21, 1938. The dredge spoils consist of fine-grained to medium-grained sand with shell fragments varying in abundance. The dredge spoils, at least over the southern part of the valley, rest on organic-rich, fine-grained material. The thickness of this material is unknown but is at least several meters thick. The organic-rich material beneath the dredge spoils is a black, silty material that contains some roots.

3.6.1.3 Structural Geology

The trace of the east-west trending Honey Hill Fault is believed to pass beneath Trading Cove[1] and is thought to be a thrust fault. Geologic features along the faults suggest that faulting began when the rocks were being metamorphosed. The final stages of movement in the fault probably predated Triassic tectonic activity in this area.[1] Stratified drift deposits surrounding Trading Cove are not offset along the projected trace of the fault, precluding significant late Pleistocene displacement.

3.6.2 Mineral Resources

The staff is not aware of a potential for any mineral resource that could be actively exploited within or near the plant boundaries, with the possible exception of sand and gravel. Gravel has been extracted from the site in the past.

3.6.3 Seismicity

The area of eastern Connecticut where the UNC facility is located lies in a relatively quiet seismic region of the United States (Fig. 3.2). Although areas

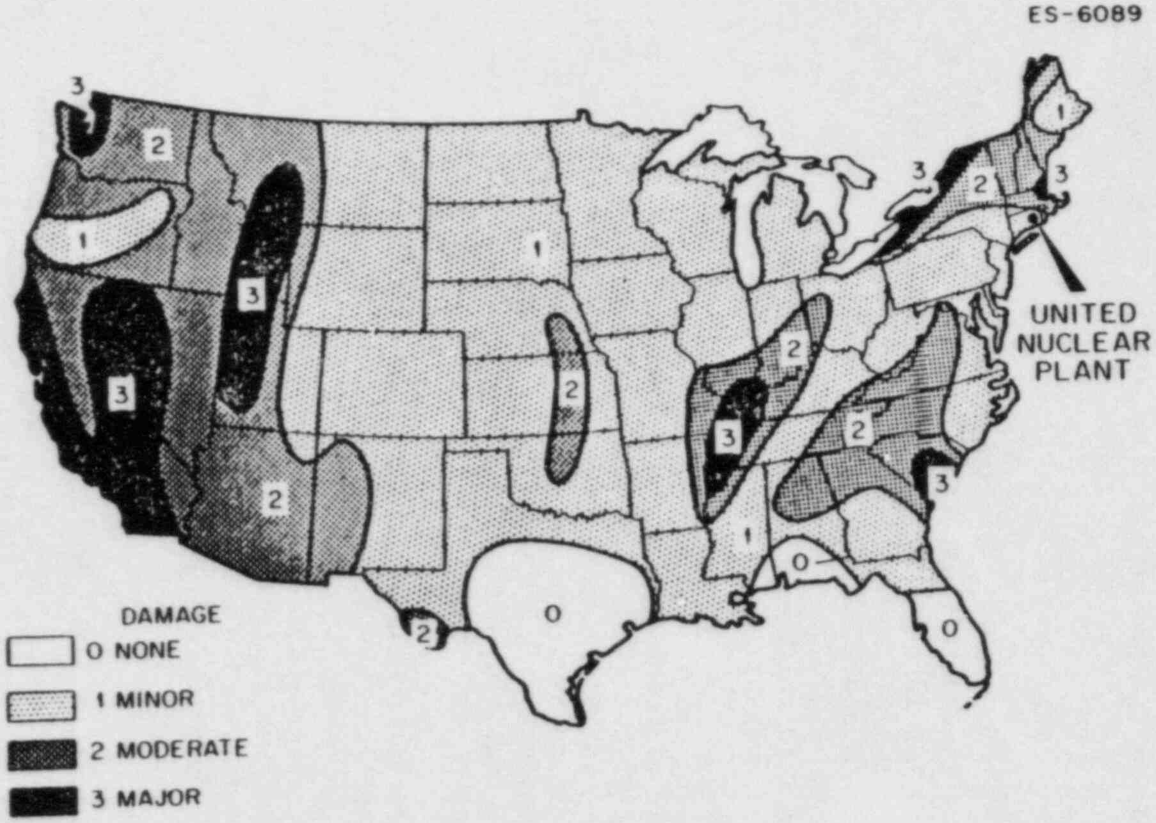

Fig. 3.2. Seismic risk map of the United States. Source: S. T. Algermissen, *United States Earthquakes*, Fig. 2.4, U.S. Government Printing Office, Washington, D.C., 1968.

in New England have experienced reasonably large damaging earthquakes in the past,[1] the recurrence rates of earthquakes in this region are much lower than those in the western United States.

A recent probabilistic acceleration map of the contiguous United States (Fig. 3.3) indicates that the horizontal acceleration at the facility site, with 90% probability of not being exceeded in 50 years, is less than 0.10 gravities. On the basis of the historic seismicity record and the tectonic framework of the region, it is highly unlikely that an earthquake of high magnitude will affect the facility site during its projected life.

3.7 Biota

3.7.1 Terrestrial

The ecology of the Montville site is described in Appendix B of the "Environmental Report" for 1972.[1] Undisturbed portions of the site are forestland and cover about 86 ha (211 acres). About half of the forest is on slopes more than 12 m (39 ft) above MSL in the southwestern half of the site. The substrate is coarse-textured glacial till, and the soil is a very stony, sandy loam that is capable of holding much moisture. Red and white oaks, black birch, and red maple are the dominant tree species. Both the canopy and the shrub layer are well developed.

The other half of the forest area is located in the northeastern half of the site and is also more than 12 m above MSL. Soils are well drained and dry, and the forest is dominated by oaks and red maple. Ground and shrub vegetation are poorly developed. The area lying less than 12 m above MSL, much of which is occupied by plant facilities, has sandy soils and scattered clumps of trees dominated by scarlet oak, pitch pine, large-tooth aspen, and pin cherry. Ground vegetation is sparse.

Wildlife that may be observed in the Montville area includes 170 species of summer-resident land birds[10] and 60 species of mammals.[12] The Montville site is too small to contain the habitats required by all these species. Therefore, not all the species would be expected to be living on the site. Game species most often observed include the raccoon and mourning dove, although the site is not particularly abundant with either one. Ruffed grouse are present in low numbers. White-tailed deer are virtually absent.

3.7.2 Aquatic

Because of the limited amount of freshwater habitat (Sect. 3.5.1), there are few freshwater species. There are two onsite ponds. One, an overflow pond of the Thames River next to the gravel pit, contains bluegills and killifish but appears to lack amphibians. The other, which is adjacent to the railroad track, is a temporary pond and contains typical pond vegetation dominated by cattails. Large numbers of wood-frog tadpoles are present in the spring and early summer.

The effluent stream from the plant facilities and the wastewater ponds produce a limited freshwater habitat in a channel next to the sand flat; this channel ultimately leads to the Thames River. Because of its shallow depth and the

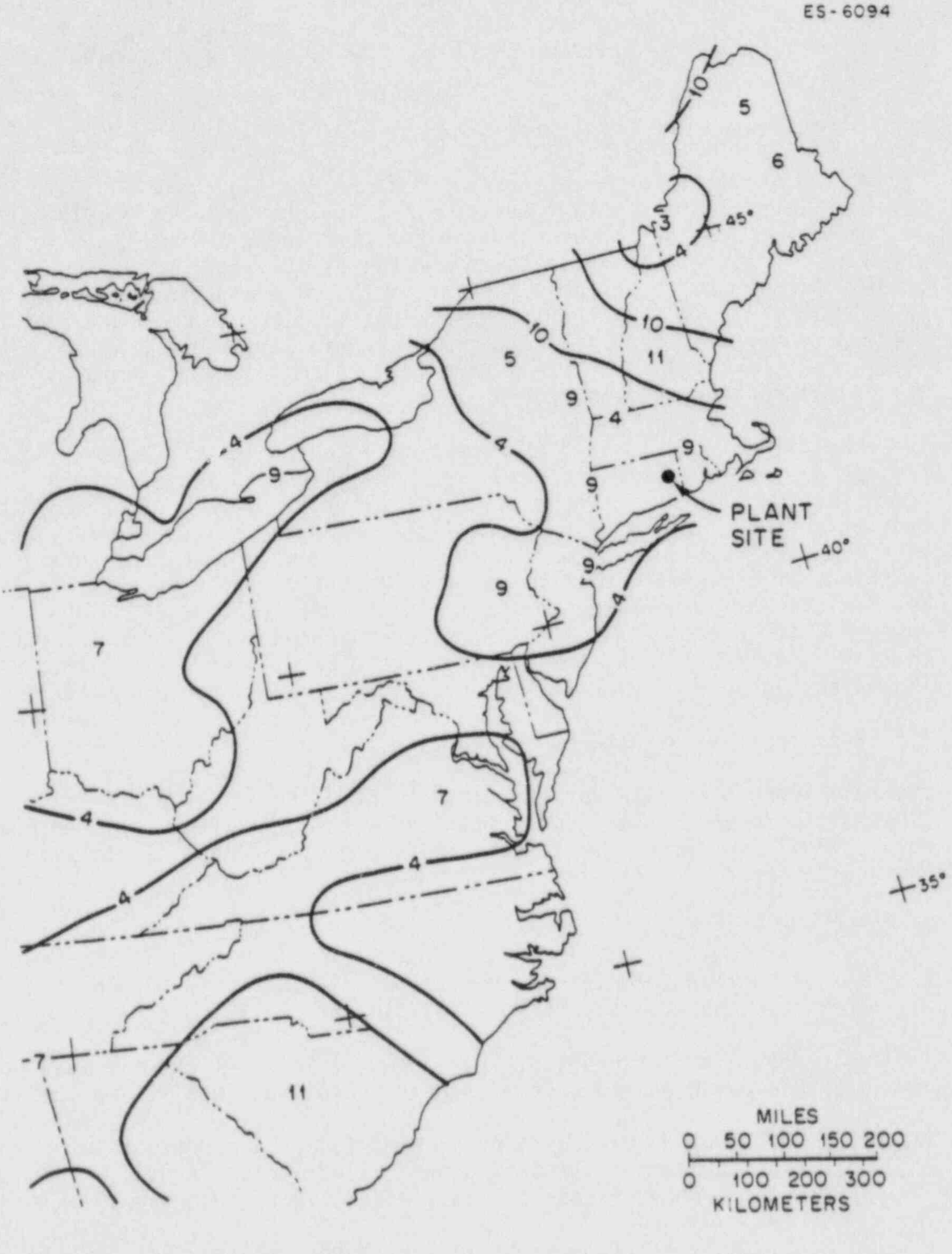

Fig. 3.3. A preliminary map of horizontal acceleration (expressed as percent of gravity) in rock with 90% probability of not being exceeded in 50 years. Source: S. T. Algermissen and D. M. Perkins, *A Probabilistic Estimate of Maximum Acceleration in Rock in the Contiguous United States*, Open File Report 76-426, U.S. Geologic Survey, 1976.

sandy soil, the effluent stream supports few aquatic animals, although patches of aquatic and riparian vegetation exist.[2]

The aquatic biota of Trading Cove is typical of other backwater areas of the Thames River. The biotic diversity of the cove may, however, be restricted by the culvert under the railroad track that separates Trading Cove from the Thames River.

3.7.3 Threatened and Endangered Species

The United States endangered species list (50 CFR 17), as of July 27, 1983, includes several species that may occur in Connecticut. In a 1976 study, it was reported that the Indiana bat had not been found in the state for many years.[12] It spends winter in caves and raises its young primarily in wooded areas along streams. Suitable habitat at the site appears to be lacking, and it is highly unlikely that this type of bat will be found in the area. The eastern cougar may occur in wilder, more remote parts of the state; however, it is highly unlikely that the cougar would find suitable habitat at the site, which lies in a densely populated area.

The bald eagle formerly bred in more remote regions of the state,[12] but no nesting eagles have been recorded since the 1950s (R. Kroodsma, ORNL, personal communication with R. Narenchelli, Connecticut Department of Environmental Protection, Nov. 18, 1983). The American peregrine falcon formerly nested on high, rocky cliffs in central Connecticut.[12] However, suitable nesting habitat is absent at the site, and sitings of this species would be rare. A plant species, the small whorled pogonia, grows in dry, rich woods in the southeastern hills region and coastal regions of Connecticut, which include the town of Montville. Thus, this species could be present on the site, although it was not observed during onsite surveys.[1]

3.8 Radiological Characteristics (Background)

The total-body dose rate for the vicinity of Montville is approximately 110 millirem/year.[13] This dose rate includes 41 millirem/year from cosmic rays, 51 millirem/year from terrestrial sources, and 18 millirem/year from internal emitters.

REFERENCES FOR SECTION 3

1. United Nuclear Corporation, Environmental Report, Montville Site, Naval Products Division, Docket No. 70-371, Sept. 8, 1972.

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5. D. H. Slade, ed., "Meteorology and Atomic Energy," U.S. Atomic Energy Commission, Division of Technical Information, July 1968.

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7. Department of the Interior, "National Register of Historic Places; Annual Listing of Historic Places," Fed. Regist. 44(26) (Feb. 6, 1979); Part II; 45(54) (Mar. 18, 1980), Part II; 46(22) (Feb. 3, 1981); 47(22) (Feb. 2, 1982), and 48(41) (Mar. 1, 1983).

8. Department of the Interior, "National Registry of Natural Landmarks," Fed. Regist. 48 (Mar. 1, 1983).

9. W. F. Kirk, United Nuclear Corporation, letter with additional information to Marc J. Rhodes, U.S. Nuclear Regulatory Commission, Docket No. 70-371, Aug. 19, 1983.

10. R. E. Cook, "Variation in Species Density of North American Birds," Syst. Zool. 18: 6364 (1969).

11. G. G. Simpson, "Species Density of North American Recent Mammals," Syst. Zool. 12: 5773 (1964).

12. J. J. Dowhan and R. J. Craig, "Rare and Endangered Species of Connecticut and Their Habitats," Connecticut Department of Environmental Protection, Report of Investigations No. 6, 1976.

13. D. T. Oakley, Natural Radiation Exposure in the United States, ORP/SID 72-1, U.S. Environmental Protection Agency, June 1972.

4. ENVIRONMENTAL CONSEQUENCES OF PROPOSED LICENSE RENEWAL

4.1 Monitoring Programs and Mitigatory Measures

The locations for effluent and environmental monitoring are shown in Fig. 4.1. A summary of the monitoring program is presented in Table 4.1.[1]

4.1.1 Effluent Monitoring Programs

4.1.1.1 Radiological

Gaseous

All stacks emitting radioactive particulates are continuously monitored for alpha activity at the point of release.

Liquid

Presently, a proportional sample of liquid effluent from each radwaste tank is taken and analyzed for gross alpha prior to discharge to the septic field. Prior to rerouting the liquid process waste line to bypass the septic tank, samples were analyzed from the 9.5m^3 (2500 gal) retention tanks before discharge to the septic tank. Additionally, the septic tank effluent was monitored every other month for gross alpha and uranium and the septic tank sludge was sampled at 2-year intervals or when records showed that 350 g of uranium could have been released to the septic tank. At present, no uranium contaminated liquid is routed through the septic tank and neither of the two analyses mentioned above is required.

Process pond water is analyzed for gross alpha and uranium on a monthly basis.

4.1.1.2 Nonradiological

Gaseous

Airborne chemical effluents are generated during nitric acid pickling operations and during cleaning operations with volatile solvents. Pickling results in the release of nitrogen oxides and to a much lesser degree hydro-fluoric acid fumes. The State of Connecticut Department of Environmental Protection has issued UNC four "Permits to Operate." Three of these permits are for pickling operations and one is for an incinerator used to burn uncontaminated combustibles generated onsite. At present, the State of Connecticut does not require that UNC monitor their stack effluent for NOx or fluorides. The State does maintain a system of periodic inspections on stack effluent opacity, as a means of evaluating pollution abatement equipment performance. If deemed necessary, the state can request that UNC initiate stack monitoring. The release of volatile materials from cleaning operations is less than the State of Connecticut's limit for discharging both photochemically reactive and unreactive solvents, therefore no monitoring is required (Sect. 4.2.1).

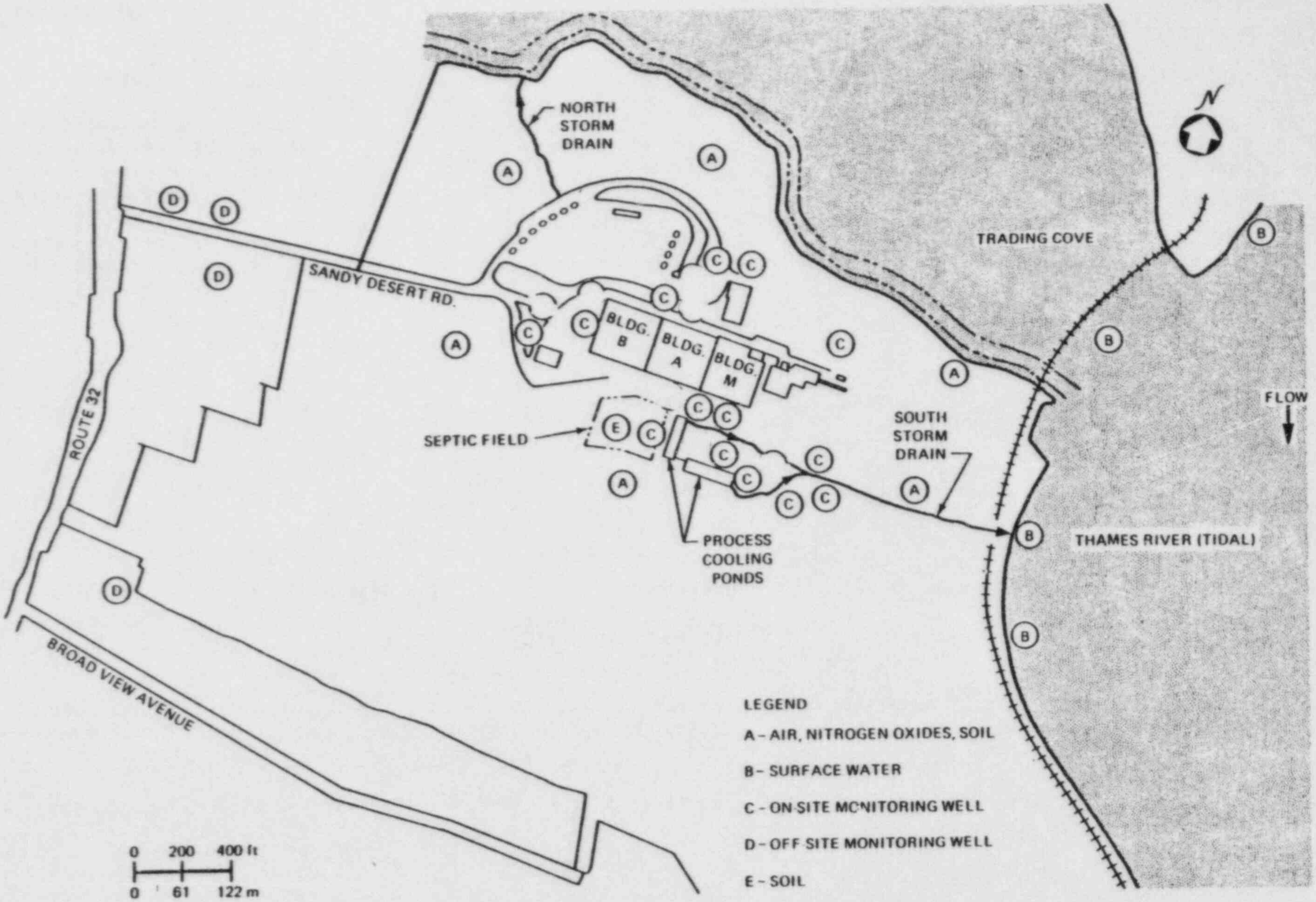

Fig. 4.1. Locations of monitoring stations for the United Nuclear Corporation Naval Products Division facility in Montville, Connecticut.

Table 4.1. Operation of the radiological monitoring program for the UNC facility

Sample medium		Number of Samples taken	Collection frequency	Analysis frequency	Analysis parameters
			Effluent surveillance		
Air effluents	Air				
Stacks	Particulates	15	Continuous	Varies from 1-4 d	Gross alpha
Liquid effluents					
Rad waste	Water	1	Continuous per batch release	Daily and monthly composite	Gross alpha
Process pond water	Water	1	Weekly	Monthly	Gross alpha, uranium
			Site surveillance		
Air effluents					
Monitoring stations	Air	6	24-h samples, bimonthly	Bimonthly	Gross alpha
Water effluents					
Surface water	Water	4	Quarterly	Quarterly	Gross alpha, uranium
On-site well	Water	17	Quarterly	Quartery	Gross alpha, uranium
Residential well	Water	4	Annually	Annually	Gross alpha, uranium
Soil samples	Soil	6	Semiannually	Semiannually	Gross alpha, uranium

Source: W. F. Kirk, United Nuclear Corporation, letter with additional information to Marc J. Rhodes, U.S. Nuclear Regulatory Commission, Docket 70-371, Aug. 19, 1983.

Liquid

The applicant monitors the process wastewater pond on a monthly basis and the outfall from the pond for selected chemicals on a quarterly basis. A summary of this data along with data from the Thames River (upstream and downstream) and Trading Core, for the years 1977-1982 is presented in Table 4.2.[2] The 1983 data (Table 4.3)[1] show elevated pH and nitrate levels in the discharge from the plant and from the wastewater pond outfall. These increased levels are the result of resin regeneration and occur on a daily short-term basis.[1]

4.1.2 Environmental Monitoring Programs

4.1.2.1 Radiological

Gaseous

Offsite air monitoring for radioactive pollutants is not routinely performed and is not needed because stack effluent is monitored and dispersion modeling shows that relevant offsite location concentrations are well below acceptable limits. (See Section 4.2.5.)

Liquid

Surface water is sampled quarterly at the following locations:

1. Thames River, upstream and downstream of the plant;

2. Trading Cove;

3. Outfall of the drainage trench; and

4. Incoming city water.

Samples are analyzed for uranium and gross alpha. The staff has reviewed UNC's data and finds that there is no significant difference between concentrations of uranium at upstream Thames River, downstream Thames River, Trading Cove locations and Norwich City water.

Seventeen onsite monitoring wells surrounding the plant are sampled quarterly to monitor the uranium activity in the groundwater to ensure that the plant discharge water is not adversely affecting local groundwater.

At least four residential wells near the site boundary are sampled annually and analyzed for uranium to detect any changes in the basic water quality in the residential wells. The locations of these offsite groundwater monitoring wells are shown in Fig. 4.1. Data indicates that plant operations have not resulted in any significant level in groundwater uranium concentrations over UNC's well water or Thames River water.

Table 4.2. Average values for physical and chemical parameters at both onsite and offsite monitoring stations for 1977-1982

Parameter	Process pond	Process pond outfall	Thames River		Trading Cove
			Downstream	Upstream	
Nitrate, mg/L	8.8	3.0	0.7	0.6	0.9
Phosphate, mg/L	0.3	0.4	0.1	0.2	0.2
Fluoride, mg/L	2.8	0.7	0.2	0.2	0.3
Oil and grease, mg/L	F2.0	F2.0	F2.0	F2.0	F2.0
Temperature, °C	28	17	14	13	13
pH	6.5	6.5	6.7	6.6	6.7
Fecal coliform, number/L	NA[a]	480	500	580	380
Biological oxygen demand (BOD)					4.2

[a]Not available.
Source: United Nuclear Corporation, Environmental Information (provided to the U.S. Nuclear Regulatory Commission), Docket No. 70-371, Jan. 17, 1983.

Table 4.3. Results of the 1983 grab samples taken for analysis of wastewater discharge from the facility

	DD[a] above cooling pond outfall	Cooling pond outfall	DD[a] below cooling pond	DD[a] near the Thames River
pH	7.3	9.6	8.6	7.2
Dissolved oxygen, mg/L	11.4	10.6	10.6	9.1
Nitrate as nitrogen, mg/L	1.9	3.6	2.2	1.9
Phosphorus, mg/L	0.03	0.05	0.04	0.02
Chlorine, mg/L	10.2	7.9	9.0	9.0
Iron, mg/L	0.17	0.31	0.29	0.35
Copper, mg/L	0.26	0.24	0.36	0.38
Zirconium, mg/L	<2	<2	<2	<2
Biological oxygen demand (BOD) (5-d), mg/L	14	<6	13	<6

[a]DD = drainage ditch.

Source: W. F. Kirk, United Nuclear Corporation, letter with additional information to Marc J. Rhodes, U.S. Nuclear Regulatory Commission, Docket No. 70-371, Aug. 19, 1983.

Soil

Soil samples are taken at 6 locations identified in Fig. 4.1. Six locations surrounding the manufacturing facilities are sampled and analyzed semiannually for gross alpha and uranium. All sampling is done within the first foot of soil. Data indicates that there is no significant buildup of radioactivity in soil from past operations. In addition, UNC has proposed, by letter dated August 19, 1983, an immediate and long term plan to sample and analyze subsurface soil within the area of the septic tank drain field to determine if there is accumulation of trace element and uranium in soil. The proposed plan is acceptable and is recommended as a license condition.

4.1.2.2 Nonradiological

Gaseous

Air quality monitoring at the Montville site is conducted for ambient nitrogen oxide concentrations at six monitoring stations surrounding the UNC facilities (Fig. 4.1). The sampling is done continuously for a 24-h period every other month.[1] Because of the insignificant levels of HF discharged, environmental monitoring for HF is not performed. The past monitoring data on NO_x shows that the NO_x standard (100 μg/m^3) had been exceeded occasionally at the onsite sampling stations. The offsite concentrations are below the standard (Sect. 4.2.1).

Liquid

The same parameters as those monitored onsite are also monitored by the applicant on a routine basis in Trading Cove and the Thames River, both upstream and downstream of the site. A summary of the monitoring results is found in Table 4.2. Assuming there is considerable water exchange between Trading Cove and the Thames River through the culvert under the railroad track--particularly as the result of the tidal influence in the river--the comparative results of the offsite and onsite monitoring programs show that levels of chemicals monitored are not increased in Trading Cove because of surface runoff discharge to the cove or in the Thames River downstream of the plant because of drainage discharge from the cooling pond (Table 4.2).

Groundwater from 17 onsite wells is monitored for selected chemical constituents (Fig. 4.1 and Table 4.1). Only nitrate and chloride exceed drinking water standards in some samples from a few of the wells. Percolation from the septic field is probably the nitrate source, and the brackish Thames River water accounts for the chloride. Since the groundwater flow is to Trading Cove and the Thames River, both of which are brackish, and there is no potential for drinking water use, these occasional values in excess of the standards are of no consequence.

Terrestrial ecology and land use

There is no monitoring of the effects of plant operation on terrestrial ecology or land use at the Montville site. Monitoring is not necessary because the potential impacts are not significant (Sects. 4.2.2 and 4.2.4).

4.2 Direct Effects and Their Significance

4.2.1 Air Quality

Gaseous emissions from the plant stacks are discussed in Sect. 2.2.2.1. Emissions of nitrogen oxide, trichloroethylene, and trichloroethane have the largest potential for impacts on the environment. A total of 12.17 metric tons (13.4 short tons) of nitrogen oxide is released to the air each year from pickling operations. To predict the annual average ground level concentrations of nitrogen oxide in 16 compass sectors and at various distances from the UNC facilities, the staff used meteorological data from the Connecticut Yankee Power Station at Haddam Neck. The maximum annual average concentrations occurred in the east-southeast sector. At the site boundary in this sector, about 425 m (1394 ft) from the plant, the nitrogen oxide concentrations were calculated to be 16.1 μg/m^3. At the site boundary in the northeast sector, about 195 m (640 ft) from the plant, the nitrogen oxide concentrations were calculated to be 46 μg/m^3. This nitrogen oxide concentration, when added to ambient nitrogen oxide levels monitored at Norwich,[3] does not exceed the Connecticut ambient air quality standard of 100 μg/m^3. The average nitrogen oxide concentration for the years 1977-1980 at Norwich was 49 μg/m^3. Over these 4 years, the nitrogen oxide concentrations showed no tendency to increase. The Connecticut State maintains a system of periodic inspections for compliance. The Air Quality Division in the Connecticut Department of Environmental Protection indicated to the NRC staff that the applicant is in compliance with all air quality standards.

A total of 0.9 metric tons (1.0 short tons) of trichloroethylene and trichloroethane, which are photochemically reactive, are emitted to the air each year. The daily average is about 3.5 kg (7.7 lb). The State of Connecticut permits such photochemically reactive substances to be released at a rate of 18.2 kg (40 lb) per day (R. Kroodsma, ORNL, personal communication with J. Royce, Connecticut Department of Environmental Protection, Nov. 17, 1983). Isopropyl alcohol, acetone, methyl ethyl ketone, and hexane, which are photochemically unreactive, are emitted at an average rate of 20.2 kg (44.4 lb) per day. The allowable rate is 363 kg (800 lb) per day. The UNC facilities thus comply with state regulations for emissions of these organic substances.

4.2.2 Land Use

No additional buildings, major additions to existing buildings, or changes in operations are proposed by the applicant for this relicensing action. Current operations have not resulted in any significant impacts on land use, and their continuation also should have no significant or unexpected impacts. Emissions to the air do not violate national or state air quality standards (Sect. 4.2.1) and should, therefore, have an insignificant effect on plants and vegetation important to agriculture and other types of land uses.

4.2.3 Water Use

Up to 2080 m^3 (550,000 gal) of water is used per day on site; of this amount, 530 m^3 (140,000 gal) is pumped from onsite wells. The remainder is obtained from the Norwich municipal water supply.[2] Because the topography of the facility area is such that there is considerable groundwater recharge, facility water use should have no effect on the surrounding area.

4.2.4 Ecological

4.2.4.1 Terrestrial

Because no expansion of the UNC facilities currently is planned, no new losses of habitat for biota will occur as a result of this licensing action. Although emissions to the air could have a potential impact on biota, the emissions are in compliance with local air quality standards (Sect. 4.2.1), and impacts on biota are not expected. Therefore, the population levels of plant and animal species in the area should remain unchanged. The primary long-term impact is the continued preclusion of wildlife populations on the land area occupied by buildings, parking lots, and associated facilities. Because of the lack of endangered species and other ecologically important species in the area (Sects. 3.7.1 and 3.7.3), the potential for significant impact is small.

4.2.4.2 Aquatic

Because of the limited amount of freshwater habitat on site, the ephemeral nature of the water courses, and the low number of aquatic species (Sect. 3.7.2), the impact on the freshwater biota from operation of the plant is minimal. The staff expects no significant impact on the biota of Trading Cove and the Thames River in the plant vicinity from the UNC's liquid discharge because of the insignificant change in water quality (Sect. 4.1.1). An initial NPDES permit for liquid discharge for 60,000 GPD was issued to UNC by the State of Connecticut in 1971. UNC requested in 1972 for increase to 250,000 GPD. The NPDES permit is currently under review by the Department of Environmental Protection of Connecticut.

4.2.5 Radiological Impacts

The radiological impacts of the UNC facility were assessed by calculating the maximum dose to the individual living at the nearest residence to the plant and to the local population living within an 80-km (50-mile) radius of the plant.

Except where specified, the term "dose," as referred to in this report, is actually a 50-year dose commitment for all internal exposures. This means the commitment is the total dose to the reference organ that will accrue from 1 year of intake of radionuclides during the remaining lifetime (50 years) of the individual. A conservative assumption is that the individuals spend all their time at the reference location and that all the food consumed is produced at the site. The dose reflects the annual release of radionuclides from the combined effluents. Where possible, site-specific data are used for estimating dose.

4.2.5.1 Doses from airborne releases

Emissions from building exhaust stacks are monitored continuously, and the average annual release rates[1] over the period 1978-1982 are shown in Table 4.4. The nearest residence is about 425 m west of the release stacks.

Table 4.4. Average annual release of radionuclides in the stack effluents of the United Nuclear Corporation fuel fabrication plant[a]

Radionuclides	Release rate (Ci/year)
^{234}U	4.3×10^{-5}5
^{235}U	1.2×10^{-6}
^{236}U	7.8×10^{-8}
^{238}U	2.1×10^{-9}

[a]Average annual release rate during the years 1978-1982.

Source: United Nuclear Corporation, Environmental Information (provided to the U.S. Nuclear Regulatory Commission), Docket No. 70-371, Jan. 17, 1983.

Table 4.5. Fifty-year dose commitments[a] to the maximum exposed individual at the nearest residence[b] from the airborne effluents of the United Nuclear Corporation plant

Pathway	Dose (millirem)			
	Total body	Bone	Lungs	Kidneys
Immersion in air	1.3×10^{-9}	2.2×10^{-9}	1.2×10^{-9}	9.5×10^{-10}
Exposure to surface	5.9×10^{-5}	9.8×10^{-5}	4.8×10^{-5}	4.0×10^{-5}5
Inhalation[c]	2.8×10^{-3}	3.8×10^{-2}	7.0×10^{-4}	8.3×10^{-3}
Ingestion[d]	1.3×10^{-2}	1.7×10^{-1}	1.0×10^{-3}	3.7×10^{-2}
Total	1.6×10^{-2}	2.1×10^{-1}	1.7×10^{-3}	4.5×10^{-2}

[a]Fifty-year dose commitment for the intake of radionuclides resulting from one year of plant operation.

[b]Nearest residence is approximately 425 m west of the plant site.

[c]Based on an inhalation rate of 8000 m^3/year.

[d]Based on a maximum intake rate for adults of 280 kg/year of vegetables, 310 L/year of milk, and 110 kg/year of meat as given by the U.S. Nuclear Regulatory Commission in Regulatory Guide 1.109, Rev. 1, October 1977.

Doses were estimated using the AIRDOS-EPA computer code.[4] The methodology is designed to estimate (1) the rates of deposition on ground surfaces; (2) ground surface concentrations; (3) intake rates via inhalation of air and ingestion of meat, milk, and vegetables; and (4) radiation doses to man from the airborne releases of radionuclides. The highest estimated doses to the individual living closest to the plant and to the population living within an 80-km (50-mile) radius of the plant are calculated with the code.

Meteorological dispersion factors, χ/Q, were estimated using the Gaussian plume model and diffusion coefficients for Pasquill-type turbulence.[5,6] Because all the stack heights are less than twice the building heights, and also because of the topography of the site, ground level releases were assumed with no credit given to the building wakes effect. The χ/Q values are summarized in Appendix A.

Radionuclide concentrations in meat, milk, and vegetables consumed by man are estimated by coupling the output of the atmospheric transport models with NRC Regulatory Guide 1.109.[7] In lieu of site-specific information, average wind speed data for each segment and for each stability class, based on the 1975-1976 measurements at the nearby Connecticut Yankee Power Station, were used for determining the dispersion and deposition of the radionuclides released. Other parameters used in the dose calculations are given in Appendix A.

Dose to the maximally exposed individual

The 50-year dose commitments to the maximally exposed individual living at the nearest residence (425 m west of the plant) from the airborne effluents are shown in Table 4.5. The total-body dose of 0.013 millirem resulted primarily from the ingestion (76%) and inhalation (22%) pathways. Approximately 97% of the dose was attributable to the ^{234}-U released (Table 4.6). The highest organ dose of 0.17 was to the bone and was caused primarily by ingestion (76%) of ^{234}U (97%).

The total-body and organ doses resulting from the airborne releases are only a small fraction of the applicable NRC regulations of 500 millirem/year to the total body; 3000 millirem/year to the bones; and 1500 millirem/year to the other organs, designated in or derived from 10 CFR Part 20. Similarly, the doses are well below the Environmental Protection Agency (EPA) standards for the uranium fuel cycle (40 CFR Part 190). The total-body dose is only about 0.052%, the bone dose about 0.68%, and the lung dose about 0.004% of the EPA standard of 25 millirem/year for the total body and these organs.

Additionally, the total-body dose of 0.013 millirem is only about 0.012% of the background for the area (110 millirem/year), and thus the contribution to the existing background levels would be negligible.

Dose to the population within 80 km of the plant site

The 1980 population distribution with an 80-km (50-mile) radius of the plant site is shown in Tables 3.4 and 3.5. A total of 3,597,500 persons live within this area. The population dose commitments from the routine annual releases of radionuclides (Table 4.4) are shown in Table 4.7. The total-body dose to the population of 0.015 man-rem is only about 0.000008% of the population dose of 1.8×10^5 man-rem resulting from natural background radiation.

Table 4.6. Major contributions to dose to the nearest residence from the airborne effluents of the United Nuclear Corporation plant

Radionuclide	Percentage contribution to dose			
	Total body	Bone	Lungs	Kidneys
^{234}U	97.0	97.3	93.6	97.3
^{235}U	2.8	2.5	6.2	2.5
^{236}U	0.2	0.2	0.2	0.2
^{238}U	<0.1	<0.1	<0.1	<0.1

Table 4.7. Fifty-year dose commitments[a] from the airborne effluents to the population[b] living within 80 km of the United Nuclear Corporation plant

Pathway	Dose (man-rem)			
	Total body	Bone	Lungs	Kidneys
Immersion in air	1.2×10^{-9}	2.1×10^{-9}	1.1×10^{-9}	8.9×10^{-10}
Exposure to surface	1.1×10^{-4}	1.9×10^{-4}	9.3×10^{-5}	7.6×10^{-5}
Inhalation[c]	2.6×10^{-3}	3.6×10^{-2}	6.6×10^{-4}	7.9×10^{-3}
Ingestion[d]	1.2×10^{-2}	1.7×10^{-1}	3.7×10^{-4}	3.6×10^{-2}
Total	1.5×10^{-2}	2.1×10^{-1}	1.1×10^{-3}	4.4×10^{-2}

[a]Fifty-year dose commitment for the intake of radionuclides resulting from one year of plant operation.

[b]Based on the 1980 population of 3,597,500 persons.

[c]Based on an inhalation rate of 8,000 m^3/year.

[d]Based on a average intake rate for adults of 103 kg/year of vegetables, 110 L/year of milk, and 95 kg/year of meat as given by the U.S. Nuclear Regulatory Commission in Regulatory Guide 1.109, Rev. 1, October 1977.

4.2.5.2 Doses from aqueous releases

The operations of the various facilities at the Montville site will not result in the discharge of radioactive liquid waste into any local surface waters.

All liquids that may have picked up uranium-bearing materials are piped into collecting tanks, sampled, treated if necessary, and discharged to the sanitary sewage septic systems. Quantities of about 3.8 m^3/d (1000 gpd) of liquid radioactive waste are discharged along with 148 m^3/d (39,000 gpd) of uncontaminated liquid to the sanitary sewage system. The annual liquid waste discharge to the sewage system is shown in Table 4.8.

Since no radioactive wastes are normally released to local streams, there should be no dose to individuals through the aqueous exposure pathways.

4.3 Indirect Effects and Their Significance

4.3.1 Socioeconomic Effects

As discussed in Sect. 3.3, employment at the UNC facility accounts for little of the employment in the region. Continued operation would have no socioeconomic impact.

4.3.2 Potential Effects of Accidents

The fabrication of fuel for nuclear reactors for naval applications involves the processing of enriched uranium. The only significant radioactive material present at the fuel fabrication facility is the uranium for fuel element fabrication. Plant accidents at the UNC facility have been postulated and analyzed in the applicant's safety report. Environmental impacts would result from postulated accidents involving nuclear criticality, equipment failure, industrial hazards, and natural disturbances. Although the nuclear criticality accident has a very low probability of occurrence, there may be potentially significant or measurable environmental impact. The radiological environmental impacts of the more probable postulated industrial accidents are insignificant at this facility. Impacts of accidents not involving the enriched uranium would be similar to those expected at other manufacturing facilities where nonradioactive materials are stored. A spectrum of possible accidents related to the operation of the UNC facility and their potential consequences are presented in the following section. However, it should be noted that there have been no major accidents related to plant operations in past years that have affected people or the offsite environment.

4.3.2.1 Criticality accident

In evaluating the potential offsite effects of a postulated criticality event, the staff assumed accident conditions similar to those described in Regulatory Guide 3.34 (Rev. 1)[8] in which an excursion occurs in a vented vessel of unfavorable geometry and produces a total of 1×10^{19} fissions over an 8-h period. The retention time within the building is based on an air exchange rate of 1.4 volumes/h from the recovery area. It was assumed that 100% of the noble gases and 25% of the halogens were released into the building atmosphere. The filters or other installed controls were not credited with any removal of these gases. However, for the ground level release, the air

Table 4.8. Discharge of liquid waste to the sanitary sewage system

Year	Amount discharged (m^3)	Enriched uranium g	Enriched uranium Ci[a]	Percent MPC[a,b]
1978	1.35×10^3	174	0.011	20.4
1979	1.43×10^3	109	0.008	17.5
1980	9.61×10^2	45	0.003	13.1
1981	1.20×10^3	85	0.006	19.3
1982 (six months)	5.60×10^2	51	0.004	17

[a]Maximum permissible concentration (MPC) for release to uncontrolled areas (10 CFR Part 20).

[b]The curies and percent MPC is influenced by the specific activity of the ^{234}U, which has changed over the years.

Source: United Nuclear Corporation, Environmental Information (provided to the U.S. Nuclear Regulatory Commission), Docket No. 70-371, Jan. 17, 1983.

concentrations were reduced by a factor of three due to additional dispersion produced by the building wake. The amount of radionuclides that would be released over the 8-h period of excursion is shown in Table 4.9.

The atmospheric diffusion model for the release is based on Regulatory Guide 3.34 (Rev. 1),[8] with a wind speed of 1 m/s and uniform direction. The release of radionuclides was considered to be a ground release, and a Pasquill Type F wind stability class was used for determining the doses at the nearest residence (427 m west of the site), because this stability class gave the maximum dose at these distances.

The offsite consequences from a nuclear criticality at the nearest residence (427 m west of the site) are shown in Table 4.10. The total-body dose of 714 millirem and the highest organ dose of 749 millirem to the thyroid should not result in any injury to the nearest resident.[9] The total-body dose is not significantly higher than the NRC standard for exposures to routine operating levels of 500 millirem/year, and the organ doses are less than the comparable standard of 1500 millirem/year.

4.3.2.2 Accidents involving nonradioactive materials

Chemicals are stored in bulk quantities at the site. Spills, fires, and explosions are the major potential accidents through which stored chemicals could affect the environment. These potential accidents, their environmental effects, and the plant design features to minimize such effects are discussed in the following sections.

Major spills

The chemicals potentially subject to spills include HNO_3, NaOH, liquid argon, liquid alcohol or hexane, spent acids, and spent detergent. The UNC has employed the following measures to ensure the integrity of chemical storage tanks: proper design and operation, safety relief valves, remote location, and routine visual inspection by trained plant personnel.

The chance of a major spill, such as the contents of a tank, is considered to be remote. Should a spill of this magnitude occur, appropriate measures would be taken to recover or neutralize the spilled material. Therefore, accidental spills would not be expected to affect offsite waters.

Fires and explosions

Potential sources of fires or explosions are acetone, alcohol, zirconium machining chips and fines, natural gas and fuel oil, lubricating oils, compressed gases (acetylene, hydrogen, oxygen, propane), hexane, and methyl ethyl ketone. Flammable liquids are used with appropriate safety controls such as safety cans, CO_2 extinguishing systems, inert gas atmospheres, thermally activated lid-closures on tanks, and proper ventilation. Zirconium machine chips and fines are collected underwater and promptly burned outside the plant to eliminate the possibility of combustion or explosion.

The probability of a fire has been minimized through carefully engineered safeguards, strict control of combustible materials, and protective measures to control a fire if it does occur. Safeguards include extensive sprinkler

Table 4.9. Release rate of volatile radionuclides[a] to the atmosphere from a criticality accident

Radionuclide	Released into the building[b] (Ci/8 h)	Released to outside atmosphere (Ci/8 h)
^{83m}Kr	1.6×10^{2}	3.19×10^{1}
^{85m}Kr	1.5×10^{2}	7.6×10^{1}
^{85}Kr	1.6×10^{-3}	1.5×10^{-3}
^{87}Kr	9.9×10^{2}	1.6×10^{2}
^{88}Kr	6.5×10^{2}	2.4×10^{2}
^{89}Kr	4.2×10^{4}	3.5×10^{1}
^{131m}Xe	8.2×10^{-2}	7.3×10^{-2}
^{133m}Xe	1.8	1.6
^{133}Xe	2.7×10^{1}	2.4×10^{1}
^{135m}Xe	2.2×10^{3}	3.5×10^{1}
^{135}Xe	3.6×10^{2}	2.4×10^{2}
^{137}Xe	4.9×10^{4}	6.5×10^{1}
^{138}Xe	1.3×10^{4}	1.8×10^{2}
^{131}I	2.2	2.0
^{132}I	2.8×10^{2}	8.5×10^{1}
^{133}I	4.0×10^{1}	3.1×10^{1}
^{134}I	1.1×10^{3}	1.1×10^{2}
^{135}I	1.2×10^{2}	7.2×10^{1}

[a]Based on 1×10^{19} fissions and approximate decay schemes based on building retention time (calculated from a ventilation rate of 1.4 volumes/h from the recovery area).

[b]It is assumed that 100% of the noble gases and 25% of the halogens are released into the building atmosphere.

Table 4.10. Maximum 50-year dose commitment to the nearest residence[a] from the criticality accident[b]

Exposure type	Dose (millirem)			
	Total body	Thyroid	Bone	Lungs
Airborne radioactivity	37	72	36	35
Prompt gamma	267	267	267	267
Prompt neutron	410	410	410	410
Total	714	749	713	712

[a]Nearest residence is 427 m west of the site.
[b]Accident parameters and calculations are based on information given by the U.S. Nuclear Regulatory Commission in Regulatory Guide 3.34 (Rev. 10, July 1979). The total number of fissions produced during the 8-h excursion is assumed to be 10^{19}. It is assumed that 100% of the noble gases and 25% of the halogens are released into the building.

systems, a 1135-m^3 (300,000-gal) water storage tank with backup pumping capability, outside fire hydrants, portable fire extinguishers within the buildings, and a well-equipped fire truck and fire brigade.

Accidents that have occurred during the past 5 years of operation have been of a minor nature. Accidents that have occurred were

- fuel oil overflow with a few liters going to floor drains,
- minor spills of acids or detergents during delivery or pickup,
- minor brush fires onsite,
- uranium contamination inside the plant due to spills or penetration,
- visible nitrogen oxide effluent upon fan failure or excessive bath temperature,
- minor fires on machines involving zirconium alloy chips and fines,
- minor fire in ductwork involving zirconium alloy fines containing uranium, and
- fire inside electrical switchgear inside the plant building.

None of these accidents had any measurable effect on the site or surrounding environment.

4.3.2.3 Transportation accidents

Shipment of nonradioactive materials

Possible vehicular collisions and other accidents during shipment of nonradioactive materials to and from the UNC plant may result in a threat to human life. Published accident statistics yield an accident probability of between 1×10^{-6} and 1.6×10^{-6} per kilometer (1.6×10^{-6} and 2.6×10^{-6} per mile), with risks to human life being 0.51 injury per accident and 0.03 fatality per accident.

Total nonradioactive material delivery and shipment requirements for this defense-related production facility are not available. However, the staff has conservatively estimated about one shipment per day. On this basis, and an estimated average round-trip shipping distance of 320 km (200 miles) per delivery, the probability of an accident involving shipments of nonradioactive materials is between 0.12 and 0.19 per year. The estimated injury and fatality rates associated with this accident rate are between 6×10^{-2} to 9×10^{-2} injuries per year and 3.6×10^{-3} to 5.7×10^{-3} fatalities per year.

The nonradioactive material shipments to and from the applicant's plant do not present any unique transportation hazard over and above those handled by nonnuclear manufacturing facilities handling similar materials. All hazardous and flammable materials will be packaged and shipped in accordance with U.S. Department of Transportation (DOT) regulations and any applicable state and local laws.

Shipments of radioactive materials

The majority of the material shipped from UNC will be finished reactor fuel cores. The cores will consist of fully encapsulated uranium fuel elements and will be shipped in specially designed type B containers under government cognizance.

All radioactive materials other than completed cores will be shipped from the facility in exclusive-use trucks. All containers and the transport vehicles are completely surveyed for proper loading, absence of defects that could affect container integrity, and levels of radioactive contamination before offsite shipment.

A criticality accident or major contamination incident as the result of a transportation accident is very unlikely because DOT and NRC container performance standards and vehicle-loading rules specify that containers and fuel assemblies must be able to withstand conditions of transport and hypothetical accident conditions without either losing the contents or attaining a critical array. To date, no transportation accidents with special nuclear material have ever resulted in criticality.

Small amounts of uranium could be released from the containers as a result of a severe highway accident; however, the small amount and chemically unreactive nature of the material shipped in these containers would limit the environmental impact to the cleanup of several hundred microcuries in the immediate vicinity of the accident site. An evaluation of possible accident situations shows that transportation accidents would usually result in no more than minor cleanup problems with no environmental impact of any consequence.

No significant external radiation exists from any uranium material transported from the site. Protective action responses involve the notification of the state Department of Environmental Protection and the state police, and the prompt dispatch of health physics personnel to assist in controlling the accident site and coordinating any spill cleanup.

4.3.2.4 Natural phenomena

Tornado

The probability of tornado occurrence has been estimated as once in 1300 years. Were the UNC facility to be struck by a tornado of sufficient force to damage a building containing uranium, radioactive material might be released to the atmosphere. However, most of the uranium in the facility is packaged in rugged shipping containers or is intimately bound within fuel element structures, with only a small amount available at any moment that could be subject to dispersion. Although the ultimate fate of this material is impossible to predict with accuracy, the staff expects that dispersion of the material will result in minor offsite unsequences.

The staff also expects that any elevated uranium concentrations will be very brief and will result in a 50-year dose commitment to the public that is small compared with the dose commitments from background.

Earthquakes

The chance of a major earthquake occurring near the site is improbable. The UNC plant site is located in an area of Zone 1 earthquake intensity, corresponding to Intensity V or VI on the Modified Mercalli scale of 1931. The UNC plant was not designed for a specific earthquake level, but it is unlikely that the metal-framed, metal-covered buildings would lose their integrity with an Intensity VI earthquake.

4.3.3 Possible Conflicts Between the Proposed Action and the Objectives of Federal, Regional, State, and Local Plans and Policies

At this time, the staff is not aware of any conflict between the proposed action and the objectives of federal, regional, state (Connecticut), or local plans, policies, or controls for the action proposed as long as proper agencies are contacted, proper applications are submitted, and proper monitoring and mitigatory measures are taken to protect the environment and public health and safety.

4.3.4 Effects on Urban Quality, Historical and Cultural Resources and Society

The environmental effects of the proposed license renewal action as discussed previously are considered to be insignificant. There may be adverse effects on national defense if reactor fuel were not available for the naval vessels.

The facility has not affected historical or cultural resources. The short-term societal effects during operation are and will be minimal, and there will be minimal effects after decommissioning and reclamation because the site then will be required to meet federal standards for unrestricted use.

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Appendix A

METHODOLOGY AND ASSUMPTIONS FOR CALCULATING RADIATION DOSE COMMITMENTS FROM THE RELEASE OF RADIONUCLIDES

Appendix A

METHODOLOGY AND ASSUMPTIONS FOR CALCULATING RADIATION DOSE COMMITMENTS FROM THE RELEASE OF RADIONUCLIDES

A.1 Methodology and Assumptions For Airborne Releases

A.1.1 Methodology

The radiation dose commitments resulting from the atmospheric releases of radionuclides are calculated using the AIRDOS-EPA computer code.[1] The methodology is designed to estimate the radionuclide concentrations in air; rates of deposition on ground surfaces; ground-surface concentrations; intake rates via inhalation of air and ingestion of meat, milk, and fresh vegetables; and radiation doses to man from the airborne releases of radionuclides.

With the code, the highest estimated dose to an individual in the area and the doses to the population living within an 80-km radius of the plant site are calculated. The doses may be summarized by radionuclide, exposure mode, or significant organ of the body.

Many of the basic incremental parameters used in AIRDOS-EPA are conservative; that is, values are chosen to maximize intake by man. Many factors that would reduce the radiation dose, such as shielding provided by dwellings and time spent away from the reference location, are not considered. It is assumed that an individual lives outdoors at the reference location 100% of the time. Moreover, in estimating the doses to individuals via ingestion of vegetables, beef, and milk, all of the food consumed by the individual is assumed to be produced at the reference location specified in the calculation. Thus, the dose estimates calculated by these methods are likely to be higher than the doses that would actually occur.

Meteorological dispersion factors, χ/Q, were estimated using the Gaussian plume model and diffusion coefficients for Pasquill-type turbulence.[2,3] Radionuclide concentrations in meat, milk, and vegetables consumed by man are estimated by coupling the output of the atmospheric transport models with the NRC Regulatory Guide 1.109, "Terrestrial Food Chain Models."[4] The models are described in ORNL/TM-6100.[5]

A.1.2 Radiation exposure pathways and dose conversion factors

Environmental transport links the source of release to the receptor by numerous exposure pathways. Figure A.1 is a diagram of the most important pathways that result in the exposure of man to radioactivity released to the environment. The resulting radiation exposures may be either external or internal. External exposures occur when the radiation source is outside the irradiated body, and internal exposures are those from radioactive materials within the irradiated body. Because aqueous releases of radioactivity are inconsequential, the aquatic pathway for radiological dose commitments is omitted in this assessment.

Factors for converting the radiation exposures to estimates of dose are calculated using the latest dosimetric criteria of the International Commission on Radiological Protection (ICRP) and other recognized authorities.

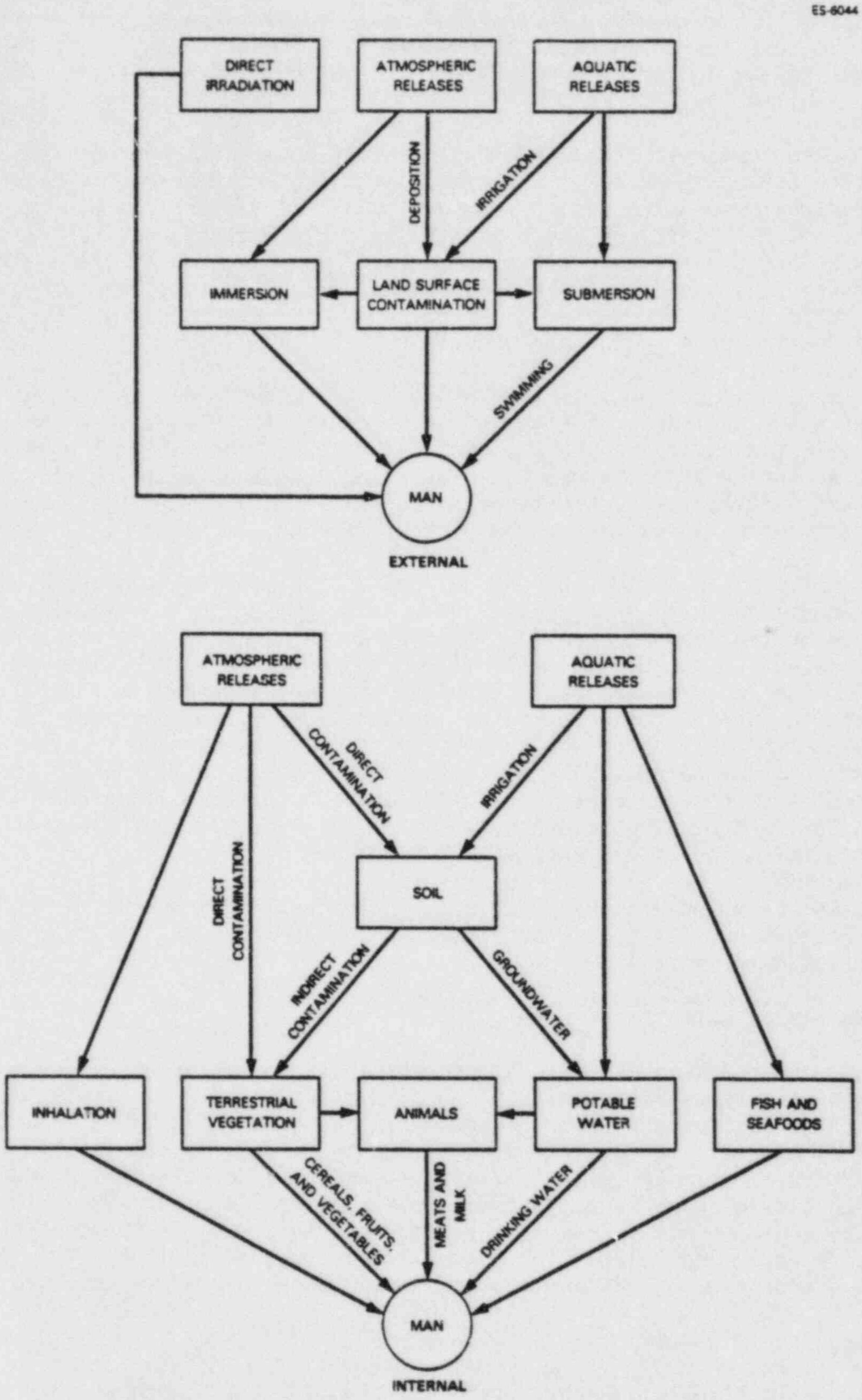

Fig. A.1. Pathways for exposure to man from releases of radioactive effluents.

External dose conversion factors. Releases of radioactive gases and particulates to the atmosphere may result in external doses by exposure to and/or immersion in the plume and to contaminated land surfaces. The dose conversion factors are summarized by Kocher in ORNL/NUREG-79,[6] and those used in this report are shown in Table A.1.

Internal dose conversion factors. Factors for converting internal radiation exposure to estimates of dose have been computed based on recent models[7,8] and are summarized by Dunning et al. in ORNL/NUREG/TM-190/V3.[9] The dose conversion factors used in this report are presented in Table A.2. These factors are input data into the AIRDOS-EPA computer code, which is used to calculate the dose from inhaled and ingested radionuclides.

A.1.3 Radiation dose to the individual

Internal exposure continues as long as radioactive material remains in the body, which may be longer than the duration of the individual's residence in the contaminated environment. The best estimates of the internal dose resulting from an intake are obtained by integrating over the remaining lifetime of the exposed individual; such estimates are called dose commitments. The remaining lifetime is assumed to be 50 years for an adult.

External doses are assumed to be annual doses. The dose rate above the contaminated land surface is estimated for a height of 1 m. Following the initial deposition of radionuclides, the potential for exposure of man may persist, depending on the influence of environmental redistribution, long after the plume leaves the area. Concentrations of radionuclides at the point of deposition normally are reduced by infiltration of radionuclides into the soil, by loss of soil particles due to erosion, and by transport in surface water and in groundwater. When the effects of these processes cannot be quantified, a conservative estimate of dose due to external exposure to contaminated surface is obtained by assuming that the radionuclide concentrations are diminished by radioactive decay only.

The dose is estimated for individuals at the nearest site boundary at the nearest residence. The intake parameters used for individual dose determination are shown in Table A.3.

A.1.4 Radiation dose to the population

The total dose received by the exposed population is estimated by the summation of individual dose estimates within the population. The area within the 80-km (50-mile) radius of the site is divided into 16 sectors (22.5° each) and into a number of annuli. The average dose for an individual in each subdivision is estimated, that estimate multiplied by the number of persons in the subdivision, and the resulting products are summed across the entire area. The unit used to express the population dose is man-rem. For this report, the population dose estimates are calculated for a population composed entirely of adults. The parameters used for calculating population doses are shown in Table A.3.

A.2 Atmospheric Dispersion

The atmospheric dispersion model used in estimating the atmospheric transport to the terrestrial environment is discussed in detail in NRC Regulatory

Table A.1. Dose conversion factors for major contributor to the external exposure pathways

Radionuclide	Organ			
	Total body	Bone	Kidney	Lungs
Exposure to ground surfaces (millirem/year per μCi/cm^2)				
^{233}U	7.1×10^2	3.0×10^2	1.0×10^2	1.7×10^2
^{235}U	1.5×10^5	2.1×10^5	1.3×10^5	1.4×10^5
^{236}U	6.4×10^2	2.4×10^2	7.0×10^1	1.4×10^2
^{238}U	5.7×10^2	2.1×10^2	5.9×10^1	1.2×10^2
Immersion in air (millirem/year per μCi/cm3)				
^{234}U	6.8×10^5	7.1×10^5	3.7×10^5	4.1×10^5
^{235}U	6.8×10^8	9.4×10^8	5.9×10^8	6.3×10^8
^{236}U	5.3×10^5	5.4×10^5	2.6×10^5	3.0×10^5
^{238}U	4.6×10^5	4.5×10^5	2.2×10^5	2.5×10^5

Source: D. C. Kocher, Dose-Rate Conversion Factors for External Exposure to Photons and Electrons, ORNL/NUREG-79, Oak Ridge National Laboratory, August 1981.

Table A.2. Dose conversion factors[a] for internal exposure pathways

Radionuclide	Organ			
	Total body	Bone	Kidney	Lungs
	Inhalation (rem/μCi)			
^{234}U	6.4	87	19	1.6
^{235}U	5.8	79	17	1.4
^{236}U	6.1	82	18	1.5
^{238}U	5.7	78	17	1.4
	Ingestion (rems/Ci)			
^{234}U	5.8×10^{-1}	7.8	1.7	1.7×10^{-2}
^{235}U	5.2×10^{-2}	7.1	1.5	1.6×10^{-2}
^{236}U	5.4×10^{-1}	7.4	1.6	1.6×10^{-2}
^{238}U	5.1×10^{-1}	7.0	1.5	1.5×10^{-2}

[a]Factors for a particle size of 0.3 μm and solubility class D for inhalation and solubility class W for ingestion from information supplied by United Nuclear Corporation.

Source: D. E. Dunning, Jr., S. R. Bernard, P. J. Walsh, G. G. Killough, and J. C. Pleasant, Estimates of Internal Dose Equivalent to 22 Target Organs for Radionuclides Occurring in Routine Releases from Nuclear Fuel Cycle Facilities, Vol. II, ORNL/NUREG/TM-190/V3, Oak Ridge National Laboratory, October 1981.

Table A.3. Intake parameters (adult)[a] used in lieu of site-specific data

Pathway	Maximum exposed individual	Average exposed individual[b]
Vegetables, kg/year	281[c]	190
Milk, L/year	310	110
Meat, kg/year	110	95
Inhalation, m^3/year	8000	8000

[a]From NRC Regulatory Guide 1.109.

[b]Used for calculating population doses.

[c]This value includes leafy vegetables.

Guide 1.111 (Rev. 1). For particulate release, the meteorological χ/Q values are used in conjunction with dry deposition velocities and scavenging coefficients to estimate air concentrations and steady-state ground concentrations. The atmospheric dispersion model estimates the concentration of radionuclides in air at ground surfaces as a function of distance and direction from the point of release. Site-specific averages of annual meteorological data are supplied as input for the model. Radioactive decay during the plume travel is taken into account in the AIRDOS-EPA code.[1] Daughters produced during plume travel are calculated and added to the source term.

The area surrounding the plant site is divided into 16 sectors by compass direction (Sect. 3.3). The meteorological χ/Q values are calculated for the midpoint of each sector defined by the radial distances of 0.4, 1.2, 2.4, 4.0, 5.6, 7.2, 12.1, 24.1, 40.2, 56.3, and 72.4 km (Table A.4). Concentrations in the air for each sector are used to calculate dose via inhalation and submersion in the air. The ground deposits result in external gamma dose and, in addition, are assimilated into food and contribute dose upon ingestion via the food chain.

The meteorological data required for the calculations are joint frequency distributions of wind velocity and direction summarized by stability class. Meteorological data (Tables A.5 and A.6) from the nearest collection station (Connecticut Yankee Power Station) are used to calculate the concentrations of radionuclides at a reference point per unit of source strength. Depletion of the airborne plume as it is blown downwind is accounted for in the AIRDOS-EPA code by taking into account the deposition on surfaces by dry deposition, scavenging, and radioactive decay. Other parameters used in determining air concentration are shown in Table A.7.

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Table A.4. Ground-level x/Q values for particulates at various distances in each compass direction

Distance (m)	x/Q toward indicated direction (s/m3)							
	N	NNW	NW	WNW	W	WSW	SW	SSW
425	0.171E-04	0.154E-04	0.169E-04	0.288E-04	0.390E-04	0.980E-05	0.825E-05	0.874E-05
1207	0.219E-05	0.195E-05	0.219E-05	0.370E-05	0.506E-05	0.126E-05	0.102E-05	0.109E-05
2414	0.597E-06	0.532E-06	0.610E-06	0.101E-05	0.140E-05	0.348E-06	0.272E-06	0.293E-06
4023	0.231E-06	0.205E-06	0.242E-06	0.394E-06	0.546E-06	0.136E-06	0.101E-06	0.110E-06
5632	0.126E-06	0.112E-06	0.134E-06	0.218E-06	0.304E-06	0.739E-07	0.530E-07	0.580E-07
7240	0.778E-07	0.688E-07	0.837E-07	0.133E-06	0.185E-06	0.448E-07	0.309E-07	0.340E-07
12068	0.286E-07	0.252E-07	0.321E-07	0.503E-07	0.706E-07	0.164E-07	0.102E-07	0.114E-07
24135	0.568E-08	0.496E-08	0.720E-08	0.111E-07	0.158E-07	0.311E-08	0.151E-08	0.177E-08
40225	0.134E-08	0.116E-08	0.203E-08	0.302E-08	0.421E-08	0.756E-09	0.283E-09	0.341E-09
56315	0.397E-09	0.329E-09	0.709E-09	0.101E-08	0.138E-08	0.196E-09	0.568E-10	0.686E-10
72405	0.155E-09	0.119E-09	0.306E-09	0.399E-09	0.484E-09	0.599E-10	0.142E-10	0.165E-10
	S	SSE	SE	ESE	E	ENE	NE	NNE
425	0.945E-05	0.141E-04	0.272E-04	0.417E-04	0.295E-04	0.296E-04	0.284E-04	0.228E-04
1207	0.118E-05	0.168E-05	0.351E-05	0.562E-05	0.381E-05	0.356E-05	0.344E-05	0.292E-05
2414	0.316E-06	0.437E-06	0.972E-06	0.161E-05	0.105E-05	0.935E-06	0.906E-06	0.797E-06
4023	0.119E-06	0.161E-06	0.381E-06	0.651E-06	0.409E-06	0.348E-06	0.338E-06	0.208E-06
5632	0.624E-07	0.845E-07	0.209E-06	0.368E-06	0.227E-06	0.186E-06	0.182E-06	0.169E-06
7240	0.366E-07	0.493E-07	0.129E-06	0.234E-06	0.139E-06	0.111E-06	0.108E-06	0.104E-06
12068	0.122E-07	0.166E-07	0.477E-07	0.940E-07	0.526E-07	0.389E-07	0.382E-07	0.381E-07
24135	0.186E-08	0.262E-08	0.979E-08	0.239E-07	0.116E-07	0.700E-08	0.688E-08	0.762E-08
40225	0.351E-09	0.506E-09	0.255E-08	0.790E-08	0.331E-08	0.153E-08	0.145E-08	0.190E-08
56315	0.692E-10	0.103E-09	0.898E-09	0.337E-08	0.130E-08	0.466E-09	0.413E-09	0.657E-09
72405	0.164E-10	0.244E-10	0.429E-09	0.175E-08	0.666E-09	0.219E-09	0.183E-09	0.314E-09

Table A.5. Frequencies of wind directions and true-average wind speeds

Wind toward[a]	Frequency	Wind speeds for each stability class (m/s)						
		A	B	C	D	E	F	G
1	0.049	1.14	0.0	1.02	1.27	1.10	0.40	0.40
2	0.038	0.94	0.0	0.80	1.28	1.16	0.60	0.40
3	0.050	1.67	0.0	1.27	1.82	1.27	0.60	0.40
4	0.069	2.38	0.0	1.83	1.62	1.15	0.77	0.76
5	0.079	0.0	0.0	0.0	1.98	1.17	1.19	0.98
6	0.017	0.0	0.0	0.0	1.57	0.76	0.60	0.0
7	0.012	0.0	0.0	0.0	0.8[illegible]	0.55	0.40	0.0
8	0.013	0.0	0.0	0.0	0.82	0.58	0.40	0.0
9	0.014	0.0	0.0	0.0	0.82	0.56	0.40	0.0
10	0.020	0.0	0.0	0.0	0.77	0.57	0.40	0.40
11	0.084	2.90	0.0	2.64	1.80	1.06	0.55	0.40
12	0.211	4.32	0.0	3.67	2.53	1.61	0.69	0.60
13	0.104	3.53	0.0	3.33	2.50	1.65	0.69	0.82
14	0.065	2.20	0.0	2.06	1.66	1.19	0.52	0.47
15	0.061	1.72	0.0	1.88	1.64	1.19	0.55	0.47
16	0.073	1.55	0.0	2.13	1.61	1.18	0.53	0.40

[a]Wind directions are numbered counterclockwise starting at 1 for due north.

Table A.6. Frequency of atmospheric stability classes for each direction

Sector	Fraction of time in each stability class						
	A	B	C	D	E	F	G
1	0.2041	0.0	0.0408	0.4490	0.2653	0.0204	0.0204
2	0.1316	0.0	0.0263	0.4474	0.3158	0.0526	0.0263
3	0.0818	0.0	0.0599	0.4990	0.2994	0.0399	0.0200
4	0.0580	0.0	0.0435	0.3913	0.3768	0.0725	0.0580
5	0.0	0.0	0.0	0.3038	0.4684	0.1392	0.0886
6	0.0	0.0	0.0	0.2353	0.6471	0.1176	0.0
7	0.0	0.0	0.0	0.2500	0.6667	0.0833	0.0
8	0.0	0.0	0.0	0.2308	0.6923	0.0769	0.0
9	0.0	0.0	0.0	0.2143	0.7143	0.0714	0.0
10	0.0	0.0	0.0	0.2500	0.6500	0.0500	0.0500
11	0.1429	0.0	0.0833	0.4048	0.3095	0.0476	0.0119
12	0.2009	0.0	0.1182	0.4539	0.1939	0.0236	0.0095
13	0.2404	0.0	0.0865	0.3558	0.2404	0.0481	0.0288
14	0.1385	0.0	0.0769	0.3231	0.3385	0.0769	0.0462
15	0.1475	0.0	0.0328	0.3443	0.3607	0.0656	0.0492
16	0.2329	0.0	0.0822	0.3973	0.2329	0.0411	0.0137

Table A.7. Other parameters used in determining exposure to air concentrations of radionuclides released in the building vent effluents

Parameters	Quantity or dimensions
Release height, m	1[a]
Temperature (annual average for area), °C	13.5
Rainfall (annual average), cm/year	129
Height of lid (annual average), m	961
Population within 80 km of radius of site, persons	1,647,400

[a]Ground level.

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This Environmental Assessment is issued by the U.S. Nuclear Regulatory Commission (NRC) in response to an application by UNC Naval Products, Division of UNC Resources, Inc., for the renewal of Special Nuclear Material (SNM) License No. SNM-368 for the operation of the existing fuel fabrication facility.

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