NUREG-0921

Final Environmental Statement

related to the operation of Catawba Nuclear Station, Units 1 and 2

Docket Nos. 50-413 and 50-414

Duke Power Company, et al.

U.S. Nuclear Regulatory Commission

Office of Nuclear Reactor Regulation

January 1983

NOTICE

Availability of Reference Materials Cited in NRC Publications

Most documents cited in NRC publications will be available from one of the following sources:

1. The NRC Public Document Room, 1717 H Street, N.W.
   Washington, DC 20555

2. The NRC/GPO Sales Program, U.S. Nuclear Regulatory Commission,
   Washington, DC 20555

3. The National Technical Information Service, Springfield, VA 22161

Although the listing that follows represents the majority of documents cited in NRC publications, it is not intended to be exhaustive.

Referenced documents available for inspection and copying for a fee from the NRC Public Document Room include NRC correspondence and internal NRC memoranda; NRC Office of Inspection and Enforcement bulletins, circulars, information notices, inspection and investigation notices; Licensee Event Reports; vendor reports and correspondence; Commission papers; and applicant and licensee documents and correspondence.

The following documents in the NUREG series are available for purchase from the NRC/GPO Sales Program: formal NRC staff and contractor reports, NRC-sponsored conference proceedings, and NRC booklets and brochures. Also available are Regulatory Guides, NRC regulations in the *Code of Federal Regulations*, and *Nuclear Regulatory Commission Issuances.*

Documents available from the National Technical Information Service include NUREG series reports and technical reports prepared by other federal agencies and reports prepared by the Atomic Energy Commission, forerunner agency to the Nuclear Regulatory Commission.

Documents available from public and special technical libraries include all open literature items, such as books, journal and periodical articles, and transactions. *Federal Register* notices, federal and state legislation, and congressional reports can usually be obtained from these libraries.

Documents such as theses, dissertations, foreign reports and translations, and non-NRC conference proceedings are available for purchase from the organization sponsoring the publication cited.

Single copies of NRC draft reports are available free upon written request to the Division of Technical Information and Document Control, U.S. Nuclear Regulatory Commission, Washington, DC 20555.

Copies of industry codes and standards used in a substantive manner in the NRC regulatory process are maintained at the NRC Library, 7920 Norfolk Avenue, Bethesda, Maryland, and are available there for reference use by the public. Codes and standards are usually copyrighted and may be purchased from the originating organization or, if they are American National Standards, from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

GPO Printed copy price: $8.50

NUREG-0921

Final Environmental Statement
related to the operation of Catawba Nuclear Station, Units 1 and 2

Docket Nos. 50-413 and 50-414

Duke Power Company, et al.

U.S. Nuclear Regulatory Commission

Office of Nuclear Reactor Regulation

January 1983

ABSTRACT

This Final Environmental Statement contains the second assessment of the environmental impact associated with the operation of the Catawba Nuclear Station, Units 1 and 2, pursuant to the National Environmental Policy Act of 1969 (NEPA) and 10 CFR 51, as amended, of the NRC regulations. This statement examines: the affected environment, environmental consequences and mitigating actions, and environmental and economic benefits and costs. Land use and terrestrial and aquatic-ecological impacts will be small. Operational impacts to historic and archeological sites will be negligible. The effects of routine operations, energy transmission, and periodic maintenance of rights-of-way and transmission facilities should not jeopardize any populations of endangered or threatened species. No significant impacts are anticipated from normal operational releases of radioactivity. The risk associated with accidental radiation exposure is very low. The net socioeconomic effects of the project will be beneficial. The action called for is the issuance of operating licenses for Catawba Nuclear Station, Units 1 and 2.

Further information may be obtained from:

Dr. Kahtan N. Jabbour, Project Manager
Division of Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555
301/492-7821

SUMMARY AND CONCLUSIONS

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

(1) This action is <u>administrative</u>.

(2) The proposed action is the issuance of operating licenses to Duke Power Company, North Carolina Municipal Power Agency Number 1, North Carolina Electric Membership Corporation, and Saluda River Electric Cooperative, Inc. (applicant) for the startup and operation of Units 1 and 2 of Catawba Nuclear Station (NRC Docket Numbers 50-413 and 50-414), located in York County, South Carolina, approximately 9.6 km (6 mi)* north of Rock Hill and adjacent to Lake Wylie.

The two-unit Catawba Nuclear Station uses two four-loop pressurized water reactors manufactured by Westinghouse Electric Corporation. Each reactor has a rated thermal output of 3411 MWt. The 16 MWt input from the reactor coolant pumps increases the reactor coolant system gross thermal output to 3427 MWt. Inplant electrical power consumption is expected to be 57 MWe per unit, and the net electrical rating is 1145 MWe per unit.

(3) The information in this statement represents the second assessment of the environmental impacts pursuant to the guidelines of the National Environmental Policy Act of 1969 (NEPA) and Title 10 of the <u>Code of Federal Regulations</u> Part 51 (10 CFR 51) of the Commission's Regulations. After receiving an application in July 1972 to construct this station, the staff carried out a review of impacts that would occur during its construction and operation. That evaluation was issued as a Final Environmental Statement--Construction Phase (FES-CP) in December 1973. After completing a safety review, an evaluation by the Advisory Committee on Reactor Safeguards, and public hearings, the U.S. Nuclear Regulatory Commission issued Construction Permits Nos. CPPR-116 and CPPR-117 in August 1975. As of September 1982, the construction of Unit 1 was about 91.5% complete. The applicant estimates a fuel-loading date of October 1984 for Unit 1 and October 1986 for Unit 2. In March 1979 the applicant applied for operating licenses for the units and submitted the required safety and environmental reports in support of the application.

(4) The staff has reviewed the activities associated with the proposed operation of the station and the potential environmental impacts. The staff's conclusions are summarized as follows:

---

*Throughout the text of this document values are presented in both metric and English units. For the most part, measurements and calculations were originally made in English units and subsequently converted to metric. The number of significant figures given in a metric conversion is not meant to imply greater or lesser accuracy than that implied in the original English value.

(a) Catawba station will improve the ability of the applicant and the Southeastern Electric Reliability Council (SERC) to supply system load requirements. There will be a net savings in overall system production costs that will result from the operation of the station (Section 6).

(b) Permanent alteration of about 52 ha (129 acres) of land for the station has been necessary. This is not significant.

(c) The presence of the station and station operations will have negligible effect on the 100-year floodplain (Section 5.3.3).

(d) Periodic operation of the diesel generators (the predominant contributors to air pollutant discharges) should not have a significant impact on air quality (Section 5.4).

(e) Operation of Catawba station will not have an adverse impact on any Federal- or State-designated terrestrial or aquatic endangered or threatened species (Sections 5.5 and 5.6).

(f) While experimental work is still under way on the biological effects of electric fields along transmission lines, the staff has found no evidence to date to support a conclusion that the operation of the 230-kV transmission lines will have an adverse effect on the health of humans or that their operation will adversely affect plant or animal life (Section 5.2.2).

(g) Impingement and entrainment of aquatic biota are not expected to result in detrimental impacts to any species inhabiting Lake Wylie (Section 5.5.2.1).

(h) Surface water quality impacts in Lake Wylie caused by discharges from Catawba Nuclear Station will be small. Adverse impacts on aquatic species inhabiting Lake Wylie are not expected (Sections 5.3.2.2 and 5.5.2.2).

(i) The operation and maintenance of Catawba station will not adversely impact existing archeological resources or historic sites (Section 5.7).

(j) The overall socioeconomic impact of operating Catawba station will be beneficial (Section 5.8).

(k) The environmental analysis in this statement takes into account impacts from exposure to routine releases as a result of the storage of spent fuel from Catawba and the spent fuel from Oconee and McGuire that may be stored at Catawba (Section 5.9.3.1.2 and Appendix D). The environmental impacts associated with transshipment of spent fuel between Oconee or McGuire, and Catawba are discussed in Appendix G.

(l) The risk to public health and safety from exposure to radioactive effluents and the transportation of fuel and wastes from normal operations will be very small (Section 5.9.3.2).

(m) Activities off site that might adversely affect operation of the plant (nearby industrial, military, and transportation facilities that might create explosive, missile, toxic gas, or similar hazards) were evaluated. The risk to Catawba station from such hazards is negligibly small (Section 5.9.4.4(2)).

(n) The environmental risks of accidents, assuming protective action is taken, is of the same order of magnitude as the risk from normal operation, although accidents have a potential for early fatalities and economic costs not associated with normal operations. The risk of early fatality is small in comparison with the risk of early fatality from other human activities. There are no special or unique characteristics of the site and environs that would warrant requiring special accident-mitigating features (Section 5.9.4.6). A qualitative discussion of accidents involving the spent-fuel pool is in Appendix E.

(o) The environmental impact of Catawba station as a result of the uranium fuel cycle is very small when compared to the impact of natural background radiation (Section 5.10).

(p) Noise levels off site during Catawba Nuclear Station operation are predicted by the staff to be at or below the EPA-identified level for protection of public health and welfare for nearby residences. A confirmatory noise-monitoring program is recommended for the operational phase of the station (Sections 5.12 and 5.14.4).

(5) This statement assesses various impacts associated with the operation of the facility in terms of annual impacts and balances these impacts against the anticipated annual energy production benefits. Thus, the overall assessment and conclusion would not be dependent on specific operating life. Where appropriate, however, a specific operating life of 40 years was assumed.

(6) This Final Environmental Statement is being made available to the public, to the Environmental Protection Agency, and to other specified agencies in 1983.

(7) On the basis of the analyses and evaluations set forth in this statement, and after weighing the environmental, economic, technical, and other benefits against environmental and economic costs and after considering available alternatives at the operating license stage, the staff concludes that the action called for under NEPA and 10 CFR 51 is to issue operating licenses for Catawba Units 1 and 2, subject to the following conditions for the protection of the environment (Section 6.1):

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

(b) The applicant shall carry out the environmental monitoring programs outlined in Section 5 of this statement, as modified and approved by the staff and implemented in the Environmental Protection Plan and Technical Specifications that will be incorporated in the operating licenses for Catawba Units 1 and 2.

(c) If adverse environmental effects or evidence of irreversible environmental damage occurs during the operating life of the plant, the applicant shall provide the staff with an analysis of the problem and a proposed course of action to alleviate it.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

Page

LIST OF FIGURES

LIST OF TABLES

TABLE OF CONTENTS (continued)

FOREWORD

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

This environmental review deals with the impacts of operation of the Catawba Nuclear Station, Units 1 and 2. Assessments relating to operation that are presented in this statement augment and update those described in the Final Environmental Statement-Construction Phase (FES-CP) that was issued in December 1973 in support to issuance of construction permits for Catawba Units 1 and 2.

The information to be found in various sections of this statement updates the FES-CP in four ways by

(1) evaluating changes in facility design and operation that will result in different environmental effects of operation (including those which would enhance as well as degrade the environment) than those projected during the preconstruction review

(2) reporting the results of relevant new information that has become available subsequent to the issuance of the FES-CP

(3) factoring into the statement new environmental policies and statutes that have a bearing on the licensing action

(4) identifying unresolved environmental issues or surveillance needs which are to be resolved by means of license conditions (no unresolved environmental issues or surveillance needs have been identified in this statement for the case of Catawba Units 1 and 2).

Introductions (Résumés) in appropriate sections of this statement summarize both the extent of updating and the degree to which the staff considers the subject to be adequately reviewed.

Copies of this statement and the FES-CP (1973) are available for inspection at the Commission's Public Document Room, 1717 H Street NW, Washington, DC, and at the York County Library, 325 South Oakland Avenue, Rock Hill, SC 29730. The documents may be reproduced for a fee at either location. Copies of this statement may be obtained by writing to sources indicated on the inside front cover.

Dr. Kahtan N. Jabbour is the NRC Project Manager for the environmental review of this project. Should there be any questions regarding the content of this statement, Dr. Jabbour may be contacted by telephoning 301/492-7821 or by writing to the following address:

Dr. Kahtan N. Jabbour, Project Manager
Division of Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

1 INTRODUCTION

The proposed action is the issuance of operating licenses to Duke Power Company, North Carolina Municipal Power Agency Number 1, North Carolina Electric Membership Corporation, and Saluda River Electric Cooperative, Inc. (the applicant) for the operation of the Catawba Nuclear Station (the station), Units 1 and 2, located on a peninsula about 7.2 km (4.5 mi) northwest of Wylie Dam, York County, South Carolina, and approximately 9.6 km (6 mi) north of Rock Hill, South Carolina.

The two-unit Catawba Nuclear Station uses two four-loop pressurized water reactors manufactured by Westinghouse Electric Corporation. The rated thermal output of each reactor is 3411 MWt. The 16-MWt input from the reactor coolant pumps increases the reactor coolant system (RCS) gross thermal output to 3427 MWt. Reactor heat absorbed by the RCS produces steam in four steam generators sufficient to drive a turbine generator unit with a net electrical rating of 1145 MWe. The turbine generator unit is manufactured by the General Electric Company. Inplant electrical power consumption is expected to be 57 MWe per unit.

1.1 Administrative History

In July 1972, Duke Power Company filed an application with the Atomic Energy Commission (AEC), now the Nuclear Regulatory Commission (NRC), for permits to construct Catawba Units 1 and 2. The conclusions resulting from the staff's environmental review were issued as a Final Environmental Statement--Construction Phase (FES-CP) in December 1973. Following reviews by the AEC regulatory staff and its Advisory Committee on Reactor Safeguards, public hearings were held before an Atomic Safety and Licensing Board. Construction permits for Units 1 and 2 were issued on August 7, 1975.

In March 1979 the applicant submitted applications for operating licenses for the Catawba Units 1 and 2. As of September 30, 1982, construction of Unit 1 was 91.5% complete and that of Unit 2 was 45% complete. The applicant estimates that Unit 1 will be ready for fuel loading in October 1984.

1.2 Permits and Licenses

The applicant has provided in Section 12 of the Environmental Report-Operating License Stage (ER-OL) a status listing of environmentally related permits, approvals, and licenses required from Federal and state agencies in connection with the proposed project. The staff has reviewed the listing and other information and is not aware of any potential non-NRC licensing difficulties that would significantly delay or preclude the proposed operation of the plant.
The issuance of a water quality certification, or a waiver thereof, pursuant to Section 401 of the Clean Water Act of 1977 by the South Carolina Department of Health and Environmental Control (SCDHEC) is a necessary prerequisite for the issuance of an operating license by the Nuclear Regulatory Commission. This certification was received by the applicant on December 27, 1974. The SCDHEC

issued a National Pollutant Discharge Elimination System (NPDES) permit, pursuant to Section 402 of the Clean Water Act of 1977 to the applicant on June 29, 1981 (Appendix I). This permit has expired, but has been administratively extended by the State of South Carolina until further action is taken.

2 PURPOSE AND NEED FOR THE ACTION

The Commission has amended 10 CFR 51, "Licensing and Regulatory Policy and Procedures for Environmental Protection," effective April 26, 1982, to provide that need for power issues will not be considered in ongoing and future operating license proceedings for nuclear power plants unless a showing of "special circumstances" is made under 10 CFR 2.758 or the Commission otherwise so requires (47 FR 12940, March 26, 1982). Need for power issues need not be addressed by operating license applicants in environmental reports to the NRC, nor by the staff in environmental impact statements prepared in connection with operating license applications. (See 10 CFR 51.21, 51.23(e), and 51.53(c).)

This policy has been determined by the Commission to be justified even in situations where, because of reduced capacity requirements on the applicant's system, the additional capacity to be provided by the nuclear facility is not needed to meet the applicant's load responsibility. The Commission has taken this action because the issue of need for power is correctly considered at the construction permit (CP) stage of the regulatory review where a finding of insufficient need could factor into denial of issuance of a license. At the operating license (OL) review stage, the proposed plant is substantially constructed and a finding of insufficient need would not, in itself, result in denial of the operating license.

Substantial information exists which supports the contention that nuclear plants are lower in operating costs than conventional fossil plants. If conservation, or other factors, lowers anticipated demand, utilities remove generating facilities from service according to their costs of operation, with the most expensive facilities removed first. Thus, a completed nuclear plant would serve to substitute for less economical generating capacity. (See 46 FR 39440, August 3, 1981 and 47 FR 12940, March 26, 1982).

Accordingly, this statement does not consider "need for power." Section 6 does, however, consider the savings associated with the operation of the nuclear plant.

2.1 References

Federal Register Notice, 46 FR 39440, "Need for Power and Alternative Energy Issues in Operating License Proceedings," Proposed Rule, U.S. Nuclear Regulatory Commission, August 3, 1981.

---, 47 FR 12940, "Need for Power and Alternative Energy Issues in Operating License Proceedings," Final Rule, U.S. Nuclear Regulatory Commission, March 26, 1982.

3 ALTERNATIVES TO THE PROPOSED ACTION

The Commission has amended its regulations in 10 CFR 51 effective April 26, 1982, to provide that issues related to alternative energy sources will not be considered in ongoing and future operating license proceedings for nuclear power plants unless a showing of special circumstances is made under 10 CFR 2.758 or the Commission otherwise so requires (47 FR 12940, March 26, 1982). In addition, these issues need not be addressed by operating license applicants in environmental reports to the NRC, nor by the staff in environmental impact statements prepared in connection with operating license applications. (See 10 CFR 51.21, 51.23(e), and 51.53(c).)

The Commission has concluded that alternative energy source issues are resolved at the construction permit (CP) stage and the CP is granted only after a finding that, on balance, no superior alternative to the proposed nuclear facility exists. In addition, this conclusion is unlikely to change even if an alternative is shown to be marginally environmentally superior in comparison to operation of the nuclear facility because of the economic advantage that operation of the nuclear plant would have over available alternative sources. (See 46 FR 39440, August 3, 1981 and 47 FR 12940, March 26, 1982.) By earlier Amendment (46 FR 28630, May 28, 1981), the Commission also stated that alternative sites will not be considered at the operating license stage, except under special circumstances in accordance with 10 CFR 2.758. Accordingly, this statement does not consider alternative energy sources or alternative sites.

3.1 References

Federal Register Notice, 46 FR 28630, "Alternative Site Issues in Operating License Proceedings," Final Rule, U.S. Nuclear Regulatory Commission, May 28, 1981.

---, 46 FR 39440, "Need for Power and Alternative Energy Issues in Operating License Proceedings," Proposed Rule, U.S. Nuclear Regulatory Commission, August 3, 1981.

---, 47 FR 12940, "Need for Power and Alternative Energy Issues in Operating License Proceedings," Final Rule, U.S. Nuclear Regulatory Commission, March 26, 1982.

4 PROJECT DESCRIPTION AND AFFECTED ENVIRONMENT

4.1 Résumé

This résumé highlights changes in the design of and operating procedures for Catawba station, as well as new information on the local environment gained since the FES-CP was issued in 1973.

Site appearance and layout have been modified as a result of selection of closed cycle circular mechanical draft towers and various additions and changes to buildings (see Section 4.2.1). Volumetric flow rates for various water systems at Catawba station have been revised as discussed in Section 4.2.3.2 of this statement. Sodium hypochlorite to control biofouling in the cooling tower portion of the condenser circulating water system will be used instead of gaseous chlorine; other water treatments are slightly modified as well (see Section 4.2.3.4). The Catawba station intake structure has been modified by the addition of a fourth pump bay, pump, and associated trashrack and screen as discussed in Section 4.2.4.2. The discharge structure design has been revised to consist of two pipes instead of four pipes as discussed in Section 4.2.4.5. The design and capacity of the sanitary-waste-treatment system have been changed from those presented in the FES-CP (see Section 4.2.6.4). There have been slight changes in the power transmission system, such as the final routing of transmission lines and the removal from service of some existing lines (see Section 4.2.7).

New and updated information relevant to the operational phase of Catawba Units 1 and 2 also is provided in this section. An updated summary is presented of land use and of site boundaries in Section 4.2.2. Updated water quality data are given in Section 4.3.2; new information on severe weather and site atmospheric dispersion characteristics is provided in Section 4.3.3; and new information concerning threatened and endangered species is discussed in Section 4.3.5. Community characteristics of the site area are updated in Section 4.3.6, and the most recent archeologic information is discussed in Section 4.3.7.

4.2 Facility Description

4.2.1 External Appearance and Plant Layout

These topic areas are discussed in Sections 2.1, 2.2, and 3.1 of the FES-CP. Since that analysis, the major appearance and layout change has been in the selection of the cooling tower design by the applicant. Of the three options presented in the FES-CP, the closed cycle circular mechanical draft towers were selected, as shown in Figure 4.1. The towers are approximately 21 m (70 ft) high and are about 83 m (272 ft) in diameter. Other changes include the construction of a three story office building, designating Construction Warehouse 3 as permanent, and making additions to the Steam Production Warehouse, the

Administrative Building, the Auxiliary Service Building, and the Service Building Machine Shop (response to ER-OL - Review Question (RQ) 310.1). Additionally, the spent fuel pools were enlarged after the FES-CP was published in 1973.

4.2.2 Land Use

The station property line encompasses 419 ha (1036 acres) of which 158 ha (391 acres) are within the site boundary. The exclusion area boundary is a 762 m (2500 ft) radius circle centered on the center line between the reactor buildings. Permanent station facilities are contained within the 52 ha (129 acres) boundary. However, there are two areas within the exclusion boundary that are devoted to nonstation operation activities. The first is the Concord Cemetery 0.4 ha (1 acre), which is used only for visitations and memorial and burial services. The cemetery has a small number of visitors who gain access by contacting the station's security personnel. The second is the visitors' overlook area 0.8 ha (2 acres), which is a sight-seeing and limited-use picnic area. It has been averaging 27 visits per day (response to ER-OL RQ 310.4). There are no other significant changes from the descriptions in FES-CP Sections 2.1, 2.2, and 3.1.

4.2.3 Water Use and Treatment

4.2.3.1 General

The overall water use scheme by Catawba Nuclear Station has not changed since the FES-CP was issued. That is, the station is equipped with a closed cycle cooling system that uses circular mechanical draft cooling towers in the condenser circulating water system, once through cooling for the low pressure service water system and the nuclear service water system, and closed loop cooling through the standby nuclear service water pond for the station's essential service water system during other-than-normal operation. The water supply for the Catawba station remains as described in the FES-CP. Lake Wylie, an onstream impoundment of the Catawba River, will supply all of the station water uses and will receive all liquid station discharges.

4.2.3.2 Surface Water Use

The volumetric flow rates for the various water systems of the Catawba Nuclear Station have been revised since the FES-CP was issued because of a greater degree of completion in the design of the station's water use systems and a change in the design of the station's cooling towers.

Intake from Lake Wylie is projected to occur at an average of 5.2 m^3/sec (184 ft^3/sec) with a maximum withdrawal of 10.7 m^3/sec (379 ft^3/sec), compared to a projected 10.1 m^3/sec (358 ft^3/sec) in the FES-CP. From this withdrawal, up to 4.3 m^3/sec (152 ft^3/sec) would be used in the nuclear service water system, down from an estimated 7.8 m^3/sec (275 ft^3/sec) for this use in the FES-CP. The remainder will serve the condenser circulating water system and the filtered water system. The estimated station makeup and blowdown rates for the condenser circulating water system have changed since the FES-CP as a result of the change in cooling tower design from linear mechanical draft towers to circular mechanical draft towers. These values are now estimated as follows for 100% station load:

	Makeup	Blowdown
Average	2.0 m^3/sec (69 ft^3/sec)	0.3 m^3/sec (9.7 ft^3/sec)
Maximum	3.5 m^3/sec (125 ft^3/sec)	1.8 m^3/sec (62 ft^3/sec)

The station will consume water primarily through evaporation from the circulating and nonessential water systems. The average evaporative loss is estimated at 1.7 m^3/sec (59 ft^3/sec). Monthly maximum evaporative loss is estimated to range from 1.6 m^3/sec (55 ft^3/sec) for the month of January to 1.8 m^3/sec (62 ft^3/sec) for the month of September. Water loss from drift from the station cooling towers will be very low, estimated at less than 0.01 m^3/sec (0.25 ft^3/sec) maximum. The Catawba Nuclear Station's water use is shown in Table 4.1 and in Figure 4.2. At 100% station load, the water use rates given above represent an average concentration factor of about 7.1 with a maximum of about 10, which is the same as was anticipated in the FES-CP.

The nuclear essential service water system will be supplied by the standby nuclear service water pond, as described in the FES-CP. The as-built size of the pond, 18.6 ha (46 acres), is slightly smaller than the previously planned 19.4 ha (48 acres). Maximum water flow rate between the pond and the station is estimated at 4.1 m^3/sec (151.5 ft^3/sec). During normal operation, this flow rate is zero.

4.2.3.3 Groundwater Use

As stated in the FES-CP, there will be no withdrawal from or discharge to groundwater by the Catawba Nuclear Station.

4.2.3.4 Water Treatment

The planned treatment of water for use in the Catawba Nuclear Station remains the same in concept as proposed in the FES-CP. That is, water for the station condenser cooling will be treated with biocides to control biofouling, with sulfuric acid to control scaling, and with a dispersant to control sediment deposition within the system. Water for the remainder of the conventional low pressure service water system (the filtered water system which supplies the station sanitary and potable water and the demineralized water system) will be filtered, disinfected, and, as appropriate, demineralized The estimated amounts of chemicals to be used have changed from those indicated in the FES-CP as described below.

The applicant plans to use sodium hypochlorite to control biofouling in the cooling tower portion of the condenser circulating water system instead of gaseous chlorine, as indicated in the FES-CP. The planned application rate of biocide is 272 kg/unit/day (600 lb/unit/day) instead of 136 kg/unit/day (300 lb/unit/day), as estimated in the FES-CP. However, because of the change in the form of chlorine to be applied, the proposed application rate will cause the same average 1.0 mg/l free available chlorine to exist in the cooling water as was anticipated in the FES-CP. This residual is expected to vary between 1.5 mg/l in the summer and 0.5 mg/l in the winter, based on a 3-4 mg/l chlorine demand.

Other condenser circulating water treatments proposed are (1) continuous sulfuric acid addition at 612 kg/unit/day (1350 lb/unit/day) instead of 453 kg/unit/day (1000 lb/unit/day) as proposed in the FES-CP and (2) possible intermittent use of aminomethylenephosphonate (AMP), a dispersant, and a yet-to-be-determined EPA approved organic biocide for chlorine resistant organisms (for example, Corbicula sp.) should they become a problem. The frequency and rate of application of the latter treatments have not been finalized and may differ from those presented in the FES-CP.

4.2.4 Cooling System

4.2.4.1 General

Although the station will employ closed cycle cooling, the type and arrangement of the components in the Catawba Nuclear Station cooling system have changed since the FES-CP was issued. The most obvious change that has occurred is the selection and construction of circular mechanical draft cooling towers for station heat rejection. Linear mechanical draft cooling towers had been indicated as the chosen design in the FES-CP. These and other changes are discussed below.

4.2.4.2 Intake

The Catawba Nuclear Station intake structure has been modified slightly since the FES-CP was issued. The modification consists of the addition of a fourth pump bay, pump, and associated trashrack and screen. This change has been made to accommodate the fire protection system. Revised estimates of the water velocities at various locations in the intake structure are given in Table 4.2 for average flow rates at 100% power level operation for the station. Based on an approximate 50% increase in flow rates for the maximum water demand condition, the flow rates would increase accordingly to about 0.11 m/sec (0.36 ft/sec) through the pump bay gross opening at Lake Wylie full pond or 0.17 m/sec (0.57 ft/sec) at the same location for the Lake Wylie maximum drawdown of 3 m (10 ft).

4.2.4.3 Condenser Circulating Water System

The design of the cooling tower portion of this system has been changed since the FES-CP was issued. Circular mechanical draft cooling towers have been constructed instead of the linear mechanical draft towers indicated in the FES-CP. Data on the new towers are presented in Table 4.3. The cooling towers are designed to dissipate 8.33×10^{12} J/hr (7.9×10^{9} Btu/hr) per unit instead of 8.65×10^{12} J/hr (8.2×10^{9} Btu/hr) per unit, as stated in the FES-CP. The projected condenser transit time for the cooling water at design conditions is about 16 sec. The expected rise in cooling water temperature across the condenser at the design heat rejection rate and a cooling water flow rate of 5000 m^3/min (1.32×10^{6} gpm) is 13.3C° (24F°). As stated in the FES-CP, the stainless steel condenser tubes will be mechanically cleaned while in operation by a system using sponge rubber balls passing through the tubes. These balls will be strained out of the cooling water after condenser passage and will be held for recycle.

4.2.4.4 Service Water System (NPDES 001)*

This system was designated in the FES-CP as a portion of the "Conventional Service Water System." This system supplies cooling water to the secondary side of the Catawba Nuclear Station, such as the turbine oil coolers and the generator coolers. The temperature rise of this water as it passes through the station is 8.3C° (15F°) under winter design conditions. There have been no changes noted for this system since the FES-CP was issued.

4.2.4.5 Nuclear Service Water System (NPDES 001, 002)

This system supplies cooling water to both the primary and secondary sides of the Catawba Nuclear Station. The temperature rise of this water as it passes through the station is 4.97C° (8.95F°). There have been no changes noted for this system since the FES-CP was issued.

The location of the station discharge structure is shown on Figure 4.3 and is in essentially the same location as was indicated in the FES-CP. The low pressure service water, cooling tower blowdown, nuclear service water, and liquid radwaste will pass through this structure.

The design of the discharge structure has changed since the FES-CP was issued. The revised design (as shown in Figure 4.4) consists of two pipes, each with a diameter of 1.37 m (54 in.), instead of the four pipes, each with a diameter of 1.07 m (42 in.) as shown in the FES-CP. The new discharge structure pipe cross sectional area is 83% of the area indicated in the FES-CP. The discharge velocity at the pipe exit for the average discharge flow would be about 1.2 m/sec (3.9 ft/sec) and for the maximum flow would be about 3.0 m/sec (9.7 ft/sec). The discharge flow rate for the conditions given in the FES-CP was 2.3 m/sec (7.7 ft/sec). The centerline of the discharge pipes is located at el 555.4 ft mean sea level (MSL), 4.3 m (14 ft) below the normal full-pond water surface of Lake Wylie.

4.2.5 Radioactive-Waste-Management Systems (NPDES 005)

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

---

*The National Pollution Discharge Elimination System (NPDES) number refers to the outfall serial number in the NPDES Permit or to special conditions included in Part III of the NPDES Permit (see Appendix I).

To comply with the requirements of 10 CFR 50.34a, the applicant has provided final designs of radwaste systems and effluent control measures for keeping levels of radioactive materials in effluents to unrestricted areas ALARA within the requirements of Appendix I to 10 CFR 50. In addition, the applicant has provided an estimate of the quantity of each principal radionuclide expected to be released annually to unrestricted areas in liquid and gaseous effluents produced from normal operation, including anticipated operational occurrences.

The staff's detailed evaluation of the radwaste system and the capability of this system to meet the requirements of Appendix I will be presented in Section 11 of the Safety Evaluation Report (SER). The quantities of radioactive material calculated by the staff to be released from the plant will also be presented in SER Section 11 and in Section 5.9 of this Environmental Statement with the calculated doses to individuals and the population that will result from these effluent quantities.

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

4.2.6 Nonradioactive-Waste-Management Systems

4.2.6.1 General

The nonradioactive effluents will result from operation of the evaporative cooling system, the water treatment systems, and the wastewater treatment system. There have been changes in the systems producing these effluents as well as changes in the volume and character of the effluents themselves since the FES-CP was issued. These changes are discussed below.

4.2.6.2 Cooling Water System (NPDES 001)

The operation of the closed cycle cooling system for the station will result in the discharge of water of different composition than that withdrawn from Lake Wylie. As indicated in Section 4.2.3 of this report, the evaporative loss from the circular mechanical draft cooling towers will result in a concentration of the physical and chemical constituents in the makeup water. The expected average concentration of the constituents, based on average Lake Wylie water quality data collected since the FES-CP was issued through 1978, is shown in Table 4.4. These data are based on a projected annual average concentration factor in the system of 7 (ER-OL Section 3.6.2). Concentration factors as high as 10 may be experienced, however, and would likely represent the maximum constituent discharge values from this system. Cooling system discharge concentration values for a concentration factor of 10 were presented in the FES-CP. The values projected in this review differ only slightly from those presented in the FES-CP, based on updated analyses of Lake Wylie intake water (see Section 4.3.2).

Also affecting the composition of the blowdown from the cooling water system are the chemical additions to the makeup water to control biofouling, scales, sediment deposition and pH (see Section 4.2.3.4). These additions will noticeably affect the total dissolved solids, sulfate, and alkalinity concentrations, and, to a lesser extent, the chloride concentration in the blowdown.

Sodium hypochlorite additions for biofouling control in the cooling tower loop of the low pressure service water system will result in the discharge of combined residual chlorine, as indicated in the FES-CP. However, the amount and concentration expected in the station discharge differs from that indicated in the FES-CP. The applicant will control the discharge concentration of total residual chlorine in the cooling tower blowdown by interrupting system blowdown during the time of application of biocide, and for some time afterward, until sampling indicates that the total residual chlorine concentration in the system has fallen to about 0.1 mg/l. Blowdown will be restored at this time (ER-OL Section 3.6.1) so that, upon mixing with the nuclear service water system and the remainder of the low pressure service water system discharges, the total residual chlorine concentration in the cooling system discharge will be below 0.1 mg/l.

A final plan for cleaning the cooling water systems outside of the condenser-cooling tower system has not been decided upon by the applicant. The applicant's preliminary plans are as follows: (1) The nuclear service water system is equipped with strainers on the system intake to prevent entry of debris and large organisms (for example, adult Corbicula sp.). Redundant heat exhangers in the system will allow for removal from service, inspection, and cleaning without interruption to station operation, and isolation of cleaning wastes for control and treatment, if needed, before disposal. (2) The fire protection system uses chlorinated filtered water as input when system volume is being adjusted by the system's makeup pumps. When the main fire pumps are operating, water input to the system is unchlorinated lake water. The system also has strainers for large object exclusion and the system can be isolated for inspection and cleaning. (3) The low pressure service water system outside of the condenser cooling tower loop will be maintained by inspections and operational controls (for example, backflushing thermal treatment or mechanical cleaning) in a clean condition (ER-OL Section 3.4). Use of a biocide such as sodium hypochlorite in these systems in a manner that would result in its discharge is not planned at this time.

The estimated amount of dissolved solids expected to escape from the station's cooling towers in the drift has changed from the estimate given in the FES-CP. Based on an estimated maximum drift rate of 0.008% of the circulating water flow rate and a maximum total dissolved solids concentration of about 860 mg/l (the same as the maximum circulating water concentration at 10 cycles of the concentration) about 495 kg/day (1090 lb/day) could be dispersed in the drift. Under average conditions, this value is not expected to exceed 345 kg/day (760 lb/day). The value estimated in the FES-CP was 468 kg/day (1030 lb/day) based on a 650 mg/l drift total dissolved solids concentration and the then estimated 0.01% drift loss figure.

4.2.6.3 Conventional Waste-Water-Treatment System (NPDES 002)

Waste and spent process waters from the fire protection system and the filtered water system through the demineralized water system and the sanitary/potable water (nonsewage wastes only) are routed to and treated before discharge in the conventional waste-water-treatment system (CWWTS). This system replaces the wastewater collection basin described in the FES-CP. The CWWTS provides physical and chemical treatment to the nonradioactive station wastes listed in ER-OL Table 3.6.1-3. The CWWTS consists of an initial holdup pond for wastewater flow equalization and sedimentation, two parallel stream settling ponds, and a final holdup pond for aeration and final stabilization of the treated wastewater before discharge. Treatment of wastes will employ coagulant aids and pH adjustment in the intermediate settling ponds, with provision for recirculation of wastes between ponds if the desired level of treatment has not been attained. Additional system description is presented in ER-OL Section 3.6.1.

Expected effluent characteristics of the CWWTS discharge based on the system design are given in Table 4.5. The expected characteristics of the CWWTS discharge, based on station chemical usage and on analyses of influent waters, are presented in Table 4.4.

Discharge from the CWWTS will be through a separate structure located in the discharge cove. The discharge flow rate will be small, compared to the other station discharges to Lake Wylie, and will average about 1,140 l/min (300 gpm). Other losses from the CWWTS are expected to be negligible because the initial holdup pond is lined with concrete, the two settling ponds are lined with tamped clay, and the final holdup pond is lined with impermeable hypalon (ER-OL Section 3.6.1).

4.2.6.4 Sanitary-Waste-Treatment System (NPDES 003)

The design and capacity of the sanitary-waste-treatment system to be used during the operational phase of the Catawba Nuclear Station have been changed from those presented in the FES-CP. The estimated, average volume of waste influent to the system has increased from 1.9×10^4 l/day (5000 gal/day) as presented in the FES-CP to 1.9×10^5 l/day (50,400 gal/day). The capacity of the treatment system is being increased for a maximum expected influent of 3.0×10^5 l/day (80,000 gal/day). Although the flow rates into and out of this system will vary over the diurnal cycle, continuous values for the average and maximum conditions are presented in Table 4.1 for comparison with other station water flow rates.

Instead of treatment via septic tank, sand filtration, and chlorination followed by disposal to a wastewater collection basin and then discharge to Lake Wylie, the system will employ a four-chamber aerated facultative lagoon and an effluent polishing basin followed by discharge into the discharge canal in Lake Wylie adjacent to the station discharge structure. The aerobic biological treatment accomplished in the lagoon provides about a 26-day retention time for the wastes at the rated capacity. The effluent polishing basin is designed as a tertiary aquaculture system that uses aquatic macrophytes, animals (such as, zooplankton and fish) and final aeration in three main compartments to reduce suspended solids, nitrogen and phosphorus concentrations through biological assimilation. The assimilated materials can then be harvested and disposed of without disposal to Lake Wylie. This system effluent will be chlorinated. Further description of the system is presented in the ER-OL and in a January 5, 1977 letter from L. C. Dail, Duke Power Company. The design, construction, and proposed operation of this system has been approved by the State of South Carolina. The operation of the system will be under the supervision of an operator certified by the State (ER-OL Section 3.7.2).

4.2.7 Power Transmission System

The procedures planned for connecting Catawba with Duke's existing transmission system consist of constructing two new 230 kV lines and connecting three existing 230 kV lines to the Catawba Switching Station. The FES-CP described a Catawba station to Shelby station tap 230 kV line. This line has been slightly modified and is called the Catawba-Ripp 230 kV line. The other important changes from the FES-CP are: (1) removal from service of the existing section of line from point B (as shown in Figure 4.5) to Allison Creek tap and (2) removal from service of the existing section of Catawba-Newport "Allison Creek B&W" 230 kV line from Allison Creek tap to point C (Figure 4.5), and (3) removal of Allison Creek tap from service after energizing the Catawba-Newport, Catawba-Pacolet, and Catawba-Allen 230 kV lines from Catawba Switching. Only minor differences exist between the final routing of the other transmission lines as given in the ER-OL and that proposed in the FES-CP. All the pertinent information concerning the land use aspects of the transmission lines are presented in Table 4.6.

4.3 Project-Related Environmental Descriptions

4.3.1 Hydrology

4.3.1.1 Surface Water

The surface water descriptions presented in Sections 2.5.1 and 3.4.3 of the FES-CP are still valid, as supplemented by the following discussion. In addition, Section 5.3.3 of this Final Environmental Statement contains a discussion of the hydrologic effects of alterations in the floodplain, in compliance with the guidelines for implementing Executive Order 11988 on floodplain management (43 FR 6030, February 10, 1978). Major hydrologic features of the Catawba River are shown in Figure 4.6.

The Catawba Nuclear Station is located at Lake Wylie on the Catawba River in northeastern South Carolina. The site is on a peninsula bounded by Beaver Dam Creek to the north, Big Allison Creek to the south, and Lake Wylie to the east.

Water inflow to Lake Wylie is from Mountain Island Lake, South Fork Catawba River and tributary creeks. The Federal Energy Regulatory Commission (FERC) license for the Catawba-Wateree Project (No. 2232) requires a minimum average daily release of 8.9 m^3/sec (314 cfs) from Mountain Island Dam and 11.6 m^3/sec (411 cfs) from Wylie Dam.

The applicant estimated the 7-day once-in-10-year low flow entering Lake Wylie to be 14.6 m^3/sec (516 cfs). This estimate was based on the minimum average daily release from Mountain Island Dam and the 7-day once-in-10-year low flow per square mile from the South Fork Catawba River for the remainder of the basin.

With operation of the Catawba Nuclear Station, the maximum drawdown which will be allowed by the FERC License is 3 m (10 ft) or an elevation of 559.4 ft MSL. During the 30-year period, 1950-1980, the level of Lake Wylie has never fallen below this elevation. The lowest level of record was el 559.9 ft MSL on October 23, 1952. However, the lake was intentionally lowered at this time to permit work to be done at the Allen Steam Plant.

In addition to Lake Wylie, the only major water impoundment at the Catawba Nuclear Station is the standby nuclear service water pond (SNSWP), located at the north end of the site. The SNSWP is to be used as a source of water for emergency shutdown of the station. At full pond elevation of 571.0 ft MSL, the pond has a surface area of 19 ha (46 acres) and a volume of 6.9×10^5 m^3 (560 acre-ft).

4.3.1.2 Groundwater

The groundwater descriptions presented in Section 2.5.2 of the FES-CP are still valid with the following additions.

In the site area, groundwater is generally encountered under water table conditions in weathered rock and saprolite soils that overlie less weathered rocks. Observations of groundwater levels at about 60 locations in the immediate vicinity of the site indicate that the water table varies from 3 m (10 ft) to 12 m (40 ft) below natural ground surface near the location of the reactors, and it approaches the surface elevation of Lake Wylie near the lake shore. Groundwater movement is from the plant area towards the lake coves, which cut into the peninsula to the north and south of the site.

A permanant safety-related groundwater drainage system has been installed to maintain a normal groundwater level near the base of the foundation mat and basement walls of the auxiliary and reactor buildings. The drainage system will decrease the groundwater gradient, and groundwater movement away from the site will be decreased.

4.3.2 Water Quality

Data on the surface water quality of Lake Wylie were presented in the FES-CP, as part of the applicant's baseline water quality monitoring program for the period of September 1973 through August 1974. This information has been supplemented by the applicant with the Water Quality Interim Study, beginning in September 1974 and projected to continue until the Second-Year Preoperational Study is initiated. This latter program will be the second 1-year-long interim study of preoperational ecological conditions in the site vicinity and it is expected to commence one full year before fuel loading of Unit 1. The interim water quality study initially collected data from 12 locations and later from 8 locations on Lake Wylie. The applicant's analysis of the data from this interim study indicates (1) that Lake Wylie is a seasonally stratified lake system typical of Carolina Piedmont reservoirs, (2) that the level of major chemical constituents in Lake Wylie reflect the geology and mineralogy of the drainage system, (3) that Lake Wylie is phosphorus limited (i.e., although phosphorus is relatively abundant in Lake Wylie, it has been implicated as a limiting nutrient because of the high nitrogen/phosphorus ratio), and (4) that heavy metal concentrations show large variations temporally and spatially, but that no adverse effects on aquatic life have been noted from these constituents. The data from the interim water quality study are presented in ER-OL Sections 2.4 and 6.1.1.

Data from the water quality studies of Lake Wylie since the FES-CP was issued are presented in Table 4.4. These data are from the time period 1974-1978 and represent spatial and temporal averages. A comparison of these data with those presented in the FES-CP shows a decrease in nitrogen, phosphorus, and silica nutrients, and increases in metals, iron, manganese, magnesium, and potassium; values for copper, alkalinity, hardness, and total suspended and dissolved solids remained about the same. Data from the time period 1978-1980 indicate similar differences from the FES-CP.

Data collected by the State of South Carolina (South Carolina Wildlife and Marine Resources Department, Columbia, South Carolina) for the period 1975-1976 in Lake Wylie, including the Big Allison Creek lake area (i.e., the area to receive discharges from Catawba Nuclear Station) show somewhat better water quality (for example, lower nutrient levels) than that indicated in the FES-CP. This study concluded that these data did not indicate reasons for immediate concern to the fishery resources of the lake.

In a study (State of South Carolina Water Resources Commission, March 1981) of the Catawba-Wateree River system in South Carolina, the state surveyed physical and chemical water quality in an attempt to identify existing and potential problems associated with people's use of the river system. The study cites only occasional exceedances of state water quality standards in the river basin. The state study indicated that only nutrients, especially phosphorus, consistently occurred at "higher than desirable concentrations." Although this study cites U.S. EPA identification of eutrophic conditions in Lake Wylie, adverse effects of nutrient enrichment and eutrophication have not been identified for the higher trophic communities, such as fish. It is noted, however, that the state has designated Lake Wylie as being "water quality limited" for the purpose of defining the level of waste treatment required to maintain state standards for dissolved oxygen. This designation of Lake Wylie requires waste treatment of effluents containing oxygen-demanding substances, ammonia, and phosphorus to be more advanced than secondary treatment technology or "best practicable technology," as defined by the U.S. EPA.

4.3.3 Meteorology

The discussion of the general climatology of the site and vicinity contained in the FES-CP remains unchanged. The FES-CP did not include a discussion of severe weather phenomena experienced in the region of the Catawba station. Thunderstorms, tornadoes, and hurricanes occur in the region. About 54 thunderstorms (Changery, November 1981) can be expected on about 42 days each year (National Climatic Center, 1976). Hail often accompanies severe thunderstorms. During the period 1955-1967, 14 occurrences of hail with diameters 19 mm (3/4 in.) or greater were reported in the one-degree latitude-longitude square containing the site. Tornadoes are not uncommon in the region. For a 161-km square (100-mi square) corresponding to 26,000 km^2 (10,000 mi^2) containing the site, an average of 2.6 tornadoes per year were reported for the period 1950-1976 (Kelly, August 1978). Using an average tornado path area of 7.3 km^2 (2.8 mi^2), the computed recurrence interval for a tornado at the Catawba site is about 1360 years (Thom, December 1963). The applicant has examined tornado occurrences in the region for the period 1956-1980, and calculated a slightly longer recurrence interval of 1610 years. In the period 1871 to 1978, about 23 tropical depressions, tropical storms, and hurricanes have passed within about 80 km (50 mi) of the site. Hurricane David, September 1979, was the last hurricane to affect the area.

Since the FES-CP was issued, the applicant has relocated the onsite meteorological tower and collected two additional years (12/17/75 - 12/16/77) of meteorological data. For this period of record, prevailing winds at the 10 m (33 ft) level are from the south-southwest (13.9%) and from the southwest (13.5%). A somewhat bimodal airflow pattern is evident with winds from the south, south-southwest, and southwest totalling about 35.5% and winds from the north, north-northeast, and northeast totalling about 24.9%. The wind direction frequencies observed at the new tower location for the 2-year period of record contrast markedly with observations for the 1-year period (6/30/71 - 6/30/72) used for the FES-CP. Prevailing winds also were from the southwest (19.5%) but winds from the south-southwest occurred only about 5.3% of the time. Strong secondary airflow from the northeast (16.9%) also was evident for the earlier data collection period, but is not discernable from the most current data. The applicant has attributed these differences to "synoptic based variations in direction preferences" (that is, natural variations in winds caused by the movement of large-scale weather features); however, the differences could be attributable to changes in terrain and vegetation caused by plant construction or to nonrepresentative tower locations.

Similar differences also are evident in the distribution of atmospheric stability conditions as defined by vertical temperature gradient. For example, for the most current two-year period of record, moderately stable (Pasquill type "F") and extremely stable (Pasquill type "G") conditions occurred 8.7% and 11.7% of the time, respectively. For the earlier 1-year period of record, these conditions occurred 14.1% and 12%, respectively. Extremely unstable (Pasquill type "A") conditions occurred 10.2% of the time for the period of June 30, 1971 to June 30, 1972, while these conditions were observed 18.7% of the time for the period of December 17, 1975 to December 16, 1977. Atmospheric stability conditions defined by vertical temperature gradient are more dependent on tower location and instrument exposure than synoptic variations in airflow patterns.

Stable atmospheric conditions (represented by temperature increases with height, called inversions) accompanied by low windspeeds were common at Catawba during the period of December 17, 1975 to December 16, 1977. Almost 80% of the time moderately stable conditions (Pasquill type "F") occurred with windspeeds less than 2 m/s. Similarly, for the same period of record, over 90% of the time extremely stable conditions occurred with windspeeds less than 2 m/s. The meteorological data sets used for dose consequence assessments for accidental or routine releases contained in the FES adequately reflect expected occurrences of stable atmospheric conditions accompanied by low windspeed in the vicinity of the Catawba site.

The staff has requested the applicant to perform a number of studies to determine the representativeness of meteorological data collected at the Catawba site. These studies are discussed in Section 5.14.3.

4.3.4 Ecology

4.3.4.1 Terrestrial Ecology

The description of the plant-life communities on the Catawba site presented in the FES-CP remain valid. Actual animal surveys had not been performed on site by the time the FES-CP was published. Such studies were performed and the results presented to NRC in 1975 (Duke Power Company). As a result of these studies evidence was found for 80 species of birds, 15 species of mammals, 6 species of amphibians, and 11 species of reptiles on site.

4.3.4.2 Aquatic Ecology

Lake Wylie was originally impounded in 1904; however, the dam was raised 15 m (50 ft) in 1925. The impoundment's nominal pool elevation has not changed since that time. Impoundments undergo ecological succession resulting in shifts in species diversity and abundance. Initially the biotic community is highly productive followed by a decrease in production and ultimate stability. Lake Wylie has through the years achieved a degree in ecological stability, however, increasing nutrient enrichment has resulted in the lake being described as having a trophic status of mesotrophic to eutrophic (ER-OL Section 2.2.2.1.3).

Phytoplankton

In a year-long survey (Industrial BIO-TEST Laboratories, Inc., 1974) conducted from September 1973 to August 1974 the applicant found that the phytoplankton community of Lake Wylie was dominated by diatoms, green algae, cryptomonads, blue-green algae, and dinoflagellates. Green algae, diatoms, and blue-green algae represented the greatest number of different taxa. Diatoms, which are typically cold water algae, were prevalent in the spring and fall, and reached their greatest abundance in the lake between March and May. Green and blue-green algae were found to be most abundant from March to August and May through September, respectively. Blue-greens reached their highest densities in June.

Sampling conducted during 1977 by the South Carolina Department of Health and Environmental Control (SCDHEC) indicated a diverse algal community that is dominated primarily by diatoms followed by blue-greens. Their findings indicate that Lake Wylie is being affected by nutrient enrichment (Johnson and de Kozlowski, 1981).

Periphyton

Monitoring, contracted by the applicant from September 1973 to August 1974, reported that the dominant periphytic algae were diatoms (Industrial BIO-TEST Laboratories, Inc., 1974). The study found that populations exhibited a bimodal seasonal distribution with maximum densities present in October and April with minimum concentration occurring in January and July. The SCDHEC monitored periphyton from Lake Wylie in 1977 (Johnson and de Kozlowski, 1981). Over 97% of the periphytic taxa collected from the lake were diatoms. No periphytic blue-green algae were observed.

Zooplankton

The applicant found that the dominant zooplankton genera in Lake Wylie were primarily planktonic or limnetic species characteristic of most North American reservoirs. A total of 41 genera were collected from the lake in the vicinity of the station. The dominant taxa found were Copepoda, Cladocera, and Rotifera. Rotifers averaged 47% of the total zooplankton, copepods 43% and cladocerans 10%. Immature copepods were a numerically significant component of the zooplankton throughout the year. Nauplii were usually more abundant in the spring but densities were occasionally high in the fall and winter near the Catawba station discharge and intake. Cladocerans were the least abundant of the three major zooplankton taxonomic groups on Lake Wylie. Bosmina longirostris, the dominant species of cladoceran, was generally more abundant in October, May, and June with maximum densities in June.

Rotifers were the best represented group in Lake Wylie both in species diversity and density. Most common species were Conochilus spp., Keratella spp. and Polyarthra spp. Peak densities for all three species were in the spring.

Weiss et al. (1975) found that seasonal fluctuations occurred in zooplankton composition in the lake but the community averaged about 72% rotifers, 20% copepods, 5% protozoans and 3% cladocerans throughout the year generally agreeing in ranking with the earlier study. Weiss et al. (1975) found that maximum population densities in Lake Wylie occurred during the spring with a secondary peak in the fall.

Benthos

The applicant reported a total of 88 macroinvertebrate taxa from Lake Wylie in the vicinity of the station (ER-OL, Section 2.2.3.1). The midges (Chironomidae) were the most diverse group with 33 taxa known from the study area. The dominant invertebrates from the grab samples were the Asiatic clam, Corbicula sp. (24.9% of the total density) and immature tubificid worms (23.4%). The Asiatic clam dominated the benthic biomass. Other common taxa included species of the midges and the burrowing mayfly (Hexagenia spp.). Peaks in total macroinvertebrate density occurred in December, April, and June. Minimum densities occurred in mid and late summer and were attributed to midge emergence and fish predation. Corbicula sp. densities peaked in December and February and declined thereafter.

The applicant found that the Asiatic clam densities averaged 505/m^2 with the highest recorded of 1472/m^2 in the vicinity of the Catawba station (ER-OL Section 2.2.2.3.2). Densities were highest at shallow depths with a sandy or muddy-sandy substrate. Densities of Corbicula sp. have continued to increase in Lake Wylie since they were first collected in 1968. The clams usually reach a size of 35 mm (1.4 in.) to 45 mm (1.8 in.) (Nash, undated).

On April 10, 1981, the staff issued Inspection and Enforcement Bulletin 81-03 to holders of operating licenses and construction permits requiring them to submit the following information: the known occurrence of Corbicula sp. in the vicinity of their plants, an inspection of plant equipment for fouling by this organism, and a description of methods (in use or planned) for preventing and detecting fouling by Corbicula sp. The applicant responded on July 8, 1981 (Parker, 1981) and stated that Asiatic clams were known from Lake Wylie. Further, the applicant stated that inspection of the nuclear service water system, the fire protection system, and the conventional low-pressure service water found four small clams, one in the service water supply header and three small clams in the fire system. Some small clam shells and shell fragments have been reported from the fire protection system deluge nozzles in the past.

The fire protection systems were still on temporary construction lake water supplies which are not chlorinated. The applicant stated (Parker, 1981) that provisions have been designed into the station to (1) minimize the introduction of clams into the raw water systems, (2) performance monitor components to verify adequate flow, (3) allow visual inspection of intake piping and inlet heat exchanger heads during maintenance, (4) and aid in removing these organisms if they become established in piping and components (see Section 4.2.6.2).

The 1977 study by SCDHEC found that the midge larvae Chaoborus was the most abundant organism in the lake comprising over 90% of the fauna (Johnson and de Kozlowski, 1981).

Fish

A total of 28 fish species from 9 families were collected from 4 locations near the Catawba site (ER-OL Section 2.2.2.4.1). A lakewide survey by Industrial BIO-TEST Laboratories, Inc. (1974) and unpublished cove rotenone data collected during 1978 and 1979 by South Carolina Wildlife and Marine Resources Department found that the dominant species are threadfin shad, gizzard shad, bluegill, largemouth bass, redbreast sunfish, pumpkinseed, redear sunfish, black crappie, white catfish, channel catfish, and yellow perch.

Threadfin shad were the most numerous fish collected near the Catawba site accounting for 27.2% of the total (ER-OL Section 2.2.2.4.2). Nash (personal communication, 1981) thought that the threadfin shad population in Lake Wylie is relatively stable, although naturally occurring low water temperatures during the winter of 1975-1976 is suspected of causing a threadfin dieoff (Nash, 1980). White catfish were the most abundant of the catfishes near the site and bluegills the most abundant of the sunfishes. The largemouth bass accounted for the greatest biomass of all species collected at locations near the Catawba site (ER-OL, Section 2.2.2.4.2).

Average standing crop estimates from cove rotenone for major sports species in Lake Wylie in 1978-1979 were 11.4 kg/ha (12.8 lb/acre) for largemouth bass, 6.9 kg/ha (7.7 lb/acre) for channel catfish, 3.4 kg/ha (3.8 lb/acre) for black crappie (Nash, 1980).

Attempts have been made at establishing a striped bass fishery in Lake Wylie. These have been largely unsuccessful and stocking of fry has been discontinued (Nash, personal communication, 1981).

A limited commercial catfish basket fishery apparently exists on Lake Wylie. Industrial BIO-TEST Laboratories, Inc. (1974) reported that approximately six individuals commercially fished the lake in 1973-1974. Nash (personal communication, 1981) stated that there are presently two to three individuals still fishing on a part-time basis. Since the harvest is unregulated in South Carolina, no estimates of harvest or effort are available.

All fish species collected from Lake Wylie can be generally classified as spring and/or summer spawners. Actual spawning time varies considerably from year to year. Some species apparently begin spawning earlier in the Allen Steam Plant discharge area than elsewhere (Industrial BIO-TEST Laboratories, Inc., 1974). In the 1973-1974 study the peak shad (Dorosoma spp.) spawning activity apparently occurred during May. Shad larvae made up 85% of the total number of larval fish taken between the end of March and the beginning of July. Most of the spawning activity of golden shiners occurred during April and May. White catfish apparently reach spawning condition earlier in the Allen discharge area than elsewhere. Peak activity for this species occurred in June. Peak sunfish spawning probably occurred in May and June while most crappie spawning apparently occurred in April. Highest larval densities reported from the sampling station nearest the Catawba intake were 38.5 larval fish/100 m^3 of water in early May with 96% of the larvae collected identified as shad (Industrial BIO-TEST Laboratories, Inc., 1974).

The most common external fish parasite or disease is the protozoan Epistylis (ER-OL, Section 2.2.2.4.3 and Nash, 1980). Other parasites and diseases are known however infestations were low and of little concern. Epistylis has been found on 12 host species and contributes to the spring mortalities of black crappie. It has also been frequently identified on largemouth bass and white bass particularly during the winter months (Nash, 1980). The factors contributing to Epistylis infestations are unknown, however, organic enrichment and release of nutrients during lake destratification have been suggested (ER-OL, Section 2.2.2.4.3).

4.3.5 Threatened and Endangered Species

On September 1, 1981 a letter (Adensam, 1981) was sent to the U. S. Fish and Wildlife Service (FWS) area office in Asheville, North Carolina, notifying them of the proposed licensing of Catawba Nuclear Station Units 1 and 2. Adensam (1981) requested that the NRC be notified of any federally listed or proposed endangered or threatened plant or animal species in the vicinity of the project. The FWS responded on September 11, 1981 (Ryan, 1981) notifying the NRC that no endangered or threatened species, listed or officially proposed for listing, are known to be in the project area. The letter states that the NRC has satisfied the requirements of Section 7(c) of the Endangered Species Act.

The State of South Carolina has its own list of endangered species (South Carolina State Regulation 50-15). In June 1980 two bird species observed on the Catawba site were added to the state list. The two species are Cooper's Hawk (Accipiter cooperii) and American Osprey (Pandion haliatus). Also in June 1980 the Carolina darter, Etheostoma collis collis, was added to the state list. This species has not been collected from Lake Wylie in the vicinity of the site and it is unlikely to be found nearby in the future. This species is known from small to medium sized streams 0.6-0.9 m (2-3 ft) deep from backwater pools or near stream banks in slow moving water (Collette, 1962) and would be unlikely to be collected from Lake Wylie.

4.3.6 Community Characteristics

The socioeconomic characteristics of the area, including demography, recreation, zoning, and land use are described in Sections 2.1 and 2.2 of the FES-CP. The area remains predominantly rural, nonfarm with residential and recreational development along Lake Wylie. Mecklenburg County, North Carolina has predominantly residential zoning within 8 km (5 mi) of the station while York County, South Carolina has no zoning outside of city limits. The area within 80 km (50 mi) of the station has been experiencing population growth at a rate fairly consistent with that previously projected in the FES-CP. Mecklenburg County experienced a 14 percent growth rate through the 1970s to arrive at a 1980 population of 404,270. This population figure is slightly lower than previously predicted. York County's 1980 population was 106,720 a little higher than predicted, resulting from a growth rate of 25% through the past decade.

Other recent data not included in the FES-CP relates to transient population estimates. Heritage U.S.A. is a campground and religious retreat complex (affiliated with the PTL Club) in Fort Mill, South Carolina. It is within 16 km (10 mi) of Catawba. The complex has about 500 employees and about the same number of vistors daily. At peak attendance there is around 38,000 for the large annual Labor Day weekend show (1980). This annual show is being moved to the Fourth of July. In the next 5 years, a hotel and World Conference Center are scheduled for completion on the property.

The Arrowwood Industrial Park, which was included in the FES-CP, has grown to about 120 different firms and a total of 11,000 employees. No other significant changes have occurred from the descriptions in the FES-CP.

4.3.7 Historic and Archeologic Sites

These topics are described in Sections 2.3 and 4.2 of the FES-CP. The sites listed on the National Register of Historic Places (U.S. Department of the Interior, 1976, and subsequent listings) and within 16 km (10 mi) of the station included: The White House, Ebenezer Academy, Tillman Hall, and the McCorkle-Fewell-Long House. All are in Rock Hill, and over 6 mi from the station. The Catawba-Ripp 230-kV line passes within a half mile of the Kings Mountain National Military Park and the Kings Mountain State Park. The National Military Park is in the National Register.

The only changes in archeologic information since the issuance of the FES-CP, was the result of the transmission corridors being archeologically surveyed. A site in the Catawba-Newport (East) 230-kV line was considered potentially eligible for nomination to the National Register of Historic Places (Brockington, 1980). The site, which was identified as a Late Archaic campsite where animals were butchered, was further tested after tower placement. The conclusion of that study was that no further investigation of the site was recommended in conjunction with the Catawba transmission line project (Canouts, 1980).

4.4 References

Adensam, E. G., NRC, letter to W. Hicklin, U.S. Fish and Wildlife Service, Ashville, NC, Subject: Catawba Nuclear Station, Units 1 and 2 - Environmental Impact Statement, September 1, 1978.

Brockington, Jr., P. E., "Test Pits in the Piedmont: An Archeological Survey of Duke Power Company's Proposed Catawba Transmission Lines," Institute of Archeology and Anthropology, University of South Carolina, Columbia, SC, August 1980 (Contained in ER-OL, Appendix 2).

Canouts, V., "The Archeological Testing Program at Site 38YK72," Institute of Archeology and Anthropology, University of South Carolina, Columbia, SC, August 1980 (Contained in ER-OL, Appendix 2).

Changery, M. J., "National Thunderstorm Frequencies for the Contiguous United States" NUREG/CR-2252, National Climatic Center, NOAA, Asheville, NC, November 1981.

Collette, B. B. "The Swamp Darters of the Subgenus Hololepis (Pisces, Percidae)," Tulane Studies in Zoology 9(4): 115-211, 1962.

Dail, L. C., Duke Power Company, letter to W. H. Regan, Jr., NRC, Subject: Environmental Report, Docket No. 50-413/414, January 5, 1977.

Duke Power Company, "Catawba Nuclear Station Terrestrial Studies,"/January 1975."

Federal Register Notice, 43 FR 6030, "Floodplain Management Guidelines for Implementing E.O. 11988," U.S. Water Resources Council, February 10, 1978.

Industrial BIO-TEST Laboratories, Inc., "A Baseline/Predictive Environmental Investigation of Lake Wylie-Catawba Nuclear Station and Plant Allen. Sept. 1973-Aug. 1974," Vol. II, Industrial BIO-TEST Laboratories, Inc., Northbook, IL, p. 387, 1974.

Johnson, D. L., and S. J. de Kozlowski, "Surface Water Resource Investigation of the Catawba-Wateree River System in South Carolina," South Carolina Water Resources Comm. Rept. #134, Columbia, SC, 1981.

Kelly, D. L., J. T. Schaeffer, R. P. McNulty, C. A. Doswell, III, and R. F. Abbey, "An Augmented Tornado Climatology," Monthly Weather Review, 106: 1172-1182, August 1978.

National Climatic Center, "Local Climatological Data, Charlotte, NC - Annual Summary with Comparative Data," National Climatic Center, Environmental Data Service, Asheville, NC, 1976.

Nash, V. S., "Fisheries Investigations in Lakes and Streams, District IV, Study Completion Report July 1, 1975 Through June 30, 1980, Project No. F-11," South Carolina Wildlife and Marine Resources Department, Columbia, SC, 1980.

---, "Lake Wylie Fisherman's Guide." Freshwater Fisheries Section, South Carolina Wildlife and Marine Resources Department, Columbia, SC, Undated.

Parker, W. O., Duke Power Company, letter to J. P. O'Reilly, NRC, Subject: Response to IE Bulletin 81-03 for Catawba Nuclear Station, July 8, 1981.

Ryan, C. L., U.S. Fish and Wildlife Service letter to E. Adensam, NRC, Subject: Response to E. Adensam's Letter of September 1, 1981 Dealing With Threatened and Endangered Species, September 11, 1981.

State of South Carolina Water Resources Commission, Report No. 134. "Surface Water Resource Investigation of the Catawba-Wateree River System in South Carolina," March 1981.

---, State Regulations Part 50-15 Entitled "South Carolina Nongame and Endangered Species Conservation Act 1974."

Thom, H. C. S., "Tornado Probabilities," Monthly Weather Review, pp. 730-736, October-December 1963.

U.S. Department of the Interior, National Park Service, National Register of Historic Places, Volumes 1 and 2 (and subsequent listings as they appear in the Federal Register), Washington, D.C., 1976.

Weiss, C. M., R. H. Cambell, T. P. Anderson, and S. L. Pfander, "The Lower Catawba Lakes - Characterization of Phyto- and Zooplankton Communities and Their Relationships to Environmental Factors," Department of Environmental Sciences and Engineering, School of Public Health, University of North Carolina ESE Publication Number 389, Chapel Hill, NC, 1975.

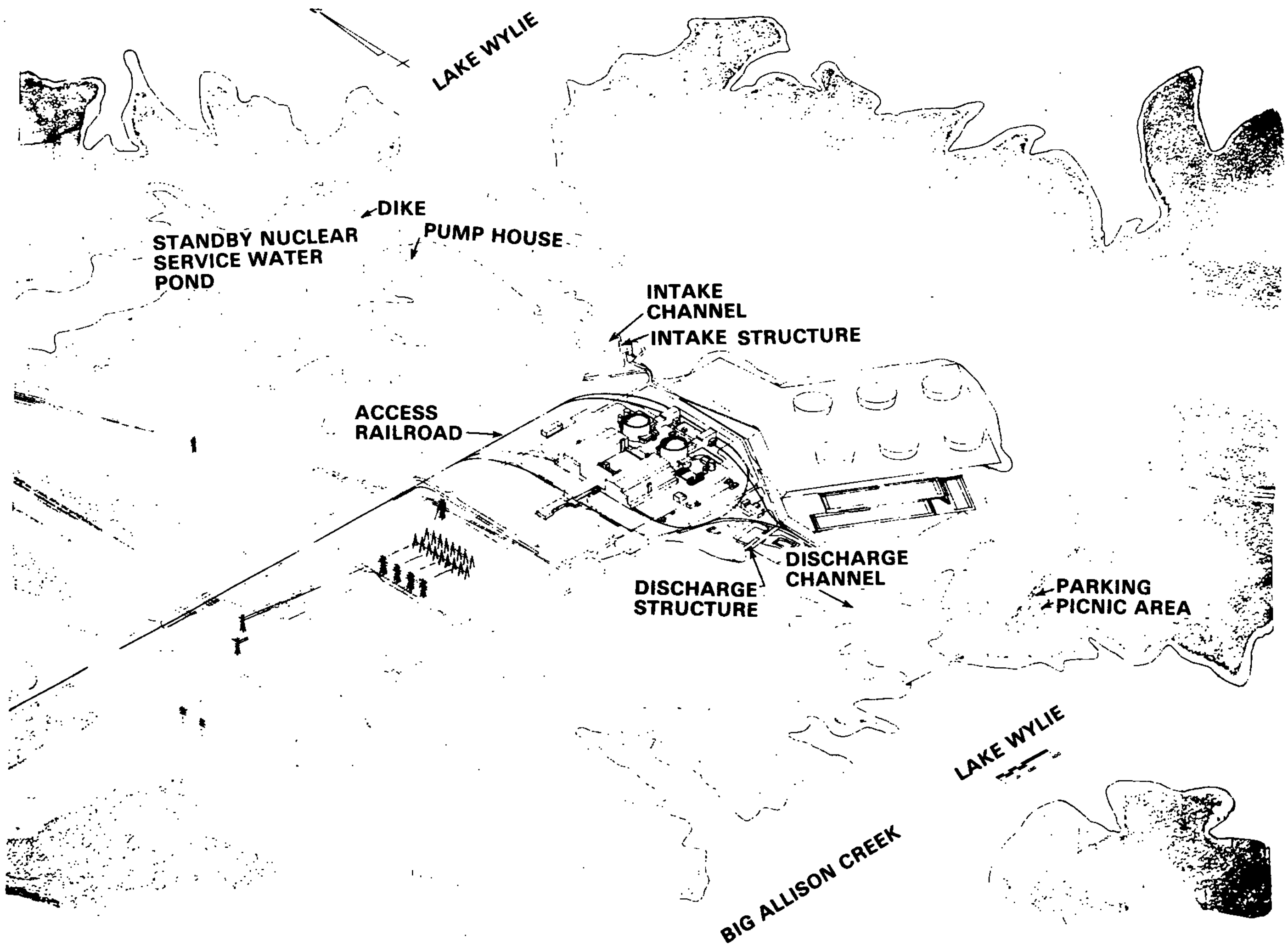

Figure 4.1 Perspective drawing, Catawba Nuclear Station
Source: ER-OL Figure 3.1.0-6, Revision 2

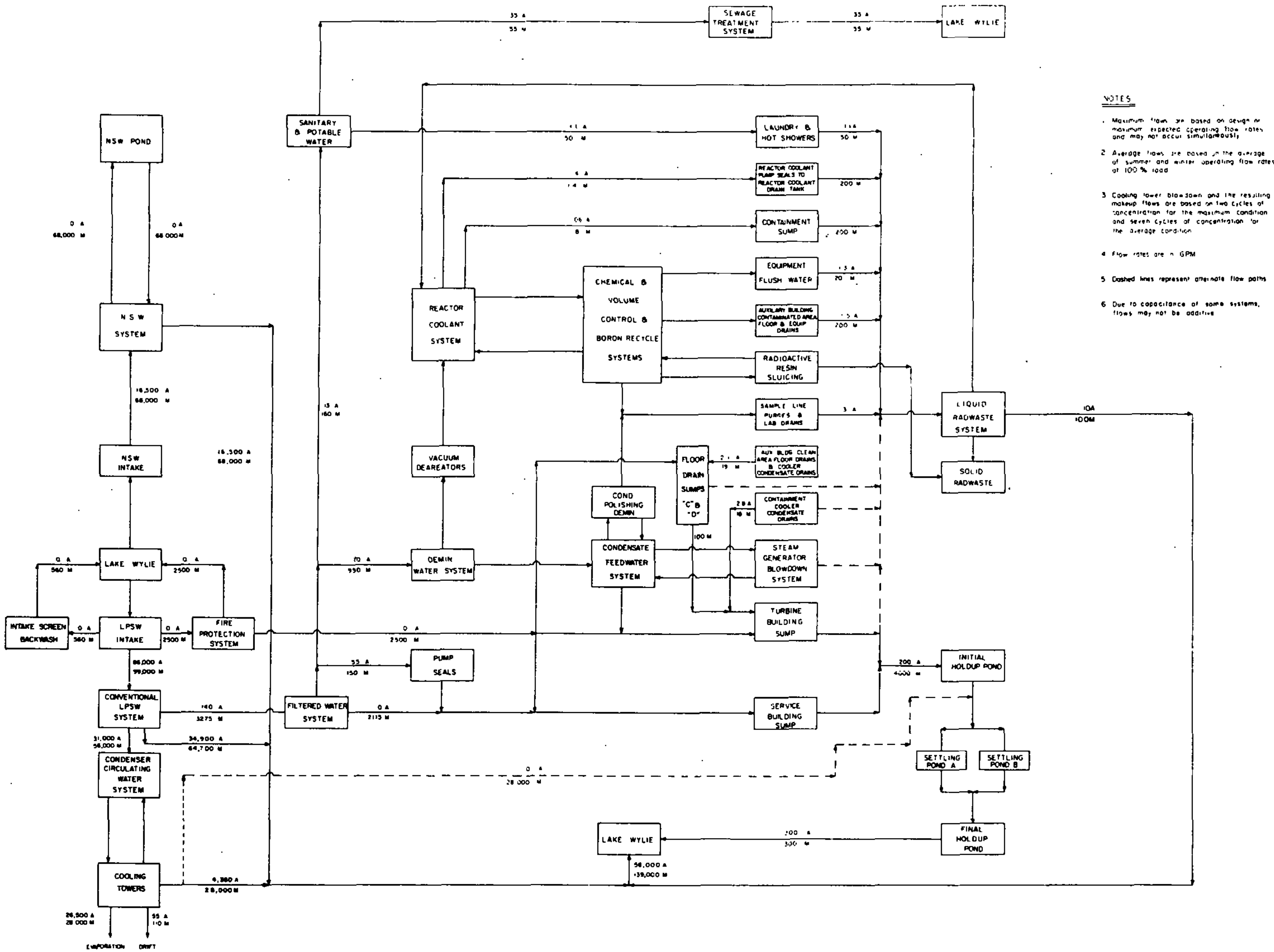

Figure 4.2 Station water use, Catawba Nuclear Station
Source: ER-OL Figure 3.3.1-1, Revision 2

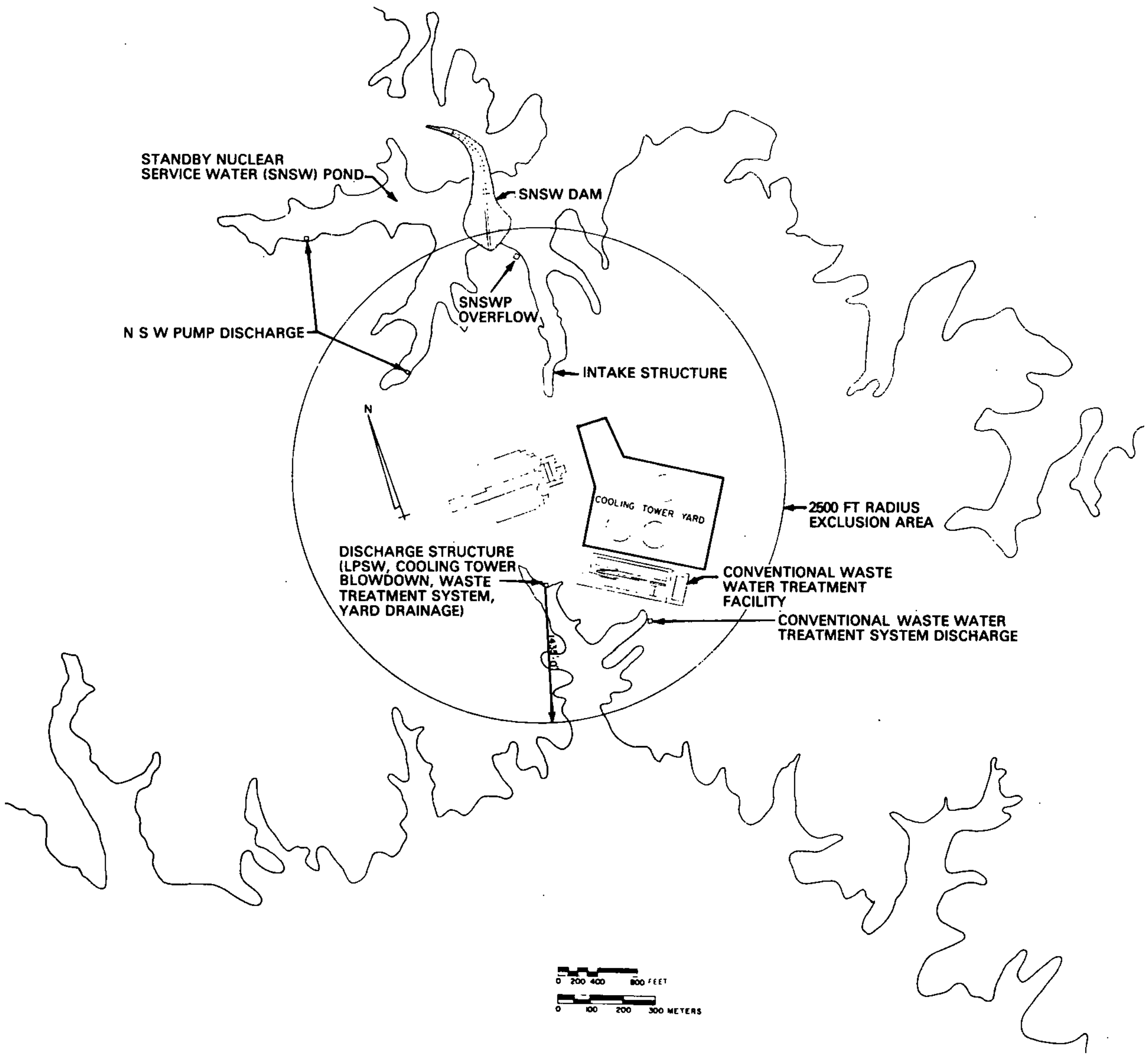

Figure 4.3 Nonradiological release points
Source: ER-OL Figure 2.1.1-5, Revision 3

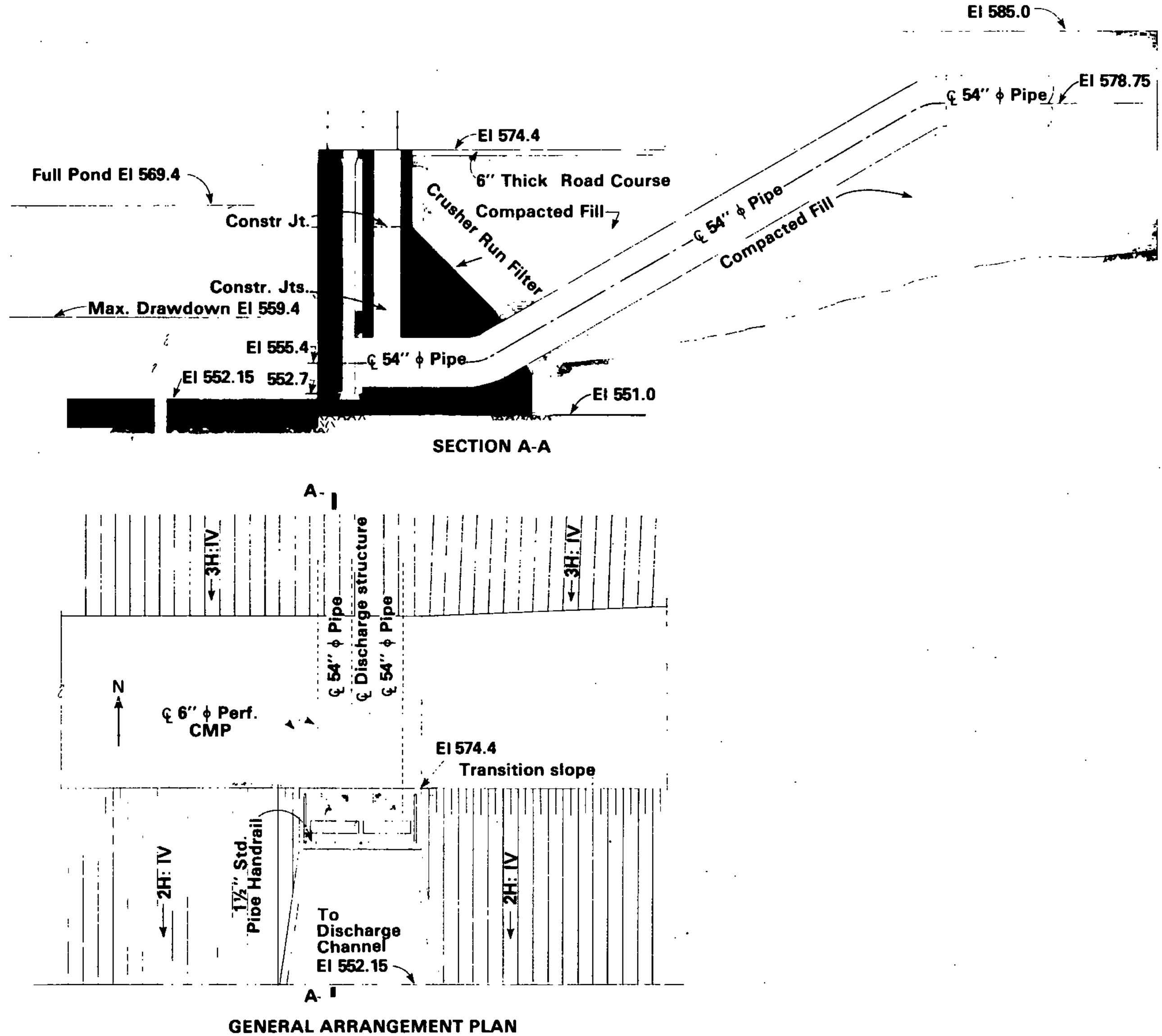

Figure 4.4 Low-pressure service water discharge structure
Source: ER-OL Figure 3.4.4-1

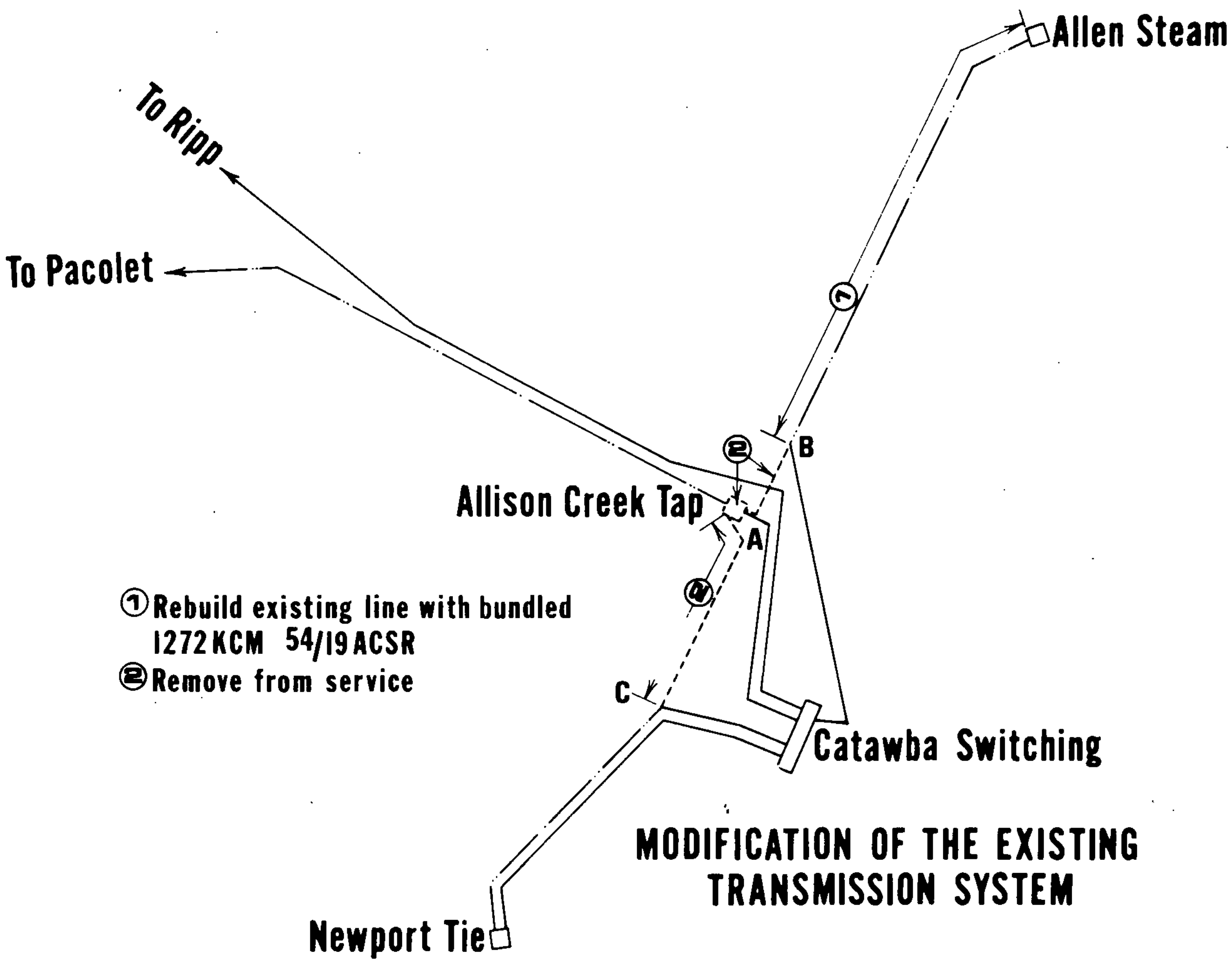

Figure 4.5 Modification of the existing transmission system
Source: ER-OL Figure 4.2.2-1

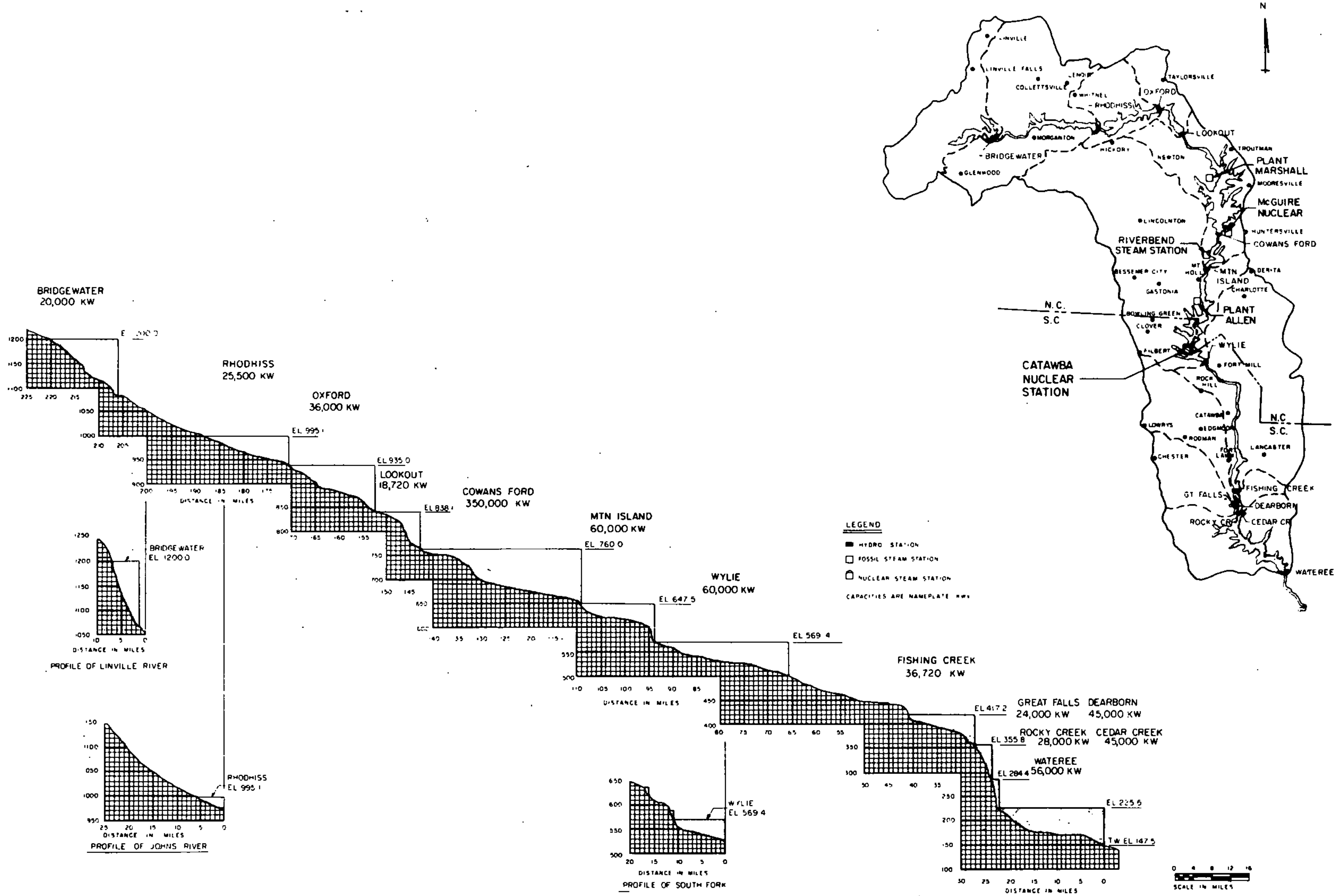

Figure 4.6 Major hydraulic features of the Catawba River drainage basin, Catawba Nuclear Station
Source: ER-OL Figure 2.4.1-1, Revision 1

Table 4.1 Catawba Nuclear Station water use

Title	Average GPM	Average Liter/min	Maximum (1) GPM	Maximum (1) Liter/min
Intakes from Lake Wylie				
I. Nuclear Service Water Intake:				
Nuclear Service Water System	16,500	62,400	68,000	257,000
Nuclear Service Water Pond (Regulated)	0	0	68,000	257,000
Total	16,500	62,400	68,000	257,000
II. Low Pressure Service Water Intake:				
A. Intake Screen Backwash	0	0	560	2,100
B. Fire Protection	0	0	2,500	9,500
C. Conventional LPSW System				
1. Condenser Circulating Water System				
Cooling Tower Evaporation	26,500	100,000	28,000	106,000
Cooling Tower Drift	55	210	110	420
Cooling Tower Blowdown	4,360	16,500	28,000	106,000
Subtotal	31,000	117,000	56,000	212,000
2. Filtered Water System				
a. Pump Seals	55	210	150	570
b. Demineralized Water System	70	260	950	3,600
c. Sanitary and Potable Water	13	50	160	610
Subtotal	140	530	3,275 (5)	12,400 (5)
3. LPSW Heat Removal and Service Loads	34,900	132,000	64,700	245,000
Total for Conventional Low Pressure Service Water	66,000 (C.1+C.2+C.3)	250,000	99,000 (2)	375,000 (2)
Total for Low Pressure Service Water Intake (A+B+C)	66,000	250,000	102,000	386,000
Total for Intake From Lake Wylie (Nuclear Service Water plus Low Pressure Service Water Intakes)	~82,000	310,000	~170,000	640,000

Source: ER-OL Table 3.3.1-1

Table 4.1 (Continued)

Title	Average (GPM)	Average Liter/min	Maximum (1) (GPM)	Maximum (1) Liter/min
Discharges to Lake Wylie				
I. From LPSW and NSW Intake				
From Cooling Towers	4,360	16,500	28,000	106,000
From NWS System	16,500	62,500	68,000	257,000
From Liquid Radwaste System	10	38	100	380
From Conventional LPSW System	34,900	132,000	64,700	257,000
Subtotal	~56,000	~212,000 (3)	~139,000	~526,000 (4)
II. From Sewage Treatment System	35	132	55	208
III. From Final Holdup Pond	300	1,135	300	1,100
Total Discharges to Lake Wylie (I+II+III)	~56,000	~212,000	~139,000	~526,000

NOTES:

1. Maximum Flows may not occur simultaneously
2. Based on design capacity of all LPSW pumps
3. Average intake differs from discharge due to cooling tower atmospheric losses
4. Maximum intake differs from discharge due to cooling tower atmospheric losses. Also, flows from Fire Protection and Intake Screen Backwash are not included.
5. Filter system backwash flow included in subtotal

Source: ER-OL Table 3.3.1-1

Table 4.2 Lake Wylie intake structure areas and water velocities for Catawba Nuclear Station

Area*	Velocity**
Full pond (el. 172.8 m (569.4 ft)	
Gross opening 28.4 m^2 (306.0 ft^2)	0.07 m/s (0.24 fps)
Through trashcracks 20.8 m^2 (224.3 ft^2)	0.10 m/s (0.33 fps)
Through screens 14.7 m^2 (158.6 ft^2)	0.14 m/s (0.47 fps)
Maximum drawdown (el 170.5 m (559.4 ft)	
Gross opening 18.1 m^2 (194.3 ft^2)	0.12 m/s (0.38 fps)
Though trashracks 13.2 m^2 (141.9 ft^2)	0.16 m/s (0.53 fps)
Though screens 9.4 m^2 (100.7 ft^2)	0.23 m/s (0.74 fps)

*Areas given are for each pump bay. There is one pump per bay. Two-unit operation will use two pumps and twice the area indicated.

**Velocities based on average water flow at 100% power operation.
Source: ER-OL Section 3.4

Table 4.3 Data on circular mechanical draft cooling towers for Catawba Nuclear Station

Number of towers	6 (3 per unit)
Number of fans/tower	13
Height	21.3 m (70 ft)
Basin diameter	77.4 m (254 ft)
Outside diameter	82.9 m (272 ft)
Drift rate (% of circulating water flow rate)	0.008%
Cooling range (summer design conditions	12.8°C (22.9°F)
Cooling tower basin temperature (summer design condition)	31.4°C (88.6°F)
Exit air temperature	38.9°C (102.1°F)

Sources: ER-OL Section 3.4; ER-OL Table 3.4.1-1; and ER-OL, Table 10.1.1-3.

Table 4.4 Catawba Nuclear Station waste water discharge (NPDES 001, 002)

Parameter	Conc Units	Average Intake Conc	Cooling Tower Blowdown Average Conc	Conventional Waste Water Treatment Avg Conc (2)	Incremental Concentrations: Dis Cove Avg Conc (3)	Incremental Concentrations: Lake Wylie Max Conc	Incremental Concentrations: Lake Wylie Avg Conc (4)
Alkalinity as $CaCO_3$	mg/l	15	24(1)	10	1.5	0.28	.04
Boric Acid as B,	μg/l			12.5	44.3	.01	--
Hardness as $CaCO_3$	mg/l	16	112	12	6.7	1.3	.19
Calcium, Ca,	mg/l	3.5	25	2.5	1.5	0.29	.04
Magnesium, Mg,	mg/l	1.5	10.5	1.3	0.6	0.12	.02
Sodium, Na,	mg/l	7.3	72	70	4.6	0.9	.13
Potassium, K,	mg/l	1.8	13	1.3	0.8	0.15	.02
Aluminum, Al,	mg/l	1.6	11	2.1	0.7	0.13	.02
Iron, Fe,	mg/l	1.2	8.4	0.8	0.5	0.10	.01
Manganese, Mn,	mg/l	0.18	1.3	0.12	0.1	0.01	--
Cadmium, Cd,	μg/l	1.0	7	--	0.4	--	--
Chromium, Cr,	μg/l	6	42	--	2.5	0.5	--
Copper, Cu,	μg/l	5	35	--	2.1	0.4	--
Lead, Pb,	μg/l	3	21	--	1.3	--	--
Nickel, Ni,	μg/l	11	77	--	4.6	0.9	--
Zinc, Zn,	μg/l	19	134	--	8.0	1.6	--
Ammonia, N,	mg/l	0.19	1.3	1.1	0.1	0.01	--
Nitrate-Nitrite, N,	mg/l	0.28	2.0	2	0.1	0.02	--
Chloride, Cl,	mg/l	6.5	78	15	4.7	0.9	.13
Fluoride, F,	mg/l	0.15	1.0	0.12	0.1	0.01	--
Phosphorus, Total P.	μg/l	56	392	0.6	25.4	5	--
Silicon, Si,	mg/l	4.2	29	3.3	1.8	0.34	.05
Sulfate, SO_4,	mg/l	10	194(2)	141	12.1	3.3	.34
Suspended Solids	mg/l	10	70	16	4.2	0.82	.12
Dissolved Solids	mg/l	60	600	317	36.9	7	1.0
Total Organic Carbon	mg/l	3.1	22	9	1.3	0.26	.04
Detergents	μg/l			5.4	19.2	--	--
Ethylene Glycol	μg/l			0.5	1.9	--	--
Hydrazine	μg/l			1.0	3.5	--	--

1. Alkalinity is treated with sulfuric acid.
2. Average is for 115 regenerations/year, with caustic recycle, and 8 wet layups a year. Average mg/l is based on average lbs/day including sanitary sewage 35 gpm average flow.
3. Incremental concentrations in the discharge cove estimates average station wastes in a flow of 56,200 gpm (125.2 cfs).
4. Incremental concentrations in Lake Wylie are based on average station waste discharges and a flushing flow through the reservoir. The maximum incremental concentration is based on the 7-Q-10 flow of 648 cfs, and average incremental concentration is based on the average flow of 4445 cfs.

Source: ER-OL Table 3.6.1-2

Table 4.5 Catawba Nuclear Station conventional waste water treatment system effluent analysis (NPDES 002)

Design Parameter Units	Normal Range	Limit
pH	7.0-8.0	6.0-9.0[1]
Total Suspended Solids, mg/l	$\leq$30	100[1]
Biological Oxygen Demand, mg/l	$\leq$5	10[2]
Chemical Oxygen Demand, mg/l	$\leq$10	20[2]
Dissolved Oxygen, mg/l	$\geq$5	4[2]
Fe, mg/l	$<$1	1[1]
Cu, mg/l	$<$1	1[1]
Mn, mg/l	$<$0.5	0.5[2]

[1]40 CFR 423 - EPA effluent guidelines and standards for steam electric power generating
[2]Design Criteria

Source: ER-OL Table 3.6.1-1

Table 4.6 Catawba Nuclear Station transmission line additions

	Catawba-Allen	Catawba-Ripp	Catawba Pacolet	Catawba-Newport (Allison Creek B&W)	Catawba-Newport (Newport B&W)	Totals
Total R/W Length-mi(km)	10.9(17.5)	24.4(39.3)	41.3(66.5)	5.2(8.3)	5.2(8.3)	86.9(139.8)
New R/W Length-mi(km)	1.3(2.1)	24.4(39.3)	1.2(1.9)	0.7(1.1)	0.7(1.1)	28.4(45.7)
Total R/W-ac(ha)	197.6(80.0)	426.2(172.5)	750.7(303.8)	93.6(37.9)	72.6(29.4)	1540.7(623.6)
Total New R/W-ac(ha)	23.8(9.6)	426.2(172.5)	22.2(9.0)	12.7(5.1)	10.2(4.1)	495.1(200.3)
Forest-ac(ha)	11.5(4.6)	323.5(130.9)	10.4(4.2)	7.7(3.1)	5.9(2.4)	359.0(145.2)
-% of total New R/W	48.2	75.0	46.8	60.5	57.8	72.5
Pasture & Agriculture -ac(ha)	0	94.2(38.1)	1.6(0.6)	0	0	95.8(38.7)
-% of Total New R/W	0	22.1	7.0	0	0	19.3
Cleared for Catawba Nuclear -ac(ha)	12.4(5.0)	8.5(3.4)	10.3(4.2)	4.2(1.7)	3.6(1.5)	39.0(15.8)
-% of Total New R/W	51.8	2.0	46.2	32.9	35.4	7.9
Water Crossings-ac(ha)	0	0	0	0.8(0.3)	0.7(0.3)	1.5(0.6)
-% of Total New R/W	0	0	0	6.6	6.8	0.3
Total New Cleared R/W -ac(ha)	11.5(4.6)	323.5(130.9)	10.4(4.2)	7.7(3.1)	5.9(2.4)	359.0(145.2)
Man-Made Structures Removed		0	2	0	0	0 2
R/R Crossings on New R/W-#		1	2	1	0	0 4
Hwy. Crossings on New R/W-#	0	5	0	0	1	6

Source: ER-OL, Table 3.9.1-1

5 ENVIRONMENTAL CONSEQUENCES AND MITIGATING ACTIONS

5.1 Résumé

This résumé highlights changes in the staff's evaluation of the environmental effects of operating Catawba Nuclear Station in the light of information gained since the FES-CP was issued in 1973. No discussion is provided of those impacts for which there has been no new information or change since the construction review.

Land-use impacts are addressed in Section 5.2.1, and transmission line impacts as a result of the operation of Catawba station are evaluated in Section 5.2.2. Water use and hydrological impacts are updated in Sections 5.3.1 and 5.3.2, respectively. The impact of Catawba station on the Catawba River floodplain is evaluated in Section 5.3.3 pursuant to Executive Order 11988, which was promulgated after the FES-CP was issued. Effects of fogging, icing, and other emissions are updated in Sections 5.4.1 and 5.4.2. Terrestrial and aquatic ecology are reviewed and updated in Sections 5.5.1 and 5.5.2, and the effects of thermal discharge on biota are discussed in Section 5.5.2.2. The effects of the operation of Catawba station on historic and archeologic sites are reviewed in Section 5.7; socioeconomic effects are updated in Section 5.8. Information on radiological impacts of normal operation has been revised in Section 5.9 to reflect updated knowledge gained since the FES-CP was issued. Section 5.9.4 on postulated plant accidents now contains information that has been revised and updated to include Class 9 accidents and the lessons learned from the accident at Three Mile Island, Unit 2 (TMI-2). The latest information on environmental effects of the uranium fuel cycle and decommissioning is provided.

Operational monitoring programs are to be conducted in accordance with the Environmental Protection Plan (EPP) and the Environmental Technical Specifications for radiological monitoring to be issued by NRC as part of the operating license. The EPP will require the applicant, as licensee, to (1) notify NRC if changes in plant design or operation occur, or if tests or experiments affecting the environment are performed, provided that such changes, tests, or experiments involve an unreviewed environmental question; (2) maintain specific environmentally related records; (3) report violations of conditions stated in the NPDES permit or State certification pursuant to Section 401 of the Clean Water Act; (4) report unusual or important environmental events; and (5) monitor potential effects of cooling tower drift.

5.2 Land Use

5.2.1 Plant Site

Land use impacts from the operation of the station are discussed in Section 5.1 of the FES-CP. No significant changes are expected from those discussed at the CP stage of review.

5.2.2 Transmission Lines

Environmental impacts that typically could be associated with the operation of transmission lines are caused by (1) ozone production, (2) induced electrical currents, (3) electric fields, and (4) corridor maintenance. The amount of ozone produced by transmission lines has been determined to be so small that ozone poses no detrimental environmental threat.

There have been several recent studies of health effects on humans from electric fields associated with transmission lines. Although experimental work is still under way on the biological effects of electric fields along extra high voltage (EHV) transmission lines, the staff has found no major effects associated with the operation of the lower voltage (230 kV) lines as proposed by the applicant.

The applicant has designed the station-related portion of his transmission system in accordance with practices approved by the National Electric Safety Code (1977 edition) to ensure the safeguarding of persons from hazards resulting from the operation of overhead lines.

About 72% of the transmission line corridors pass through forested land. This means that about 145 ha (359 acres) will have to be maintained in a nonforested condition. This will be accomplished primarily by bush-hogging with some hand- or power-saw felling of large saplings. No herbicides are used. Because a vegetative cover is maintained, soil erosion should be minimal and wildlife habitat maintained.

5.3 Water

5.3.1 Use

5.3.1.1 Surface Water

Catawba Nuclear Station water supply will be derived from Lake Wylie. As described in Section 4.2.3, withdrawal rates for average and maximum meteorological conditions will be 312,000 l/min (82,000 gpm) and 643,000 l/min (170,000 gpm), respectively. Approximately 33% of the water withdrawn from Lake Wylie for station use will be lost to the atmosphere from operation of the cooling towers. The remaining water will be discharged back into Lake Wylie.

The present average daily surface water withdrawals from the Catawba River within 32 km (20 mi) upstream and 80 km (50 mi) downstream of the site are 333,000 l/min (88,000 gpm). The present consumptive water use of Catawba River water is estimated to be about 38,900 l/min (10,300 gpm). With the operation of the Catawba station the present average daily water withdrawals from the Catawba River in this region will almost double; however, the withdrawals will only be about 8% of the average daily flow at the Rock Hill gaging station (see Table 5.1). The present consumptive water use from the Catawba River in the region will increase from an estimated 38,900 l/min (10,300 gpm) to 140,900 l/min (37,200 gpm) with plant operation. This is less than 2% of the average daily flow at the Rock Hill gaging station.

As described in Section 4.3.1.1, the applicant has estimated the 7-day once-in-10-year low flow into Lake Wylie to be 14.6 m^3/sec (516 cfs = 8.77×10^5 l/min =

2.315 x 10^5 gpm). The station consumptive use will be less than 12% of the 7-day once-in-10-year low flow (see Table 5.2). The total average daily consumptive water use from the Catawba River in the site region will be about 16% of the 7-day once-in-10-year low flow entering Lake Wylie.

Based on the above analysis the staff concludes that operation of the Catawba Nuclear Station will not have an adverse effect on regional water use from the Catawba River. This primarily is due to the large storage volume of Lake Wylie and the upstream control on the Catawba River provided by six dams with approximately 1.9 x 1^9 m^3 (1.5 x 10^6 acre-ft) of water storage.

5.3.1.2 Groundwater

Operation of the Catawba Nuclear Station will be sustained by water obtained from Lake Wylie. No groundwater will be used for operation of the station. A groundwater drainage system at the base of the foundation mat and basement walls of the auxiliary and reactor buildings will alter the groundwater gradient for a maximum distance of a few hundred feet around the buildings. The changes in the groundwater gradients will be within the station property boundaries and will not affect domestic groundwater wells in the vicinity of the site.

5.3.2 Water Quality

5.3.2.1 General

Water quality impacts in Lake Wylie may be caused by chemical and other wastes in the station effluent discharged during preoperational cleaning and operation. The potential for impacts to receiving water quality were assessed during the construction permit environmental review (FES-CP Sections 5.5.2.2 and 5.5.2.3). There have been changes in the volume and concentration of wastes in the station effluent as a result of changes in station design and environmental data (see Sections 4.2.6 and 4.3.2). The resulting changes in potential water quality impacts are examined below.

5.3.2.2 Surface Water

The applicant performed a thermal plume analysis on the combined service water and cooling tower blowdown releases into the Allison Creek arm of Lake Wylie. Thermal plume areas resulting from the discharge were computed for the winter with a discharge flow of 1,199 l/sec (19,000 gpm) and a temperature rise of 8.6C° (15.5F°) above ambient temperature and for the summer with a discharge flow of 3,532 l/sec (56,000 gpm) and a temperature rise of 4.7C° (8.5F°) above ambient temperature. Areas enclosed by the 2.8C° (5F°) isotherm above ambient lake temperatures and the 32.2°C (90°F) isotherm, with the percent of lake surface area affected, are presented on a seasonal basis in Table 5.3 for average and worst-case conditions.

Under worst-case winter (February) conditions the 2.8C° (5F°) above ambient isotherm would extend from the mouth of the discharge cove to less than 914 m (3,000 ft). downstream and to 244 m (800 ft) upstream of the Allison Creek arm of Lake Wylie. This would represent less than 0.9% of the total lake area. Under average winter conditions it would affect only 0.6% of the total lake area. Under worst-case summer (August) conditions the 2.8C° (5F°) above ambient isotherm would be confined almost entirely to the discharge cove and the 32.2°C

(90°F) isotherm would extend from the mouth of the discharge cove to less than 914 m (3,000 ft) downstream and to 244 m (800 ft) upstream of the Allison Creek arm of Lake Wylie. This would represent an area bounded by the 32.2°C (90°F) isotherm of about 40 ha (100 acres) or 1.1% of the total lake area. Under average summer conditions the 32.2°C (90°F) isotherm would enclose 2 ha (5 acres) or 0.1% of the total lake area.

The South Carolina water quality standards require that fresh waters, other than those classified as trout habitat, not exceed 32.2°C (90°F) at any time and that temperature increases as a result of pollutant discharges be limited to 2.8C° (5.0F°) above natural temperatures, as a weekly average. Thus, the areas given above for the station under worst-case and average conditions represent the areas of Lake Wylie that are considered mixing zones, which are allowed by the South Carolina State regulations. The South Carolina Department of Health and Environmental Control has issued a National Pollutant Discharge Elimination System (NPDES) Permit for the station (Appendix I). This permit does not specifically limit the station discharge temperature during operation nor delineate specific mixing zones since the station design, consisting of a closed cycle cooling system with "cold side blowdown" (i.e., diversion of blowdown at a point in the flow path beyond passage through the cooling towers), will tend to minimize discharge of heated water from the facility.

The revised estimates of the average and maximum concentrations of wastes to be discharged to Lake Wylie by Catawba Nuclear Station during operation are given in Tables 4.4 and 4.5. With regard to average station effluent characteristics (from the cooling tower blowdown, the conventional waste water treatment system, and the sanitary waste treatment system), most of the changes are increases (see FES-CP Table 3.13 for comparison). The increases are projected for concentrations of iron, magnesium, potassium, sodium, chloride, fluoride, sulfate, hardness, and total dissolved solids. These changes are a result of changes in the estimated ambient Lake Wylie concentration of dissolved substances, changes in station water flow rates, and changes in station wastewater treatment. These same parameters are estimated to have higher incremental concentrations in Lake Wylie than projected in the FES-CP. This is as a result of the factors given above for the effluent levels and also as a result of lower estimate of the flushing flow through the reservoir (648 cfs versus 713 cfs in the FES-CP). The staff has examined the levels of these parameters reported for the ambient conditions in Lake Wylie and the levels projected to exist in the Big Allison Creek arm of the lake and in the lake proper when station operation begins. With the possible exception of total iron, none of these constituents are currently, nor are they expected (upon station operation), to reach levels inconsistent with the designated uses assigned to Lake Wylie by the South Carolina Water Resources Commission (March 1981). Although earlier data from the applicant showed total iron concentration to average above 1.0 mg/l (that is, the value identified for protection of fresh aquatic life), the applicant's latest data show a decrease in average total iron concentration in Lake Wylie to a level below this identified value. Also, none of these parameters are currently, nor are they projected to become (upon station operation), in violation of State water quality standards.

Some constituents in the station effluents are now projected to be discharged in concentrations less than those evaluated in the FES-CP (although these concentrations represent increases over ambient levels). Included in this group are nutrients nitrate-nitrite-N, total phosphorus, and silica.

The NPDES Permit (Appendix I) issued by the State for station operation has expired, but has been administratively extended, pending finalization of Effluent Guidelines and New Source Performance Standards by the U.S. Environmental Protection Agency. The staff has examined the effluent limitations and other requirements of the permit and compared them to the proposed mode of operation of the station. The staff concludes that

(1) Compliance with the limitations on cooling tower blowdown and service water discharge is likely without change or mitigation, based on the applicant's commitments to hold up blowdown to allow for residual chlorine concentration decay to a level below that in the permit and the current plans to not chlorinate the once through cooling waters (Section 4.2.6). The staff also notes that the applicant will be required, as a part of the NPDES permit, to conduct "an internal evaluation of practicable methods to reduce total residual chlorine levels from the combined discharge of cooling tower blowdown, conventional service water and nuclear service water."

(2) Compliance with the conventional waste water treatment system and metal cleaning wastes limitations is likely, based on the applicant's projected effluent analysis (Section 4.2.6) and the staff's review of applicant experience with a similar waste treatment system associated with the McGuire Nuclear Station located upstream on the Catawba River.

(3) Compliance with the sewage treatment limitations is likely, but only with careful control of the tertiary aquaculture effluent polishing lagoon operation. This system has experienced total suspended solids and biochemical oxygen demand levels in the effluent in excess of the NPDES limits (Peacock, 1981). However, corrective actions have been initiated by the applicant to maintain effluent characteristics at or below the permit limits.

The staff concludes, on the comparison of ambient lake water quality, expected discharge quality and quantity, available criteria in the literature, and the analyses presented in the FES-CP that surface water quality impacts caused by operation of Catawba Nuclear Station will be small.

5.3.3 Floodplain Aspects

The objective of the Executive Order 11988, "Floodplain Management" (May 1977), is "...to avoid to the extent possible the long and short term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative...."

Defining an elevation for a 100-year flood in Lake Wylie is not practical because of the high degree of regulation and storage provided by the six upstream impoundments; however, since portions of the intake and discharge structures are, by design, located below the Lake Wylie water level, these structures can be considered to be in the floodplain. All of the structures located in the floodplain were substantially complete when Executive Order 11988 was signed in May 1977. Thus the staff concludes that consideration of alternative locations for these structures is neither required nor practicable.

The Catawba Nuclear Station, including the structures located in the floodplain, has been designed to withstand the flooding effects of a standard project flood combined with seismic failure of an upstream dam. This combination of events, which is a more severe event than the 100-year flood, reaches a static water level of 592.4 ft (180.57 m) MSL. Plant grade is at 593.5 ft (180.90 m) MSL. Based on this, the staff concludes that none of the structures located in the floodplain will be affected by flooding caused by a 100-year flood. In addition, the staff concludes that structures located in the floodplain will have a negligible effect on water levels in Lake Wylie during a flood event. This conclusion is based on the small cross sectional area of those structures in relation to the total area of Lake Wylie. The staff, therefore, concludes that the objectives of Executive Order 11988 have been met.

5.4 Air Quality

5.4.1 Fog and Ice

As stated in the FES-CP, atmospheric emissions from the mechanical draft cooling towers will consist primarily of waste heat and water vapor, resulting in conspicuous moisture plumes. When such plumes are near the ground, fogging could be observed. If air temperatures are below 0°C, icing could occur.

The applicant has used observations from the operation of two mechanical draft cooling towers at the nearby Cliffside Plant (located about 64 km (40 mi) northwest of Catawba) as the principal bases for describing atmospheric impacts resulting from cooling tower operation at the Catawba site. Several differences between the Cliffside and Catawba plants and cooling towers should be noted. Total heat load at Cliffside is about 820 MWt, while the total heat load at Catawba is about 4,630 MWt. The applicant has estimated the increased moisture output and evaporation at Catawba by a ratio of the total heat loads. Other differences between plants and cooling towers, including number of cooling tower units (two at Cliffside, six at Catawba), and tower shape (rectangular at Cliffside, round at Catawba) could affect initial plume behavior. Both the Cliffside and Catawba plants are in areas with similar climatology (for example, ambient temperatures and mixing heights), although wind direction frequencies are different.

Catawba, like Cliffside, has a high frequency of low wind speed conditions, and ground contact of the plume is expected to be minimal because of the initial bouyancy of the plume. The round shape of the towers at Catawba may enhance the initial bouyancy of the plume compared with those at Cliffside. The applicant maintains that ground contact of the plume at Cliffside has been limited to within 0.3 km (0.2 mi) of the plant. Based on plume observations at Cliffside, the applicant has estimated that the extent of ground level fogging as a result of plume contact should be limited to within 0.8 (0.5 mi) km of the Catawba plant at a frequency of less than 1% per year. Icing is not expected often because of the infrequent occurrence of temperatures less than 0°C.

Steam fog (formed as cold air drifts across relatively warm water) is also of concern, although the horizontal and vertical dimensions of steam fog are not usually large away from the water body. Steam fog in the immediate vicinity of Lake Wylie could be increased because of higher water temperatures, particularly in the vicinity of the plant discharge.

Based on observations made at Cliffside and adjusted to reflect wind direction frequencies for Catawba, the applicant has estimated the frequency and length of visible cooling tower plumes in the vicinity of Catawba (see ER Figures 5.1.4-1 and 5.1.4-2). The applicant estimates that the visible plume will be mostly confined to within 5 km (3.1 mi) of the station. The applicant has not specifically addressed the impact of the visible plume on the operation of such facilities as the municipal airport serving Rock Hill (located about 8 km (5 mi) south of the station). However, the applicant expects the impact to be minimal at this location because of the low frequency (about 5% annually) of visible plume extent.

The applicant has modeled the nonvisible humidity plume and determined that during most atmospheric conditions the increases in hourly average surface relative humidity are generally small (5-10%) within 8 km (5 mi) of the plant. Short-term increases of this order are not expected to be discernible from natural variations in relative humidity.

The determination of the atmospheric impact resulting from plant operation will depend almost entirely on comparison of the results of a preoperational (baseline) monitoring program with the results of an operational monitoring program. The preoperational program (described in Section 5.14.3) included fog observations and visibility monitoring at selected locations. The postoperational program (also described in Section 5.14.3) will include the same types of observations and visibility monitoring. The staff's evaluation of the operational program is included in Section 5.14.3. The staff will evaluate the results of the preoperational and operational monitoring programs to determine the need for continued monitoring and/or mitigating actions to lessen the atmospheric impact of plant operation.

5.4.2 Other Emissions

As stated in the FES-CP, nonradioactive pollutants (for example, SO_2 and NO_x) produced by operation of emergency and safe shutdown diesel engines should not have a significant impact on air quality in the vicinity of the plant if fuels with relatively low sulfur content are used.

5.5 Ecology

5.5.1 Terrestrial Ecology

The terrestrial ecology impacts that were expected to be caused by operation of the plant were assessed during the construction-permit review (FES-CP Section 5.4.1). No additional impacts are expected to occur that were not considered at the construction-permit stage.

5.5.1.1 Cooling Tower Emissions

Salt drift is the principal component of cooling tower emissions. Drift deposition has the potential for adversely affecting plants, but tolerance levels of native plants, ornamentals, and crops are not known with precision. Experiments simulating drift deposition on plants indicate that some species have threshholds for visible leaf damage in the range of 10 to 20 kg/ha/month (9 to 18 lb/acre/month) of NaCl applied to the leaves during the growing season

(NUREG/CR-1231). These effects can be altered by frequency of rainfall, humidity, type of salt, and sensitivity of species.

The applicant's predicted maximum NaCl deposition rate expressed on a monthly basis (2-3 kg/ha/month or 2-3 lb/acre/month) should not cause visible injury to the plants even in the areas of maximum deposition (NE and SW sectors). Further, these predicted deposition rates should not cause changes in the floral composition of the areas' vegetation. However, because of the uncertainty concerning the quantity of drift to be released (this quantity is based on a model not actual measurements) from the cooling towers and the uncertainty of threshhold levels of injury for the local flora a monitoring program will be required to detect any possible damage to the local flora caused by drift deposition. The monitoring program is specified in Section 5.14.1.

5.5.2 Aquatic

5.5.2.1 Impingement and Entrainment

The biological effects on aquatic organisms inhabiting Lake Wylie as a result of the withdrawal of water for the Catawba station heat dissipation system cannot be predicted with accuracy. Losses of aquatic life associated with the intake structure and withdrawal of water are a result of impingement and entrainment. Organisms small enough to pass through the 1-cm (3/8-in.) mesh intake screens will be entrained into the station heat dissipation system and subjected to elevated temperatures, changes in pressure, high flow velocities, and biocides. Organisms that are unable to resist the flow and are drawn into the intake structure that are too large to pass through the intake screens will be impinged. Organisms impinged on the screens and unable to escape will ultimately die and will be removed through the screen wash system for disposal.

<u>Impingement</u>

The flow velocities in the vicinity of the intake vary with station operation levels and Lake Wylie pond elevation. At full-pond elevation and both units at full power, the flow rate through the trashracks is 10 cm/sec (0.33 fps) and through the intake traveling screens is 14 cm/sec (0.47 fps). At the maximum lake drawdown and at full power for both units, the flow through the trashracks is 16 cm/sec (0.53 fps) and through the intake traveling screens is 23 cm/sec (0.74 fps) (ER, Section 3.4.3). The volume of water withdrawn also is a factor that influences impingement rates. The amount of water withdrawn is dependent on the station power level. If both units are operating at full capacity, the amount of water withdrawn through the low pressure service water intake structure is expected to average 4.2 m^3/sec (147 cfs) with a maximum of 6.2 m^3/sec (221 cfs) (ER-OL, Section 3.3).

Impingment of aquatic organisms will be limited almost exclusively to fish. Predicting, with accuracy, which species and the numbers of individuals that will be affected is difficult. Duke Power Company has a five-unit fossil station, Allen Steam Plant, on Lake Wylie north of the Catawba station. Intake velocities at Plant Allen (Edwards et al., 1976) vary by unit, power level, and pond level from 4.57 cm/sec (0.15 ft/sec) to 18.9 (0.62 ft/sec). Maximum flow rate is 35 m^3/sec (1,236 cfs). Therefore, intake velocities are slightly less than that at the Catawba station, but the Plant Allen maximum flow rate is

5 times greater than that expected at Catawba station. Between October 1973 and September 1974, Plant Allen conducted an impingement monitoring program, the results (Edwards et al., 1976) of which may be used to aid in the evaluation of the potential impact of Catawba station. At Plant Allen a total of 55,762 fish were collected from the intake screens during the study period. Threadfin shad accounted for 98.6% of the total catch. The remaining 1.4% of the fish impinged were primarily gizzard shad, channel catfish, and bluegill. About 92% of all the threadfin shad taken were collected between November 1973 and January 1974. The high threadfin shad impingement rates during this period are attributed to natural cold-induced mortality and disequilibrium resulting from the fall cooldown of the lake. The stressed threadfin shad are unable to maintain their equilibrium or orient to the flow and are therefore impinged. The estimated number of all species of fish impinged per day calculated on a seasonal basis ranged from 195 to 5,235 for the spring and the fall, respectively (Edwards et al., 1976).

Similar relative abundance by species is expected to be impinged at the Catawba station; however, the actual number of individuals is expected to be significantly lower because of the much lower volume of water withdrawn from the lake. Although siting the intake at the end of a cove is less preferable than the recessed shoreline intake at Plant Allen, the expected losses at the Catawba station are still predicted to be insignificant. Assuming a conservative 50% reduction in non-threadfin shad impingement losses at the Catawba station than was observed at Plant Allen, the annual loss of 42 channel catfish, 156 bluegills, 99 gizzard shad (one-half the Plant Allen losses in 1973-74) will not significantly affect the Lake Wylie fishery for these species. Threadfin shad losses on the order of 27,000 per year (one-half the Plant Allen losses) also are not expected to impact the lake fishery because of the high reproductive capacity of this species and the fact that many of these individuals would be lost to the fishery as a result of cold-induced mortality. The presence of Catawba station will provide a warm water refuge for this species, which will allow many to survive the winter and repopulate the lake in the spring.

It is therefore concluded that impingement as a result of the operation of Catawba station will not detrimentally affect any of the fish species inhabiting Lake Wylie.

Entrainment

Phytoplankton, zooplankton, fish eggs, and larvae are essentially free-floating organisms that are small enough to pass through the intake screens and become entrained through the station cooling systems. A 100% mortality is expected for the 25% of the organisms diverted to the cooling tower makeup stream. The remainder of the organisms will pass through various service water systems and will be subjected to physical and thermal stresses; however, some survival is expected. The percent survival is unknown for organisms entrained through these other station cooling systems; therefore, the staff conservatively estimated 100% mortality of all organisms entrained.

Phytoplankton and zooplankton mortality as a result of entrainment is not expected to be significant to lake populations since both groups of organisms exhibit high reproductive capacities and only about 7% of the flow through Lake Wylie will pass through Catawba station.

Fish eggs and larvae are seasonal and significant impacts to fish populations at other facilities as a result of entrainment have been postulated. Highest larval densities reported from the sampling station nearest the Catawba intake in the 1973-74 study (Industrial BIO-TEST Laboratories, Inc., 1974) were 38.5 larval fish/100 m^3 in early May. Approximately 96% of the larvae collected were identified as shad. The high shad levels were a result of the high reproductive capacity of the genus and their pelagic nature. The low number of non-shad larvae reported from the 1973-74 study is principally the result of the species' use of bottom nests (Lepomis sp.) overbank and week banks (Ictalurus sp. and Pomoxis sp.) for egg laying (Breder and Rosen, 1966) and the preference of shallow shoreline habitat by the larvae.

Losses of shad larvae as a result of station operation is not anticipated to have a detrimental effect on the Lake Wylie populations. The high reproductive potential of shad and the high natural larval mortality will greatly exceed any mortality as a result of station operation.

Some localized depletion on non-shad fish larvae in the vicinity of the intake cove is expected; however, its effect on lakewide populations is expected to be insignificant.

It is therefore concluded that entrainment of aquatic organisms resulting from the operation of the Catawba station will not detrimentally affect any species inhabiting Lake Wylie.

5.5.2.2 Thermal Discharge

Some loss of phytoplankton and zooplankton entrained in the discharge plume is expected, however, the high regeneration rates exhibited by these organisms will limit areas of depletion to the discharge cove. Studies (Duke Power Company, 1976) conducted at Plant Allen on upper Lake Wylie showed no evidence that the thermal discharge from the fossil plant was causing any shift in the phytoplankton diversity toward more heat-tolerant or nuisance species. Also the discharge of Plant Allen had no overall measurable influence on zooplankton populations in Lake Wylie. Scour of benthic organisms in the vicinity of the discharge plume will occur; however, the area affected will be significantly less than 1% of the total lake bottom.

No significant impact is expected to occur to fishes inhabiting Lake Wylie as a result of the thermal discharge. Fish are highly mobile organisms and are able to avoid unfavorable temperature regimes.

Even under a worst-case condition only about 36 ha (90 acres) or 1% of the lake is projected to be more than 2.8°C (5°F) above ambient temperature. During the summer some species of fish will avoid this area while during the winter some species will be attracted. Studies (Duke Power Company, 1976) conducted at Plant Allen, which has a significantly larger thermal discharge plume and is located in upper Lake Wylie, concluded that the sport fishery in Lake Wylie had not been adversely affected by operation of the plant even though summer time monthly average discharge temperature reached 38.7°C (101.6°F). No shift in fish composition from sport to either forage or rough fish was observed in gill netting studies conducted in Lake Wylie outside the Plant Allen discharge cove. Similar lack of observable impact as a result of the thermal plume to fishes inhabiting the lower portions of Lake Wylie is expected.

The potential for cold-shock fish kill during the winter is minor, and the potential for this kill having a detrimental effect on the fish community is insignificant because of small areal extent of the 2.8°C (5°F) isotherm in relation to the area of Lake Wylie and the presence of two units (which lessens the probability of a complete cessation of blowdown because simultaneous outage of two units is less likely than the outage of one unit).

The potential for gas-bubble disease killing a significant number of fish in the area of discharge is minimal because closed-cycle cooling is used. This closed-cycle system is not likely to result in supersaturation of the blowdown. Furthermore, the small size and rapid mixing of the discharge plume minimizes the number of fish that can be exposed to the station discharge and the supersaturated water should it occur.

Because of the small size and rapid mixing of the expected plume in relation to Lake Wylie, the staff concluded that the fishery will not experience any of the following at significant or detectable levels: increased incidence of disease organisms, asynchrony of fish spawning, loss of eggs and larvae as a result of plume entrainment, reduction in forage, or the alteration of migratory or interspecific relationships.

It is, therefore, concluded that the thermal plume from the operation of the Catawba Nuclear Station will not detrimentally affect any species inhabiting Lake Wylie.

5.6 Endangered and Threatened Species

No federally protected endangered or threatened species are known from the Catawba site or vicinity.

For the two species of birds known from the site that are protected by the State of South Carolina, no causal link that could result in a detrimental impact between the operation of the station and either species can be identified. The Carolina darter, *Etheostoma collis collis*, although known from the drainage, has not been taken from Lake Wylie and, therefore, is not known from the site. It is concluded therefore that no impact to species protected by the State will occur.

5.7 Historic and Archeologic Site Impacts

The staff believes that operation of Catawba station will not significantly affect any sites listed or eligible for listing in the *National Register of Historic Places* (U.S. Department of the Interior, 1976, and subsequent listings). An archeologic site located in the Catawba-Newport (East) 230-kV line was originally recommended as being potentially eligible for inclusion in the *National Register of Historic Places*. However, since the site is located in cleared agricultural land, it will not be affected by normal transmission line maintenance and operation such as bush-hogging, tree trimming, etc. A letter from the State archeologist granted archeological clearance for the line (Appendix H).

The Catawba-Ripp 230-kV line near the Kings Mountain National Military Park will have no significant impact on the park. The line is not visible from the roads, trails, monuments, and visitors' center in the park.

A letter from the State historic preservation officer (Appendix H) indicates that no adverse effects on cultural resources will result from the operation of Catawba Station.

5.8 Socioeconomic Impacts

The socioeconomic impacts of plant operation are described in Section 5.6 of the FES-CP. Changes that have occurred in these topic areas since then include a revised estimate of the number of operating personnel to 846. Their annual payroll is estimated to be $14.5 million (1984 dollars). The applicant also estimates that about 200 contractual workers having an annual payroll of $2.6 million (1984 dollars) will be employed at the site during station operation (ER-OL, RQ 310.8). The staff does not expect these personnel or their families to present any significant impacts on the traffic use patterns or on the demand for private and public facilities and services in the area.

It is also estimated that the station will annually spend approximately $1.5 million (1981 dollars) on purchases of goods and services from the York and Mecklenburg counties area (ER-OL, RQ 310.7). Property taxes other than school taxes are not levied against new industry in South Carolina for a period of time dependent upon the size of the investment. For Catawba, this period is 5 years.

Therefore, for the first 5 years of operation, the taxes payable to the school district would be about $20.1 million (1981 dollars) annually. After that, the amount would be $29.2 million (1981 dollars) annually. Both of these amounts represent calculations given in 1981 tax rates. However, since the millage rates are determined so that the local jurisdictions' budgets are to be covered, both the estimated taxes and rates may vary.

The staff anticipates no other significant socioeconomic impact resulting from the station's operation.

5.9 Radiological Impacts

5.9.1 Regulatory Requirements

Nuclear power reactors in the United States must comply with certain regulatory requirements in order to operate. The permissible levels of radiation in unrestricted areas and of radioactivity in effluents to unrestricted areas are contained in 10 CFR 20. These regulations specify limits on levels of radiation and limits on concentrations of radionuclides in the facility's effluent releases to the air and water (above natural background) under which the reactor must operate. These regulations state that no member of the general public in unrestricted areas shall receive a radiation dose, as a result of facility operation, of more than 0.5 rem in 1 calendar year, or if an individual were continuously present in an area, 2 mrems in any 1 hour or 100 mrems in any 7 consecutive days to the total body. These radiation-dose limits are established to be consistent with considerations of the health and safety of the public.

In addition to the radiation protection standards of 10 CFR 20, there are the license requirements of 10 CFR 50.36a that are to be imposed on licensees in the form of technical specifications on effluents from nuclear power reactors to keep releases of radioactive materials to unrestricted areas during normal operations, including expected operational occurrences, as low as is reasonably achievable (ALARA). Appendix I of 10 CFR 50 provides numerical guidance on dose-design objectives for light-water reactors (LWRs) to meet this ALARA requirement. Applicants for permits to construct and for licenses to operate an LWR shall provide reasonable assurance that the following calculated dose-design objectives will be met for all unrestricted areas: 3 mrems/yr to the total body or 10 mrems/yr to any organ from all pathways of exposure from liquid effluents; 10 mrads/yr gamma radiation or 20 mrads/yr beta radiation air dose from gaseous effluents near ground level--and/or 5 mrems/yr to the total body or 15 mrems/yr to the skin from gaseous effluents; and 15 mrems/yr to any organ from all pathways of exposure from airborne effluents that include the radioiodines, carbon-14, tritium, and the particulates. (See Table D.8 of Appendix D for the RM-50-2 annual dose design objectives for a site with more than one reactor unit, such as Catawba.)

Experience with the design, construction, and operation of nuclear power reactors indicates that compliance with these design objectives will keep average annual releases of radioactive material in effluents at small percentages of the limits specified in 10 CFR 20 and, in fact, will result in doses generally below the dose-design objective values of Appendix I. At the same time, the licensee is permitted the flexibility of operation, compatible with considerations of health and safety, to ensure that the public is provided a dependable source of power, even under unusual operating conditions that may temporarily result in releases higher than such small percentages, but still well within the limits specified in 10 CFR 20.

In addition to the impact created by the station's radioactive effluents as discussed above, within the NRC policy and procedures for environmental protection described in 10 CFR 51.20 there are generic treatments of environmental effects of all aspects of the uranium fuel cycle. These environmental data have been summarized in Table S-3 (see Table 5.4) and are discussed later in this report in Section 5.10. In the same manner the environmental impact of transportation of fuel and waste to and from an LWR is summarized in Table S-4 (see Table 5.5) and presented in Section 5.9.3 of this report.

Recently an additional operational requirement for uranium-fuel-cycle facilities, including nuclear power plants, was established by the Environmental Protection Agency in 40 CFR 190. This regulation limits annual doses (excluding radon and daughters) for members of the public to 25 mrems total body, 75 mrems thyroid, and 25 mrems other organs from all fuel-cycle facility contributions that may impact a specific individual in the public.

5.9.2 Operational Overview

During normal operations of Catawba, small quantities of radioactivity (fission and activation products) will be released to the environment. As required by NEPA, the staff has determined the estimated dose to members of the public outside the plant boundaries resulting from the radiation from these radioisotope releases and relative to natural-background-radiation dose levels.

These facility-generated environmental dose levels are estimated to be very small because of both the station design and the development of a program that will be implemented at Catawba to contain and control all radioactive emissions and effluents. As mentioned in Section 4.2.5, radioactive-waste management systems are incorporated into the plant design. These systems are designed to remove most of the fission-product radioactivity that is assumed to leak, in small amounts, from the fuel, as well as most of the activation-product radioactivity produced by neutrons in the reactor-core vicinity. The effectiveness of these systems will be measured indirectly by process and effluent radiological monitoring systems that record the amounts of radioactive constituents remaining in the various airborne and waterborne process and effluent streams. The amounts of radioactivity released through vents and discharge points to be further dispersed and diluted to points outside the plant boundaries are to be recorded and published semiannually in the Radioactive-Effluent-Release Reports for the station.

The small amounts of radioactive materials that are released in treated airborne effluents will diffuse in the atmosphere in a fashion determined by the meteorological conditions existing at the time of release and are generally much dispersed and diluted by the time they reach unrestricted areas that are open to the public. Similarly, the small amounts of radioactive materials that are released in treated waterborne effluents released will be diluted with plant waste water and then further diluted as they mix with Lake Wylie beyond the plant boundary (see Table D.5).

Radioisotopes in the station's effluents that enter unrestricted areas will produce doses through their radiations to members of the general public in a manner similar to the way doses are produced from background radiations (that is, cosmic, terrestrial, and internal radiations), which also include radiation from nuclear-weapons fallout. These radiation doses can be calculated for the many potential radiological exposure pathways specific to the environment around the facility, such as direct-radiation doses from the gaseous plume or liquid effluent stream outside the plant boundaries, or internal-radiation-dose commitments from radioactive contaminants that might have been deposited on vegetation, or in meat and fish products eaten by people, or that might be present in drinking water outside the plant or incorporated into milk from cows at nearby farms.

These doses, calculated for the "maximally exposed" individual (that is, the hypothetical individual potentially subject to maximum exposure), form the basis of the NRC staff's evaluation of impacts. Actually, these estimates are for a fictitious person because assumptions are made that tend to overestimate the dose that would accrue to members of the public outside the plant boundaries. For example, if this "maximally exposed" individual were to receive the total body dose calculated at the plant boundary as a result of external exposure to the gaseous plume, he/she is assumed to be physically exposed to gamma radiation at that boundary for 70% of the year, an unlikely occurrence.

Site-specific values for various parameters involved in each dose pathway are used in the calculations. These include calculated or observed values for the amounts of radioisotopes released in the gaseous and liquid effluents, meteorological information (for example, wind speed and direction) specific to the site topography and effluent release points, and hydrological information pertaining to dilution of the liquid effluents as they are discharged.

An annual land census will identify changes in the use of unrestricted areas to permit modifications in the programs for evaluating doses to individuals from principal pathways of exposure. This census specification will be incorporated into the Radiological Technical Specifications and satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR 50. As use of the land surrounding the site boundary changes, revised calculations will be made to ensure that the dose estimate for gaseous effluents always represents the highest dose that might possibly occur for any individual member of the public for each applicable foodchain pathway. The estimate considers, for example, where people live, where vegetable gardens are located, and where cows are pastured.

An extensive radiological environmental monitoring program, designed specifically for the environs of Catawba, provides measurements of radiation and radioactive contamination levels that exist outside the facility boundaries both before and after operations begin. In this program, offsite radiation levels are continuously monitored with thermoluminescent detectors (TLDs). In addition, measurements are made on a number of types of samples from the surrounding area to determine the possible presence of radioactive contaminants which, for example, might be deposited on vegetation, be present in drinking water outside the plant, or be incorporated into cow's milk from nearby farms. The results for all radiological environmental samples measured during a calendar year of operation are recorded and published in the Annual Radiological Environmental Operating Report for the facility. The specifics of the final operational-monitoring program and the requirement for annual publication of the monitoring results will be incorporated into the operating license Technical Specifications for Catawba station.

5.9.3 Radiological Impacts From Routine Operations

5.9.3.1 Radiation Exposure Pathways: Dose Commitments

The potential environmental pathways through which persons may be exposed to radiation originating in a nuclear power reactor are shown schematically in Figure 5.1. When an individual is exposed through one of these pathways, the dose is determined in part by the amount of time he/she is in the vicinity of the source, or the amount of time the radioactivity inhaled or ingested is retained in his/her body. The actual effect of the radiation or radioactivity is determined by calculating the dose commitment. The annual dose commitment is calculated to be the total dose that would be received over a 50-year period, following the intake of radioactivity for 1 year under the conditions existing at about the midpoint after the station begins operation. (Calculation for the midpoint of station operation represents an average exposure over the life of the plant.) However, with few exceptions, most of the internal dose commitment for each nuclide is given during the first few years after exposure because of the turnover of the nuclide by physiological processes and radioactive decay.

There are a number of possible exposure pathways to humans that are appropriate to be studied to determine the impact of routine releases from the Catawba site on members of the general public living and working outside the site boundaries, and whether the releases projected at this point in the licensing process will in fact meet regulatory requirements. A detailed listing of these exposure pathways would include external radiation exposure from the gaseous effluents, inhalation of iodines and particulate contaminants in the air, drinking milk from a cow or eating meat from an animal that feeds on open pasture near the site on which iodines or particulates may have deposited, eating vegetables from a garden near the site that may be contaminated by similar deposits, and drinking water or eating fish caught near the point of discharge of liquid effluents.

Other less important pathways include: external irradiation from radionuclides deposited on the ground surface, eating animals and food crops raised near the site using irrigation water that may contain liquid effluents, shoreline, boating and swimming activities near lakes or streams that may be contaminated by effluents, drinking potentially contaminated water, and direct radiation from within the plant itself.

Calculations of the effects for most pathways are limited to a radius of 80 km (50 mi). This limitation is based on several facts. Experience, as demonstrated by calculations, has shown that all individual dose commitments (>0.1 mrem/yr) for radioactive effluents are accounted for within a radius of 80 km from the plant. Beyond 80 km the doses to individuals are smaller than 0.1 mrem/yr, which is far below natural-background doses, and the doses are subject to substantial uncertainty because of limitations of predictive mathematical models.

The NRC staff has made a detailed study of all of the above important pathways and has evaluated the radiation-dose commitments both to the plant workers and the general public for these pathways resulting from routine operation of the facility. A discussion of these evaluations follows.

5.9.3.1.1 Occupational Radiation Exposure for Pressurized Water Reactors (PWRs)

Most of the dose to nuclear plant workers results from external exposure to radiation coming from radioactive materials outside the body rather than from internal exposure from inhaled or ingested radioactive materials. Experience shows that the annual collective dose to nuclear plant workers varies from reactor to reactor and from year to year. For environmental-impact purposes, the average annual collective dose to nuclear plant workers can be projected by using the experience to date with modern PWRs. Recently licensed 1,000-MWe PWRs are operated in accordance with the post-1975 regulatory requirements and guidance that place increased emphasis on maintaining occupational exposure at nuclear power plants ALARA. These requirements and guidance are outlined primarily in 10 CFR 20; Standard Review Plan, Chapter 12 (NUREG-0800); and Regulatory Guide 8.8, "Information Relevant to Ensuring That Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable."

The applicant's proposed implementation of these requirements and guidelines is reviewed by the NRC staff during the licensing process, and the results of that review are reported in the staff's Safety Evaluation Reports. The license is granted only after the review indicates that an ALARA program can be implemented. In addition, regular reviews of operating plants are performed to determine whether the ALARA requirements are being met.

Average collective occupational dose information for 239 PWR reactor years of operation is available for those plants operating between 1974 and 1980. (The year 1974 was chosen as a starting date because the dose data for years before 1974 are primarily from reactors with average rated capacities below 500 MWe.) These data indicate that the average reactor annual collective dose at PWRs has been about 440 person-rems, with some plants experiencing an average plant lifetime annual collective dose to date as high as 1300 person-rems (NUREG-0713, Vol. 2). These dose averages are based on widely varying yearly doses at PWRs. For example, for the period mentioned above, annual collective doses for PWRs have ranged from 18 to 5262 person-rems per reactor. However, the average annual dose per nuclear plant worker of about 0.8 rem (NUREG-0713, Vol 2) has not varied significantly during this period. The worker dose limit, established by 10 CFR 20, is 3 rems/quarter (if the average dose over the worker lifetime is being controlled to 5 rems/year) or 1.25 rems/quarter if it is not.

The wide range of annual collective doses experienced at PWRs in the United States results from a number of factors such as the amount of required maintenance and the amount of reactor operations and inplant surveillance. Because these factors can vary widely and unpredictably, it is impossible to determine in advance a specific year-to-year annual occupational radiation dose for a particular plant over its operating lifetime. There may on occasion be a need for relatively high collective occupational doses, even at plants with radiation protection programs designed to ensure that occupational radiation doses will be kept ALARA.

In recognition of the factors mentioned above, staff occupational dose estimates for environmental impact purposes for Catawba are based on the assumption that the facility will experience the annual average occupational dose for PWRs to date. Thus the staff has projected that the average annual collective occupational doses for each unit at Catawba will be 480 person-rems, but doses could average as much as 3 to 4 times this value over the life of the plant.

In addition to the occupational radiation exposures discussed above, during the period between the initial power operation of Unit 1 and the similar startup of Unit 2, construction personnel working on Unit 2 will potentially be exposed to sources of radiation from the operation of Unit 1. The applicant has estimated that the integrated dose to construction personnel, over a period of 2 years, will be about 7.2 person-rems. This radiation exposure will result predominantly from Unit 1 radioactive components and gaseous effluents from Unit 1. Based on experience with other PWRs, the staff finds that the applicant's estimate is reasonable. A detailed breakdown of the integrated dose to the construction workers by the location of their work and its duration is given in Section 12.4 of the FSAR.

The average annual dose of about 0.8 rem per nuclear-plant worker at operating BWRs and PWRs has been well within the limits of 10 CFR 20. However, for impact evaluation, the NRC staff has estimated the risk to nuclear power plant workers and compared it in Table 5.6 to published risks for other occupations. Based on these comparisons, the staff concludes that the risk to nuclear plant workers from plant operation is comparable to the risks associated with other occupations.

In estimating the health effects resulting from both offsite (see Section 5.9.3.2) and occupational radiation exposures as a result of normal operation of this facility, the NRC staff used somatic (cancer) and genetic risk estimators that are based on widely accepted scientific information. Specifically, the staff's estimates are based on information compiled by the National Academy of Sciences' Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR I)(1972). The estimates of the risks to workers and the general public are based on conservative assumptions (that is, the estimates are probably higher than the actual number). The following risk estimators were used to estimate health effects: 135 potential deaths from cancer per million person-rems and 258 potential cases of all forms of genetic disorders per million person-rems. The cancer-mortality risk estimates are based on the "absolute risk" model described in BEIR I. Higher estimates can be developed by use of the "relative risk" model along with the assumption that risk prevails for the duration of life. Use of the "relative risk" model would produce risk values up to about four times greater than those used in this report. The staff regards the use of the "relative risk" model values as a reasonable upper limit of the range of uncertainty. The lower limit of the range would be zero because health effects have not been detected at doses in this dose-rate range. The number of potential nonfatal cancers would be approximately 1.5 to 2 times the number of potential fatal cancers, according to the 1980 report of the National Academy of Science's Advisory Committee in the Biological Effects of Ionizing Radiation (BEIR III) (1980).

Values for genetic risk estimators range from 60 to 1500 potential cases of all forms of genetic disorders per million person-rems (BEIR I). The value of 258 potential cases of all forms of genetic disorders is equal to the sum of the geometric means of the risk of specific genetic defects and the risk of defects with complex etiology.

The preceding values for risk estimators are consistent with the recommendations of a number of recognized radiation-protection organizations, such as the International Commission on Radiological Protection (ICRP)(1977), the National Council on Radiation Protection and Measurement (NCRP)(1975), the National Academy of Sciences (BEIR III), and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)(1977).

The risk of potential fatal cancers in the exposed work-force population at the Catawba facility is estimated as follows: multiplying the annual plant-worker-population dose (about 480 person-rems/unit) by the somatic risk estimator, the staff estimates that about 0.06 cancer death may occur in the total exposed population. The value of 0.06 cancer death means that the probability of one cancer death over the lifetime of the entire work force as a result of 1 year of facility operation is about 6 chances in 100. The risk of potential genetic disorders attributable to exposure of the work force is a risk borne by the progeny of the entire population and is thus properly considered as part of the risk to the general public.

5.9.3.1.2 Public Radiation Exposure

- Transportation of Radioactive Materials

The transportation of "cold" (unirradiated) nuclear fuel to the reactor, of spent irradiated fuel from the reactor to a fuel reprocessing plant, and of solid radioactive wastes from the reactor to waste burial grounds is considered in 10 CFR 51.20. The contribution of the environmental effects of such transportation to the environmental costs of licensing the nuclear power reactor is set forth in Summary Table S-4 from 10 CFR 51.20, reproduced herein as Table 5.5. The cumulative dose to the exposed population as summarized in Table S-4 is very small when compared to the annual collective dose of about 60,000 person-rems to this same population or 26,000,000 person-rems to the U.S. population from background radiation.

The transportation of spent fuel between Oconee or McGuire and Catawba is discussed in Appendix G.

- Spent Fuel Storage and Handling

The environmental analysis in Section 5.9 and Appendix D takes into account impacts from exposures to routine releases resulting from spent fuel from Catawba and the spent fuel from Oconee and McGuire that may be stored at Catawba. The aspects of handling spent fuel from Oconee and McGuire within the fuel-handling facility at Catawba are discussed in the following paragraphs.

The total-body dose for normal handling of a spent-fuel cask from Oconee or McGuire at Catawba is estimated at 0.029 person-rem. For 300 shipments, it is 8.7 person-rems. This is a very small fraction of the total occupational dose projected for the operation of the Catawba facility, and this dose would be incurred only by workers assigned to fuel handling within the confines of the fuel-handling facility at Catawba.

The radiological impacts from postulated cask-drop accidents during handling will be small because the cask is designed to withstand a drop of 30 ft onto a flat, essentially unyielding horizontal surface, striking the surface in a position for which maximum damage is expected, with a release of not more than a very small amount of radioactivity and because the fuel will have decayed for 5 years before it is shipped. In addition, no safety-related equipment or additional sources of radioactivity are located beneath the cask transfer path within the fuel-handling facility. No site-specific evaluation was made of the probability of a cask-drop accident at Catawba. However, using data from the Reactor Safety Study, Appendix I (NUREG-75/014), scaled to the maximum number of lifts expected, would result in 10^{-4} per year. Therefore, the staff concludes that the overall consequences of such accidents is very small.

The cask is precluded from entering the spent-fuel pool, because the cask crane stops are located in a position to prevent the cask from being moved into the fuel pool area. The cask area is separated from the spent-fuel pool by a 3-ft reinforced concrete wall (FSAR Section 9.1.2.3).

For more information on the environmental impacts of spent-fuel storage and handling (from both normal operations and accidents) see NUREG-0575.

- Direct Radiation for PWRs

Radiation fields are produced around nuclear plants as a result of radioactivity within the reactor and its associated components, as well as a result of radioactive-effluent releases. Direct radiation from sources within the plant is primarily a result of nitrogen-16, a radionuclide produced in the reactor core. Because the primary coolant of a PWR is contained in a heavily shielded area, dose rates in the vicinity of PWRs are generally undetectable (less than 5 mrems/year).

Low-level radioactivity storage containers outside the plant are estimated to make a dose contribution at the site boundary of less than 1% of that resulting from the direct radiation from the plant.

• Radioactive-Effluent Releases: Air and Water

As pointed out in an earlier section, all effluents from this facility will be subject to extensive decontamination, but small controlled quantities of radioactive effluents will be released to the atmosphere and to the hydrosphere during normal operations. Estimates of site-specific radioisotope-release values have been developed on the basis of estimates regarding fuel performance and the descriptions of operational and radwaste systems in the applicant's ER and FSAR and by using the calculational models and parameters developed by the NRC staff in NUREG-0017. These have been supplemented by extensive use of the applicant's site and environmental data in the ER and in subsequent answers to NRC staff questions, and should be studied to obtain an understanding of airborne and waterborne releases from the facility.

These radioactive effluents are then diluted by the air and water into which they are released before they reach areas accessible to the general public.

Radioactive effluents can be divided into several groups. Among the airborne effluents the radioisotopes of the fission product noble gases, krypton and xenon, as well as of argon, do not deposit on the ground nor are they absorbed and accumulated within living organisms; therefore, the noble gas effluents act primarily as a source of direct external radiation emanating from the effluent plume. Dose calculations are performed for the site boundary where the highest external-radiation doses to a member of the general public as a result of gaseous effluents have been estimated to occur; these include the total body and skin doses as well as the annual beta and gamma air doses from the plume at that boundary location.

Another group of airborne radioactive effluents--the fission product radioiodines, as well as carbon-14 and tritium--are also gaseous but these tend to be deposited on the ground and/or inhaled into the body during breathing. For this class of effluents, estimates of direct external-radiation doses from deposits on the ground, and of internal radiation doses to total body, thyroid, bone, and other organs from inhalation and from vegetable, milk, and meat consumption are made. Concentrations of iodine in the thyroid and of carbon-14 in bone are of particular significance here.

A third group of airborne effluents, consisting of particulates that remain after filtration of airborne effluents in the plant prior to release, includes fission products such as cesium and barium and activated corrosion products such as cobalt and chromium. The calculational model determines the direct external radiation dose and the internal radiation doses for these contaminants through the same pathways as described above for the radioiodines, carbon-14, and tritium. Doses from the particulates are combined with those of the radioiodines, carbon-14, and tritium for comparison to one of the design objectives of Appendix I to 10 CFR 50.

The waterborne-radioactive-effluent constituents could include fission products such as nuclides of strontium and iodine; activation products, such as nuclides of sodium and manganese; and tritium as tritiated water. Calculations estimate the internal doses (if any) from fish consumption, from water ingestion (as drinking water), and from eating of meat or vegetables raised near the site on irrigation water, as well as any direct external radiation from recreational use of the water near the point of discharge.

The release values for each group of effluents, along with site-specific meteorological and hydrological data, serve as input to computerized radiation-dose models that estimate the maximum radiation dose that would be received outside the facility via a number of pathways for individual members of the public, and for the general public as a whole. These models and the radiation dose calculations are discussed in the October 1977 Revision 1 of Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I," and in Appendix B of this statement.

Examples of site-specific dose assessment calculations and discussions of parameters involved are given in Appendix D. Doses from all airborne effluents except the noble gases are calculated for individuals at the location (for example, the site boundary, garden, residence, milk cow, meat animal) where the highest radiation dose to a member of the public has been established from all applicable pathways (such as ground deposition, inhalation, vegetable consumption, cow milk consumption, or meat consumption). Only those pathways associated with airborne effluents that are known to exist at a single location are combined to calculate the total maximum exposure to an exposed individual. Pathway doses associated with liquid effluents are combined without regard to any single location, but they are assumed to be associated with maximum exposure of an individual through other than gaseous-effluent pathways.

5.9.3.2 Radiological Impact on Humans

Although the doses calculated in Appendix D are based primarily on radioactive-waste treatment system capability and are well below the Appendix I design objective values, the actual radiological impact associated with the operation of the facility will depend, in part, on the manner in which the radioactive-waste treatment system is operated. Based on its evaluation of the potential performance of the liquid and gaseous radwaste treatment systems, the NRC staff has concluded that the systems as now designed and built are capable of controlling effluent releases to meet the dose-design objectives of Appendix I to 10 CFR 50.

Operation of Catawba station will be governed by operating license Technical Specifications that will be based on the dose-design objectives of Appendix I to 10 CFR 50. Because these design-objective values were chosen to permit flexibility of operation while still ensuring that plant operations are ALARA, the actual radiological impact of plant operation may result in doses close to the dose-design objectives. Even if this situation exists, the individual doses for the member of the public subject to maximum exposure will still be very small when compared to natural background doses (~100 mrems/year) or the dose limits (500 mrems/year - total body) specified in 10 CFR 20 as consistent with considerations of the health and safety of the public. As a result, the staff concludes that there will be no measurable radiological impact on any member of the public from routine operation of Catawba station.

Operating standards of 40 CFR 190, the Environmental Protection Agency's Environmental Radiation Protection Standards for Nuclear Power Operations, specify that the annual dose equivalent must not exceed 25 mrems to the whole body, 75 mrems to the thyroid, and 25 mrems to any other organ of any member of the public as the result of exposures to planned discharges of radioactive materials (radon and its daughters excepted) to the general environment from all uranium-fuel-cycle operations and radiation from these operations that can be expected to affect a given individual. The NRC staff concludes that under normal operations Catawba station is capable of operating within these standards.

The radiological doses and dose commitments resulting from a nuclear power plant are well known and documented. Accurate measurements of radiation and radioactive contaminants can be made with very high sensitivity so that much smaller amounts of radioisotopes can be recorded than can be associated with any possible observable ill effects. Furthermore, the effects of radiation on living systems have for decades been subject to intensive investigation and consideration by individual scientists as well as by select committees that have occasionally been constituted to objectively and independently assess radiation dose effects. Although, as in the case of chemical contaminants, there is debate about the exact extent of the effects of very low levels of radiation that result from nuclear power plant effluents, upper bound limits of deleterious effects are well established and amenable to standard methods of risk analysis. Thus, the risks to the maximally exposed member of the public outside of the site boundaries or to the total population outside of the boundaries can be readily calculated and recorded. These risk estimates for Catawba station are presented below.

The risk to the maximally exposed individual is estimated by multiplying the risk estimators presented in Section 5.9.3.1.1 by the annual dose-design objectives for total-body radiation in 10 CFR 50, Appendix I. This calculation results in a risk of potential premature death from cancer to that individual from exposure to radioactive effluents (gaseous or liquid) from 1 year of reactor operations of less than one chance in one million.* The risk of potential premature death from cancer to the average individual within 80 km (50 mi) of the reactors from exposure to radioactive effluents from the reactors is much less than the risk to the maximally exposed individual. These risks are very small in comparison to natural cancer incidence from causes unrelated to the operation of Catawba station.

Multiplying the annual U.S. general public population dose from exposure to radioactive effluents and transportation of fuel and waste from the operation of this facility (that is, 82 person-rems) by the preceding somatic risk estimator, the staff estimates that about 0.01 cancer death may occur in the exposed population. For purposes of evaluating the potential genetic risks, the progeny of workers are considered members of the general public. Multiplying the sum of the U.S. population dose to the general public from exposure to radioactivity attributable to the normal annual operation of the plant (i.e., 82 person-rems), and the estimated dose from occupational exposure (i.e., 960 person-rems) by the preceding genetic risk estimators, the staff estimates that about 0.27 potential genetic disorder may occur in all future generations of the exposed population. The significance of these risk estimates can be determined by comparing them to the natural incidence of cancer death and genetic abnormalities in the U.S. population and in the first five generations of the U.S. population, respectively. Multiplying the estimated U.S. population for the year 2000 ($\sim$260 million persons) by the current incidence of actual cancer fatalities ($\sim$20%) and the current incidence of actual genetic diseases in each

*The risk of potential premature death from cancer to the maximally exposed individual from exposure to radioiodines and particulates would be in the same range as the risk from exposure to the other types of effluents.

generation (~11%), about 52 million cancer deaths and about 140 million genetic abnormalities are expected in the year 2000 population and in the first five generations of the year 2000 population, respectively (BEIR III; American Cancer Society, 1978). The risks to the general public from exposure to radioactive effluents and transportation of fuel and wastes from the annual operation of Catawba station are very small fractions of the estimated normal incidence of cancer fatalities and genetic abnormalities in the year 2000 population and in the first five generations of the year 2000 population, respectively.

On the basis of the preceding comparison, the staff concludes that the risk to the public health and safety from exposure to radioactive effluents and the transportation of fuel and wastes from normal operation of Catawba station will be very small.

5.9.3.3 Radiological Impacts on Biota Other Than Humans

Depending on the pathway and the radiation source, terrestrial and aquatic biota will receive doses that are approximately the same or somewhat higher than humans receive. Although guidelines have not been established for acceptable limits for radiation exposure to species other than humans, it is generally agreed that the limits established for humans are sufficiently protective for other species.

Although the existence of extremely radiosensitive biota is possible and increased radiosensitivity in organisms may result from environmental interactions with other stresses (for example, heat or biocides), no biota have yet been discovered that show a sensitivity (in terms of increased morbidity or mortality) to radiation exposures as low as those expected in the area surrounding the station. Furthermore, at all nuclear plants for which radiation exposure to biota other than humans has been analyzed (Blaylock, 1976), there have been no cases of exposure that can be considered significant in terms of harm to the species, or that approach the limits for exposure to members of the public that are permitted by 10 CFR 20. Inasmuch as the 1972 BEIR Report (BEIR I) concluded that evidence to date indicated no other living organisms are very much more radiosensitive than humans, no measurable radiological impact on populations of biota is expected as a result of the routine operation of this facility.

5.9.3.4 Radiological Monitoring

Radiological environmental monitoring programs are established to provide data where there are measurable levels of radiation and radioactive materials in the site environs and to show that in many cases no detectable levels exist. Such monitoring programs primarily are conducted to verify the effectiveness of in-plant systems used to control the release of radioactive materials and to ensure that unanticipated buildups of radioactivity will not occur in the environment. Secondarily, the environmental monitoring programs could identify the highly unlikely existence of releases of radioactivity from unanticipated release points that are not monitored. An annual surveillance (land census) program will be established to identify changes in the use of unrestricted areas to provide a basis for modifications of the monitoring programs or of the Technical Specifications conditions that relate to the control of doses to individuals.

These programs are discussed in greater detail in NRC Regulatory Guide 4.1, Revision 1, "Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants," and the Radiological Assessment Branch Technical Position, Revision 1, November 1979, "An Acceptable Radiological Environmental Monitoring Program."*

5.9.3.4.1 Preoperational

The preoperational phase of the monitoring program should provide for the measurement of background levels of radioactivity and radiation and their variations along the anticipated important pathways in the areas surrounding the facility, the training of personnel, and the evaluation of procedures, equipment, and techniques. The applicant proposed a radiological environmental monitoring program to meet these objectives in the ER-CP, and it was discussed in the FES-CP. This early program has been updated and expanded; it is presented in Section 6.1.5 of the applicant's ER-OL and is summarized here in Table 5.7.

The applicant states that the preoperational program has been implemented at least 2 years before initial criticality of Unit 1 to document background levels of direct radiation and concentrations of radionuclides that exist in the environment. The preoperational program will continue up to initial criticality of Unit 1 at which time the operational radiological monitoring program will commence.

The staff has reviewed the preoperational environmental monitoring plan of the applicant and finds that it is acceptable as presented. However, the current NRC staff position is that a total of about 40 dosimetry stations (or continuously recording dose-rate instruments) should be placed as follows: an inner ring of stations in the general area of the site boundary and an outer ring in the 6-to-8-km (4-to-5-mi) range from the site with a station in each sector of each ring (16 sectors x 2 rings = 32 stations). The remaining eight stations should be placed in special interest areas such as population centers, nearby residences and schools, and in two or three areas to serve as control stations.

The use of real-time monitor has been evaluated in an NRC contractor's report (NUREG/CR-2644). On the basis of the results of this study, the staff has concluded that it is unlikely that a fixed-station monitoring system could provide sufficiently reliable technical information to be used in a decision-making process in the event of an emergency situation. Other sources of information--such as, instrumentation that monitors certain plant parameters, radiological effluent monitors, and special health physics surveys--will provide reliable technical information in a timely manner for emergency response.

5.9.3.4.2 Operational

The operational, offsite radiological-monitoring program is conducted to provide data on measurable levels of radiation and radioactive materials in the site environs in accordance with 10 CFR 20 and 50. It assists and provides backup support to the effluent-monitoring program recommended in NRC Regulatory Guide 1.21, "Measuring, Evaluating and Reporting Radioactivity in Solid Wastes

*Available from the Radiological Assessment Branch, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555.

and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water Cooled Nuclear Power Plants."

The applicant states that the operational program will in essence be a continuation of the preoperational program described above with some periodic adjustment of sampling frequencies in expected critical exposure pathways. The proposed operational program will be reviewed before Catawba station is in operation. Modification will be based upon anomalies and/or exposure pathway variations observed during the preoperational program.

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

5.9.4 Environmental Impacts of Postulated Accidents

5.9.4.1 Plant Accidents*

The staff has considered the potential radiological impacts on the environment of possible accidents at the Catawba Nuclear Station, Units 1 and 2, in accordance with a Statement of Interim Policy published by the Nuclear Regulatory Commission on June 13, 1980 (45 FR 40101-40104). The following discussion reflects the staff's considerations and conclusions.

---

*With respect to psychological stress impacts, the U.S. Court of Appeals for the District of Columbia Circuit has held, in People Against Nuclear Energy (PANE) v. NRC No. 81-1131, that the National Environmental Policy Act (NEPA) requires the Commission to evaluate the effects on psychological health of operation of the Three Mile Island Unit 1 facility. On July 15, 1982 the Commission issued a Statement of Policy, "Consideration of Psychological Stress Issues," providing guidance on the applicability of the decision to NEPA issues in other reactor licensing proceedings. The Commission indicated that in accordance with the opinion in PANE, cognizability of psychological stress impacts under NEPA hinges on three elements:

First, the impacts must consist of "post traumatic anxieties," as distinguished from mere dissatisfaction with agency proposals or policies. Second, the impacts must be accompanied by physical effects. Third, the "post traumatic anxieties" must have been caused by "fears of a recurring catastrophe." This third element means that some kind of nuclear accident must already have occurred at the site in question, since the majority's holding was directed to "post-traumatic" anxieties and by fears of a "recurring" catastrophe. Moreover, the majority clearly had only serious accidents in mind, because of the use of the word "catastrophe" and its references to the "unique" Three Mile Island Unit 2 accident in the opinion. [Policy Statement at 3. (Underlining added.)]

Since there has been no nuclear accident at the Catawaba site, the elements necessary for consideration of psychological stress impacts in accordance with the Policy Statement are not present in connection with the Catawba reactors.

Section 5.9.4.2 deals with general characteristics of nuclear power plant accidents including a brief summary of safety measures to minimize the probability of their occurrence and to mitigate their consequences if they should occur. Also described are the important properties of radioactive materials and the pathways by which they could be transported to become enviromental hazards. Potential adverse health effects and impacts on society associated with actions to avoid such health effects also are identified.

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

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

5.9.4.2 General Characteristics of Accidents

The term "accident," as used in this section, refers to any unintentional event not addressed in Section 5.9.3 that results in a release of radioactive materials into the environment. The predominant focus, therefore, is on events that can lead to releases substantially in excess of permissible limits for normal operation. Normal release limits are specified in the Commission's regulations at 10 CFR 20, and 10 CFR 50, Appendix I.

There are several features that combine to reduce the risk associated with accidents at nuclear power plants. Safety features in the design, construction, and operation comprising the first line of defense are to a very large extent devoted to the prevention of the release of these radioactive materials from their normal places of confinement within the plant. There are also a number of additional lines of defense that are designed to mitigate the consequences of failures in the first line. Descriptions of these features for Catawba Units 1 and 2 may be found in the applicant's FSAR and in the staff's Safety Evaluation Report (to be issued in 1983). The most important mitigative features are described in Section 5.9.4.4(1) below.

These safety features are designed taking into consideration the specific locations of radioactive materials within the plant; their amounts; their nuclear, physical, and chemical properties; and their relative tendency to be transported into and for creating biological hazards in the environment.

(1) Fission Product Characteristics

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

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

The gaseous materials include radioactive forms of the chemically inert noble gases krypton and xenon. These have the highest potential for release into the atmosphere. If a reactor accident were to occur involving degradation of the fuel cladding, the release of substantial quantities of these radioactive gases from the fuel is a virtual certainty. Such accidents are very low frequency but credible events (see Section 5.9.4.3). It is for this reason that the safety analysis of each nuclear power plant incorporates a hypothetical design-basis accident that postulates the release of the entire contained inventory of radioactive noble gases from the fuel into the containment structure. If these gases were further released to the environment as a possible result of failure of safety features, the hazard to individuals from these noble gases would arise predominantly through the external gamma radiation from the airborne plume. The reactor containment structure is designed to minimize this type of release.

Radioactive forms of iodine are formed in substantial quantities in the fuel by the fission process and in some chemical forms may be quite volatile. For these reasons, they have traditionally been regarded as having a relatively high potential for release from the fuel. If released to the environment, the principal radiological hazard associated with the radioiodines is ingestion into the human body and subsequent concentration in the thyroid gland. Because of this, the potential for release of radioiodines to the atmosphere is reduced by the use of special systems designed to retain the iodine.

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

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

All of these radioactive materials exhibit the property of radioactive decay with characteristic half-lives ranging from fractions of a second to many days or years (see Table 5.8). Many of them decay through a sequence or chain of decay processes and all eventually become stable (nonradioactive) materials. The radiation emitted during these decay processes is the reason that they are hazardous materials.

(2) Exposure Pathways

The radiation exposure (hazard) to individuals is determined by their proximity to the radioactive materials, the duration of exposure, and factors that act to shield the individual from the radiation. Pathways from the transport of radiation and radioactive materials that lead to radiation exposure hazards to humans are generally the same for accidental as for "normal" releases. These are depicted in Figure 5.1. There are two additional possible pathways that could be significant for accident releases that are not shown in Figure 5.1. One of these is the fallout onto open bodies of water of radioactivity initially carried in the air. The second would be unique to an accident that results in temperatures inside the reactor core sufficiently high to cause melting and subsequent penetration of the basemat underlying the reactor by the molten core debris. This creates the potential for the release of radioactive material into the hydrosphere through contact with groundwater. These pathways may lead to external exposure to radiation, and to internal exposures if radioactive material is inhaled or ingested from contaminated food or water.

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

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

(3) Health Effects

The cause-and-effect relationships between radiation exposure and adverse health effects are quite complex (National Research Council, 1979; Land, 1980) but they have been more exhaustively studied than any other environmental contaminant.

Whole-body radiation exposure resulting in a dose greater than about 10 rems for a few persons and about 25 rems for nearly all people over a short period of time (hours) is necessary before any physiological effects to an individual are clinically detectable. Doses about 10 to 20 times larger than the latter dose, also received over a relatively short period of time (hours to a few days), can be expected to cause some fatal injuries. At the severe, but extremely low probability end of the accident spectrum, exposures of these magnitudes are theoretically possible for persons in the close proximity of such accidents if measures are not or cannot be taken to provide protection, such as by sheltering or evacuation.

Lower levels of exposures also may constitute a health risk, but the ability to define a direct cause-and-effect relationship between any given health effect and a known exposure to radiation is difficult given the backdrop of the many other possible reasons why a particular effect is observed in a specific individual. For this reason, it is necessary to assess such effects on a statistical basis. Such effects include randomly occurring cancer in the exposed population and genetic changes in future generations after exposure of a prospective parent. Occurrences of cancer in the exposed population may begin to develop only after a lapse of 2 to 15 years (latent period) from the time of exposure and then continue over a period of about 30 years (plateau period). However, in the case of exposure of fetuses (in utero), occurrences of cancer may begin to develop at birth (no latent period) and end at age 10 (that is, the plateau period is 10 years). The health consequences model currently being used is based on the 1972 BEIR I Report of the National Academy of Sciences (NAS). The occurrence of cancer itself is not necessarily indicative of fatality.

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

(4) Health Effects Avoidance

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

5.9.4.3 Accident Experience and Observed Impacts

The evidence of accident frequency and impacts in the past is a useful indicator of future probabilities and impacts. As of mid-1981, there were 71 commercial nuclear power reactor units licensed for operation in the United States at 50 sites with power-generating capacities ranging from 50 to 1130 MWe. (The Catawaba Units 1 and 2 are designed for 1145 MWe per unit.) The combined experience with these units represents approximately 500 reactor years of operation over an elapsed time of about 20 years. Accidents have occurred at several of these facilities (Oak Ridge National Laboratory, 1980; NUREG-0651). Some of these have resulted in releases of radioactive material to the environment, ranging from very small fractions of a curie to a few million curies. None is known to have caused any radiation injury or fatality to any member of the public, nor any significant individual or collective public radiation exposure, nor any significant contamination of the environment. This experience base is not large enough to permit a reliable quantitative statistical inference. It does, however, suggest that significant environmental impacts caused by accidents are very unlikely to occur over time periods of a few decades.

Melting or severe degradation of reactor fuel has occurred in only one of these units, during the accident at Three Mile Island Unit 2 (TMI-2) on March 28, 1979. In addition to the release of a few million curies of xenon-133, it has been estimated that approximately 15 curies of radioiodine also were released to the environment at TMI-2 (U.S. Nuclear Regulatory Commission, Special Inquiry Group, 1980). This amount represents an extremely minute fraction of the total radioiodine inventory present in the reactor at the time of the accident. No other radioactive fission products were released in measurable quantity.

It has been estimated that the maximum cumulative offsite radiation dose to an individual was less than 100 mrems (U.S. Nuclear Regulatory Commission, Special Inquiry Group, 1980; President's Commission on the Accident at Three Mile Island, 1979). The total population exposure has been estimated to be in the range from about 1000 to 3000 person-rems. This exposure could produce between none and one additional fatal cancer over the lifetime of the population. The same population receives each year from natural background radiation about 240,000 person-rems and approximately a half-million cancers are expected to develop in this group over its lifetime (U.S. Nuclear Regulatory Commission, Special Inquiry Group, 1980; President's Commission on the Accident at Three Mile Island, 1979), primarily from causes other than radiation. Trace quantities (barely above the limit of detectability) of radioiodine were found in a few samples of milk produced in the area. No other food or water supplies were impacted.

Accidents at nuclear power plants also have caused occupational injuries and a few fatalities but none attributed to radiation exposure. Individual worker exposures have ranged up to about 4 rems as a direct consequence of reactor accidents (although there have been higher exposures to individual workers as a result of other unusual occurrences). However, the collective worker exposure levels (person-rem) are a small fraction of the exposures experienced during normal routine operations that average about 440 to 1300 person-rems in a PWR and 740 to 1650 person-rems in a BWR per reactor-year.

Accidents also have occurred at other nuclear reactor facilities in the United States and in other countries (Oak Ridge National Laboratory, 1980; NUREG-0651). Because of inherent differences in design, construction, operation, and purpose of most of these other facilities, their accident record has only indirect relevance to current nuclear power plants. Melting of reactor fuel occurred in at least seven of these accidents, including the one in 1966 at the Enrico Fermi Atomic Power Plant, Unit 1. Fermi Unit 1 was a sodium-cooled fast breeder demonstration reactor designed to generate 61 MWe. The damages were repaired and the reactor reached full power in 4 years following the accident. It operated successfully and completed its mission in 1973. This accident did not release any radioactivity to the environment.

A reactor accident in 1957 at Windscale, England, released a significant quantity of radioiodine, approximately 20,000 curies, to the environment. This reactor, which was not operated to generate electricity, used air rather than water to cool the uranium fuel. During a special operation to heat the large amount of graphite in this reactor, the fuel overheated and radioiodine and noble gases were released directly to the atmosphere from a 123-m (405-ft) stack. Milk produced in a 518-km^2 (200-mi^2) area around the facility was impounded for up to 44 days. This kind of accident cannot occur in a water-cooled reactor like Catawaba, however.

5.9.4.4 Mitigation of Accident Consequences

Pursuant to the Atomic Energy Act of 1954, the Nuclear Regulatory Commission has conducted a safety evaluation of the application to operate Catawba Units 1 and 2. Although this evaluation contains more detailed information on plant design, the principal design features are presented in the following section.

(1) Design Features

The Catawba Nuclear Station contains features designed to prevent accidental release of radioactive fission products from the fuel and to lessen the consequences should such a release occur. Many of the design and operating specifications of these features are derived from the analysis of postulated events known as design-basis accidents. These accident preventive and mitigative features are collectively referred to as engineered safety features (ESFs). The possibilities or probabilities of failure of these systems are incorporated in the assessments discussed in Section 5.9.4.5(2).

The containment is of the ice-condenser type like McGuire and consists of a free-standing steel structure within a separate reinforced concrete reactor building and is designed to minimize accidental radioactivity releases to the environment. Safety injection systems are incorporated to provide cooling water to the reactor core during an accident to prevent or minimize fuel damage.

The ice condenser is designed to prevent unacceptable postaccident pressures in the containment and to provide a medium (by the ice bed containing sodium tetraborate) for the removal of iodine from the containment atmosphere. The containment spray system further minimizes fission product leakage by cooling and scrubbing the postaccident containment atmosphere.

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

The fuel-handling building for each unit also has accident-mitigating systems. The safety-grade ventilation system contains both charcoal and high-efficiency particulate filters. This ventilation system also is designed to keep the area around the spent-fuel pool below the prevailing barometric pressure during fuel-handling operations so that outleakage will not occur through building openings. If radioactivity were to be released into the building, it would be drawn through the ventilation system and any radioactive iodine and particulate fission products would be removed from the flow stream before exhausting to the outdoor atmosphere.

There are features of the plant that are necessary for its power-generation function that can also play a role in mitigating certain accident consequences. For example, the main condenser, although not classified as an ESF, can act to mitigate the consequences of accidents involving leakage from the primary to the secondary side of the steam generators (such as steam generator-tube ruptures). If normal offsite power is maintained and the turbine bypass system is operable, the ability of the plant to send contaminated steam to the condenser instead of releasing it through the safety valves or atmospheric dump valves can significantly reduce the amount of radioactivity released to the environment. In this case, the capability of the normally operating waste gas system to remove fission products would come into play.

Much more extensive discussions of the Catawba Nuclear Station safety features and characteristics may be found in the applicant's FSAR. The staff evaluation of these features is addressed in the SER. In addition, the implementation of the lessons learned from the TMI-2 accident--in the form of improvements in design and procedures and operator training--will significantly reduce the likelihood of a degraded-core accident which could result in large releases of fission products to the containment. Specifically, the applicant will be required to meet those TMI-related requirements specified in NUREG-0737. As noted in Section 5.9.4.5(7), no credit has been taken for these actions and improvements in discussing the radiological risk of accidents.

(2) Site Features

The NRC's reactor site criteria, 10 CFR 100, require that the site for every power reactor have certain characteristics that tend to reduce the risk and potential impact of accidents. The discussion that follows briefly describes the Catawba site characteristics and how they meet these requirements.

The site has an exclusion area as required by 10 CFR 100. The exclusion area, located within the 158-ha (391-acre) site owned by the Duke Power Company, is a circular area with a 762-m (2,500-ft) radius measured from a point midway on a common centerline between Units 1 and 2. There are no permanent residents within the exclusion area. The applicant owns all the land and mineral rights within the exclusion area except for a 1-acre cemetery owned by the Concord Cemetery Association in agreement with the Duke Power Company. With the ownership and the agreement providing control, the applicant has the authority, required by 10 CFR 100, to determine all activities in this area. Activities unrelated to plant operation that occur within the exclusion area include activity associated with the construction of Unit 2, visitation at the Concord Cemetery for the purpose of conducting memorial or burial services, water-related activities in and around two small Lake Wylie coves that extend into the exclusion area, and persons viewing the site and picnicking in the 2-acre visitors' overlook area. There are no railroads, highways, or waterways traversing the exclusion area, but in case of an emergency, arrangements have been made to limit access and control the activity and evacuation of anyone in the exclusion area.

Beyond and surrounding the exclusion area is a low population zone (LPZ), also required by 10 CFR 100. The LPZ for the Catawba site is a circular area with a 6,096-m (20,000-ft) radius measured from a point midway on a common centerline between Units 1 and 2. Except for Lake Wylie and its tributaries, the LPZ consists mostly of wooded areas and some farmland. Within the zone the applicant must ensure that there is a reasonable probability that appropriate protective measures could be taken on behalf of the residents and other members of the public in the event of a serious accident. The applicant has indicated that there were about 7,428 persons residing in the LPZ in 1980, and projects the population to increase to approxmately 16,755 by the year 2020. In case of a radiological emergency, the applicant has made arrangements to carry out protective actions, including evacuation of personnel in the vicinity of the Catawba Nuclear Station. (See also the following section on Emergency Preparedness.)

10 CFR 100 also requires that the distance from the reactor to the nearest boundary of a densely populated area containing more than about 25,000 residents be at least one and one-third times the distance from the reactor to the outer boundary of the LPZ. Since accidents of greater potential hazards than those commonly postulated as representing an upper limit are conceivable, although highly improbable, it was considered desirable to add the population center distance requirements in 10 CFR 100 to provide for protection against excessive exposure doses to people in large centers. The city of Rock Hill, South Carolina, located about 9 km (5.8 mi) south-southeast of the plant, with a population of 35,344 persons in 1980 is the nearest population center. The distance from the site to Rock Hill is at least one and one-third times the distance to the outer boundary of the LPZ. The nearest major city within 80 km (50 mi) is Charlotte, North Carolina, which had a population of 314,477 in 1980 and is located about 18 km (11 mi) northeast of the site. The population density within 48 km (30 mi) of the site is projected for 1982 to be 300 persons per square mile and is not expected to exceed 425 persons per square mile during the life of the plant.

The safety evaluation of the Catawba site also has included a review of potential external hazards generated by man (activities off site that might adversely affect the operation of the plant and cause an accident). This review encompassed nearby industrial, transportation, and military facilities that might create explosive, missile, toxic gas, or similar hazards. The risk to Catawba station from such hazards has been found to be negligibly small. A more detailed discussion of the compliance with the Commission's siting criteria and the consideration of external hazards are given in the staff's Safety Evaluation Report (SER). Also discussed in the staff's SER are design provisions required for severe natural phenomena such as earthquakes, floods, and tornadoes.

(3) Emergency Preparedness

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

NRC and the Federal Emergency Management Agency (FEMA) have agreed that FEMA will make a finding and determination as to the adequacy of state and local government emergency response plans. NRC will determine the adequacy of the applicant's Emergency Response Plans with respect to the standards listed in Section 50.47(b) of 10 CFR 50, the requirements of Appendix E to 10 CFR 50, and the guidance contained in NUREG-0654/FEMA-REP-1, Revision 1, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants," dated November 1980. After the above determinations by NRC and FEMA, the NRC will make a finding in the licensing process as to the overall and integrated state of preparedness. The NRC staff findings will be reported in its SER. Further, if those findings indicate that the risk to the public from severe accidents, discussed in the following sections, is significantly larger because of the details of the final plans, a supplement to the Environmental Statement will be issued. Although the presence of adequate and tested emergency plans cannot prevent an accident, it is the staff's judgment that such plans can and will substantially mitigate the consequences to the public if an accident should occur.

5.9.4.5 Accident Risk and Impact Assessment

(1) Design-Basis Accidents

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

In the safety analysis and evaluation of the Catawba Nuclear Station, three categories of accidents have been considered. These categories are based upon their probability of occurrence and include (a) incidents of moderate frequency (events that can reasonably be expected to occur during any year of operation), (b) infrequent accidents (events that might occur once during the lifetime of the plant), and (c) limiting faults (accidents not expected to occur but that have the potential for significant releases of radioactivity). The radiological consequences of incidents in the first category, also called anticipated operational occurrences, are discussed in Section 5.9.3. Some of the initiating events postulated in the second and third categories for the Catawba Nuclear Station are shown in Table 5.9. These events are designated design-basis accidents in that specific design and operating features as described above in Section 5.9.4.4(1) are provided to limit their potential radiological consequences. Approximate radiation doses to the whole body and the thyroid that might be received by a person at the boundary of the plant exclusion area during the first 2 hours of the accidents were calculated by the applicant and are also shown in the table. The results shown in the table reflect the expectation that engineered safety and operating features designed to mitigate the consequences of the postulated accidents would function as intended. An important implication of this expectation is that the releases considered are limited to noble gases and radioiodines and that any other radioactive materials (for example, in particulate form) are not expected to be released. The results also use the meteorological dispersion conditions that are an average value determined by actual site measurements. In order to contrast the results of these calculations with those using more pessimistic, or conservative, assumptions described below, the doses shown in Table 5.9 are sometimes referred to as "realistic" doses.

These calculations indicate that the risk of incurring any adverse health effects as a consequence of these events is exceedingly small. By comparison with the estimates of radiological impact for normal operations shown in Section 5.9.3, the staff also concludes that radiation exposures from design-basis accidents are roughly comparable to the exposures to individuals and the population from normal station operations over the expected lifetime of the plant.

The staff is carrying out calculations to estimate the potential upper bounds for individual exposures from the same initiating accidents in Table 5.9 for the purpose of implementing the provisions of 10 CFR 100. For these calculations, much more pessimistic (conservative or worst-case) assumptions are made as to the course taken by the accident and the prevailing conditions. These assumptions include much larger amounts of radioactive material released by the initiating events, additional single failures in equipment, operation of ESFs in a degraded mode,* and very poor meteorological dispersion conditions. A license to operate the plant will not be given unless the results of these calculations would show that for these events the exposures are not expected to exceed 25 rems to the whole body and 300 rems to the thyroid of any individual at the exclusion area boundary over a period of 2 hours. For calculation of the thyroid dose, it will be assumed that an individual is located at a point on the exclusion area boundary where the radioiodine concentration in the plume has its highest value and inhales at a breathing rate characteristic of a person jogging for a period of 2 hours. The health risk to an individual receiving 300 rems to the thyroid is the potential appearance of benign or malignant thyroid nodules in about 1 out

---

*The containment structure, however, is assumed to prevent leakage in excess of that which can be demonstrated by testing, as provided in 10 CFR 100.11(a).

of 10 cases, and the development of a fatal thyroid cancer in about 4 out of 1000 cases.

The staff also will evaluate the potential upper bounds for individual exposures at the outer edge of the low population zone in its SER. These exposures, in general, are not limiting. However, a license to operate will not be issued unless the calculated exposures are also less than 25 rems to the whole body or 300 rems to the thyroid.

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

(2) Probabilistic Assessment of Severe Accidents

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

The assessment methodology employed is that described in the Reactor Safety Study (RSS) which was published in 1975 (NUREG-75/014).* However, the sets of accident sequences that were found in the RSS to be the dominant contributors to the risk in the prototype PWR (Westinghouse-designed Surry Unit 1) have recently been updated ("rebaselined") (NUREG-0715). The rebaselining has been done largely to incorporate peer group comments (NUREG/CR-0400) and better data and analytical techniques resulting from research and development after the publication of the RSS. Entailed in the rebaselining effort was the evaluation of the individual dominant accident sequences--as they are understood to evolve. The earlier technique of grouping a number of accident sequences into the encompassing "Release Categories" as was done in the RSS has been largely (but not completely) eliminated.

The Catawba plants are Westinghouse-designed PWRs having design and operating characteristics similar to the RSS prototype PWR. Therefore, the present assessment for Catawba has used as its starting point the rebaselined accident sequences and release categories referred to above, and more fully described in Appendix E. Characteristics of the sequences and release categories used (all of which involve partial to complete melting of the reactor core) are shown in Table 5.10. Sequences initiated by natural phenomena such as tornadoes, floods, or seismic events and those that could be initiated by deliberate acts of sabotage are not included in these event sequences. The radiological consequences

*Because this report has been the subject of considerable controversy, a discussion of the uncertainties surrounding it is provided in Section 5.9.4.5(7).

of such events would not be different in kind from those which have been treated. Moreover, there are design requirements in 10 CFR 50, Appendix A, relating to effects of natural phenomena, and safeguards requirements in 10 CFR 73, ensuring that these potential accident intiators are in large measure taken into account in the design and operation of the plant. The data base for assessing the probabilities of events more severe than the design bases for natural phenomena and sabotage is small. Hence, inclusion, in an accurate manner, of accident sequences initiated by natural phenomena and sabotage events more severe than used as design bases in the staff's SER is beyond the state of the art of probabilistic risk assessment. In addition, the staff judges that the additional risk from severe accidents initiated by natural events or sabotage is within the uncertainty of risks presented for the sequences considered here.

Calculated probability per reactor-year associated with each accident sequence or release category used is shown in the second column in Table 5.10. As in the RSS there are substantial uncertainties in these probabilities. This is due, in part, to difficulties associated with the quantification of human error and to inadequacies in the data base on failure rates of individual plant components that were used to calculate the probabilities (NUREG/CR-0400). The probability of accident sequences from the Surry plant were used to give a perspective of the societal risk at Catawba because, although the probabilities of particular accident sequences may be substantially different and even improved for Catawba, the overall effect of all sequences taken together is likely to be within the uncertainties (see Section 5.7.4.5(7) for a discussion of uncertainties in risk estimates).

The magnitudes (curies) of radioactivity release for each accident sequence or release category are obtained by multiplying the release fractions shown in Table 5.10 by the amounts that would be present in the core at the time of the hypothetical accident. These are shown in Table 5.8 for a Catawba unit at a core thermal power level of 3,565 MWt, the power level used in the FSAR. The 54 nuclides shown in the table represent those (of the hundreds actually present in an operating plant) that are the major contributors to the health and economic effects of severe accidents. They were selected on the basis of the half-life of the original nuclide, consideration of the health effects of daughter products, and the approximate relative offsite dose contribution.

The potential radiological consequences of these releases have been calculated by the consequence model used in the RSS (NUREG-0340) adapted and modified as described below to apply to a specific site. The essential elements are shown in schematic form in Figure 5.2. Environmental parameters specific to the site of Catawba station have been used and include the following:

- meteorological data for the site representing a full year of consecutive hourly measurements and seasonal variations
- projected population for the year 2000 extending throughout regions of 80-km (50-mi) and 563-km (350-mi) radius from the site
- the habitable land fraction within the 563-km (350-mi) radius

- land-use statistics, on a statewide basis, including farm land values, farm product values including dairy production, and growing season information, for the State of South Carolina and each surrounding state within the 563-km (350-mi) region

For the region beyond 563 km (350 mi), the U.S. average population was assumed.

The calculation represents an extended region out to 3,200 km (2,000 mi) from the site, with rain assumed in the interval between 563 and 3,200 km to deplete the plume of all non-noble-gas inventory.

To obtain a probability distribution of consequences, the calculations are performed assuming the occurrence of each accident-release sequence at each of 91 different "start" times throughout a 1-year period. Each calculation utilizes the site-specific hourly meteorological data and seasonal information for the time period following each "start" time. The consequence model also contains provisions for incorporating the consequence reduction benefits of evacuation, relocation, and other protective actions. Early evacuation and relocation of people would considerably reduce the exposure from the radioactive cloud and the contaminated ground in the wake of the cloud passage. The evacuation model used (see Appendix F) has been revised from that used in the RSS for better site-specific application. The quantitative characteristics of the evacuation model used for the Catawba site are estimates made by the staff and are partly based upon evacuation time estimates prepared by the applicant. There normally would be special facilities near a plant, such as schools or hospitals, where special equipment or personnel may be required to effect evacuation. Several such facilities have been identified near the Catawba site, such as the Carrowinds Theme Park and York General Hospital and Ambulance Service. Further, there may be people who either do not receive notification to evacuate or who choose not to evacuate; therefore, actual evacuation effectiveness could be greater or less than that characterized but would not be expected to be very much less.

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

Early evacuation within and early relocation of people from outside the plume exposure pathway EPZ (see Appendix F) and other protective actions as mentioned above are considered as essential sequels to serious nuclear reactor accidents involving significant release of radioactivity to the atmosphere. Therefore, the results shown for Catawba include the benefits of these protective actions.

There are also uncertainties in each facet of the estimates of consequences and the error bounds may be as large as they are for the probabilities (see Figure 5.2).

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

(3) Dose and Health Impacts of Atmospheric Releases

The results of the calculations of dose and health impacts performed for the Catawba Nuclear Station and site are presented in the form of probability distributions in Figures 5.3 through 5.6 and are included in the impact summary Tables 5.11 and 5.12. All the accident sequences and release categories shown in Table 5.10 contribute to the results, the consequences from each being weighted by its associated probability. For these calculations, early evacuation of the plume exposure pathway EPZ was ensured.

Figure 5.3 shows the probability distribution for the number of persons who might receive whole-body doses equal to or greater than 25 rems, total bone marrow doses equal to or greater than 200 rems, and thyroid doses equal to or greater than 300 rems from early exposure,* all on a per-reactor-year basis. The 200-rem total bone marrow dose figure corresponds approximately to a threshold value for which hospitalization would be indicated for the treatment of radiation injury. The 25-rem whole-body (which has been identified earlier as the lower limit for a clinically observable physiological effect in nearly all people) and 300-rem thyroid dose figures correspond to the Commission's guideline values for reactor siting in 10 CFR 100.

Figure 5.3 shows in the left-hand portion that there are approximately 6 chances in 1 million (6×10^{-6}) per reactor-year that one or more persons may receive doses equal to or greater than any of the doses specified. The fact that the three curves run almost parallel in horizontal lines initially shows that if one person were to receive such doses, the chances are about the same that ten to hundreds would be so exposed. The chances of larger numbers of persons being exposed at those levels are seen to be considerably smaller. For example, the chances are about 1 in 1 million (10^{-6}) that 1,000 or more people might receive doses of 200 rems or greater. A majority of the exposures reflected in this figure would be expected to occur to persons within a 32-km (20-mi) radius of the plant. Virtually all would occur within a 160-km (100-mi) radius.

Figure 5.4 shows the probability distribution for the total population exposure in person-rems; that is, the probability per reactor-year that the total population exposure will equal or exceed the values given. Most of the population exposure up to 1 million person-rems would occur within 80 km (50 mi) but the more severe releases (as in the first two accident sequences in Table 5.10) would result in exposure to persons beyond the 80-km (50-mi) range as shown.

For perspective, population doses shown in Figure 5.4 may be compared with the annual average dose to the population within 80 km (50 mi) of the Catawba site resulting from natural background radiation of 160,000 person-rems, and to the

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

anticipated annual population dose to the general public (total U.S.) from normal plant operation of 40 person-rems (excluding plant workers) (Appendix D, Tables D.7 and D.9).

Figure 5.5 represents the statistical relationship between population exposure and the induction of fatal cancers that might appear over a period of many years following exposure. The impacts on the total population and the population within 80 km (50 mi) are shown separately. Further, the fatal, latent cancers have been subdivided into those attributable to exposures of the thyroid and all other organs.

Figure 5.6 provides probability distributions and Table 5.12 provides probabilities and consequences for early fatalities. Two cases are shown, representing two potential protective actions. The first case shows the results considering early evacuation of the entire 10-mi plume exposure pathway EPZ, the model for which is more fully discussed in Appendix F. For this case, the model predicts near-zero early fatalities within the EPZ. The early fatalities predicted by the calculation are all within 32 km (20 mi) of the site. A second possible emergency response is early relocation of people after passage of the plume. This is considered to be a possible response to significant ground contamination in the relatively restricted "footprint" from passage of the cloud. The benefits of this protective action in the distance between 10 and 25 mi from the plant, combined with the evacuation of the EPZ, are shown also in Figure 5.6 and Table 5.12. Figure F.1 in Appendix F shows the effects of a much more pessimistic emergency response, as well as a more optimistic evacuation assumption.

An additional potential pathway for doses resulting from atmospheric release is from fallout onto open bodies of water. This pathway has been investigated in the Fermi Unit 2 plant, which is located on Lake Erie, and for which appreciable fractions of radionuclides in the plume could be deposited in the Great Lakes (NUREG-0769). It was found that for the Fermi site, the individual and societal doses from this pathway could be substantially eliminated by the interdiction of the aquatic food pathway, in a manner comparable to interdiction of the terrestrial food pathway in the present analysis. Since Catawba is not on a large surface water body, the fraction of radioactive material that could fall out in nearby lakes or streams is correspondingly reduced, and this pathway is of small importance compared to the results presented here for fallout onto land.

(4) Economic and Societal Impacts

As noted in Section 5.9.4.2, the various measures for avoiding adverse health effects including those resulting from residual radioactive contamination in the environment are possible consequential impacts of severe accidents. Calculations of the probabilities and magnitudes of such impacts for Catawba station and environs also have been made. Unlike the radiation exposure and health effect impacts discussed above, impacts associated with avoiding adverse health effects are more readily transformed into economic impacts.

The results are shown as the probability distribution for cost of offsite mitigating actions in Figure 5.7 and are included in the impact summary Table 5.11. The factors contributing to these estimated costs include the following:

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

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

Figure 5.7 shows that at the extreme end of the accident spectrum these costs could exceed several billion dollars but that the probability that this would occur is exceedingly small, less than one chance in a 10 million per reactor-year.

Additional economic impacts that can be monetized include costs of decontamination of the facility itself and the costs of replacement power. Probability distributions for these impacts have not been calculated but they are included in the discussion of risk considerations in Section 5.9.4.5(6) below.

(5) Releases to Groundwater

A groundwater pathway for public radiation exposure and environmental contamination that could be unique for severe reactor accidents was identified in Section 5.9.4.2(2). Consideration has been given to the potential environmental impacts of this pathway for the Catawba Nuclear Station. The principal contributors to the risk are the core-melt accidents associated with the evaluated accident sequences and release categories. The penetration of the basemat of the containment buildings can release molten core debris to the strata beneath the station. The soluble radionuclides in the debris can be leached and transported in the groundwater to downgradient domestic wells used for drinking water or to surface water bodies used for drinking water, aquatic food, and recreation. In pressurized water reactors such as the Catawba units, there is an additional opportunity for groundwater contamination resulting from the release of sump water to the ground through a breach in the containment.

An analysis of the potential consequences of a liquid pathway release of radioactivity for generic sites was presented in the "Liquid Pathway Generic Study" (LPGS) (NUREG-0440). The LPGS compares the risk of accidents involving the liquid pathway (drinking water, irrigation, aquatic food, swimming, and shoreline usage) for four conventional, generic land-based nuclear plants and for a floating nuclear plant, wherein the nuclear reactor would be mounted on a barge and moored in a body of water. Parameters for each generic land-based site were chosen to represent averages for a wide range of real sites and were thus "typical" although they represented no real sites. The study concluded that the individual and population doses for the liquid pathway range from fractions to very small fractions of those that can arise from the airborne pathway.

The discussion in this section is a summary of an analysis performed to determine whether or not the liquid pathway consequences of a postulated accident at the Catawba site would be unique when compared with the generic "small river" land-based site considered in the LPGS. The method of comparison consists of a direct scaling up or down of the LPGS population doses based on the relative values of key parameters characterizing the LPGS small river site and the Catawba site. The parameters that were evaluated include the amounts and rate of release of radioactive materials to the ground, groundwater travel time, sorption on geological media, surface water transport, drinking water usage, aquatic food consumption, and shoreline usage.

All of the reactors considered in the LPGS were Westinghouse pressurized water reactors (PWRs) with ice condenser containments; thus, they are directly comparable with the equipment present at Catawba station. The source term used for Catawba in this comparison is assumed to be equal to that used in the LPGS.

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

The Catawba Nuclear Station is located on a peninsula on the South Carolina side of Lake Wylie, a power generation reservoir on the Catawba River. Groundwater at the site is present within limited joints and fractures in a granitic (adamellite) bedrock. At the site the groundwater table, under ambient conditions, slopes rather steeply toward Lake Wylie, both north and south of the station. A dewatering system reverses the normal direction of groundwater flow during normal station operations.

The station's dewatering system has the potential to place contaminated groundwater directly into Lake Wylie, with virtually no holdup or dilution, if the system continued to operate in its "normal" mode following a melt-through accident. To prevent this from occurring, it is necessary to shut down the dewatering system and allow groundwater levels to return to their preconstruction levels. Duke Power Company has committed to providing instruction in the plant Emergency Procedures to secure the dewatering pumps in cases of accidents where core degradation is indicated. Therefore, the pathway to Lake Wylie with no holdup or dilution is considered to be blocked. Although Catawba station uses dewatering, the units are structurally designed to handle the hydrostatic loads accompanying a return of preplant groundwater levels.

Major site buildings are founded on the adamellite bedrock material. This material demonstrates a very low hydraulic conductivity. It is conservatively assumed that in the case of a core-melt accident releasing contaminated material to this rock, groundwater transport would occur along fractures known to be present at shallow depths. Maps of these fractures in their preconstruction condition, as prepared by the applicant, show them to be virtually absent at the basemat level. Contamination would reach the waters of Lake Wylie, some 210 m (700 ft) distant, through the shallow system of fractures. The initial flow of groundwater would be toward the site as a result of the cone of depression caused by the dewatering system. Following shutdown or failure of the dewatering system under normal operating conditions, the time required for water levels to rebound to preconstruction conditions would be about 56 days. Following reestablishment of normal gradients, flow would be toward the lake. Groundwater would travel through the sparsely fractured bedrock to reach Lake Wylie. Analysis of groundwater travel time has been conservatively estimated to be in the range of 1 to 20 years following reestablishment of a "lakeward" gradient. The wide range is due to the complicated flow path fluids must follow to reach Lake Wylie.

For groundwater travel times on the order of years, the only significant contributors to population dose are Cs-137 and Sr-90. Landstrom et al. (1978) report on field experiments measuring the retardation of several nuclides in similar fractured materials. Retardation factors presented by Landstrom et al. (1978) are about 560 for Cs-137 and 6 for Sr-90. Using these values of retardation, the travel time for Cs-137 at Catawba would range from 560 to 11,200 years and for Sr-90 the travel time would be 6 to 120 years. When these times are compared to 5.7 years for Sr-90 and 51 years for Cs-137 in the LPGS case, the larger travel times at Catawba would allow a smaller portion of the radioactivity to enter the river system. Virtually all the Cs-137 will have decayed before reaching Lake Wylie. The quantity of Sr-90 that would enter the river would be reduced by a factor of from 1 to 17 over that used in the LPGS case. For conservatism, however, the Catawba dose assessment assumes that the quantity of Sr-90 entering the river will be equal to that of the LPGS case.

Radionuclides released to Lake Wylie would eventually be carried to the Atlantic Ocean through a system of rivers and lakes. The Catawba River would carry radionuclides from Lake Wylie to Lake Wateree. Radionuclides would then flow downstream from Lake Wateree into Lake Moultrie through the Wateree River and finally from Lake Moultrie to the Atlantic Ocean near Charleston, South Carolina, through the Cooper River.

There are several municipal and industrial water users that would be affected by contamination of this system of rivers and lakes. The staff estimates the affected population to be about 112,000 people. In addition, although the city of Charleston currently does not obtain its water supply from any of the rivers or lakes that would be affected by contamination of the Catawba River, it will in the future have the capability to use water from the Cooper River. Charleston is presently constructing facilities that will enable it to withdraw water from the Edisto River, which is the city's present water source, and from the Cooper River. On this basis, the staff assumed that in the future, 50% of Charleston's water will come from the Cooper River and 50% from the Edisto River. The estimated population of Charleston in the year 1990 that would be affected by this assumed water use, is about 325,000 people. Thus, the total population assumed by the staff to be affected by liquid effluent from a core-melt accident at Catawba station would be about 437,000 people.

The hypothetical LPGS river site had a water drinking population of 620,000 people distributed down the river. Hence, the uninterdicted drinking-water dose for the Catawba site was calculated to be about 70% of that for the LPGS river site by comparing the populations, groundwater travel times and dilutions for the two sites, the radioactive source terms being essentially equal.

Population dose resulting from the consumption of finfish, mollusks, and crustaceans was calculated in a similar manner to the drinking-water dose. The annual harvest that could be affected by contamination downstream of the Catawba site has been conservatively estimated to be about 3.0 x 10^6 kg. The LPGS small river site, by comparison, used an annual fish harvest of 1.2 x 10^6 kg. The uninterdicted population dose due to fish consumption from the Catawba site was calculated to be about 1.8 times that of the LPGS site when consumption of the fisheries harvest, dilution, and groundwater travel time were compared.

Lake Wylie is a popular summer residential area, and it is assumed that a large segment of the population participates in swimming, water skiing and other water contact activities. These activities would expose people to direct radiation from contaminated water and sediments. The LPGS population dose assessment, however, showed that virtually all of the shoreline, boating and swimming dose resulted from Cs-137. Because almost no Cs-137 is predicted to escape in the case of Catawba, the staff estimates that the shoreline/contact population dose will be virtually zero in comparison with the LPGS site.

In summary, the staff's analyses have shown that population doses at the Catawba site resulting from drinking water, fisheries consumption, and recreation exposure would be approximately 0.7, 1.8, and 0.0 times the exposures computed for the LPGS small river site, respectively. The total dose at the Catawba site would be about 0.24 times the LPGS total dose. Therefore, it has been demonstrated that the Catawba liquid pathway contribution to population dose would be of the same order of magnitude as that predicted for the LPGS small river site and that the Catawba site is not unique in its liquid pathway contribution to risk.

Finally, there are measures which could be taken to further minimize the impact of the liquid pathway. Landstrom et al. (1978) demonstrated experimentally that additional retention of strontium and cesium could be accomplished by pressure grouting of the fracture network with a thin slurry of bentonite. Adequate time to accomplish such a grouting in the vicinity of Catawba station is indicated by the calculated travel times to Lake Wylie.

(6) Risk Considerations

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

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

Table 5.13 shows average values of risk associated with population dose, early fatalities for various protective actions, latent fatalities, and costs for evacuation and other protective actions. These average values are obtained by summing the probabilities multiplied by the consequences over the entire range of the distributions. Because the probabilities are on a per-reactor-year basis, the averages shown also are on a per-reactor-year basis.

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

There are no early fatality or economic risks associated with protective actions and decontamination for normal releases; therefore, these risks are unique for accidents. For perspective and understanding of the meaning of the early fatality risk of 0.0011 per reactor-year for evacuation to 16 km (10 mi) and no relocation, however, the staff notes that to a good approximation the population at risk is that within about 32 km (20 mi) of the plant, about 620,000 persons in the year 2000. Accidental fatalities per year for a population of this size, based upon overall averages for the United States, are approximately 1316 from motor vehicle accidents, 48 from falls, 19 from drowning, 18 from burns, and 7 from firearms (National Research Council, 1979, p. 577). The early fatality risk from reactor accidents is thus an extremely small fraction of the total risk embodied in the above combined accident modes.

Figure 5.8 shows the calculated risk expressed as whole-body dose to an individual from early exposure as a function of the downwind distance from the plant within the plume exposure pathway EPZ. The values are on a per-reactor-year basis and all accident sequences and release categories in Table 5.10 contributed to the dose, weighted by their associated probabilities.

Evacuation and other protective actions can reduce the risk to an individual of early fatality or of latent cancer fatality. Figure 5.9 shows curves of constant risk per reactor-year to an individual, living within the plume exposure pathway EPZ of the Catawba site, of latent cancer fatality as functions of distance resulting from potential accidents in the reactor. For persons living within the plume exposure pathway EPZ, the calculations show that protective actions can reduce the risk of early fatality to near zero. Directional variation of these curves reflects the variation in the average fraction of the year the wind would be blowing into different directions from the station. For comparison the following risks of fatality per year to an individual living in the United States may be noted (National Research Council, 1979, p. 577: automobile accident 2.2×10^{-4}, falls 7.7×10^{-5}, drowning 3.1×10^{-5}, burning 2.9×10^{-5}, and firearms 1.2×10^{-5}.

The economic risk associated with evacuation and other protective actions could be compared with property damage costs associated with alternative energy generation technologies. The use of fossil fuels, coal or oil, for example, would emit substantial quantities of sulfur dioxide and nitrogen oxides into the atmosphere, and, among other things, lead to environmental and ecological damage through the phenomenon of acid rain (National Research Council, 1979, pp. 559-560). This effect has not, however, been sufficiently quantified to draw a useful comparison at this time.

There are other economic impacts and risks which are not included in the cost calculations discussed in Section 5.9.4.5(4) that can be monetized. These are accident impacts on the facility itself that result in added costs to the public (ratepayers, taxpayers, and/or shareholders). These costs would be for decontamination and repair or replacement of the facility and replacement power. Experience with such costs is currently being accumulated as a result of the Three Mile Island accident. If an accident occurs during the first full year of Catawba Unit 1 operation, the economic penalty associated with the initial year of the unit's operation is estimated at between $950 and $1,600 million (Comptroller General, 1981) for decontamination and restoration, including replacement of the damaged nuclear fuel. For purposes of this analysis, the staff used the conservative (high) estimate of $1,600 million and in addition assumed the total cost occurs during the first year of the accident. In reality the costs would be spread over several years thereafter. Although insurance would cover $300 million of the $1,600 million, the insurance is not credited against the $1,600 million because the $300 million times the risk probability should theoretically balance the insurance premium. In addition, the staff estimates additional fuel costs of $130 million (1984 dollars) for replacement power during each restoration year for Catawba Unit 1. This estimate assumes that the energy that would have been forthcoming from the unit (assuming 55% capacity factor) will be replaced 85% by coal-fired generation, 10% by oil-fired generation, and 5% by other nuclear generation. Assuming the nuclear unit does not operate for 8 years, the total additional replacement power costs would be approximately $1,040 million in 1984 dollars.

If the probability of sustaining a total loss of the original facility is taken as the probability of occurrence of a core-melt accident, then the probability of a disabling accident happening during each year of the unit's service life is about 10^{-4}. Multiplying the previously estimated costs of $2,640 million for an accident to Catawba Unit 1 during the initial year of its operation by the above 10^{-4} probability results in an economic risk of approximately $264,000 (in 1984 dollars) applicable to Catawba Unit 1 during its first year of operation. This also is approximately the economic risk (in 1984 dollars) to Catawba Unit 1 during the second and each subsequent year of its operation. Although nuclear units depreciate in value and may operate at reduced-capacity factors so that the economic consequences resulting from an accident become less as the units become older, this is considered to be offset by higher costs of decontamination and restoration of the units in the later years as a result of inflation.

The economic risk to Catawba Unit 2 (in 1984 dollars) also is approximately $264,000 during its first year and each subsequent year of operation because of the balancing effect of escalation and the present worth discount factor. The $264,000 annual risk for each unit in 1984 dollars is equivalent to an annual risk of $180,000 in 1980 dollars, assuming a 10% discount rate.

(7) <u>Uncertainties</u>

The foregoing probabilistic and risk assessment discussion has been based upon the methodology presented in the Reactor Safety Study (RSS) which was published in 1975 (NUREG-75/014). There are substantial uncertainties associated with the numerical estimates of the likelihood, as well as the consequences, of reactor accidents that are evaluated using this methodology.

In the consequence calculations, uncertainties arise from an oversimplified analysis of the magnitude and timing of the fission product release, from uncertainties in calculated energy release, from radionuclide transport from the core to the receptor, from lack of precise dosimetry, and from statistical variations of health effects. Recent investigations of accident source terms, for example, have shown that a number of physical phenomena affecting fission product transport through the primary cooling system and the reactor containment have been neglected. Some of these processes have the potential for substantially reducing the quantity of fission products predicted to be released from the containment for some accident sequences. Such a reduction in the source term would result in substantially lower estimates of health effects, particularly the estimate of early fatalities.

One area given considerable recent thought with respect to uncertainty is atmospheric dispersion. Although recent developments in the area of atmospheric dispersion modeling used in CRAC (the computer code developed in RSS) indicate that an improved meteorological sampling scheme would reduce the uncertainties arising from this source (including the effect of washout by precipitation), large uncertainties would still remain in the calculations of radionuclide concentrations in the air and the ground from which radiological exposures to an individual and the population are calculated. These uncertainties arise from lack of precise knowledge about the particle-size distribution of the radionuclides released in particulate forms and about their chemical behavior. Therefore, the parameters of particulate deposition which exert considerable influence on the calculated results have uncertain values. Vertical rise of the radioactive plume is dependent on the heat and momentum associated with the release categories and calculations of both factors have considerable uncertainty. The duration of the release that determines cross-wind spread of the plume is another example of considerable uncertainty. Warning time before evacuation has considerable impact on effectiveness of offsite emergency response; and this parameter is not precisely calculated because of its dependence on other parameters (for example, time of release) that are not precisely known.

The state of the art for quantitative evaluation of the uncertainties in the probabilistic risk analysis such as the type presented here is not well developed. Therefore, although the staff has made a reasonable analysis of the risks presented herein, there are large uncertainties associated with the results shown. It is the qualitative judgment of the staff that the uncertainty bounds could be well over a factor of 10, but not as large as a factor of 100.

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

5.9.4.6 Conclusions

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

The environmental impacts that have been considered include potential radiation exposures to individuals and to the population as a whole, the risk of near- and long-term adverse health effects that such exposures could entail, and the potential economic and societal consequences of accidental contamination of the environment. These impacts could be severe but the likelihood of their occurrence is judged to be small. This conclusion is based on (1) the fact that considerable experience has been gained with the operation of similar facilities without significant degradation of the environment, (2) the fact that, in order to obtain a license to operate Catawba station, it must comply with the applicable Commission regulations and requirements, and (3) a probabilistic assessment of the risk based upon the methodology developed in the RSS. The overall assessment of environmental risk of accidents, assuming protective action, shows that it is roughly comparable with the risk from normal operation, although accidents have a potential for early fatalities and economic costs that cannnot arise from normal operations. The risks of early fatality from potential accidents at the site are small in comparison with risks of early fatality from other human activities in a comparably sized population.

The staff has concluded that there are no special or unique circumstances about the Catawba site and environs that would warrant special mitigation features for Catawba Units 1 and 2.

5.10 Impacts From the Uranium Fuel Cycle

The Uranium Fuel Cycle rule, 10 CFR 51.20 (44 FR 45362), reflects the latest information relative to the reprocessing of spent fuel and to radioactive waste management as discussed in NUREG-0116 and NUREG-0216, which presents staff responses to comments on NUREG-0116. The rule also considers other environmental factors of the uranium fuel cycle, including aspects of mining and milling, isotopic enrichment, fuel fabrication, and management of low- and high-level wastes. These are described in the Atomic Energy Commission report WASH-1248. The NRC staff also was directed to develop an explanatory narrative that would convey in understandable terms the significance of releases in Table S-3 in 10 CFR 51.20. The narrative also was to address such important fuel cycle impacts as environmental dose commitments and health effects and socioeconomic and cumulative impacts, where these are appropriate for generic treatment. This explanatory narrative was published in the Federal Register on March 4, 1981 (46 FR 15154-15175). Appendix C to this report contains a number of sections that address the impacts of the LWR-supporting fuel cycle that reasonably appear to have significance for individual reactor licensing sufficient to warrant attention for National Environmental Policy Act purposes.

Table S-3 of the final rule is reproduced in its entirety as Table 5.4 in this report. Specific categories of natural resource use included in the table relate to land use, water consumption, thermal effluents, radioactive releases, burial of transuranic and high- and low-level wastes, and radiation doses from transportation and occupational exposures. The contributions in the table for reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no recycle); that is, the cycle that results in the greater impact is used.

On April 27, 1982, the U.S. Court of Appeals for the District of Columbia Circuit issued a decision that found the S-3 rule invalid "due to their failure to allow for proper consideration of the uncertainties that underlie the assumption that solidified high-level and transuranic wastes will not affect the environment once they are sealed in a permanent repository" (Natural Resources Defense Council vs. NRC, No. 74-1586, District of Columbia Circuit). By its order of September 1, 1982, the District of Columbia Circuit delayed implementation of its earlier decision pending the filing of application for review of the decision by the U.S. Supreme Court. On November 1, 1982, the Commission issued a Statement of Policy concerning this decision (see 47 FR 50591, November 8, 1982). The Commission views the decision by the District of Columbia Circuit not as a finding of fault with the evidentiary record on waste management impacts and uncertainties, but rather as a rejection of the Commission's policy judgments regarding the weight and effect which those impacts and uncertainties should exert in reactor licensing. In summary, the Commission, "directs its Licensing and Appeal Boards to proceed in continued reliance on the S-3 rule until further notice from the Commission, provided that any license authorizations or other decisions issued in reliance on the rule are conditioned on the final outcome of the judicial proceedings."

Appendix C to this report contains a description of the environmental impact assessment of the uranium fuel cycle as related to the operation of the Catawba facility. The environmental impacts are based on the values given in Table S-3 (Table 5.4) and on an analysis of the radiological impact from radon-222 and technetium-99 releases. The staff has determined that the environmental impact of this facility on the U.S. population from radioactive gaseous and liquid releases (including radon and technetium) resulting from the uranium fuel cycle is very small when compared with the impact of natural background radiation. In addition, the nonradiological impacts of the uranium fuel cycle have been found to be acceptable.

5.11 Decommissioning

The purpose of decommissioning is to safely remove nuclear facilities from service and to remove or isolate the associated radioactivity from the environment so that part of the facility site that is not permanently committed can be released for other uses. Alternative methods of accomplishing this purpose and the environmental impacts of each method are discussed in NUREG-0586.

Since 1960, 68 nuclear reactors, including 5 licensed reactors that had been used for the generation of electricity, have been or are in the process of being decommissioned. Although no large commercial reactor has undergone decommissioning to date, the broad base of experience gained from smaller facilities is generally relevant to the decommissioning of any type of nuclear facility.

Radiation doses to the public (as a result of decommissioning activities) at the end of a commercial power reactor's useful life should be small and will come primarily from the transportation of waste to appropriate repositories. Radiation doses to decommissioning workers should be well within the occupational exposure limits imposed by regulatory requirements.

The NRC is currently conducting a generic rulemaking that will develop a more explicit overall policy for decommissioning commercial nuclear facilities. Specific licensing requirements are being considered that include the development of decommissioning plans and financial arrangements for decommissioning nuclear facilities.

Estimates of the economic cost of decommissioning are provided in Section 6 of this statement.

5.12 Noise Impacts at Catawba

Sound pressure levels expected to result from operation of the Catawba Nuclear Station have been calculated for 17 receptor locations (see Figure 5.10). These receptor locations are the same ones chosen by the applicant (ER-OL Section 2.7) and represent points within noise sensitive land use areas in the vicinity of the site. Ambient measurements representative of the residual noise level (L_{90} or noise level exceeded 90% of the time) were made by the applicant at each of these receptors over a time period of at least a day to determine diurnal variation. Those measurements include the effect of construction activity of Catawba; the ambient measurements generally varied over space and time from 30-to-50 dBA [noise is measured as A-weighted sound level in decibels (db)].

A computer model based largely on the Edison Electric Institute environmental noise guide (Report 3637, 1978) was used to predict the effect of plant noise on the above 17 receptors. The sources of largest expected noise from Catawba Nuclear Station were used: six circular mechanical draft cooling towers, four transformers, and the three low pressure service water (LPSW) pumps at the intake structure. All sources were assumed to be in operation continuously and throughout the day and night. Standard day conditions (18°C ambient temperature and 70% relative humidity) were also assumed. Results of the model predictions appear in Table 5.14. These noise levels are the result of station operation only. Ambient levels of 30-to-50 dBA have not been accounted for in that table. The total noise level would be the logarithm sum of the ambient and plant contributions.

North and South Carolina have no noise regulations that apply to the operation of the Catawba station. However, the U.S. Environmental Protection Agency (EPA) has noise guidelines with which predictions may be compared. EPA recommends a limit of 70 dBA for the 24-hour equivalent level for farmland and general unpopulated land (EPA, March 1974). This is primarily for protection from hearing loss. For farm residents and residential areas with outside space (Catawba case), the recommendations for the day-night equivalent sound level (L_{dn}) are 55 dBA outdoors and 45 dBA indoors for protection of public health and safety with an adequate margin of safety. These identified levels of environmental noise would be expected to result in little, if any, activity interference or annoyance. The 55 dBA recommendation is violated at location 2 (prediction is 66 dBA) for any ambient level 30-to-50 dBA. Locations 1 and 3 are close to the recommended 55 dBA and may be within the EPA criterion. The accuracy of the model is not sufficient to clearly indicate compliance with the EPA recommendation at points 1 and 3. Point 2 is clearly above the 55 dBA criterion for any ambient chosen; this result is to be expected since point 2 is very close to the mechanical draft cooling tower. The high level of plant noise predicted for location 2 is not expected to be a problem since that location contains only a bridge over the discharge channel and does not represent a noise sensitive land use. Land use at locations 1 and 3 is residential, with recreational homes and permanent and recreational homes at these locations, respectively (M. Childers, Duke Power Company, personal communication, 1982).

Thus, the staff concludes that the noise provided by operation of the station will be very close to the EPA recommendation (above or below) for points 1 and 3. At other noise sensitive locations identified in the ER, predictions are very slightly above local ambient level. Adverse effects at these locations as a result of noise from routine operation at Catawba Nuclear Station would not be expected.

5.13 Emergency Planning Impacts

In connection with the promulgation of the Commission's upgraded emergency planning requirements, the staff issued NUREG-0654. The staff believes that the only noteworthy potential source of impacts to the public from emergency planning would be associated with the testing of the early notification system. The test requirements and noise levels will be consistent with those used for existing alert systems; therefore, the staff concludes that the noise impacts from the system will be infrequent and insignificant.

5.14 Environmental Monitoring

5.14.1 Terrestrial Monitoring

Because of the uncertainty concerning the quality of drift to be released from the cooling towers a monitoring program will be required to detect any possible changes to the terrestrial environment resulting from cooling tower drift. The staff recommends that this monitoring program use aerial photography using infrared film of the site area during the growing season before operation. Aerial photographs using infrared film can then be taken at intervals after Catawba station becomes operational to detect possible changes. The program will be presented in the Environmental Protection Plan, which will be included as Appendix B of the operating license.

5.14.2 Aquatic Monitoring

The certifications and permits required under the Clean Water Act provide the mechanisms for protecting water quality and aquatic biota. Operational monitoring of effluents will be required by the NPDES permit issued by the South Carolina Department of Health and Environmental Control (SCDHEC). The NRC will rely on the decisions made by the State of South Carolina, under the authority of the Clean Water Act, for any requirements for monitoring intake losses of aquatic biota and for any requirements for intake-design changes, should they be necessary. The applicant received from the SCDHEC an NPDES permit effective from June 29, 1981 through June 30, 1981 (Appendix I). The permit has been extended by the State pending finalization of effluent guidelines for the steam electric generating point source category by the U.S. Environmental Protection Agency.

An environmental protection plan will be included as Appendix B of the Catawba Nuclear Station operating license. This plan will include requirements for prompt reporting by the applicant of important events that potentially could result in significant environmental impact causally related to plant operation, for example, fish kills, mortality of any species protected by the Endangered Species Act of 1973 as amended, increase in nuisance organisms or conditions, and unanticipated or emergency discharge of waste water or chemical substances.

5.14.3 Atmospheric Monitoring

The FES-CP did not contain a description of the onsite meteorological measurements program. The current meteorological towers are not in the same location as the tower used for data collection at the construction-permit stage. The current towers are located 380 m southwest of the reactor complex. The base elevation of the towers is about 11 m above plant grade. Windspeed and direction are measured at the top a 10-m tower. Windspeed and direction also are measured at the top of a 40-m tower, and temperature difference is measured between the 10-m and 40-m levels of this tower.

The 40-m tower is an unusual structure on which to mount meteorological sensors because it is constructed from large girders. Because of concerns about the effect of this massive structure on the representativeness of windspeed and direction measurements, the staff requested that the applicant provide justification that windspeed and direction measurements made at the current elevation on this tower are not affected unduly by turbulence generated by airflow over the tower structure. The applicant measured windspeed and direction on a temporary mast at a height of 3.9 m above the top structural component where structural effects should be minimal. Concurrent measurements from this elevation were compared with measurements taken near the top structural component to determine the effect of the tower structure on windspeed and direction measurements. The results of this study indicated that the current windspeed and direction sensors should be relocated to a height of at least 3 m above the top structural component of the tower. The applicant has committed to make this change in the meteorological measurements program.

The staff also is concerned about the location of the meteorological towers. The plant site is in an area of irregular terrain, with Lake Wylie at the lowest elevation, 18 m below the elevation of the meteorological tower. Because of the irregular terrain, predominance of low-windspeed conditions, and frequent intense inversions, low-level airflow may tend to follow the terrain toward lower elevations (such as, "drainage" or gravity flow). The current location of the 10-m tower may not adequately represent low-level airflow during periods of gravity flow. As the staff requested, the applicant has installed a temporary 10-m pole or tower in an area of flat terrain at plant grade to document the existence or nonexistence of low-level gravity airflow. Measurements from the top of the temporary tower have been compared with measurements made at the current 10-m tower location for a period of several months covering a representative sample of conditions most conducive to low-level gravity airflow, such as, strong temperature inversions near the surface accompanied by low windspeeds. Preliminary analyses of the results of this comparison indicate that measurements of wind direction from the two towers are in reasonable agreement overall. Wind direction measurements from the 10-m level of the current tower appear reasonably representative of low-level airflow patterns as used in dose consequence assessments presented in this FES.

The current meteorological measurements program, with the changes described above, will be used as the operational program.

The applicant has concluded a preoperational program to monitor the frequency and intensity of naturally occurring ground fog around Lake Wylie. This program was conducted for a 2-year period (August 10, 1977-August 9, 1979). The preoperational program included visiometer and surface water temperature measurements at two locations (location 1, which is about 800 m north of the cooling towers, and location 2, which is about 250 m south of the cooling towers) and daily morning fog observations by security personnel near visiometer location 2 and by personnel at the Wylie Hydro Station (located about 6 km east-southeast of the station). When atmospheric conditions appeared to be conducive to the occurrence of steam fog, meteorologists conducted observations of the horizontal and vertical extent of the fog as well as transport of the fog off the lake. About six occurences were observed during the 2 years of the preoperational program.

The operational fog monitoring program proposed by the applicant consists of the same components as the preoperational program, that is, visiometer and surface water temperature measurements, daily observations of monitoring for occurrences near visiometer location 2 and at the Wylie Hydro Station, and selected observations of occurrences of steam fog. This program will continue for at least a 1-year period after plant startup and continued operation. The staff believes that this program should include estimates of the frequency and intensity of ground fog induced by plant operation, particularly at a nearby residential community located about 1.6 km east of the station on the eastern shore of Lake Wylie and at a municipal airport located about 8 km south of the plant and about 3 km south of Lake Wylie.

Comparisons of measurements and observations from the preoperational and operational fog monitoring programs will be evaluated by the staff to determine the frequency and intensity of ground fog induced by plant operation, particularly at the nearby residential community and at the municipal airport described above. On the basis of this evaluation, the staff will determine the need for continued monitoring and/or mitigating actions to lessen the atmospheric impact of plant operation. The staff has recommended that the submittal of the results of the preoperational and postoperational monitoring program for fog be made a condition of the operating license.

5.14.4 Environmental Noise Monitoring

The staff recommends that the applicant conduct a short-term confirmatory noise monitoring program at the site during the first year of operation of each unit. The purpose of this program will be to quantify operational-phase noise levels and mitigative measures necessary, if any, in the vicinity of the applicant's noise assessment locations 1 and 3. The staff also recommends that this program include, to the extent practicable, the measurements of ambient noise levels at the same locations as proposed for the operational phases at a time when such levels would not be significantly affected by construction or operational activities at the site. The details of this program will be included in the Environmental Protection Plan (EPP) for the station.

5.15 References

American Cancer Society, "Cancer Facts and Figures 1979," 1978.

Atomic Energy Act of 1954.

Blaylock, B. G., and J. P. Witherspoon, "Radiation Doses and Effects Estimated for Aquatic Biota Exposed to Radioactive Releases from LWR Fuel-Cycle Facilities," Nuclear Safety, 17:351, 1976.

Breder, C. M. J., and D. E. Rosen, "Modes of Reproduction in Fishes," Natural History Press, Garden City, NY, 1966.

Carter, J., Executive Order 11988, "Floodplain Management," May 1977.

Comptroller General of the United States, "Report to the Congress," EMD-81-106, Washington, D.C., August 26, 1981.

Duke Power Company, "Environmental Report, Operating License Stage," Catawba Plant Units 1 and 2, Docket Nos. 50-413 and 50-414, Docket date June 11, 1981, as amended.

Department of Energy, Division of Environmental Control Technology, "Potential Environmental Effects of 765 kV Transmission Lines," views presented before the New York State Public Service Commission, Cases 265-29 and 265-59, 1978, November 1979.

Duke Power Company, "Plant Allen Units 1, 2, 3, 4, and 5 316(a) Demonstration," Charlotte, NC, 1976.

---, "Final Safety Analysis Report, Catawba Nuclear Station, Units 1 and 2," Docket Nos. 50-413 and 50-416, Docket date June 11, 1981, as amended.

Edison Electric Institute, Report 3637, "Electric Power Plant Environment Noise Guide" (prepared by Bolt Beranak and Newman Inc.), 1978.

Edwards, T. J., W. H. Hunt, L. E. Miller, and J. J. Servic, "An Evaluation of the Impingement of Fishes at Four Duke Power Company Steam Generating Facilities," in Thermal Ecology II, G. W. Esch and R. W. McFairlane, Eds., pp. 373-380, Technical Information Center, U.S. Energy Research and Development Administration, Washington, DC., 1976.

Federal Register Notice, 44 FR 45362, "Licensing and Regulatory Policy and Procedures for Environmental Protection; Uranium Fuel Cycle Impacts From Spent Fuel Reprocessing and Radioactive Waste Management," Final Rule, U.S. Regulatory Commission, August 2, 1979.

---, 45 FR 40101-40104, "Nuclear Power Plant Accident Considerations Under the National Environmental Policy Act of 1979," U.S. Nuclear Regulatory Commission, June 13, 1980.

---, 46 FR 15154-15175, "Appendix A, Narrative Explanation of Table S-3, Uranium Fuel Cycle Environmental Data," Proposed Rule, U.S. Nuclear Regulatory Commisssion, March 4, 1981.

---, 47 FR 50591-50593, "Licensing and Regulatory Policy and Procedures for Environmental Protection, Uranium Fuel Cycle Impacts," Statement of Policy, November 8, 1982.

Industrial BIO-TEST Laboratories, Inc., "A Baseline Predictive Environmental Investigation of Lake Wylie - Catawba Nuclear Station and Plant Allen, September 1973 - August 1974," Vol. II, Northbrook, IL, 1974.

International Commission on Radiological Protection, "Recommendations of the International Commission on Radiological Protection," ICRP Publication 26, January 1977.

ITT Research Institute, "Evaluation of Health and Environmental Effects of Extra High Voltage (EHV) Transmission" (prepared for U.S. Environmental Protection Agency), Chicago, IL, February 1979.

Land, C. E., Science 209: 1197, September 12, 1980.

Landstrom, O., et al., "In Situ Experiments on Nuclide Migration in Fractured Crystalline Rocks," KBS Teknisk Rapport 110, Studsvik Energiteknik and the Geol. Survey of Sweden, 1978.

National Academy of Sciences/National Research Council, "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," Committee on the Biological Effects of Ionizing Radiations (BEIR I), November 1972.

---, "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," Committee on the Biological Effects of Ionizing Radiations (BEIR III), July 1980.

National Council on Radiation Protection and Measurements, "Review of the Current State of Radiation Protection Philosophy," NCRP Report No. 43, January 1975.

National Research Council, "Energy in Transition 1985 - 2010," Final Report of the Committee on Nuclear and Alternative Energy Systems (CONAES), Chapter 9, 1979.*

*This report was also published in 1980 by W. H. Freeman and Company. Pages cited will differ.

Oak Ridge National Laboratory, Nuclear Safety Information Center, "Descriptions of Selected Accidents That Have Occurred at Nuclear Reactor Facilities," ORNL/NSIC-176, Oak Ridge, TN, April 1980.

Peacock, B. (SCDHEC), letter to J. Lehr (NRC), Subject: Duke Power - Catawba Nuclear Station, York County, October 2, 1981.

Phillips, A. D., and W. T. Kaune, Battelle Pacific Northwest Laboratories, "Effects of Electric Fields on Small Laboratory Animals," paper presented at Environmental Control Symposium, Washington, DC, November 27-30, 1978.

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

South Carolina Water Resources Commission, "Surface Water Resources Investigation of the Catawba-Wateree River System in South Carolina," March 1981.

United Nations Scientific Committee on the Effects of Atomic Radiation, "Sources and Effects of Ionizing Radiation," 1977.

U.S. Atomic Energy Commission, WASH-1248, "Environmental Survey of the Uranium Fuel Cycle," Washington, DC, April 1974.

U.S. Department of the Interior, National Park Service, National Register of Historic Places, Volumes 1 and 2 (and subsequent listings as they appear in the Federal Register), Washington, DC, 1976.

U.S. Environmental Protection Agency, "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare and an Adequate Margin of Safety," 550/9-74-004, March 1974.

U.S. Nuclear Regulatory Commission, NUREG-75/014 (WASH-1400) "Reactor Safety Study--An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plant," October 1975.

---, NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWR-GALE Code)," April 1976.

---, NUREG-0063, "Final Environmental Statement Related to the Operation of William B. McGuire Nuclear Station, Units 1 and 2," April 1976.

---, NUREG-0116 (Supplement 1 to WASH-1248), "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," October 1976.

---, NUREG-0216 (Supplement 2 to WASH-1248), "Public Comments and Task Force Response Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," March 1977.

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

---, NUREG-0440, "Liquid Pathway Generic Study," February 1978.

---, NUREG-0575, "Final Generic Environmental Impact Statement on Handling and Storage of Spent Light Water Power Reactor Fuel," August 1979.

---, NUREG-0586, "Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities," January 1981.

---, NUREG-0651, "Evaluation of Steam Generator Tube Rupture Accidents," March 1980.

---, NUREG-0654 (FEMA-REP-1), "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants," Revision 1, November 1980.

---, NUREG-0658, "Environmental Assessment for Effective Changes to 10 CFR 50 and Appendix E to 10 CFR 50; Emergency Planning Requirements for Nuclear Power Plants," August 1980.

---, NUREG-0660, "NRC Action Plan Developed as a Result of the TMI-2 Accident," Vol. I, May 1980.

---, NUREG-0713, "Occupational Radiation Exposure at Commercial Nuclear Power Reactors 1980," Volume 2, December 1981.

---, NUREG-0715, "Task Force Report on Interim Operations of Indian Point," August 1980.

---, NUREG-0737, "Clarification of TMI Action Plan Requirements," November 1980.

---, NUREG-0769, "Final Environmental Statement Related to the Operation of Enrico Fermi Atomic Power Plant, Unit No. 2," Addendum No. 1, March 1982.

---, NUREG-0800 (formerly NUREG-75/087), "Standard Review Plan for Review of Safety Analysis Reports for Nuclear Power Plants," Chapter 12, July 1981.

---, NUREG/CR-0400, "Risk Assessment Review Group Report to the U.S. Nuclear Regulatory Commission," September 1978.

---, NUREG/CR-1231, "Remote Sensing for Detection and Monitoring of Salt Stress on Vegetation: Evaluation and Guidelines," 1980.

---, NUREG/CR-1250, Special Inquiry Group, "Three Mile Island - A Report to the Commissioners and the Public," Vol. I, Summary Section 9, Mitchell Rogovin, Director, January 1980.

---, NUREG/CR-2644, "An Assessment Offsite, Real-Time Dose Measurement Systems for Emergency Situations," W. J. Maeck et al., April 1982.

<u>Industry Code</u>

National Electric Safety Code, 1977 edition.

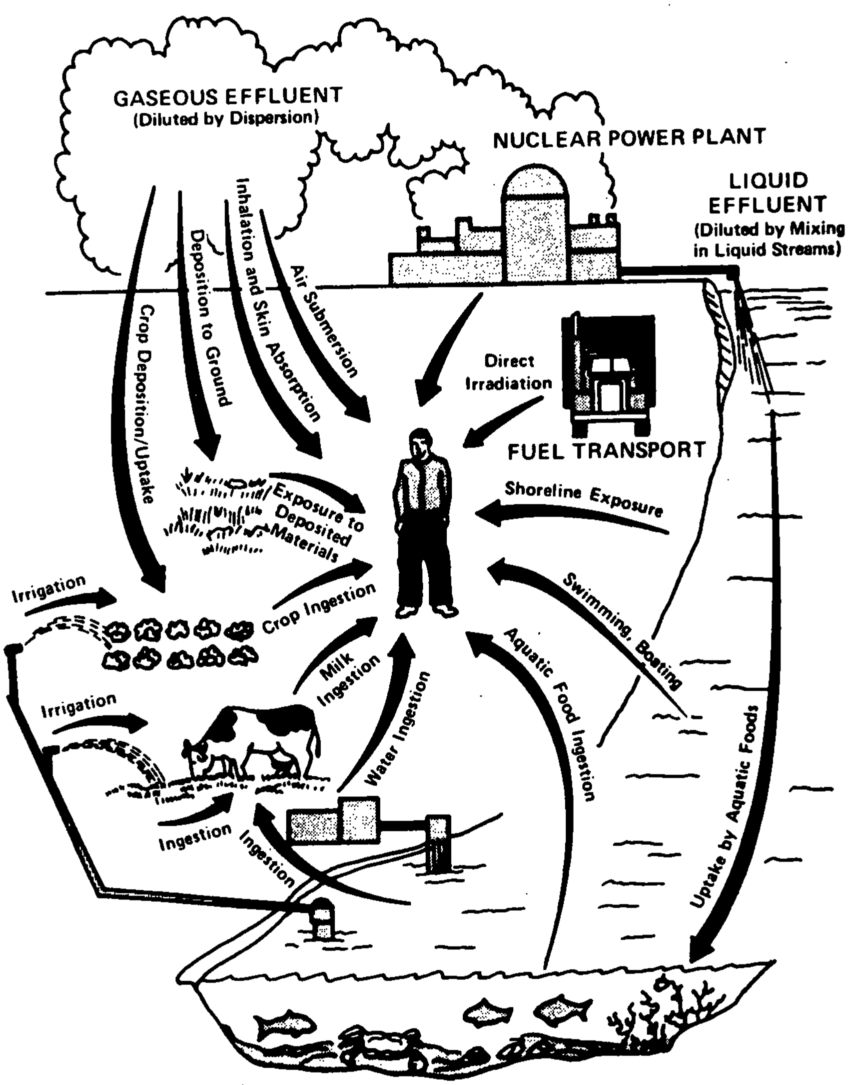

Figure 5.1 Potentially meaningful exposure pathways to individuals

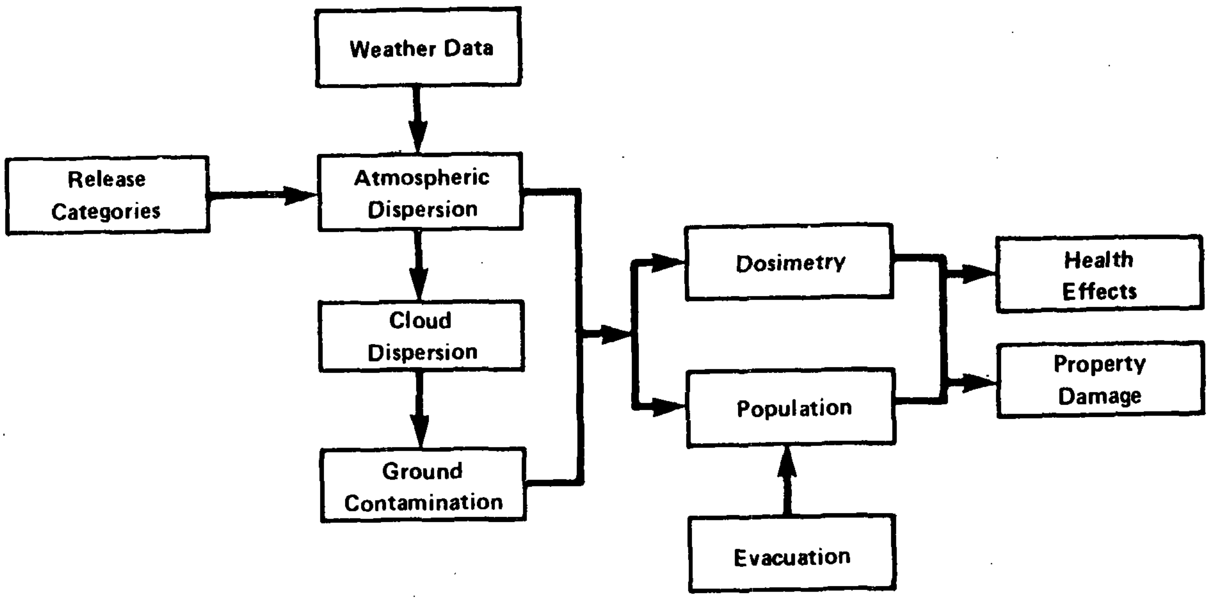

Figure 5.2 Schematic outline of atmospheric pathway consequence model

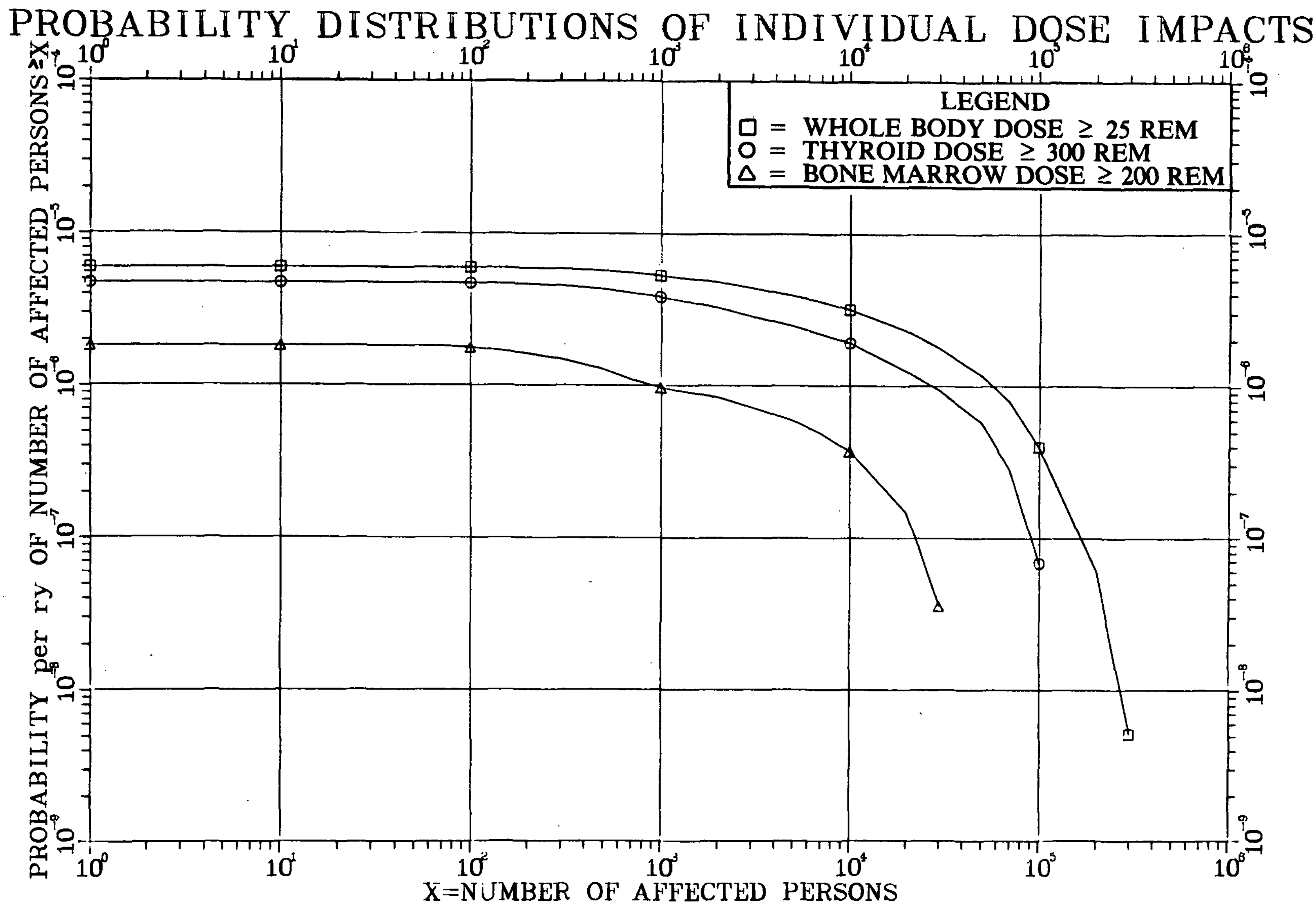

Figure 5.3 Probability distributions of individual dose impacts (see Section 5.9.4.5(7) for a discussion of uncertainties in risk estimates)

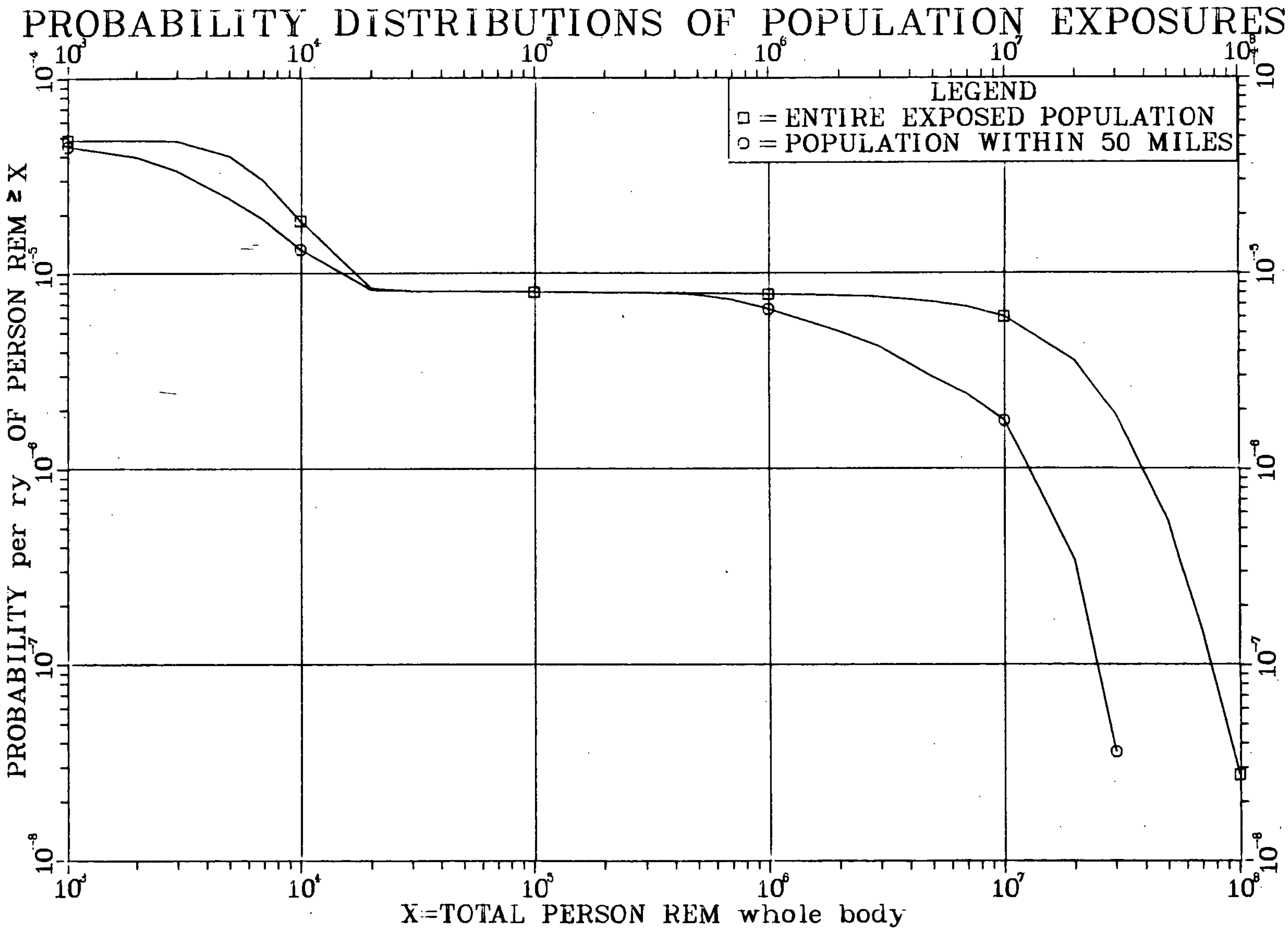

Figure 5.4 Probability distributions of population exposures (see Section 5.9.4.5(7) for a discussion of uncertainties in risk estimates)

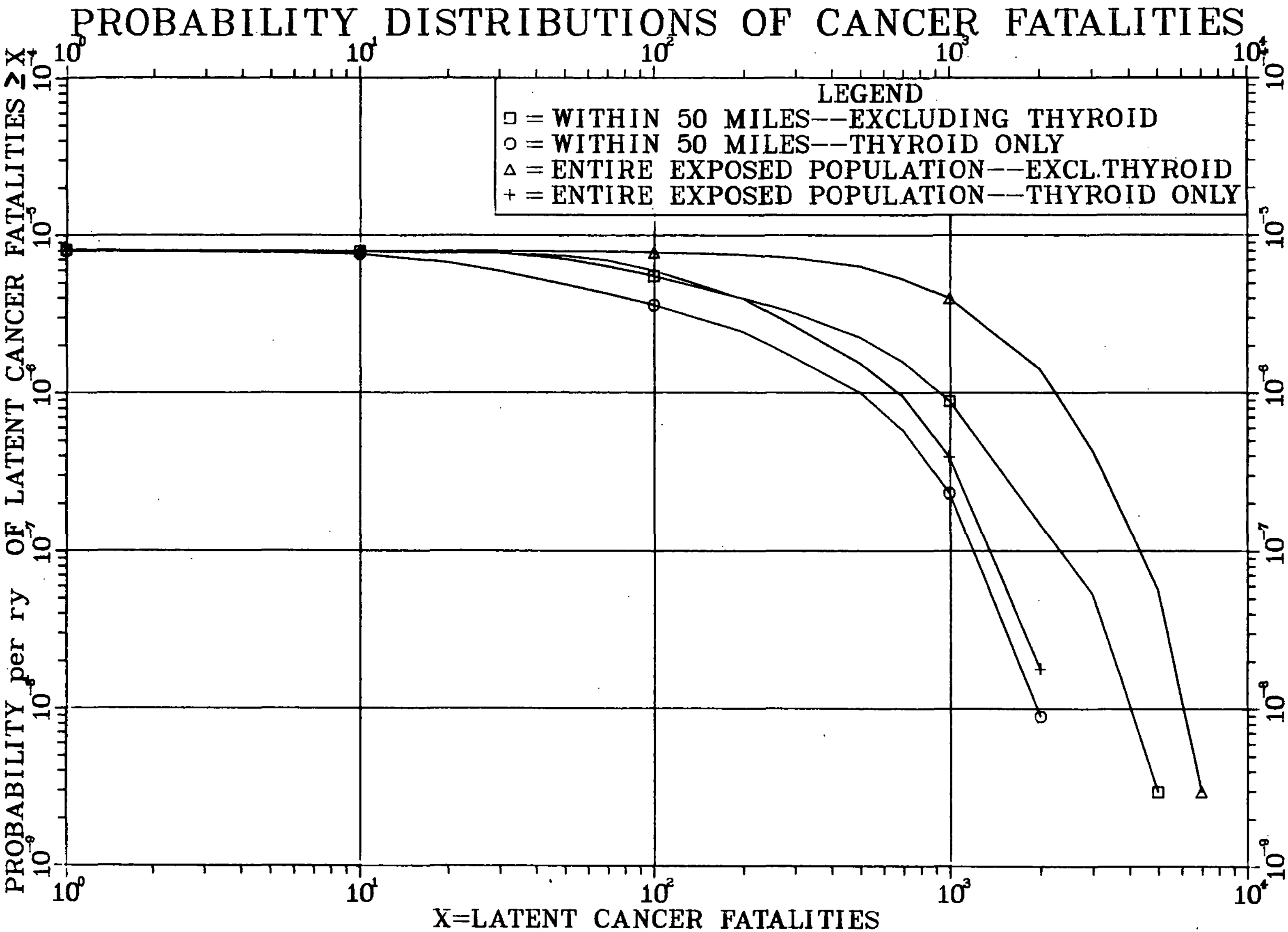

Figure 5.5 Probability distributions of cancer fatalities (see Section 5.9.4.5(7) for a discussion of uncertainties in risk estimates)

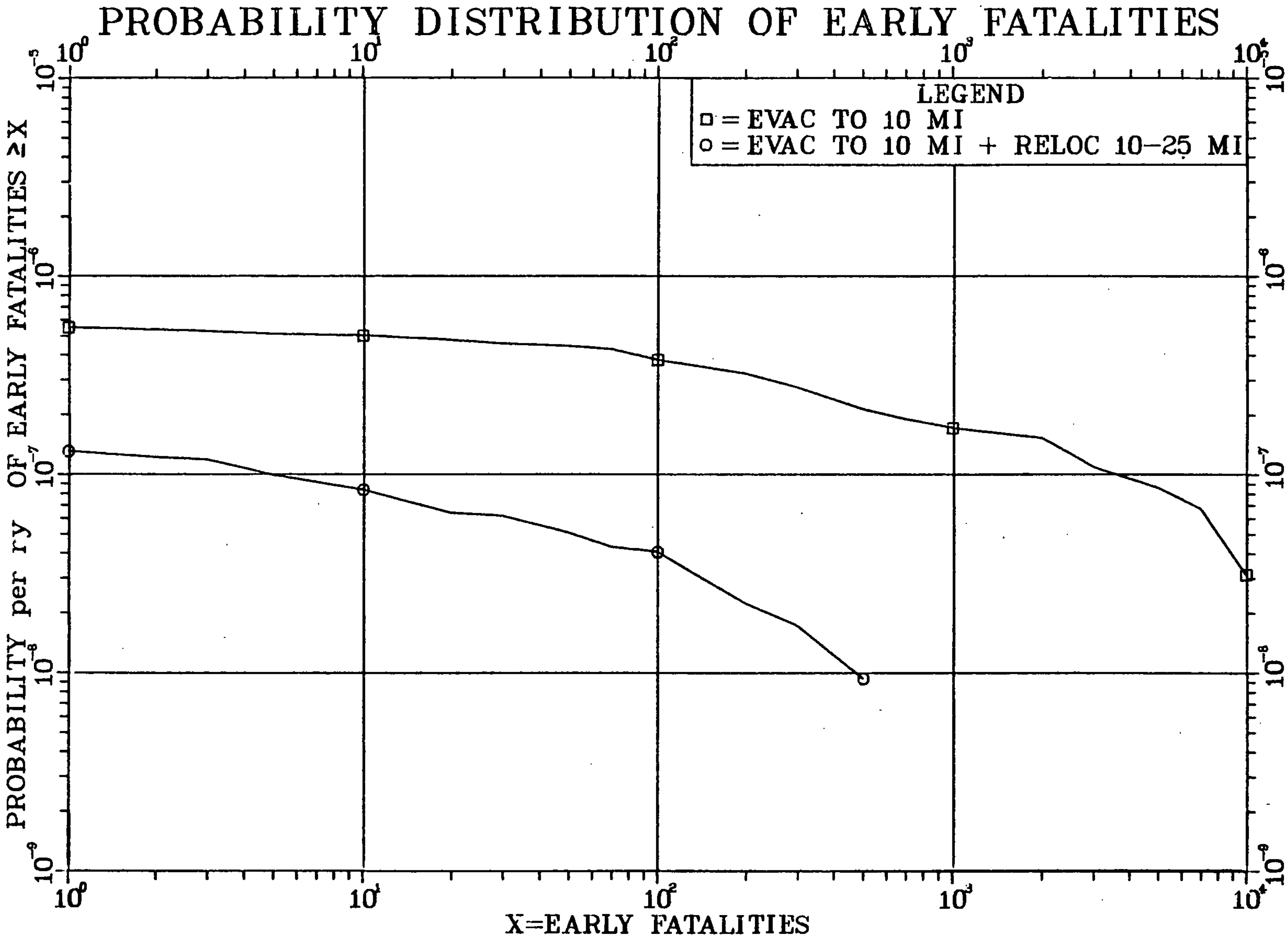

Figure 5.6 Probability distributions of early fatalities (see Section 5.9.4.5.(7) for a discussion of uncertainties in risk estimates)

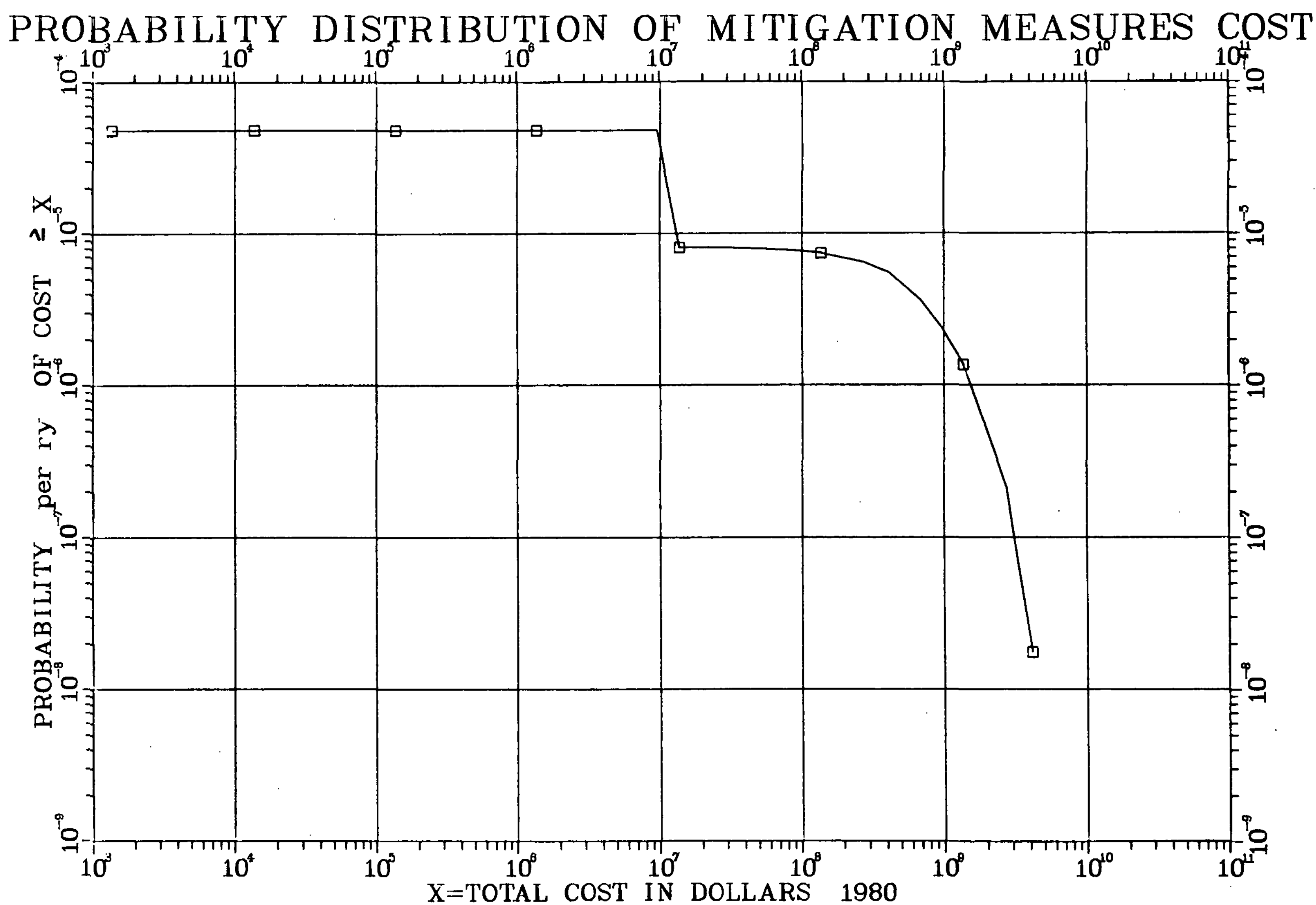

Figure 5.7 Probability distribution of mitigation measures cost (see Section 5.9.4.5(7) for a discussion of uncertainties in risk estimates)

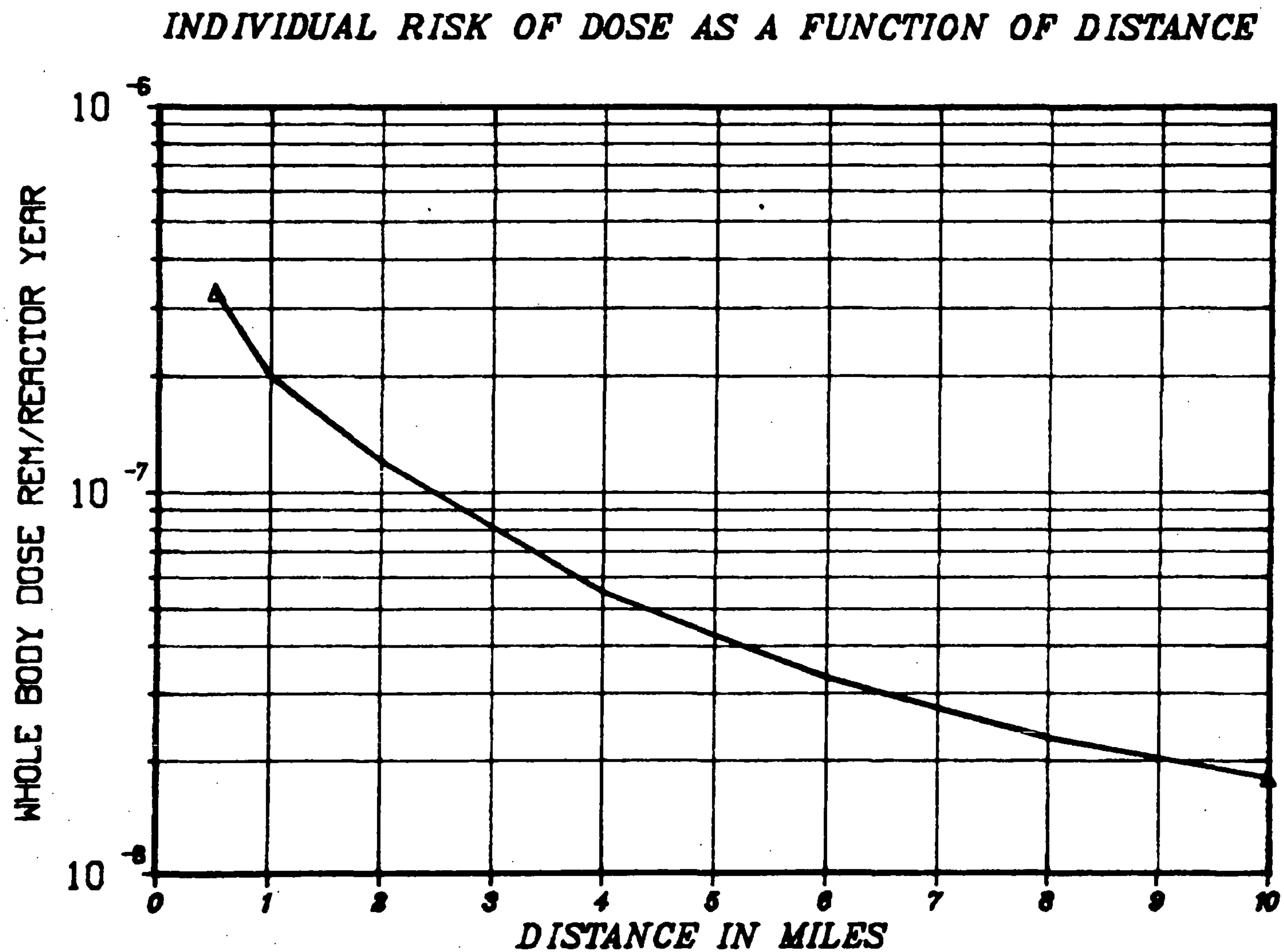

Figure 5.8 Individual risk of dose as a function of distance (curve smoothed to reflect average conditions)

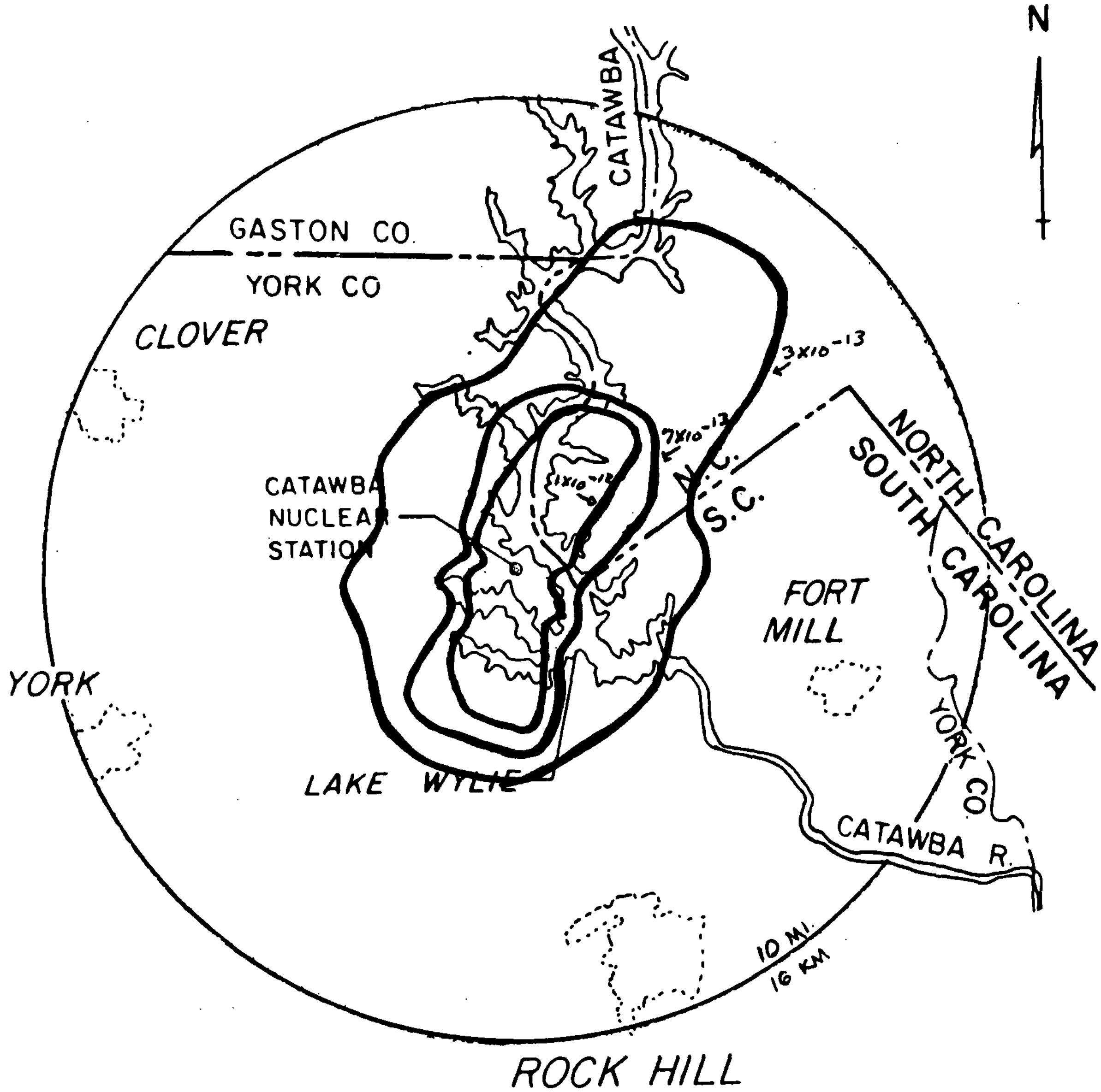

Figure 5.9 Isopleths of risk of latent cancer fatality per reactor-year to an individual

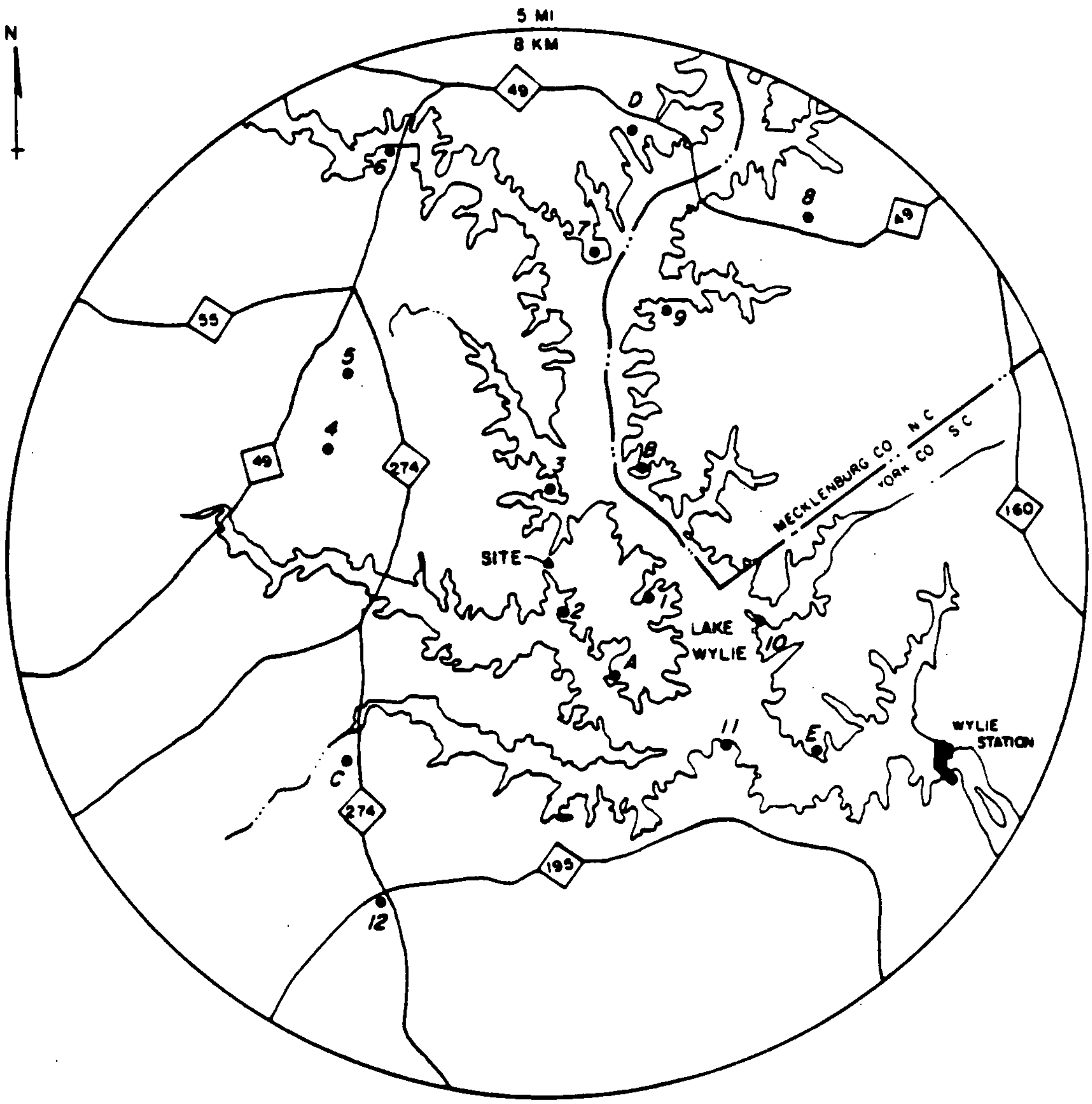

Figure 5.10 Catawba Nuclear Station site area with noise assessment locations (A-E) and (1-11)

Table 5.1 Surface water use as a percentage of average river flows, Catawba River-Lake Wylie

	Total withdrawals		Consumptive use	
Use and flow	l/min	gpm	l/min	gpm
(1) Current use	333,000	88,000	38,900	10,300
(2) Catawba Nuclear Station use	312,000	82,000	102,000	26,900
(3) Total use (1 + 2)	645,000	170,000	140,900	37,200
(4) Average daily flow in Catawba River	7,724,000	2,041,000	7,724,000	2,041,000
(5) Percent - total use to average daily flow (3 ÷ 4)	8.4		1.8	

Table 5.2 Consumptive water use as a percentage of 7-day 10-year low flow, Catawba River-Lake Wylie

	Catawba Nuclear Station use only		Total use	
Use and flow	l/min	gpm	l/min	gpm
(1) Current use	-	-	38,900	10,300
(2) Catawba Nuclear Station use	102,000	26,900	102,000	26,900
(3) Total use (1 + 2)	102,000	26,900	140,900	37,200
(4) 7-day 10-year low flow entering Lake Wylie	876,000	231,500	876,500	231,500
(5) Percent - station use or total use to 7-day 10-year low flow (3 ÷ 4)	11.6		16.1	

Table 5.3 Maximum thermal plume extent under average and worst-case conditions for the four seasons*

Season	Average conditions: Area to 2.8°C (5°F) above ambient isotherm, ha (acre)	% total** lake area	Area to 32.2°C (90°F) isotherm, ha (acre)	% total** lake area	Worst-case conditions: Area to 2.8°F (5°F) above ambient isotherm, ha (acre)	% total*** lake area	Area to 32.2°C (90°F) isotherm, ha (acre)	% total*** lake area
Spring	32 (80)	0.6	≈ 0	≈ 0	36 (90)	1.1	≈ 0	≈ 0
Summer	2 (5)	0.1	2 (5)	0.1	14 (35)	0.4	40 (100)	1.1
Fall	20 (50)	0.4	≈ 0	≈ 0	24 (60)	0.7	≈ 0	≈ 0
Winter	30 (75)	0.6	≈ 0	≈ 0	39 (85)	0.9	≈ 0	≈ 0

*From ER Table 5.1.2-1 and Applicant's Comments on DES, dated October 7, 1982.
**Based on full pond surface area of 5041 ha (12,445 acres).
***Based on maximum drawdown 3 m (10 ft), area of 3724 ha (9,203 acres).

Table 5.4 (Summary Table S-3) Uranium-fuel-cycle environmental data[1]

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

Environmental considerations	Total	Maximum effect per annual fuel requirement or reference reactor year of model 1,000 MWe LWR
NATURAL RESOURCES USE		
Land (acres):		
Temporarily committed [2]	100	
Undisturbed area	79	
Disturbed area	22	Equivalent to a 110 MWe coal-fired power plant.
Permanently committed	13	
Overburden moved (millions of MT)	2.8	Equivalent to 95 MWe coal-fired power plant.
Water (millions of gallons):		
Discharged to air	160	=2 percent of model 1,000 MWe LWR with cooling tower.
Discharged to water bodies	11,090	
Discharged to ground	127	
Total	11,377	<4 percent of model 1,000 MWe LWR with once-through cooling.
Fossil fuel:		
Electrical energy (thousands of MW-hour)	323	<5 percent of model 1,000 MWe LWR output.
Equivalent coal (thousands of MT)	118	Equivalent to the consumption of a 45 MWe coal-fired power plant.
Natural gas (millions of scf)	135	<0.4 percent of model 1,000 MWe energy output.
EFFLUENTS—CHEMICAL (MT)		
Gases (including entrainment): [3]		
SO_x	4,400	
NO_x [4]	1,190	Equivalent to emissions from 45 MWe coal-fired plant for a year.
Hydrocarbons	14	
CO	29.6	
Particulates	1,154	
Other gases:		
F	.67	Principally from UF_6 production, enrichment, and reprocessing. Concentration within range of state standards—below level that has effects on human health.
HC1	.014	
Liquids:		
SO_4^-	9.9	From enrichment, fuel fabrication, and reprocessing steps. Components that constitute a potential for adverse environmental effect are present in dilute concentrations and receive additional dilution by receiving bodies of water to levels below permissible standards. The constituents that require dilution and the flow of dilution water are:
NO_3^-	25.8	
Fluoride	12.9	
Ca^{++}	5.4	
$C1^-$	8.5	
Na^+	12.1	
NH_3	10.0	
Fe	.4	NH_3—600 cfs. NO_3—20 cfs. Fluoride—70 cfs.
Tailings solutions (thousands of MT)	240	From mills only—no significant effluents to environment.
Solids	91,000	Principally from mills—no significant effluents to environment.

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

Environmental considerations	Total	Maximum effect per annual fuel requirement or reference reactor year of model 1,000 MWe LWR
EFFLUENTS—RADIOLOGICAL (CURIES)		
Gases (including entrainment):		
Rn-222		Presently under reconsideration by the Commission.
Ra-226	.02	
Th-230	02	
Uranium	.034	
Tritium (thousands)	18.1	
C-14	24	
Kr-85 (thousands)	400	
Ru-106	.14	Principally from fuel reprocessing plants.
I-129	1.3	
I-131	.83	
Tc-99		Presently under consideration by the Commission.
Fission products and transuranics	.203	
Liquids:		
Uranium and daughters	2.1	Principally from milling—included tailings liquor and returned to ground—no effluents; therefore, no effect on environment.
Ra-226	.0034	From UF_6 production.
Th-230	.0015	
Th-234	.01	From fuel fabrication plants—concentration 10 percent of 10 CFR 20 for total processing 26 annual fuel requirements for model LWR.
Fission and activation products	5.9×10^{-6}	
Solids (buried on site):		
Other than high level (shallow)	11,300	9,100 Ci comes from low level reactor wastes and 1,500 Ci comes from reactor decontamination and decommissioning—buried at land burial facilities. 600 Ci comes from mills—included in tailings returned to ground. Approximately 60 Ci comes from conversion and spent fuel storage. No significant effluent to the environment.
TRU and HLW (deep)	1.1×10^{7}	Buried at Federal Repository.
Effluents—thermal (billions of British thermal units)	4,063	< 5 percent of model 1,000 MWe LWR.
Transportation (person-rem):		
Exposure of workers and general public	2.5	
Occupational exposure (person-rem)	22.6	From reprocessing and waste management.

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

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

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

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

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

Table 5.5 (Summary Table S-4) Environmental impact of transportation of fuel and waste to and from one light-water-cooled nulcear power reactor[1]

NORMAL CONDITIONS OF TRANSPORT

	Environmental impact
Heat (per irradiated fuel cask in transit)	250,000 Btu/hr.
Weight (governed by Federal or State restrictions)	73,000 lbs. per truck; 100 tons per cask per rail car.
Traffic density:	
Truck	Less than 1 per day.
Rail	Less than 3 per month.

Exposed population	Estimated number of persons exposed	Range of doses to exposed individuals [2] (per reactor year)	Cumulative dose to exposed population (per reactor year) [3]
Transportation workers	200	0.01 to 300 millirem	4 man-rem.
General public:			
Onlookers	1,100	0.003 to 1.3 millirem	3 man-rem.
Along Route	600,000	0.0001 to 0.06 millirem	

ACCIDENTS IN TRANSPORT

	Environmental risk
Radiological effects	Small [4].
Common (nonradiological) causes	1 fatal injury in 100 reactor years; 1 nonfatal injury in 10 reactor years; $475 property damage per reactor year.

[1] Data supporting this table are given in the Commission's "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," WASH-1238, December 1972, and Supp. I, NUREG-75/038 April 1975. Both documents are available for inspection and copying at the Commission's Public Document Room, 1717 H St. NW., Washington, D.C., and may be obtained from National Technical Information Service, Springfield, Va. 22161. WASH-1238 is available from NTIS at a cost of $5.45 (microfiche, $2.25) and NUREG-75/038 is available at a cost of $3.25 (microfiche, $2.25).

[2] The Federal Radiation Council has recommended that the radiation doses from all sources of radiation other than natural background and medical exposures should be limited to 5,000 millirem per year for individuals as a result of occupational exposure and should be limited to 500 millirem per year for individuals in the general population. The dose to individuals due to average natural background radiation is about 130 millirem per year.

[3] Man-rem is an expression for the summation of whole body doses to individuals in a group. Thus, if each member of a population group of 1,000 people were to receive a dose of 0.001 rem (1 millirem), or if 2 people were to receive a dose of 0.5 rem (500 millirem) each, the total man-rem dose in each case would be 1 man-rem.

[4] Although the environmental risk of radiological effects stemming from transportation accidents is currently incapable of being numerically quantified, the risk remains small regardless of whether it is being applied to a single reactor or a multireactor site.

Table 5.6 Incidence of job-related mortalities

Occupational group	Mortality rates (premature deaths per 10^5 person-years)
Underground metal miners*	~1030
Uranium miners*	420
Smelter workers*	190
Mining**	61
Agriculture, forestry, and fisheries**	35
Contract construction**	33
Transportation and public utilities**	24
Nuclear plant worker***	23
Manufacturing**	7
Wholesale and retail trade**	6
Finance, insurance, and real estate**	3
Services**	3
Total private sector**	10

*E. L. Richardson, Secretary, "Report on Occupational Safety and Health by the U.S. Department of Health, Education, and Welfare," The President's Report on Occupational Safety and Health, May 1972.

**U.S. Bureau of Labor Statistics, "Occupational Injuries and Illness in the United States by Industry, 1975," Bulletin 1981, 1978.

***The nuclear plant workers' risk is equal to the sum of the radiation-related risk and the nonradiation-related risk. The estimated occupational risk associated with the industry-wide average radiation dose of 0.8 rem is about 11 potential premature deaths per 10^5 person-years due to cancer, based on the risk estimators described in the following text. The average non-radiation-related risk for seven U.S. electrical utilities over the period 1970-1979 is about 12 actual premature deaths per 10^5 person-years as shown in Figure 5 of the paper by R. Wilson and E. S. Koehl, "Occupational Risks of Ontario Hydro's Atomic Radiation Workers in Perspective," presented at Nuclear Radiation Risks, A Utility-Medical Dialog, sponsored by the International Institute of Safety and Health in Washington, D.C., September 22-23, 1980. (Note that the estimate of 11 radiation-related premature cancer deaths describes a potential risk rather than an observed statistic.)

Table 5.7 Preoperational radiological environmental monitoring program summary

Exposure Pathway and/or Sample	Number of Samples and Sample Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
1. AIRBORNE			
a. Radioiodine and Particulates	Samples from 3 offsite locations (in different sectors) at points of highest calculated annual average ground-level D/Q (Locations 200, 201, 205)	Continuous or intermittent sampler operation with sample collection monthly.	Radioiodine Cannister: Gamma Isotopic analysis for I-131 on each sample.
	1 sample from the vicinity of the community having the highest calculated annual average D/Q. (Location 212)		Particulate Filter: Gamma Isotopic analysis on each sample.
	1 sample from a control location. (Location 217)		
2. DIRECT RADIATION	40 Locations (200-207, 212, 217, 222-251)	Continuous integration with quarterly collection.	Gamma Dose on each dosimeter
3. WATERBORNE			
a. Surface	1 sample upstream of the liquid effluent discharge point. (Location 216)	Grab sample monthly.	Gamma Isotopic analysis monthly. Composite for Tritium analysis quarterly.
	1 sample in the vicinity of the liquid effluent discharge point. (Location 208)		

Source: ER-OL Table 6.1.5-1

Table 5.7 (Continued)

Exposure Pathway and/or Sample	Number of Samples and Sample Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
	1 sample downstream, beyond the mixing zone: (Location 211)		
b. Drinking	1 sample each of the 2 nearest water supplies downstream of the plant discharge. (Locations 213, 214)	Grab sample monthly.	Gross Beta and Gamma Isotopic analysis monthly. Composite for Tritium analysis quarterly.
	1 sample from a control location (Location 218)		
c. Sediment from Shoreline	1 sample each from two downstream public recreational areas. (Locations 208, 210)	Grab Sample semiannually.	Gamma Isotopic analysis on each sample.
	1 sample from a control location. (Location 215)		
4. <u>INGESTION</u>			
a. Milk	Samples from milking animals in 3 locations within 3 miles distant having the highest dose potential, if available. (Locations 209, 219, 220)	Grab Sample monthly when available.	Gamma Isotopic and I-131 analysis on each sample.
	1 sample from milking animals at a control location. (Location 221)		

Source: ER-OL Table 6.1.5-1

Table 5.7 (Continued)

Exposure Pathway and/or Sample	Number of Samples and Sample Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
b. Fish	1 sample each of bass and catfish in the vicinity of the discharge point. (Location 208)	Grab Sample semiannually	Gamma Isotopic analysis semiannually on each sample.
	1 sample each of the same types in a control location (Location 216)		
c. Broad-Leaf Vegetation	Sample from 1 offsite location at point of highest calculated annual average D/Q. (Location 201)	Grab Sample quarterly	Gamma Isotopic analysis on each sample.
	1 sample from a control location. (Location 217)		

Source: ER-OL Table 6.1.5.1

Table 5.8 Activity of radionuclides in a Catawba reactor core at 3565 MWt

Group/radionuclide	Radioactive inventory (millions of Ci)	Half-life (days)
A. NOBLE GASES		
Krypton-85	0.62	3,950
Krypton-85m	27	0.183
Krypton-87	52	0.0528
Krypton-88	76	0.117
Xenon-133	190	5.28
Xenon-135	38	0.384
B. IODINES		
Iodine-131	95	8.05
Iodine-132	130	0.0958
Iodine-133	190	0.875
Iodine-134	210	0.0366
Iodine-135	170	0.280
C. ALKALI METALS		
Rubidium-86	0.029	18.7
Cesium-134	8.4	750
Cesium-136	3.3	13.0
Cesium-137	5.2	11,000
D. TELLURIUM-ANTIMONY		
Tellurium-127	6.6	0.391
Tellurium-127m	1.2	109
Tellurium-129	35	0.048
Tellurium-129m	5.9	34.0
Tellurium-131m	14	1.25
Tellurium-132	130	3.25
Antimony-127	6.8	3.88
Antimony-129	37	0.179
E. AKALINE EARTHS		
Strontium-89	100	52.1
Strontium-90	4.1	11,030
Strontium-91	120	0.403
Barium-140	180	12.8
F. COBALT AND NOBLE METALS		
Cobalt-58	0.87	71.0
Cobalt-60	0.32	1,920
Molybdenum-99	180	2.8
Technetium-99m	160	0.25
Ruthenium-103	120	39.5
Ruthenium-105	80	0.185
Ruthenium-106	28	366
Rhodium-105	55	1.50

Table 5.8 (Continued)

Group/radionuclide	Radioactive inventory (millions of Ci)	Half-life (days)
G. RARE EARTHS, REFRACTORY OXIDES AND TRANSURANICS		
Yttrium-90	4.3	2.67
Yttrium-91	130	59.0
Zirconium-95	170	65.2
Zirconium-97	170	0.71
Niobium-95	170	35.0
Lanthanum-140	180	1.67
Cerium-141	170	32.3
Cerium-143	140	1.38
Cerium-144	95	284
Praseodymium-143	140	13.7
Neodymium-147	67	11.1
Neptunium-239	1,800	2.35
Plutonium-238	0.063	32,500
Plutonium-239	0.023	8.9×10^6
Plutonium-240	0.023	2.4×10^6
Plutonium-241	3.8	5,350
Americium-241	0.0019	1.5×10^5
Curium-242	0.56	163
Curium-244	0.026	6,630

Note: The above grouping of radionuclides corresponds to that in Table 5.10.

Table 5.9 Realistic estimates of 2-hour radiation doses from design-basis accidents at exclusion area boundary

	Dose (rem) at 762 m*	
Events	Whole body	Thyroid
<u>Infrequent accidents</u>		
Waste gas tank failure	0.06	<0.001
Small-break LOCA**	<0.001	<0.001
Steam generator tube rupture***	0.001	0.05
Fuel-handling accident	0.007	0.004
<u>Limiting faults</u>		
Main steamline break	<0.001	<0.001
Control rod ejection	<0.001	0.007
Large-break LOCA	0.001	0.07

*Plant exclusion area boundary distance.

**LOCA = loss-of-coolant accident; the TMI-2 accident was one kind of a small-break LOCA.

***See NUREG-0651 for descriptions of three steam generator tube rupture accidents that have occurred in the United States.

Table 5.10 Summary of atmosphere releases in hypothetical accident sequences in a PWR (rebaselined)

Accident sequence or sequence group**	Probability per reactor-yr	Fraction of core inventory released*						
		Xe-Kr	I	Cs-Rb	Te-Sb	Ba-Sr	Ru***	La†
Event V	2.0×10^{-6}	1.0	0.64	0.82	0.41	0.1	0.04	0.006
TMLB'	3.0×10^{-6}	1.0	0.31	0.39	0.15	0.044	0.018	0.002
PWR3	3.0×10^{-6}	0.80	0.2	0.2	0.3	0.02	0.03	0.003
PWR7	4.0×10^{-5}	6×10^{-3}	2×10^{-5}	1×10^{-5}	2×10^{-5}	1×10^{-6}	1×10^{-6}	2×10^{-7}

*Background on the isotope groups and release mechanisms is presented in Appendix VII, WASH-1400.

**See Appendix E for description of the accident sequences and release categories.

***Includes Ru, Rh, Co, Mo, Tc.

†Includes Y, La, Zr, Nb, Ce, Pr, Nd, Np, Pu, Am, Cm.

Note: See Section 5.9.4.5(7) for a discussion of uncertainties in risk estimates.

Table 5.11 Summary of environmental impacts and probabilities

Probability of impact per reactor-year	Persons exposed, over 200 rem	Persons exposed, over 25 rem	Population exposure, millions of person-rem 50 mi/ total	Latent* cancers, 50 mi/ total	Cost of offsite mitigating actions, millions of dollars
10^{-4}	0	0	0/0	0/0	0
10^{-5}	0	0	0.015/0.017	0/0	13
5×10^{-6}	0	1,400	2.0/13	170/870	470
10^{-6}	900	57,000	13/39	1,400/2,900	1,500
10^{-7}	22,000	170,000	25/76	3,500/5,700	3,100
10^{-8}	44,000	270,000	42/160	6,100/8,300	6,700
Related figure	5.3	5.3	5.4	5.5	5.7

*Includes cancers of all organs. Genetic effects would be approximately twice the number of latent cancers.

Note: See Section 5.9.4.5(7) for a discussion of uncertainties in risk estimates.

Table 5.12 Summary of early fatalities and probabilities

Probability of impact per reactor-year	Early fatalities for evacuation of EPZ	Early fatalities for evacuation of EPZ and relocation at 10-25 mi
10^{-4}	0	0
10^{-5}	0	0
5×10^{-6}	0	0
10^{-6}	0	0
10^{-7}	3,600	5
10^{-8}	19,000	470

Note: EPZ = emergency planning zone.

Table 5.13 Average values of environmental risks resulting from accidents per reactor-year

Environmental risk	Average value
Population exposure	
Person-rem within 50 mi	47
Total person-rem	170
Early fatalities	
Evacuation to 10 mi	0.0011
Evacuation to 10 mi plus relocation between 10 and 25 mi	0.00002
Latent cancer, fatalities	
All organs, excluding thyroid	0.0099
Thyroid only	0.0025
Cost of protective actions and decontamination	$7,100*

*1980 dollars.

Note: See Section 5.9.4.5(7) for discussions of uncertainties in risk estimates.

Table 5.14 Noise level predictions at receptor locations shown in Figure 5.10 resulting from the operation of Catawba Nuclear Station only

Receptor location	L_{eq} (dBA)	L_{dn} (dBA)	Overall (dBO)
A	45	51	60
B	43	49	58
C	27	33	47
D	16	23	39
E	26	32	46
1	50	56	64
2	60	66	72
3	49	55	63
4	28	34	48
5	26	32	46
6	15	22	39
7	24	31	45
8	17	24	40
9	27	34	47
10	35	41	53
11	32	38	50
12	20	27	42

Notes:
L_{eq} = equivalent sound level.
dBA = A-weighted sound level.
L_{dn} = day-night equivalent sound level.
dBO = overall unweighted sound level.

6 EVALUATION OF THE PROPOSED ACTION

6.1 Unavoidable Adverse Environmental Effects

The staff has reassessed the physical, social, and economic impacts that can be attributed to operation of the Catawba station. Such impacts, beneficial or adverse, are summarized in Table 6.1 of this draft environmental statement.

At the present time the staff foresees no impacts of a magnitude requiring mitigating actions. However, the applicant is required to adhere to the following conditions for protection of the environment:

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

(2) The applicant shall carry out the environmental monitoring programs outlined in Section 5 of this statement as modified and approved by the staff and implemented in Appendix B, Environmental Protection Plan (nonradiological), and Appendix A, Technical Specifications (radiological), that will be incorporated in the operating licenses for Catawba Units 1 and 2.

(3) If adverse environmental effects or evidence of irreversible environmental damage are detected during the operating life of the plant, the applicant shall provide the staff with an analysis of the problem and a proposed course of action to alleviate it.

6.2 Irreversible and Irretrievable Commitments of Resources

There has been no change in the staff's assessment of this impact since the earlier review except that the continuing escalation of costs has increased the dollar values of the materials used for constructing and fueling the plant.

6.3 Relationship Between Local Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity

There have been no significant changes in the staff's preconstruction evaluation of the relationship between environmental effects of short-term uses (construction and operation of the plant) and long-term productivity (FES-CP, Section 8). The conclusion that the dedication of resources for a nuclear generating plant at the Catawba site is consistent with the balancing of short- and long-term objectives for use of the environment is still valid.

6.4 Benefit-Cost Summary

The benefits and costs of operating the plant are summarized in Table 6.1, which provides the staff's assessments of degrees of benefit or cost, as well as magnitudes of impact where they are quantifiable. References that contain further information are indicated.

6.4.1 Benefits

A major benefit to be derived from the operation of the Catawba Station is the more than 12 billion kWh of baseload electrical energy which will be produced annually. This projection assumes that both units will operate at an average annual capacity of 60%. A generating unit's annual-capacity factor is the ratio of the amount of electrical energy produced in a year to the amount that is potentially available if the unit could operate at full capacity throughout the year. The unit operates at less than full capacity primarily because of scheduled and unscheduled maintenance outages, refueling outages, and full and partial forced outages. The combined effects of these outages have resulted in PWRs historically operating at about 60% average annual capacity factor. The staff believes that a capacity factor of 60% represents a reasonable projection for future PWRs.

The addition of the plant also will improve the applicant's ability to reliably supply the load requirements of customers in its service area by contributing 2290 MWe of generating capacity to the bulk power system.

Another benefit to be derived is the savings in overall system production costs which will accrue from the operation of the plant. A production costs analysis was submitted by the applicant (Duke Power Company, August 7, 1981) which projected annual system production costs for the years 1984 through 1990, with and without the Catawba units in service. The analysis assumed two different rates of system load growth--one with the applicant's projected annual growth rate of 4.0% and the other with energy load held constant at the 1980 level corresponding to a growth rate of zero. The average savings projected for the first full year of operation of both units are projected to be $310 and $47 million per year (1986 dollars), respectively, for the two load growth scenarios. The staff anticipates these savings will increase as the cost of replacement energy increases and improvement in each unit's capacity factor is realized.

The staff considers these estimates to be reasonable in light of the fact that replacement energy to service load, if the plant is not allowed to operate, will come primarily from coal-fueled generating facilities. The Department of Energy has estimated (Department of Energy, 1981) that the 1981 cost of providing energy for load from coal-fueled generating facilities rather than from nuclear generation, on the average, imposes about a $66 million penalty per unit per year, on the supplying system* ($132 million per year for a two-unit station). This amount appears to support the conclusion drawn in the applicant's analysis since the magnitude of this penalty already exceeds the minimum amount projected by the applicant for 1986.

---

*Assuming nuclear unit of comparable size and operating at 60% capacity factor.

6.4.2 Costs

6.4.2.1 Economic

The economic costs associated with station operation include fuel costs and operation and maintenance costs which are expected to average 8.6 mills per kWh (Duke Power Company, 1982, Table 1.3.1-3) and 3.8 mills per kWh (Duke Power Company, 1982, Table 8.2.1-2),* respectively, in 1986, the first full year of station operation.

The applicant's estimate of decommissioning costs for each Catawba unit totals $45 million in 1977 dollars (ER-OL).

6.4.2.2 Environmental and Socioeconomic

Changes in station design, operating procedures, and environmental data that were taken into consideration in this operating-license review have not led to significant increases in the environmental or socioeconomic costs over the corresponding costs that were estimated during the construction-permit review. The costs considered include those attributable to the uranium fuel cycle and to plant accidents. Such costs are either negligible or range from small to moderate.

6.4.3 Conclusions

As a result of the analysis and review of potential environmental, technical, economic, and social impacts, the staff has prepared an updated forecast of the effects of operation of Catawba station. No new information has been obtained that alters the overall balancing of the benefits versus the environmental costs of station operation. Consequently, the staff has determined that the station will most likely operate with only minimal environmental impact. The staff finds that the primary benefits of minimizing system production costs and increasing baseload generating capacity by 2290 MWe greatly outweigh the environmental, social, and economic costs.

6.5 References

Department of Energy, "Estimates of the Costs of Delaying Operating Licenses for Nuclear Plants," May 15, 1981.

---, "A Review of the Economics of Coal and Nuclear Power," draft, September 30, 1981.

Duke Power Company, "Catawba Station ER-OL," Rev. 2, August 7, 1981.

U.S. Nuclear Regulatory Commission, NUREG-0480, "Coal and Nuclear: A Comparison of Generating Base Load Electricity by Region," December 1978.

*Sum of 1981 fixed and variable operation and maintenance costs escalated at 10% per year. Escalation rate from U.S. DOE, "A Review of the Economics of Coal and Nuclear Power," p. IV-19.

Table 6.1 Benefit-cost summary for the Catawba plant

Benefit or cost (reference)	Magnitude or reference*	Staff assessment of benefit or cost**
BENEFITS		
Direct		
Electrical energy (Sec. 6.4.1)	12 billion kWh/yr	Large
Additional generating capacity (Sec. 6.4.1)	2290 MWe (design rating)	Moderate
Reduced generating costs (Sec. 6.4.1)	\$47-\$310 million/yr (1986)	Large
Indirect***		
Local property taxes (Sec. 5.8)	\$29.2 million/yr (1981)	Large
Employment (Sec. 5.8),	846 employees	Small
Payroll (Sec. 5.8)	\$14.5 million/yr (1984)	Small
Local service and merchandise purchases by utility (Sec. 5.8)	\$1.5 million/yr (1981)	Small
COSTS		
Economic		
Fuel	8.6 mill/kWh (1986)	Small
Operation and maintenance	3.8 mill/kWh (1986)	Small
Decommissioning	\$45 million (1977)	Small
Environmental and socioeconomic		
Resources committed		
Land (Sec. 4.2.2 and 4.2.7) (station and transmission lines)	1250 ha	Small
Water (Sec. 4.2.3)	10.7 m^3/sec	Small
Uranium - U_3O_8 (NUREG-0480)	About 8000 t	Small
Damages suffered by other water users		
Surface-water consumption	(Sec. 5.3)	Small
Surface-water contamination (chemical)	(Sec. 5.3)	Small
Surface-water contamination (thermal)	(Sec. 5.3)	Small

See footnotes at end of table.

Table 6.1 (Continued)

Benefit or cost (reference)	Magnitude or reference*	Staff assessment of benefit or cost**
Damage to Lake Wylie aquatic biota		
Impingement and entrainment	(Sec. 5.5)	Small
Thermal effects	(Sec. 5.5)	Small
Chemical discharges	(Sec. 5.3)	Small
Damage to terrestrial resources		
Fog and ice	(Sec. 5.4)	Small
Transmission line maintenance	(Sec. 5.2)	Small
Adverse socioeconomic effects		
Loss of historic or archeological resources	(Sec. 5.7)	Small
Traffic	(Sec. 5.8)	Small
Demands on public facilities and services	(Sec. 5.8)	Small
Demands on private facilities and services	(Sec. 5.8)	Small
Adverse radiological health effects		
Reactor operation on		
General population	(Sec. 5.9.3)	Small
Workers on site	(Sec. 5.9.3)	Small
Balance of fuel cycle	(Sec. 5.10)	Small
Accident risks	(Sec. 5.9.4)	Small

*Where a particular unit of measure for a benefit/cost category has not been specified in the environmental impact statement (EIS), or where an estimate of the magnitude of the benefit/cost under consideration has not been made, the reader is directed to the appropriate EIS section or other source for further information.

**Subjective measure of costs and benefits is assigned by reviewers, where quantification is not possible: "Small" - impacts that in the reviewers' judgments, are of such minor nature, based on currently available information, that they do not warrant detailed investigations or considerations of mitigative actions; "Moderate" - impacts that in the reviewers' judgments are likely to be clearly evident (mitigation alternatives are usually considered for moderate impacts); "Large" - impacts that in the reviewers' judgments, represent either a severe penalty or a major benefit. Acceptance requires that large negative impacts should be more than offset by other overriding project considerations.

***Indirect benefits are presented for information purposes only and are not included in the benefit/cost balance.

7 LIST OF CONTRIBUTORS

The following personnel of the U.S. Nuclear Regulatory Commission, Washington, DC, participated in the preparation of the Final Environmental Statement:

Kahtan Jabbour	Project Manager
Germain LaRoche	Environmental Review Coordinator
Dino Scaletti	Project Manager
Dee Gable	Editor
Mary Mejac	Editor
Marilee Duncan	Licensing Assistant
John Lehr	Sr. Environmental Engineer
Michael Masnik	Sr. Fishery Biologist
Nick Fields	Electrical Engineer
Brian Richter	Cost-Benefit Economist
Raymond Gonzales	Hydraulic Engineer
Sarbeswar Acharya	Environmental/Radiation Physicist
Jocelyn Mitchell	Nuclear Engineer
James Fairobent	Meteorologist
Edward Branagan	Health Physicist
Richard Codell	Sr. Hydraulic Engineer
Kenneth Dempsey	Nuclear Engineer
Jacques Boegli	Sr. Nuclear Engineer
Alvin Brauner	Siting Analyst
R. Wayne Houston	Assistant Director, Radiation Protection
David West	Nuclear Engineer
Steven Baker	Nuclear Engineer
Gerald Simonds	Emergency Preparedness Analyst
Argil Toalston	Chief, Antitrust and Economic Analysis Branch
Justin Long	Sr. Chemical Engineer
Martin Hum	Sr. Materials Engineer
Millard Wohl	Nuclear Engineer
Amarjit Singh	Auxiliary Systems Engineer
Morton Fleishman	Sr. Nuclear Engineer
Charles Macdonald	Chief, Transportation Certification Branch

8 LIST OF AGENCIES, ORGANIZATIONS, AND PERSONS REQUESTED TO COMMENT ON THE DRAFT ENVIRONMENTAL STATEMENT

The following Federal, state, and local agencies, organizations, and persons were asked to comment on the draft environmental statement:

Advisory Council on Historic Preservation
Department of Agriculture
Department of the Army, Corps of Engineers
Department of Commerce
Department of Energy
Department of Health and Human Services
Department of Housing and Urban Development
Department of the Interior
Department of Transportation
Environmental Protection Agency
Federal Emergency Management Administration
Governor of South Carolina
South Carolina Department of Health and Environmental Control
Catawba Regional Planning Council
County Manager of York County, South Carolina

9 STAFF RESPONSES TO COMMENTS ON THE DRAFT ENVIRONMENTAL STATEMENT

Pursuant to 10 CFR 51, the "Draft Environmental Statement Related to the Operation of Catawba Nuclear Station, Units 1 and 2" was transmitted, with a request for comments, to the agencies and organizations listed in Section 8. In addition, the NRC requested comments on the Draft Environmental Statement (DES) from interested persons by a notice published in the Federal Register on August 24, 1982 (47 FR 37009). The organizations and individuals who responded to the requests for comments are listed chronologically. The letters are reproduced in Appendix A of this FES. In parentheses, after the name of each commentor listed below, is the page number in Appendix A on which the comment letter begins and the section number herein that addresses the staff response to the comment letter.

U.S. Department of Agriculture, Economics Research Service, Velmar W. Davis, August 20, 1982 (A-1, no response).

South Carolina Department of Archives and History, Charles E. Lee, August 27, 1982 (A-2, 9.1).

University of South Carolina, Institute of Archeology and Anthropology, Robert L. Stephenson, September 9, 1982 (A-3, 9.2).

Charlotte-Mecklenberg Environmental Coalition, Intervenor, Henry Presler, September 19, 1982 (A-4, 9.3).

Palmetto Alliance and Carolina Environmental Study Group, Jesse L. Riley and Robert Guild, September 22, 1982 (A-10, 9.4).

U.S. Department of the Interior, Office of the Secretary, Bruce Blanchard, September 30, 1982 (A-27, 9.5).

William A. Lochstet, Ph.D., October 6, 1982 (A-30, 9.6).

U.S. Environmental Protection Agency, Sheppard N. Moore, October 6, 1982 (A-37, 9.7).

South Carolina Department of Health and Environmental Control, Larry E. Turner, October 7, 1982 (A-39, 9.8).

Duke Power Company (Comments), Hal B. Tucker, October 7, 1982 (A-42, 9.9).

South Carolina Project Notification and Review System, Danny L. Cromer, October 8, 1982 (A-56, no response).

U.S. Department of Health and Human Services, Food and Drug Administration, Bureau of Radiological Health, John C. Villforth, October 12, 1982 (A-57, 9.10).

Carolina Environmental Study Group, Jesse L. Riley, October 22, 1982 (A-59, 9.11).

U.S. Department of the Army, Corps of Engineers, Arthur P. Crouse, Jr., November 17, 1982 (A-62, no response)

Duke Power Company (Responses), Hal B. Tucker, November 19, 1982 (A-63).

The comments received from the U.S. Department of Agriculture, the U.S. Department of the Army Corps of Engineers, and the South Carolina Project Notification and Review System did not require NRC staff responses.

Included in the listing above are contentions from Intervenors, Charlotte-Mecklenburg Environmental Coalition and Palmetto Alliance and Carolina Environmental Study Group. These contentions were transmitted to, and considered by, the Atomic Safety and Licensing Board (ASLB) in the Catawba operating license proceeding. At the second prehearing conference held in Charlotte, North Carolina, on October 7 and 8, 1982, the staff offered to address the proposed contentions. The staff's responses are in Sections 9.3 and 9.4 of this FES.

Furthermore, the ASLB issued a Memorandum and Order dated December 1, 1982, regarding these proposed contentions. The ASLB, in its December 1, 1982 Memorandum and Order, asked the staff to address certain points related to several of the proposed contentions. The staff addresses these points in Section 9.4 in connection with its responses to the corresponding numbered comments.

The staff's consideration of the comments received and its disposition of the issues involved are reflected in part by changes in the text in the pertinent sections of the FES and in part by the responses in this section. In addition, the comments are referenced by the individual comment numbers noted in the margins of each of the 11 comment letters in Appendix A. The responses to the numbered comments in each letter are provided below in the order in which they appear in Appendix A; the page number for each letter in Appendix A is given in parentheses.

The applicant also was asked to respond to some of the comments received; these responses (transmitted by Duke Power Company letter of November 19, 1982) are included in Appendix A.

9.1 South Carolina Department of Archives and History (A-2)

Response to Comment #1

Construction with regard to the site area was completed sometime in 1979. The site, which is on private property and under easement to the applicant, is not expected to be adversely affected by the normal operation and maintenance of the transmission line as indicated in Section 5.7.

9.2 University of South Carolina, Institute of Archeology and Anthropology (A-3)

Response to Comment #1

See Response to Comment #1 in Section 9.1.

9.3 Charlotte-Mecklenburg Environmental Coalition (A-4)

Response to Comment #1

In response to Comment #1, the staff notes that the absolute risk model used by the staff does take into account the time cancers take to develop after tissue irradiation by use of latency periods in the model. The latency periods used by the staff varied from 0 to 15 years, the value depended on the type of cancer and age of exposure. In addition, as the staff stated in Section 5.9.3.1.1 of the DES, the use of the relative risk model (which is based on a percent increase in mortality rates per rad) would produce risk values up to about four times greater than those used in this report.

Response to Comment #2

This comment reflects a misunderstanding of the analysis in the DES since the staff used the linear nonthreshold hypothesis in estimating potential health impacts in the DES.

Response to Comment #3

In reponse to this comment, the staff notes that the authors of the comment have misinterpreted the analysis in the DES. The risk estimates in the DES are based on the linear nonthreshold models in the BEIR-I report, not the linear-quadratic model in the BEIR III report. In addition, the staff stated in Section 5.9.3.1.1 of the DES that the values used for estimating risks in the DES are consistent with the recommendations of a number of recognized radiation protection organizations, including BEIR-III and UNSCEAR. See response to Palmetto Alliance Comment #21 (Section 9.4).

Response to Comment #4

The staff is aware of Gofman's projections as well as projections by the major radiation protection organizations that were published after 1972 (e.g., ICRP-26 (1977), BEIR-III (1980), UNSCEAR (1977), and UNSCEAR (1982)). The genetic risk estimates contained in recent reports by the major radiation protection organizations do not support the contention that genetic risk estimates have substantially increased since the issuance of the BEIR I report in 1972. For example, the 1982 UNSCEAR report (p. 26) states,

> New experiments on the genetic effects of radiation have provided further scientific information for the assessment of the risk of radiation-induced hereditary diseases in man. They have also increased the Committee's confidence that the general assumptions,

and the estimation procedures used earlier for this purpose, remain valid in the light of current knowledge. They have not led to any substantial change in the previous estimates of genetic risk.

In summary, the genetic risk estimates that were used in the DES are consistent with the recommendations of the major radiation protection organizations.

9.4 Palmetto Alliance and Carolina Environmental Study Group (A-10)

Response to Comment #1

The partial meltdown at Fermi was discussed in Section 5.9.4.3 of the DES. It was concluded that this accident was of limited relevance to considerations of current power plants because of differences in design. There is no evidence that the fire at Browns Ferry caused any release. The DES never states the "serious accident" probability, but uses in the calculations the probability of "severe release." The uncertainties in this aspect of the calculation, as well as all the other aspects, are discussed in Section 5.9.4.5(7) of the DES.

Response to Comment #2

The estimate of the amount of sulfuric acid used at the Catawba station does not differ greatly from the amount evaluated in the FES-CP, p. 3-36 (also Section 4.2.3.4 of the DES). The value given in the DES is an estimate. The applicant has indicated in ER-OL Section 3.6.2 that operation of the closed cycle cooling system will vary in terms of the cycles of concentration in the system, which will be determined by the constituents in the makeup water and the recirculating cooling water. Thus, chemical treatment of the system, including acid addition, also will be likely to vary. The actual chemical treatment will be established on the basis of operating experience.

This chemical treatment is commonly applied to closed cycle cooling systems, including those of proposed and operating fossil fueled and nuclear power plants. The amount of sulfuric acid used is closely controlled and is important in plant operation because there is a cost associated with this treatment and because an excessive amount of acid addition, in combination with other factors such as insufficient alkalinity in the circulating water, would result in costly corrosive attack of the condenser system. The universal control objective for pH is to have the circulating water in the slightly alkaline range so that it will not be corrosive.

Cooling tower drift studies of operating nuclear power plants utilizing acid and biocide treatment of cooling waters have revealed no evidence of corrosive attack nor injury to nearby vegetation by free sulfuric acid in the drift. One of these studies (NUREG/CR-1231 for Palisades Nuclear Plant) indicated that excess sulfuric acid application resulted in vegetation damage from high sulfate concentrations in the drift; however, adjustment of the acid feed rate eliminated the problem.

It also should be noted that the composition of the cooling tower drift is the same as the circulating cooling water and the cooling tower blowdown. The pH of this water is required by provision of the Catawba Nuclear Station NPDES Permit (DES-OL App. I) to be within the range of 6.0 to 9.0 standard units. Compliance with this provision provides assurance against presence of excessive amounts of alkaline or acidic substances in these plant cooling system effluents.

The staff has required monitoring of the onsite and offsite effects of cooling tower drift by means of the NRC Environmental Technical Specifications and Environmental Protection Plans (EPPs) at operating nuclear power plants. These programs have been based on potential deleterious effects of sulfates and chlorides on vegetation, as documented in the scientific literature. Specifically for Catawba, the staff has recommended (Section 5.14.1 of the DES) that a cooling tower drift monitoring program be included in the EPP for the facility to detect actual changes to the terrestrial environment resulting from such drift. Thus, the staff has considered the potential for impact on the surrounding environment from cooling tower emissions in the Catawba DES, although the potential causes of such damage should not include free sulfuric acid.

Response to Comment #3

As indicated in the Section 4.2.3.4 of the DES, the applicant has proposed a change in biocide type since the FES-CP. Sodium hypochlorite will be used as a biocide rather than gaseous chlorine. This change in biocide form accounts for the difference in application rate, while attaining the same maximum biocide concentration in the cooling water that was evaluated in the FES-CP. The overall cooling water treatment process, that is, continuous acid addition and periodic chlorination, is the same as proposed and evaluated at the CP stage. Sodium hypochlorite is a commonly proposed and permitted biocide in steam electric generating station cooling waters.

Chlorine chemistry in natural waters is characterized by many competing reactions involving available chlorine. Above pH 6 the reaction products do not include molecular chlorine. The staff does not believe that chlorine gas will be present in the cooling tower plume during operation of the Catawba Nuclear Station.

The staff has required monitoring of the onsite and offsite effects of cooling tower drift by means of the NRC Environmental Technical Specifications and EPPs at operating nuclear power plants. These programs have been based on potential deleterious effects of sulfates and chlorides on vegetation, as documented in the scientific literature. Specifically for Catawba, the staff has recommended (Section 5.14.1 of the DES) the inclusion of a cooling tower drift monitoring program in the EPP for the facility to detect actual changes to the terrestrial environment resulting from such drift. Thus, the staff has considered the potential for impact on the surrounding environment from cooling tower emissions in the Catawba DES, although the potential causes of such damage should not include chlorine gas.

Response to Comment #4

Volumetric water flow rates for Catawba station were consistently expressed in English units only in the FES-CP. However, these volumetric flow rates were given in million gallons per day (i.e., "MGD"), as well as in cubic feet per second (i.e., "cfs"). In the DES, the expression of units conforms to a policy of reporting The International System of Units (SI) first, with more familiar units (i.e., English system) following in parentheses. In addition, effort was made to express volumetric flow rates in units either that (1) are conventionally used in expressing or evaluating such flows, or (2) are convenient for use in related calculations (e.g., expression of flow rate in m^3/sec when pipe are in m^2 is known to facilitate calculation of water velocity in m/sec), or (3) are convenient for comparison with previously presented data (e.g., the FES-CP).

The volumetric flow rates given in Section 4.2.3.2 of the DES are presented based on objectives (1) and (2) above. The biocide application rate also given in the DES is a material usage rate, not a flow rate as stated in the comment. This usage rate is stated for a single unit, easily converted to a two unit or station total by multiplication by two. The time unit in the flow rate expression was presented as a per day unit by the applicant. This basis is consistent with that used in the FES-CP. This basis is appropriate because the application is not planned to be continuous. Therefore, presenting the usage rate on a derived per minute or per second basis would not be representative of the actual use of the chemical. The remaining volumetric flow rates presented in Section 4 appear in Section 4.2.6.4 (Figure 4.2 and Table 4.1). These represent continuous usage by the station during operation and are appropriately given on a volume-per-unit-time basis.

These values do not conflict with other flow rate expressions given in the DES.

Response to Comment #5

The staff's position is that wide variations in capacity factors have been experienced among nuclear facilities of similar design. Also, from year to year, a particular unit's capacity factor may vary considerably. Because of these variations, it would be inappropriate to rely on the applicant's limited experience with operation of the McGuire facility to predict a lifetime capacity and energy level factor for the Catawba units. Section 6.4.1 has been modified to reflect the staff's assumptions in determining a capacity factor for the Catawba units.

Response to Comment #6

The staff has assumed the Catawba units will operate at a 60% capacity factor. This approximates a capacity factor that, on average, large nuclear units have experienced over their commercial operating lives. (Note the staff's response to Comment #5 of Section 9.4.)

The commentor also questions the need for the Catawba facility, based on the recent load-growth experience in the applicant's service area. The Commission, by rulemaking, removed issues related to need for power from consideration at the OL stage of the licensing review.

Response to Comment #7

Because the staff views any fixed expenses resulting from construction costs as "sunk" costs, capital cost considerations are not included in the OL review. These costs will be borne by one or more segments of the consuming public whether or not the plant is allowed to operate. The only economic costs appropriate for consideration at the OL stage are those related to station operation - the variable costs associated with fuel and operation and maintenance. These costs dictate whether the unit should be allowed to operate based on its relative economic advantage over existing facilities in the applicant's system.

Response to Comment #8

The underlying premise of intervenor's contention is that the operation of this facility is only justified if the energy to be provided is necessary to meet the electrical energy requirements of the applicant's customers. This is not the case. It can be demonstrated that electricity to be generated by the facility, if licensed, will substitute for electricity generated by less economical generating units available in the applicant's system. This substitution will result in substantial economic savings. The economic advantage will result even if the applicant's system should experience zero load growth.

The staff's determination of benefit is based on the same considerations identified in the Commission's rule (47 FR 12940) on "Need for Power and Alternative Energy Issues in Operating License Proceedings," which assumes that operation of the plant is justified as a substitute for more costly energy from other generating capacity. Ordinarily, this issue need not be addressed in the FES-OL.

Response to Comment #9

(1) Environmental Impacts of Routine Operations

The staff has considered the environmental impacts of spent fuel storage in a document entitled, "Final Generic Environmental Impact Statement on Handling and Storage of Spent Light Water Power Reactor Fuel" (NUREG-0575).

> The storage of spent fuel in water pools is a well established technology, and under the static conditions of storage represents a low environmental impact and low potential risk to the health and safety of the public. It makes little difference whether spent fuel is stored at a nuclear power plant or in an independent away-from-reactor facility designed for this purpose. This conclusion is based on existing water pool storage technology (NUREG-0575, p. ES-10).
>
> The storage of LWR spent fuels in water pools has an insignificant impact on the environment, whether at AR [at reactor] or AFR [away-from-reactor] sites. Primarily this is because the physical form of the material, sintered ceramic oxide fuel pellets hermetically sealed in Zircaloy cladding tubes. Zircaloy is a zirconium-tin alloy which was developed for nuclear power applications because of its high resistance to water corrosion in addition to its favorable nuclear properites. Even in cases where defective tubes expose the fuel material to the water environment, there is little attack on the ceramic fuel (NUREG-0575, p. ES-12).
>
> The technology of water pool storage is well developed; radioactivity levels are routinely maintained about 5×10^{-4} μCi/ml. Maintenance of this purity requires treatment (filtration and ion exchange) of

the pool water. Radioactive waste that is generated is readily confined and represents little potential hazard to the health and safety of the public (NUREG-0575, p. ES-12).

There may be small quantities of Kr-85 released to the environment from defective fuel elements. However, for the fuel involved (fuel at least one year after discharge), experience has shown this to be not detectable beyond the immediate environs of a storage pool (NUREG-0575, p. ES-12).

There will be no significant discharge of radioactive liquid effluents from a spent fuel storage operation as wastes will be in solid form (NUREG-0575, p. ES-12).

(2) Environmental Impacts of Accidents

Based on the RSS, the staff stated in Appendix E of the DES that the probabilities and release fractions were orders of magnitude less for fuel pool accidents compared to reactor accidents. The rough analysis in the RSS was based on spent fuel from one reactor in the pool that is made up of off-loads from the reactor and the fuel must be of increasing age.

Another scenario, a "greatest possible failure sequence," was considered for the fuel pool of a processing plant (Bachner, August 1976). The pool considered in this case is of comparable size to the Catawba expanded pool and is assumed to be filled with modules of 200 days cooling (the transshipped fuel from Oconee and McGuire will be of 5 years cooling). The authors calculated that the fuel would not be uncovered for 10 days following loss of cooling and makeup, consistent with other evaluations and allowing time for repair or replacement of equipment. The authors estimated release fractions of classes of elements, based on experiments that they note "can scatter to an order of magnitude," using "upper boundary values" of the releases and no credit for mitigative features. Following a similar evaluation of a reactor accident, the authors compared estimated doses. The authors finally concluded:

> In summary, it can be determined that with the parameters and model concepts used here, the effects of a total cooling failure in the case of a receiving store - BE [fuel pool]... and in the case of the reactor core, are approximately the same, to the extent that one considers the maximum values, i.e., in this case bone exposure. Admittedly, reference must be made to the fact that counter measures have been considered in no case in the present analysis. Since such counter measures are possible to a different degree with the studied failures, one should regard the present analysis as a comparison of the effects to be expected under pessimistic conditions, not however as a statement of risk under realistic conditions.

A wording change has been made to Appendix E to take account of these results for the pessimistic assumption case.

Response to Comment #10

The environmental impacts of spent fuel transportation have been properly considered in the context of the initial license proceedings for the Oconee and McGuire facilities. They need not be considered further.

Response to Comment #11

Based on the National Environmental Policy Act (NEPA) of 1969, Section 102(c)(i), the Commission considers the "environmental effects of the proposed action."

However, if the effects on a particular population of more than one reactor facility are desired, the methodology for obtaining them are as follows: the risk of a particular consequence at a certain distance from a particular plant is determined. This is multiplied by the probability that the plume would be carried to that population from that plant. It is added, then, to similar factors representing the risk of the same consequence to the same population (at a different distance from another plant) multipled by the probability that the plume would be carried from the other plant to the same population.

For example, Charlotte is about 11 mi northeast of Catawba and the probability that the wind blows from Catawba to Charlotte is about 0.13. Based on the staff's calculations for severe accidents, the expectation value for individual risk of early fatality in the interval between 10 and 12.5 mi from Catawba is 6.8×10^{-9}* per reactor year and for individual risk of latent cancer is 5.0×10^{-9} per reactor year. The calculations assume evacuation of the 10-mi EPZ only. Charlotte is about 15 mi south-southeast from McGuire, and the probability that the wind blows from McGuire to Charlotte is about 0.03. There is no calculation for McGuire of consequences of severe accidents. In the absence of any other information, if it is assumed that the probability of a consequence versus distance from Catawba can be applied to McGuire, the individual risk of early fatality in the interval between 15 and 17.5 mi from the McGuire plant is 4.5×10^{-11} per reactor year and the risk of latent cancer is 1.7×10^{-9} per reactor year. To the extent that meteorology is similar at McGuire compared to Catawba, the Catawba values of risk can provide a perspective for McGuire risks.

It can be seen that at Charlotte, using the assumptions stated, the increase in risk of early fatality per reactor year considering McGuire compared to the calculations presented in the DES for Catawba is less than 1% and the increase in latent cancer risk per reactor year is about 10%. Both of these increases are well within the uncertainties of the calculations for Catawba alone.

Response to Comment #12

The nuclides listed in Table 5.8 in Section 5.9.4.5(2) of the DES are those nuclides that have the major impacts to the public from severe accidents. N-16 was not included in this list, or in the computation, because of its short half-life (7.1 sec). About 10^4 Ci of N-16 would be present in the coolant at the time of reactor shutdown. The processes by which the coolant can be blown down to release the inventory of N-16 to the environment are slow in comparison with the N-16 half-life. Further, in order for the N-16 to reach the Exclusion Area Boundary (EAB, 762 m) before its decay, the wind must be blowing with speeds ranging to 30 mph. But this high windspeed also will blow the cloud of N-16 past a hypothetical receptor at the EAB, causing a minimal dose. On the other hand, a slow windspeed, which would imply that a potential receptor at the EAB

*See Section 5.9.4.5(7) for a discussion of the uncertainties in these calculations.

would remain in the cloud for an increased time, also would allow significant additional decay.

Response to Comment #13

The staff's statement that "offsite radiation levels are continuously monitored with the thermoluminescent detectors (TLDs)" is correct. However, as is stated in BTP-RAB (November 1979, Revision 1), the TLDs are analyzed on a monthly or quarterly basis rather than a contemporaneous basis. A copy of the BTP, as well as other references, was provided to the Palmetto Alliance in response to the second set of interrogatories on Palmetto Alliance Contention 27.

Response to Comment #14

Several of the general statements in this comment reflect some misunderstanding regarding NRC policy and positions. Therefore, the staff has attempted to provide more detail on some of these concerns.

First, the comment states that the "dose commitments [in Section 5.4.3.1 in the DES for the operating license (OL)] differs [sic] from those in the CP-FES." Since the FES-CP was issued in 1973, whereas the DES for the operating license was issued in 1982, it is not surprising that both the data base and the models used to estimate doses have changed.

Although there have been some minor differences in the dose estimates, the basic conclusion of the FES-CP permit still holds (i.e., "no significant environmental impacts are anticipated from normal operational release of radioactive materials." (FES-CP, p ii).

Second, it is stated that "we doubt the correctness of this assumption [i.e., "the midpoint of station operation represents an average exposure over the life of the plant"]." Section 5.9.3 of the DES states that the models and the radiation dose calculations are discussed in the October 1977, Rev. 1 of Regulatory Guide 1.109, "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I."

The staff's models do take into account the buildup of radionuclides in the environment. For example, equation C-5 of Regulatory Guide 1.109 contains two terms that take into account the two major pathways for airborne radionuclides to enter vegetation (and subsequently meat and milk): (1) direct aerosol deposition, and (2) soil-to-plant uptake. The value for the direct aerosol deposition term is constant for a particular radionuclide and is independent of the year of release. The value for the soil-to-plant uptake term is a variable that increases with the number of years of reactor operation to take into account the buildup of radioactive materials in the soil. Since direct aerosol deposition accounts for the majority of the doses from ingesting food, the doses estimated for the last year of operation would be only slightly greater than the doses estimated for either the first year of station operation or the midpoint of station operation.

In addition, Tables A-1 and E-1 of Regulatory Guide 1.109 contain environmental transfer factors that take into account the buildup of radioactive materials in aquatic and terrestrial food, respectively. In summary, the models in Regulatory Guide 1.109 take into account the buildup of radioactive materials in the environment, and "...the midpoint of station operation represents, an average exposure over the life of the plant."

Third, the comment quotes part of Section 5.9.3.1 of the DES that states "...most of the internal dose commitment for each nuclide is given during the first few years of exposure...," and notes that Palmetto Alliance views Sr-90 "as a significant exception to this approach." In response, the staff notes that the text in Section 5.9.3.1 of the DES reads as follows:

> However, with few exceptions, most of the internal dose commitment for each nuclide is given during the first few years after exposure because of the turnover of the nuclide by physiological processes and radioactive decay.

The dose from inhalation or ingestion of Sr-90 is one of the exceptions referred to in Section 5.9.3.1 of the DES. In addition, it should be noted that the dose from inhalation and ingestion of Sr-90 account for only a small fraction of the estimated dose to the bone of the maximally exposed individual (see Table D.7 in Appendix D of this statement).

Response to Comment #15

This comment states that a statement in the DES (i.e., "fission product noble gases... do not deposit on the ground nor are they absorbed and accumulated within living organisms; therefore, the noble gas effluents act primarily as a source of direct external radiation...") is "literally correct, yet quite misleading." As support for the comment, the comment refers to some of the radioactive noble gases listed in DES Table 5.8 and some of the decay products of these noble gases. The comment implies that some of these decay products are important sources of exposure.

Section 5.9.3.1.2 of the DES refers to dose estimates for exposures to radioactive effluents from routine releases of radioactive materials. Calculated releases of radioactive materials in gaseous effluents from routine releases from Catawba are given in Table D.1 of Appendix D, not Table 5.8, which was erroneously listed in the comment.

Four radionuclides (i.e, Xe-133, Kr-85, Ar-41, and Xe-135) account for over 95% of the quantities of noble gases estimated to be released from Catawba (see Appendix D, Table D.1). The three radionuclides estimated to be released in the largest quantities (i.e., Xe-133, Kr-85, and Ar-41) decay to stable elements (i.e., Cs-133, Rb-83, and K-41, respectively), and consequently their daughter products are not a source of exposure from being deposited on the ground. The fourth largest radionulide (i.e., 21 Ci of Xe-135) decays with a half-life of about 9.1 hours to Cs-135, which as a half-life of about 3,000,000 years. The activity of Cs-135 is approximately equal to the product of the activity of Xe-133 and the ratio of the half-life of Xe-133 (i.e., 9.1 hours) to the half-life of Cs-135 (i.e., about 2.6 x 10^{10} hours) (Cember, 1969). Using the preceding equation, 21 Ci of Xe-135 will decay to about 7 x 10^{-9} Ci of Cs-135. This quantity of Cs-135 is insignificant compared with the estimated quantities of radioactive particulates (i.e., about 0.04 Ci of particulates) that are listed in Table D.1 and which have been included in the dose estimates in the DES and FES. In summary, the referenced statement in the DES [i.e., "the noble gas effluents act primarily as a source of direct external radiation emanating from the effluent plume"] is correct and is not "misleading."

Response to Comment #16

Aircraft hazards are assessed during the safety review and, in the case of Catawba, the staff will conclude and will report in the SER that the probability of an aircraft crash onto the plant is within the acceptance criteria of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," which is less than 10^{-7} per year.

Response to Comment #17

Section 5.9.4.5 of the DES discusses three calculations of reactor accidents: realistic assessments of design basis events, safety evaluations of design basis events, and severe accidents. In the first case, among other assumptions, average meteorological conditions are assumed. In the second, meteorological conditions are assumed that produce calculated doses at the EAB that would not be exceeded more than 5% of the time because of other meteorological conditions at the site. For the third case, hour-by-hour meteorological conditions are followed to the conclusion of consequence calculations for each accident for each start time. To the extent that atmospheric inversions and quiet air are common in the area, they will be appropriately reflected in average meteorological assumptions, will cause the 5% meteorology to produce large calculated EAB doses, and should be sampled in the stratified plan used in calculations of severe accidents. The stratified plan was chosen so that all seasons and all hours of the day were represented.

Response to Comment #18

The emergency planning requirements and associated guidance relating to provisions for taking protective actions for the public envision the use of "relocation centers" for evacuees from the plume exposure emergency planning zone (EPZ). The centers are to be established by the state and local organizations in host areas located at least 5 mi, and preferably 10 mi, beyond the boundaries of the plume exposure EPZ and are to be equipped with the capability for registering and monitoring all the residents and transients in the plume exposure EPZ that arrive at the relocation centers. (See 10 CFR 50.47(b)(10) and NUREG-0654, Revision 1, Planning Standard J.) These locations are not required to have housing facilities for the permanent relocation of evacuated personnel. Housing of evacuated personnel would be performed on an ad hoc basis as in any major natural disaster.

Regarding the comment that the "non-monetary" impacts of location are not considered, this issue falls within the area of psychological stress impacts and, as such, was not considered in connection with the Catawba reactors for the reasons stated in Section 5.9.4.1 of the DES.

Response to Comment #19

Once the 5-year-old spent fuel from the Oconee and McGuire nuclear power stations is in the Catawba spent fuel pool, it will not cause any detrimental environmental impacts because the spent fuel pool has been designed to prevent the escape of the more radioactive Catawba spent fuel. Therefore, the validity of the favorable cost-benefit balance struck at the construction permit phase has not been compromised.

The environmental impacts of Oconee and McGuire spent fuel transportation are accounted for as stated in Appendix G (see response to Comment 10). Measures that provide assurance that casks meet the standards of 10 CFR 71 are contained in the quality assurance regulations of 10 CFR 71.24 and 71.51 and in Appendix E to 10 CFR 71.

Regarding the need for and the benefit from the transshipment and storage of spent fuel from other plants at Catawba, the applicant stated in the Final Safety Analysis Report, Section 9.1.2.4, that in the event Duke experiences a limitation in spent fuel storage of other nuclear facilities, alternative means of accommodating further storage must be explored. One alternative is the storage of some Oconee and McGuire spent fuel assemblies in the Catawba fuel pools.

Response to Comment #20

The Catawba and McGuire Nuclear Power Stations both have Westinghouse Model-D steam generators. However, McGuire Unit 1 has the Model D-2 and McGuire Unit 2 has the Model D-3. Catawba Unit 1 has the Model D-3 and Unit 2 has the Model D-5. Both the Model D-2 and D-3 are similar in design and are being evaluated together by the NRC staff. Because of a different arrangement in the internal baffling plate, the Model D-5 has a different flow pattern for the main feedwater flow than the Model D-2 or D-3. Westinghouse expects that some modification will be required for all three models of steam generators.

The Duke Power Company has scheduled to perform a modification of the McGuire Unit 1 steam generators during the spring of 1983. A similar modification is expected to be performed at McGuire Unit 2 before startup during 1983. On the basis of a construction completion schedule for Catawba Unit 1 of October 1984, the NRC staff expects that a modification of the steam generators will be performed before plant startup. The NRC staff also expects that modifications, if necessary, will be performed on the Catawba Unit 2 steam generators before startup. Therefore, the NRC staff concludes that the issue of substantial reduction of the level of operation as a result of rapid degradation of the Catawba steam generator tubes is not valid (also see Response to Comment #5, Section 9.4). Thus, the cost-benefit analysis is not affected.

Response to Comment #21

Because the comment does not provide specific references to publications, the staff can respond only in general terms. The environmental transport, dosimetry and health effects models that have been used by the staff are described in Section 5.9.3 of the DES. The appropriate references for the models are included in the text. These models have been used in analyzing the impacts from numerous commercial nuclear power plants and have been defended successfully in numerous public forums.

Responses to Comments #22

(a) Because the publication of WASH-1400 and its subsequent critique by many authors, including Lewis et al., the methodology of the RSS has been reviewed, improved, and expanded. A "benchmarking" program has begun, where the code used in the RSS and several other similar codes from several international groups are compared. Considering the uncertainties, these codes produce qualitatively comparable results.

The "smoothing" technique as applied in the RSS is discussed in Section 4.1.2 of Appendix V to WASH-1400. Briefly, the process involves the following: after establishing the probability of a release category, based on the summation of the probabilities of all the accidents comprising the category on a "best estimate" basis, 10% of that probability was added to the next more severe and to the next less severe release category and 1% was added to the second more severe and to the second less severe release category. But "because of the minor change compared to the uncertainties," the original "best estimate" value was retained in the original release category (versus 0.78 times the probability as conservation of the total might imply).

In Section II.I of NUREG/CR-0400, the technique of "smoothing" was addressed as one of the major criticisms of the statistical and probabilistic calculations. The report states:

> For categories with small intrinsic probabilities, this 10% addition is overwhelmingly the dominant contribution. Thus the procedure artificially increases the overall risk estimate and lowers the precision as well. While the numerical effect of 'smoothing' is not large, the procedure is nevertheless arbitrary, unnecessary, and plain wrong, and had it produced the effect of reducing rather than increasing the risk estimate, would have generated an outcry.

The probabilities given in Table 5.10 of the Catawba DES are "best estimate" probabilities, that is, the technique of "smoothing" has not been applied.

In calculation of the economic consequences of the loss of the facility, the staff had incorrectly equated the probability of severe release with probability of core melt. Section 5.9.4.5(6) has been appropriately revised.

(b) Section 5.9.4 of this FES is used to give a perspective of the risks from operation of the Catawba plants. Appendix E states that in the absence of a plant-specific accident sequence analysis for Catawba, the Surry accident sequence analysis provides an adequate representation.

If the concern of containment failure resulting from hydrogen burning is alleviated by suitable hydrogen control, then the response of the Catawba containment to challenges by reactor accidents is comparable to that of a "large dry" containment like Surry's.

The following provides a brief description of the pending hydrogen control rulemaking.

During Affirmation Session 81-43 on November 24, 1981, the Commission approved a notice of proposed rulemaking for publication in the Federal Register. The notice was published on December 23, 1981, and allowed 60 days for a public comment period, which expired on February 22, 1982. A notice of extension of comment period, including editorial corrections, was published on February 25, 1982 (47 FR 8203) and extended the comment period for an extra 45 days to April 8, 1982. The proposed rule would require that

- each boiling water reactor with a Mark III type containment and each pressurized water reactor with an ice condenser type containment be provided with a hydrogen control system capable of handling an amount of hydrogen, equivalent to that which would be generated if there were at least a 75% fuel cladding-water reaction, without loss of containment integrity

- each boiling water reactor (BWR) and each pressurized water reactor (PWR) that does not rely on an inerted atmosphere for hydrogen control be provided with safety systems, needed to establish and maintain safe cold shutdown and maintain containment integrity, that can function after the burning of substantial amounts of hydrogen

- analyses be performed for the reactor categories mentioned above to justify the hydrogen control systems selected and to ensure containment structural integrity and survivability of needed safety systems during a hydrogen burn

In response to the notice of proposed rulemaking, comments were submitted by 28 persons.

The staff is currently preparing a Commission paper transmitting a final rule for consideration. The staff is considering recommending to the Commission that the rule be limited only to Mark III BWRs and ice condenser PWRs.

(c) The Catawba FES Section 5.9.4.5(3) discusses several accident scenario evacuation cases. FES Figure 5.6 and Table 5-12 show probabilities and consequences for two cases, representing two possible protective actions. The first case assumes early evacuation of the entire 16 km (10 mi) plume exposure pathway EPZ, the model is more fully discussed in Appendix F. The second case assumes in addition early relocation of the population between 10 and 25 mi from the plant after passage of the plume. This is considered to be a possible response to significant ground contamination in the relatively restricted "footprint" from passage of the cloud.

Appendix F discusses two additional cases, with complementary cumulative distribution functions for early fatalities shown in Figure F.1. One case involves evacuation to 24 km (15 mi). A more pessimistic case is also shown in which no early evacuation is assumed, and all persons are exposed for the first 24 hours following an accident and then relocated. For all cases involving evacuation, the analysis is on the basis of an effective evacuation speed that is derived from the evacuation time estimate submitted by the applicant. Regarding assumptions relating to supportive medical treatment, Appendix F discusses the impact upon the risk of early fatalities of using an assumption based on minimal as opposed to supportive medical care. Therefore, since the above cited cases cover more than the single scenario cited by the Intervenor, and since the staff has performed analysis of a much more pessimistic nature as described in Section 5.9.4.5(3) and Appendix F, the staff concludes that no further analysis is required at this time (also see Section 9.9, Response to Comment #35).

Response to Comment #23

The staff continues to rely on the Final Table S-3 rule because the Commission recently issued a Statement of Policy directing Licensing Boards to continue to rely on the Final Table S-3 Rule until further order from the Commission, provided that any license authorizations or other decisions issued that rely on the rule are conditioned pending the final outcome of the judicial proceeding.

9.5 U.S. Department of the Interior (A-27)

Response to Comment #1

The Office of the Regional Director, Southeast Region, National Park Service (NPS) was contacted as requested. Mr. Steve Price, an environmental compliance specialist at the NPS, was informed that the cognizant Park Ranger and the staff both agreed that no significant impacts would result from the operation and maintenance of the transmission line.

Response to Comment #2

The statements in Section 5.3.2.2 referred to in this comment have been revised based on comments on this section provided by the South Carolina Department of Health and Environmental Control. The thermal discharges from Catawba Nuclear Station have been judged by the state to be consistent with their mixing zone policy (see Comment #1 of the South Carolina Department of Heatlh and Environmental Control, Section 9.8). Therefore, there is no remaining statement in the FES that state water quality standards will be violated during station operation.

Response to Comment #3

Section 5.14.2 of this statement addresses nonradiological aquatic monitoring programs. The South Carolina Department of Health and Environmental Control has the authority under the Clean Water Act to impose nonradiological monitoring programs on the applicant. The NRC defers to the state with regard to imposing studies to determine the impact of plant operation on the aquatic environment.

9.6 William A. Lochstet (A-30)

Response to Comment #1

The major difference between the staff's estimated number of health effects from radon-222 emissions and Lochstet's estimated values is the issue of the time period over which dose commitments and health effects from long-lived radioactive effluents should be evaluated. Lochstet has integrated dose commitments and health effects over what amounts to an infinite time interval, whereas the staff has integrated dose commitments from radon-222 releases over a 100-year period, a 500-year period, and a 1,000-year period.

The staff has not estimated health effects from radon-222 emissions beyond 1,000 years for the following reasons. Predictions over time periods greater than 100 years are subject to great uncertainties. These uncertainties result from, but are not limited to, political and social considerations, population size, health characteristics, and, for time periods on the order of thousands of years, geologic and climatologic effects. In contrast to Lochstet's conclusion, some authors estimate that the long-term (thousands of years) impacts from the uranium used in reactors will be less than the long-term impacts from an equivalent amount of uranium left undisturbed in the ground (Cohen, 1979). Consequently, the staff has limited its period of consideration to 1,000 years or less for decision-making and impact-calculational purposes.

Response to Comment #2

Probabilistic Risk Assessment, the methodology of the Reactor Safety Study (RSS) (NUREG-75/014), is constantly being reviewed, extended, and improved by numerous workers throughout the world. It can and should be used to give a perspective of the risks from reactor accidents. The discussion of uncertainties in Section 5.9.4.5(7) should be noted in this regard.

The second reference in Appendix E contains a more detailed discussion of the process of rebaselining.

A statement has been added to Section 5.9.4.5(2) to clarify the extent of the calculation.

9.7 Environmental Protection Agency (A-37)

Response to Comment #1

The NPDES outfall serial number labeling suggested in the comment has been incorporated in the FES text.

Response to Comment #2

This is a comment on the provisions of the state-issued NPDES Permit, not under the control of the NRC. The staff notes that the provision referred to in the comment is consistent with the wording of the "Effluent Guidelines and Standards of Performance for the Steam Electric Generating Point Source Category of the U.S. Environmental Protection Agency" (40 CFR 423).

Response to Comment #3

The staff agrees with this comment. The title of Appendix I and the listing of it in the Table of Contents has been changed. As indicated in Section 5.3.2.2, the station NPDES permit has expired, but has been administratively extended, pending the issuance of the final industry category Effluent Guidelines and New Source Performance Standards by the U.S. Environmental Protection Agency. Even though it is subject to review and revision when the above mentioned EPA regulations are issued the permit is, nonetheless, effective for the purposes of the South Carolina Department of Health and Environmenttal Control (SCDHEC) regulations.

9.8 South Carolina Department of Health and Environmental Control (A-39)

Response to Comment #1

The suggested clarifications and rewording have been made to the portions of Section 5.3.2.2 addressing the areas of Lake Wylie that are projected to have temperatures in excess of those permitted by the state numerical water quality standards.

Response to Comment #2

The staff's statement (Section 5.9.4.5(5) of the DES) that there would be one major municipal water user affected by contamination of the Catawba River system was not intended to imply that this would be the only water user affected. In determining population doses for the Catawba site, the staff used an estimate of the total population that would be affected and not just the Charleston population. However, the staff has performed a reevaluation of its conclusions in Section 5.9.4.5(5) of the DES, using more current population figures. The results of this reevaluaton do not change the staff's earlier conclusion in the DES that the Catawba liquid pathway contribution to population dose would be the same order of magnitude as that predicted for the LPGS small river site and that the Catawba site is not unique in its liquid pathway contribution to risk.

Response to Comment #3

The staff's statement in Section 5.9.4.5(5) of the DES that the City of Charleston, South Carolina, draws about 10% of its water from Lake Moultrie has been deleted because the city does not have an intake on the Lake. However, the staff in its analysis, conservatively assumed that in the future, Charleston will obtain part of its water supply from the Cooper River, which receives its water from Lake Moultrie via the Durham Canal.

9.9 Duke Power Company (A-42)

Response to Comment #1

Section 4.2.4.5 has been revised to delete the reference to sanitary wastes in the description of the low-pressure service water (LPSW) discharge structure. Section 4.2.6.4 has been revised to indicate that treated sanitary wastes will be released into the discharge canal through an outfall adjacent to the discharge structure.

Response to Comment #2

The description of the contents of Table 4.4, presented in Section 4.2.4.6, has been corrected to reflect this comment.

Response to Comment #3

The description of the water use of the fire protection system, presented in Section 4.2.4.6, has been clarified.

Response to Comment #4

The reference to the discharge flow rate from the conventional waste-water-treatment system (CWWTS) in Section 4.2.6.3 has been changed to 1,135 l/min (330 gpm).

Response to Comment #5

The sanitary-waste-treatment system influent volume, as referenced in the first paragraph of Section 4.2.6.4, has been changed to reflect the revision in estimated average influent during operation from 45 l/min (12 gal/min) to 132 l/min (35 gal/min). The resulting daily volume estimate has, therefore, been changed from 6.4×10^4 l/day (17,000 gal/day) to 1.9×10^5 l/day (50,000 gal/day).

Response to Comment #6

The statement in Section 4.2.6.4 regarding chlorination of the sanitary-waste treatment system effluent has been revised to reflect this comment.

Response to Comment #7

The suggested change to the statement in Section 4.3.2 regarding the second-year preoperational study has been made.

Response to Comment #8

The suggested change to the statement in Section 4.3.2 concerning the applicant's analysis of data from the interim study has been made.

Response to Comment #9

The statement referred to in the comment represents one of the "Findings" contained in the referenced report. The complete "Findings" statement reads as follows: "Chemical water analyses indicate no areas (within those tested) which would be of particular or immediate concern to the fishery resources of the lakes...." It would be inappropriate to change the paraphrased conclusion of the South Carolina Wildlife and Marine Resources Department report.

Response to Comment #10

The applicant's clarifying statement, as given in the comment, has been added to their earlier conclusions, as presented in Section 4.3.2 of this statement.

Response to Comment #11

The text in Section 4.3.4.2 has been changed to agree with the comment that the quillback and longnose gar are not really dominant species from an abundance standpoint.

Response to Comment #12

The text in Section 4.3.4.2 has been changed to agree with the comment that threadfin shad account for 27.2% of the total collected.

Response to Comment #13

The spelling of "destratification" in Section 4.3.4.2 has been corrected.

Response to Comment #14

As indicated below the figure title Figure 4.3 is taken from the applicant's ER-OL. The locations of the structures referred to by the various figure notations have been clarified on the figure. The clarifications of the routing of the various discharges indicated in the comment have been made in the FES text.

Response to Comment #15

The footnotes for Table 4.4 have been modified to account for this comment and to account for an omission in wording in the second listed footnote concerning waste water discharge.

Response to Comment #16

The Environmental Protection Plan will provide the specific requirements that are given in a general form in Section 5.1 of this statement. The staff, therefore, has not changed the wording from the DES.

Response to Comment #17

The discharge values in Section 5.3 have been changed to agree with the proposed corrections.

Response to Comment #18

The area percentages in Section 5.3 have been changed to agree with the proposed corrections.

Response to Comment #19

The flow value in Section 5.5.2.1 has been changed to agree with the proposed corrections.

Response to Comment #20

The area value given in the DES was incorrect. The value proposed by the applicant in their comments also was incorrect because it pertained to the 32.2°C (99°F) isotherm and not to the 2.8°C (5°F) ΔT. The correct value of 36 ha (90 acres) has been included in Section 5.5.2.2.

Response to Comments #21 through #26

These comments concern the writing style and clarity of the referenced sections in the DES. The staff has considered Duke's suggestions and incorporated them as appropriate in the FES.

Response to Comment #27

The focus of Section 5.9.4.3 is on accidents that have resulted in fuel melting. Comprehensive reviews of the other accidents can be found in the documents referenced in the DES text.

Response to Comment #28

The text in Section 5.9.4.4(2) regarding the populations of Rock Hill, South Carolina, and Charlotte, North Carolina, has been changed to agree with the proposed correction.

Response to Comment #29

The typographical error in Section 5.9.4.5 regarding reference to the Midland site has been corrected.

Response to Comment #30

The NRC requires notification of important events causally related to station operation that could result in a significant environmental impact irrespective of the requirements of other agencies. The staff, therefore, does not recognize the need to indicate what notification programs are required through permits and commitments to other agencies.

Response to Comment #31

At the time Section 5.14.3 of the DES was written, the applicant had not submitted the details of the supplemental meteorological measurements program that was requested by the staff to determine possible effects of the 40 m tower structure on meteorological measurements. Common instrument-siting practice is to assume that measurements made at a height of one tower width above the tower will be uninfluenced by the tower structure. The staff assumed that the applicant would locate the supplemental sensors at a height clearly uninfluenced by the tower structure. However, the applicant chose to locate the sensors at a height of 3.9 m above the tower (compared to a tower width of 6.4 m).

Response to Comment #32

Values in Table 5.3 have been changed to conform with the values presented in Attachment 1 (included in Appendix A) of the applicant's comments on the DES.

Response to Comment #33

The typographical error in Table D.6 has been corrected in the FES.

Responses to Comments #34

In response to the comment relating to Table D.8, the staff notes that although the 10 CFR 50, Appendix I, annual dose design objectives do not specifically include the doses from exposures to C-14 and tritium, C-14 and tritium are released from the plant and would contribute to the total dose to a maximally exposed individual. For the sake of completeness, doses from exposures to C-14 and tritium are included in the estimated doses in Table D.8 (as well as in other tables in the FES). The doses from exposures to C-14 and tritium have been included in the iodines and particulates category, because the pathways for exposures to C-14 and tritium are more similar to the pathways for exposures to radioiodines and particulates, rather than the pathways for exposure to noble gases.

In response to the comment relating to page D-12, the staff has reviewed the estimated doses to the maximally exposed individuals listed in Table D.8 (as well as the supporting Tables in Appendix D) of the DES, and the estimated doses to the maximally exposed individuals listed in CNS/ER/OLS Table 5.2.4-1 (as well as the supporting tables in Sections 5.2, 5.3, 2.3 and 2.1) and notes the following:

(1) The staff's estimated doses/site from exposure to radioactive noble gases are about 90 times greater than Duke Power Company's estimates.

(2) The staff's estimated doses/site from exposure to radioiodines and particulates is about 34 times greater than Duke's estimates.

(3) The staff's estimated dose/site from exposure to radioactive liquid effluents (3 mrem, Table D.8) is lower than Duke's estimated dose/site (i.e., 3.4 mrem, Table 5.2.4-1).

The differences between the estimated doses in Table D.8 of the DES and Table 5.2.4-1 of the ER are due mainly to differences in the following factors: (1) meteorological dispersion models, and (2) the location of the nearest exposure pathways (i.e., special locations).

In regard to factor (1), the differences between the doses presented in Appendix D, Table D.8, of the DES and those presented in Table 5.2.4-1 of the Catawba Environmental Report (ER) may be largely attributable to the differences in atmospheric dispersion models used by the staff and by the applicant. As stated in Appendix D of the DES, the staff considered releases through the unit vents as ground level because the tops of the vent stacks are beneath the tops of adjacent structures. This practice is in accordance with the criteria contained in Regulatory Guide 1.111. The applicant failed to provide the staff with sufficient justification that releases from the unit vents at Catawba would escape the building wake cavity and remain elevated a large fraction of the time. However, the applicant assumed that releases through the unit vents would be a combination of elevated and ground-level releases. The differences between the staff's approach and that of the applicant is about a factor of 10 (even higher for the nearest site boundaries) in the calculation of relative concentration (X/Q) and relative deposition (D/Q) values. The magnitude of the difference diminishes with increasing distance from the station. A minor source of difference is that the staff based its evaluation of atmospheric dispersion on wind speed and wind direction measurements at the 10-m level while the applicant used data from the 40-m level for its evaluation.

Because of the independent evaluation performed by the staff to ensure compliance with the dose guidelines contained in 10 CFR 50, Appendix I, the staff expects some differences between its estimated doses and the applicant's estimated doses.

In regard to factor (2), the dose estimates in Appendix D, Table D.8, of the DES are based on a land use survey performed in November 1981 by Duke Power Company. This information was provided by Duke in response to a staff request to confirm and/or update the special locations listed in ER Table 2.1.3-1. The special locations are documented in ER Table 2.1.3-1, Rev. 5. The dose estimates in the most recent copy of Catawba Nuclear Station ER/OLS Table 5.2.4-1 (i.e, Rev. 1) are based on an earlier land use survey.

Response to Comment #35

Appendix F and the main text present calculated early fatalities with four assumptions of the emergency response by the public. Only one of those, the evacuation to 16.1 km (10 mi), represents the present plans. The others are more optimistic or more pessimistic as to the achieved response and are given to provide a perspective of the range of effects that could be expected from a range of responses. In no way does the appendix "require" any additional planning.

Response to Comment #36

The discussion contained in Appendix G of the DES has been deleted. See the revised discussion in Appendix G of this FES.

Response to Comment #37

See Response to Comment #36.

9.10 U.S. Department of Health and Human Services, Food and Drug Administration, Bureau of Radiological Health (A-57)

Response to Comment #1

Based on calculations performed for the Fermi Unit 2 Environmental Statement, the staff has shown that the individual and societal doses from the waterborne pathway from atmospheric fallout can be substantially eliminated by interdiction of the aquatic food pathway. Since the Fermi plant is located on the shores of the Great Lakes and Catawba is located away from a large-surface water body, the waterborne pathway from atmospheric fallout is correspondingly reduced. A change has been made in Section 5.9.4.5(3) of this statement to clarify this point.

Response to Comment #2

Duke Power Company refers to its Emergency Operation Facility as a Crisis Management Center and it is located onsite.

Response to Comment #3

The staff notes that the referenced NRC-funded study was completed in March 1982, prior to the date of the Department of Health and Human Services letter. Results from the NRC-funded study are published in a report by W. J. Maeck et al., "An Assessment of Offsite, Real-time Dose Measurement Systems for

Emergency Situations" (NUREG/CR-2644, 1982). NUREG/CR-2644 did not include a reevaluation of the airborne radioiodine sampling program.

9.11 Carolina Environmental Study Group (A-59)

Response to Comment #1

While it is true that nuclear units have historically proven more economical to operate than conventional fossil facilities, it is unlikely that this advantage would justify the premature retirement of these more costly units. Nuclear units would be used to supply energy for system loads before more costly generating facilities are used; however, this is standard industry procedure which represents prudent operating practice. These facilities, which are more costly to operate, would be given a different position in the order (the sequence by which generating facilities are called on to produce energy for system loads). In summary, nuclear facilities would tend to shift more expensive generation to a lower priority in the loading order, but would not force useful facilities into premature retirement.

The commentor further states that a second offsetting cost, which was excluded from the benefit/cost summary, is the impact of the plant on the applicant's rate base. Capital costs (those costs that would be reflected in the applicant's "rate base") are considered at the construction permit stage. At the OL stage these costs are viewed as "sunk" costs. The subject of the utility's rate base more appropriately falls under the jurisdiction of the local state regulatory authority.

Finally, the commentor questions the reasonableness of staff's assumption of a 60% capacity factor for the Catawba facility. The Response to Comment #5 in Section 9.4 of this statement addresses this concern.

Response to Comment #2

Although the staff's review (Section 6.4 of the DES) considers the environmental impacts of both units, it does not imply that both units will be licensed concurrently. For multi-unit plants, the Commission provides a separate license for each unit. The license is issued only after the construction of each unit is complete.

The commentor's concern regarding diminished load growth is addressed in the staff's response to Comment #2 in Section 9.4 of this statement.

The staff's analysis of the environmental impacts of the Catawba facility has produced no new information that would tend to alter the favorable benefit/cost balance that was developed at the CP stage of review. The staff finds that the primary benefits of reducing system production costs and increasing generating capacity outweighs the environmental, social, and economic costs.

Response to Comment #3

As the second footnote of Table 6.1 of the DES notes, "...'small' impacts are of such minor nature, <u>based on currently available information</u> that they do not warrant detailed investigations or considerations of mitigative actions." The staff feels that its characterization is appropriate. To substitute "uncertain" would have no material impact on the benefit/cost summary. There are uncertainties associated with any assessment. The staff relies on the best available information in formulating its assessments. This information dictates that "small" is the most appropriate characterization.

9.12 References

Bachner, D, et al., "Studies Comparing the Greatest Possible Failure Sequence in a Processing Installation and in a Nuclear Power Plant," NRC translation 161, Institute for Reactor Safety, Technical Control Association, Cologne, West Germany, August 1976.

Cember, H, Introduction to Health Physics, "Radioactivity," Pergamon Press, Chapter 4, 1969.

Code of Federal Regulations, Title 10, "Energy" (including General Design Criteria), U.S. Government Printing Office, Washington, D.C., January 1981.

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

Federal Register Notice 46 FR 62281, "Interim Requirements Related to Hydrogen Control," proposed rule, U.S. Nuclear Regulatory Commission, December 23, 1981.

---, 47 FR 12940, "Need for Power and Alternative Energy Issues in Operating License Proceedings," Final Rule, U.S. Nuclear Regulatory Commission, March 26, 1982.

U.S. Department of Health Education and Welfare, Radiological Health Handbook, Revised Edition, January 1970.

U.S. Nuclear Regulatory Commission, NUREG-75/014 (WASH-1400), "Reactor Safety Study--An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants," October 1975.

---, NUREG-0400, "Risk Assessment Review Group Report to the U.S. Nuclear Regulatory Commission," September 1978.

---, NUREG-0575, "Final Generic Environmental Impact Statement on Handling and Storage of Spent Light Water Power Reactor Fuel," August 1979.

---, NUREG-0654 (FEMA-REP-1), "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants," Rev. 1, November 1980.

---, NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, LWR Edition," July 1982.

---, NUREG/CR-1231, "Remote Sensing For Detection and Monitoring of Salt Stress on Vegetation: Evaluations and Guidelines," Final Report, September 1976-March 1979, March 1980.

---, NUREG/CR-2644, "An Assessment of Offsite, Real-time Dose Measurement Systems for Emergency Situations," W. J. Maeck et al., April 1982.

---, Regulatory Guide 1.109, "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance With 10 CFR 50, Appendix I," Rev. 1, October 1977.

---, Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Diffusion of Gaseous Effluents in Routine Releases From Light-Water-Cooled Reactors," Rev. 1, May 1977.

APPENDIX A

COMMENTS ON THE DRAFT ENVIRONMENTAL STATEMENT

TABLE OF CONTENTS

United States Department of Agriculture

Economic Research Service

Washington, D.C. 20250

August 20, 1982

Ms. Elinor G. Adensam, Chief
Licensing Branch No. 4
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Ms. Adensam:

Thank you for forwarding the Draft Environmental Statement relating to the issuance of operating licenses to Duke Power Company, North Carolina Municipal Power Agency Number 1, North Carolina Electric Membership Corporation, and Saluda River Electric Cooperative, Inc. for the operation of the Catawba Nuclear Station, Units 1 and 2 located in York County, South Carolina.

We have reviewed Docket Nos. 50-413 and 50-414 and have no comments.

Sincerely,

Velmar W. Davis

VELMAR W. DAVIS
Associate Director
Natural Resource
Economics Division

C002

South Carolina Department of Archives and History
1430 Senate Street
Columbia, S.C.

P.O. Box 11,669
Capitol Station 29211
803–758-5816

August 27, 1982

Ms. Elinor G. Adensam, Chief
Licensing Branch No. 4
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Re: Draft Environmental Statement
Catawba Nuclear Station, Units 1 and 2

Dear Ms. Adensam:

Thank you for your letter of August 16 and the Draft Environmental Statement for the operation of Catawba Nuclear Station, Units 1 and 2.

We have no additional properties to add to the list of National Register properties in the Historic and Archeological Sites section, nor do we wish to alter any of the comments in our letter of November 5, 1981 (Appendix H).

#1 We do, however, recommend clarification of the statement concerning archaeological site 38YK72; the draft Environmental Statement states that "no further investigation of the site was recommended". This recommendation was made because all construction impacts to the site could be avoided; if it appears that effects from construction cannot be avoided, then additional investigation to site 38YK72 is recommended. It is important that the reasons for the recommendation and the additional condition be added.

The Federal procedures for the protection of historic properties (36CFR800) require that the Federal agency official in charge of a federally funded or licensed project consult with the appropriate State Historic Preservation Officer. The procedures do not relieve the Federal agency official of the final responsibility for reaching an opinion of his own as to whether or not historic values have been adequately taken into account in allowing the project to proceed. The opinion of the State Historic Preservation Officer is not definitive, either by law or by established Federal procedure. In reaching a conclusion of his own, the Federal agency official may well wish to consult other experts.

Sincerely,

Charles E. Lee
Charles E. Lee
State Historic Preservation Officer

CEL/vdw
CC: Dr. Robert L. Stephenson
State Archeologist
Institute of Archeology and Anthropology
University of South Carolina
Columbia, S.C. 29208

C002

UNIVERSITY OF SOUTH CAROLINA
COLUMBIA, S. C. 29208

INSTITUTE OF ARCHEOLOGY AND ANTHROPOLOGY
(803) 777-8170

September 9, 1982

05000413
05000414

Ms. Elinor G. Adensam, Chief
Licensing Branch No. 4
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Re: Draft Environmental Statement
Catawba Nuclear Station, Units 1 and 2

Dear Ms. Adensam:

I am in receipt of a copy of Mr. Charles Lee's letter to you of August 27, 1982 regarding the referenced project. I concur completely with the recommendations that Mr. Lee has made. I especially emphasize the importance of recommending the additional condition for Site 38YK72.

#1 Site 38YK72 may well be impacted by construction activities even though it is not directly impacted by the construction. Any such construction impact would be just as detrimental to your site as if it were not avoided in the basic project itself.

Sincerely yours,

Robert L. Stephenson

Robert L. Stephenson
Director and State Archeologist

RLS:lrb

cc: Charles Lee

C002

8209140341 820909
PDR ADOCK 05000413
D PDR

SEP 2 7 1982

'82 SEP 24

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
ATOMIC SAFETY AND LICENSING BOARD

Charlotte-Mecklenburg
Environmental Coalition,

Intervenor,

In the Matter of:

Duke Power Company, et al.) Docket Nos. 50-413
(Catawba Nuclear Station,) 50-414
Units 1 & 2),)

Applicants

CMEC'S REVISED CONTENTION #4

Introduction: The Board's Order admitting and rejecting the Intervenors' contentions admitted CMEC's contentions #1-3 without conditions; it admitted contention #4 conditionally. Both the Staff and the Board faulted contention #4 on the grounds that (a) #4 was not sufficiently specific, and (b) #4 ought to be directed toward the Staff's statutory NEPA obligations as fulfilled in its ES. But the DES had not issued at the time Intervenor framed his contentions. Now that the DES has issued, CMEC tries, in this document, to cure the defects in its fourth contention by (a) stating in some detail reasons why we find the DES's projections of the radiological genetic and somatic effects of CNS operations to be inadequate and (b) specifically addressing the DES analysis.

CMEC's Revised Contention #4: The methods used in the DES (NUREG-0921) for estimating somatic and genetic effects to the population that will be exposed to releases of radioactivity from CNS inadequately assess these somatic and genetic effects. ('Releases of radioactivity' includes routine releases of radioactivty into the hydrosphere and atmosphere resulting from normal plant operation and releases of the sort specified in CMEC's contentions #1 & #2.) Intervenor's objections to the DES methodologies include the following.

\# 1. The DES (page 5-18) bases its estimations of health effects as regards cancer mortality risks on the 'absolute-risk' model. Intervenor's position is that this method fails to take into account the time cancers take to develop after tissue irradiation and that, in failing to express risk as a percent increase in mortality rates per rad of exposure, it seriously underestimates cancer morality risk for a population continuously exposed to irradiation over a long period of time. The DES (page 5-18) takes notice of the 'alternative (and in the Intervenor's view, proper) 'relative risk model.' The DES suggests that the relative risk model would give risk values of up to four times those produced by its 'absolute-risk' model. However, Intervenor is prepared to show that the 'absolute-risk' method produces risk values that are lower than 'relative-risk' values by factors much greater than four and that are lower than observed mortality rates by factors much greater than four. For instance, analysis of data collected by Saccomanno indicates that the 'absolute-risk' model predicts cancer mortality rates for smoking uranium miners that are less than the observed mortality rate by a factor of 58.[1]

\# 2. The DES does not appear to take seriously the linear hypothesis that the incidence of radiation induced cancers in an irradiated population is directly proportional to the amount of radiation sustained. For example, the DES accepts BEIR-III as authoritative;but BEIR-III rejects the linear hypothesis in favor of a combination of linear and quadratic models , a combination that had no basis in any epidemiological evidence whatsoever. (The lack of basis for BEIR--III's position was presented in a detailed dissenting discussion by Chairman Radford (BEIR-III, 1980, pages 287-314).) Statements like "The lower limit of the range (of health effects) would be zero because health effects have not been detected at doses in this dose-rate range " (DES page 5-18) suggest that Staff accepts a threshold hypothesis. But Intervenor argues that the evidence overwhelmingly supports the linear hypothesis;the linear hypothesis ought to be the basis of DES methodology in assessing radiological effects of releases from CNS.

\# 3. DES (page 5-18) basis its risk estimates on BEIR-I, BEIR-III and UNSCEAR. We find these documents seriously defficient in methodolgy. For example BEIR-III obliterates the difference in sensitivities of young and old at irradiation; its methodology assumes without warrant the model of a ten-year latent period followed by a lifetime plateau;as we have noted above, BEIR-III rejects data on the incidence of cancer caused by irradiation of the young, without warrant,and assumes without any evidence that a combination of the linear and quadratic models should be used in its analysis. We have noted our objections to the 'absolute-risk' model used in BEIR-I. Our objections to UNSCEAR are of a similar nature. For these and other reasons, we argue that the 'risk estimator' of 135 radiation induced cancer deaths per million person-rems ought to be increased by a factor of at least 25.[2]

\# 4. As regards genetic effects in exposed populations, DES (page 5-18) states that "Values for risk estimators range from 60-1500 potential cases of all forms of genetic disorders." DES takes this statement from BEIR-I issued in 1972. But considerable advances have taken place in radiology in the past decade;projections for genetic disorders are now much higher, e.g. Gofman's projections of a range of up to 20,000.[3] The DES, as far as we can determine, fails to address the more recent work.

DES (page 5-21) states that in respect to the low level radiation from CNS "the upper bound limits of deleterious effects are well established and amenable to standard methods of risk analysis." Generally, as indicated by the above remarks, we argue that "the upper bound limits" accepted by the DES in respect to somatic and genetic effects can only be maintained by ignoring recent studies[4] that indicate that 'upper bound limits of deleterious effects' are in fact many times higher than the DES assumes.

Notes

1. Saccomanno G., Comments on lung cancer in cigarette-smoking and non-smoking uranium miners. Final Report:Cluff Lake Board of Inquiry:61, Sas Dept. of the Environment, Regina, Saskatchewan 1978

2. For the basis of this view, see Gofman J.W., Radiation and Human Health; Sierra Club Books, San Francisco, 1981, pp. 314-323 and passim.

3. ibid. p. 849 and 707-853 passim.

4. ibid and e.g. Sternglass, Low-level Radiation from Hiroshima to Three-Mile Island McGraw-Hill, New York, 1981 passim.

Henry Presler

Henry Presler

Charlotte-Mecklenburg Environmental Coalition

945 Henley Place, Charlotte, N.C.

704-333-8589

September 19, 1982

Service: Al Carr by hand.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
DUKE POWER COMPANY, et al.	)	Docket Nos. 50-413
	)	50-414
(Catawba Nuclear Station,	)	
Units 1 and 2)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of "CMEC's Revised Contention #4" in the above docket have been served upon the following by deposit in the United States Mail this 22nd day of September, 1982:

James L. Kelley, Chairman
Atomic Safety and Licensing
Board Panel
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dr. A. Dixon Callihan
Union Carbide Corporation
P. O. Box Y
Oak Ridge, Tennessee 37830

Dr. Richard F. Foster
P. O. Box 4263
Sunriver, Oregon 97701

Chairman
Atomic Safety and Licensing
Board Panel
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Chairman
Atomic Safety and Licensing
Appeal Board
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

George E. Johnson, Esq.
Office of the Executive Legal
Director
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

J. Michael McGarry, III, Esq.
Debevoise & Liberman
1200 Seventeenth Street, N.W.
Washington, D. C. 20036

Richard P. Wilson, Esq.
Assistant Attorney General
State of South Carolina
P. O. Box 11549
Columbia, South Carolina 29211

Robert Guild, Esq.
Attorney-at-Law
314 Pall Mall
Columbia, South Carolina 29201

Palmetto Alliance
2135-½ Devine Street
Columbia, South Carolina 29205

Mr. Jesse L. Riley
854 Henley Place
Charlotte, North Carolina 28207

Mr. Henry A. Presler
943 Henley Place
Charlotte, North Carolina 28207

Mr. Scott Stucky
Docketing and Service Section
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Albert V. Carr, Jr.

SEP 21

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
DUKE POWER COMPANY, et al.	)	Docket No. 50-413
	)	50-414
(Catawba Nuclear Station,	)	
Units 1 and 2)	)	September 22, 1982

PALMETTO ALLIANCE AND CAROLINA ENVIRONMENTAL STUDY GROUP
SUPPLEMENT TO PETITIONS TO INTERVENE
REGARDING DRAFT ENVIRONMENTAL STATEMENT

Pursuant to 10 CFR Sections 2.714 (a)(i) and (3)(b) and the Board's Order of September 1, 1982, Intervenors Palmetto Alliance and Carolina Environmental Study Group hereby file this Supplement to their Petitions to Intervene listing the contentions which they seek to have litigated in this matter, and the bases therefore, which address issues raised by the Nuclear Regulatory Commission Staff's Draft Environmental Statement (DES) related to the operation of Catawba Nuclear Station, Units 1 and 2, NUREG-0921 (August 1982).

Should the Board construe any of these contentions as an attack upon any provision thereof, Intervenors request that such rule or regulation be identified and that they be permitted to seek an exception or waiver of the application of such rule or regulation with respect to this particular proceeding.

1

Palmetto Alliance and Carolina Environmental Study Group would respectfully show that the Application for the necessary licenses to own, use and operate the utilization facilities known as the Catawba Nuclear Station, Units 1 and 2, should be denied or appropriately conditioned since the grant of such licenses would contravene the National Environmental Policy Act of 1969 (NEPA), Pub. L. 91-190, 42 U.S.C.A. Section 4332, Executive Order 11514, Council on Environmental Quality Guidelines of August 1, 1973 (38 FR 20550) and the Commission's own licensing and Regulatory Policy and Procedures for Environmental Protection, 10 CFR Section 51.23, where the environmental, economic, socioeconomic and cumulative costs and impacts of the facility will outweigh any possible benefits, new and additional information now being available which alters the consideration made at the Construction Permit stage for the facility.

The Nuclear Regulatory Commission Staff has failed to effectively analyze and balance the environmental, economic, socioeconomic and other costs against any asserted environmental, economic, technical or other benefits of the facility and has totally ignored the alternatives available for reducing or avoiding the adverse environmental or other effects; in support of which Intervenors would contend:

2

1. The probabilities of severe accidents, radiation exposure, and damage are understated, as in figures 5.3, 5.4, 5.4, 5.5, 5.6 and 5.7 of the DES. The DES recognizes only one serious accident after 400 reactor years of operation, TMI-2, p. 5-46. In this period there were two other serious accidents, the partial meltdown at Fermi, p. 5-30, and Browns Ferry 1 and 2, not referenced. The releases at Browns Ferry were not monitored. A meltdown was averted by improvisation, not by following established guidelines. The Fermi meltdown was limited by the time of scramming. A somewhat more delayed scram would have resulted in more extensive meltdown and increased the probability of a substantial release. The actuality has been three accidents of a potentially very severe sort in 411 reactor years, a probability of one per 133 years of reactor operation. The DES understates serious accident probability in relying on the Reactor Safety Study (NUREG 75/104). The CP stage FES made no reference to severe accidents.

2. The DES fails to consider or adequately characterize cooling tower drift, pp. 4-3, 4-7. 2,700 lbs. of sulfuric acid (concentration unspecified) are to be added to condenser cooling water; 1,200 lbs. of sodium hypochlorite are also to be added. This will result in the release of chlorine.

$$H_2SO_4 + 2NaClO \longrightarrow Cl_2 + Na_2SO_4 + H_2O$$

However, only 1,014 lbs. of sulfuric acid are <u>required</u> for this reaction. The consequence is a surplus of 1,686 lbs. The DES provides no information as to how, or whether, this sulfuric acid will be neutralized. If it is not, it will enter the Catawba River in the blowdown and the atmosphere in the drift. At an average drift rate of 110 gal/min. (full plant), 42 lbs. per day of unneutralized sulfuric acid will enter the atmosphere. Sulfuric acid is a corrodent of very low volatility. It will cause damage to objects it contacts:

3

automobiles, farm machinery, wood habitations, cotten fabrics, etc. The DES either overlooks these consequences or fails to indicate that the excess of sulfuric acid in the cooling water will be neutralized.

\# 3. The DES differs from the CP FES in that Chlorine was to be injected and other additives had not been firmly identified. A total of 734 lbs. per day of Chlorine will be released by the reaction of sulfuric acid with sodium hypochlorite. The DES only indirectly indicates the disposition of this chlorine. It has it showing up in the cooling tower blowdown as the chloride ion, Table 4.2. This is not realistic. A large part of the Chlorine, quite possibly most of it, will leave the cooling water in the form of a gas in the cooling tower vapor discharge. The vapor state Chlorine will be noxious. The effect on people, particularly those with respiratory problems, should be ascertained. There will also be a corrodent effect on metals due both to Chlorine in the vapor discharge and in the drift. The DES is deficient in not addressing this impact. The DES differs from the CP FES in that biocide application is doubled p. 4-3.

\# 4. The DES unnecessisarily obfuscated the matter of water flow. Members of the general public will be confused, and possibly mislead, by the variety of units, not simply English and metric, by which flow rate for water and chemicals are presented. For example:

	English	Metric	For
water flow, p 4-2	cubic feet/second	cubic meters/second	both units
chemical flow, p 4-3	pounds/day	kilograms/day	one unit
water flow, Table 4.1	gallons/minute	liters/minute	one unit

Further in Table 4.1, for which the data are for one unit, there is no indication of basis. A reasonable interpretation would be that it is for both units. Particularly confusing are the changes in time base: seconds, minutes

4

and days. The DES should either represent quantitative information in consistent units, or supply conversion factors. For example, a seemingly trivial blowdown of 0.3 m^3/sec. (p. 4-2) corresponds to 57,100,000 pounds per day or 28,500 tons per day. This DES differs from the CP FES in that water use was consistently expressed as cfs.

5. The DES differs from the CP FES in that it rates each Catawba unit as 3,427 MWt versus 3,411 MWt and indicates a net rating of 1,145 MWe as opposed to a design power level of 1,211 MWe per unit. In any event these rates are uncertain in that Catawba is represented as a sister plant to the McGuire Station, and the McGuire Station presently operates at a maximum output of 862.5 MWe (75% of 1,150 MWe). This impinges on cost/benefit considerations.

6. The DES is deficient in its cost/benefit weighing, Table 6.1. It assesses the benefit of electrical energy as large. Assuming a 60% capacity factor it posits an annual production of 12 billion KWh. Based on the present derating of McGuire it is reasonable to ask if a rating of 9 billion annual KWh for an indefinite period would not better reflect present experience.

The Applicant has at present a very substantial generating reserve of about 30%. If McGuire-2 goes on line before Catawba-1, as scheduled, and if Applicant's present forecast of 2.9% annual growth is used, the reserve in 1985, at the time of planned first operation of Catawba-1, will also be about 30%. Under these circumstances the operation of Catawba will require the closing down of other capacity, which is a cost in the sense that a useful facility is withdrawn from use. In a fair striking of a balance a cost of, as the case may be, either 12 billion or 9 billion KWh per year should be shown. It should receive an assessment as "large", and the net benefit be taken as nil.

5

\# 7. The DES is deficient in its cost/benefit assessment in that it considers only generating costs. "The economic costs associated with station operation include fuel costs and operation and maintenance costs...," 6.4.2.1. The real bus bar cost includes fixed charges. The fixed charges on McGuire, a sister plant, have been a major factor in driving up electric rates. The DES has not compared the bus bar costs estimated for Catawba into the bus bar costs of the capacity which it will displace. All cost figures, including plant, have changed substantially since the CP FES. A difference between the CP FES is that it provides a capital cost figure for Catawba of $1,055,272,000, Table 10.2. The OL DES does not provide a capital cost figure.

\# 8. The DES concludes that the overall socio-economic impact of Catawba is beneficial, vi(j), 6.4.2.2., 5-12. The actual cost to residential, commercial, industrial and other customers of substituting Catawba generation for existing generation has not been considered. In view of the errors in Applicant's past forecasts of need for power, as attested by the cancellation of all three Perkins nuclear units, and two of the three Cherokee units, it is uncertain whether either Catawba unit will be required to meet demand and provide adequate reserve in the forseeable future. If this is the case it is clear that the cost impact on Applicant's customers will be adverse and large, quite possible reversing the cost/benefit balance.

\# 9. Since the CP FES issued, an amendment has permitted a substantial enlargement of the Catawba fuel pool. Since the CP FES both fuel pool accidents relating to handling (to be discussed in the SER, p. 5-19) and pool water loss have become topics of concern. The environmental consequences of such mishaps should be considered. They appear not to be explicitly considered in the DES. The consequences of routine operation do not appear to be specifically considered,

6

it merely having asserted that routine releases from spent fuel are taken into account in Section 5.9 and Appendix D, p. 5-19.

10. The DES is deficient in regard to the consequences of the transhipment of spent fuel from Oconee and McGuire Station to Catawba, vi(1), 5.9.3.1.2. and Appendix G. The consequences of accidents are not referred to in quantitative terms, although the estimated probabilities of accidents of different levels of severity are presented. Such transhipment was not considered in the CP FES.

11. A substantial part of the population placed at risk by nuclear operations at and relating to Catawba are also placed at risk by similar operations at McGuire. A realistic assessment of Catawba impacts will take into consideration McGuire risks. The summing of probabilities is practiced in the DES in regard to providing an estimate of the probability of the consequences of severe accidents, "If the probability of sustaining a total loss of the original facility is taken as the <u>sum</u> of the occurrence of a core-melt accident (the <u>sum</u> of the probabilities for ten categories in Table 5.10), then..." There is no corresponding concept in the CP FES.

12. The DES is incomplete in an apparent essential, an indication of the inventory during operation of nitrogen-16. It is stated that "nitrogen-16 (is) a radionuclide produced in the reactor core.", p. 5-19. Nitrogen-16 is also said to be the primary source of within plant radiation. However, it is not given in the radionuclide inventory of Table 5.8. Is the DES correct in regard to the production of nitrogen-16?

13. The DES states that "offsite radiation levels are <u>continuously monitored</u> with thermoluminescent detectors." (emphasis supplied), p. 5-15. The impression

given by this language is that the monitoring is in real time. It is not. It is intermittent and depends on the intervals at which the TLD's are evaluated. This "error" should be corrected and the statement disregarded in terms of the consideration of Palmetto Alliance contention 27.

14. The calculations of dose commitments, DES 5.4.3.1, differs from that in the CP FES. "Calculation for the midpoint of station operation represents an average exposure over the life of the plant." We doubt the correctness of this assumption. Longer-lived radionuclides will build up, increasing the dose level. Bio-accumulated radionuclides will also build up. We doubt the general applicability of the concept that "most of the internal dose commitment for each nuclide is given during the first few years of exposure because of the turnover of the nuclide by physiological processes and radioactive decay". We particularly view Strontium 90 as a significant exception to this approach. We believe that, as a result, DES dose commitments are non-conservative and will understate actual exposure.

15. We believe that the DES errs in its treatment of airborne effluents. It states, p. 5-19, that, "Among the airborne effluents the radioisotopes of the fission product noble gases, Krypton and Xenon, as well as of Argon, <u>do not deposit on the ground nor are they absorbed and accumulated within living organisms</u>; therefore, the noble gas effluents act primarily as a source of direct external radiation emanating from the effluent plume." This statement is literally correct, yet quite misleading. In the instant that a Krypton nucleus in the lung emits radiation it becomes a Rubidium nucleus, a metal and potentially a cation either of which can deposit on the ground, or in a lung depending on where it came into existence. Similarly, Xenon converts to Cesium, also a metal and potentially a cation.

Based on the prevalence of Krypton and half life of the isotope, DES Table 5.8, Rubidium 85, 87 or 88 will form. Rubidium 85, which will form in the least amount, is a stable isotope. Rubidium 87, which will form in next largest amount, is a beta emitter with a very long (6×10^{10} years) half life. However, Rubidium 88, formed in the largest amount, has a half life of about 18 months and is an emitter of highly energetic beta and gamma radiation. Xenon-133 and 135 are present in substantial amounts. Cesium-133 is stable. Cesium-135 is a beta emitter of about 3×10^6 year half life. The noble gases which irradiate the lung leave a legacy of radioactive cations in the lung and other exposed tissue, and surfaces generally. The dose contributions of the noble gas produced radioactive isotopes of rubidium and cesium should be considered in the DES.

16. The DES fails to consider this aspect of the enlarged fuel pool: the effect of the crash of a heavy aircraft on the fuel pool structure. Although external hazards are said to be reviewed, p. 5-33, there is no indication that this specific hazard was found to be negligibly small. Within the past decade a commercial airliner crashed not far from the Catawba site. Morning fogs are a frequent occurrence at the site, a contributing factor to the airplane accident. There is no reference to morning fogs in the DES, but it is recognized that the plume will cause fog, p. 5-6. The fuel pool building is less substantial in structure than the containment and is only partially shielded by the containments, figure 4.1. A crash into the fuel pool accompanied by fire could disable the water circulation and supply of the pool. Depending on the heat supplied to the pool by spent fuel, and the time necessary to regain functionality, the pool water could boil down, leading to fuel assembly exposure and cladding failure. Sufficiently heavy fragments of the

9

plane could damage the cladding of assemblies in the pool by impact. The consequences ofthe most severe accident would cause a release of the magnitude of the most severe reactor accidents and should be considered in the DES.

17. The DES is concerned with environmental impacts. Presumably these are best represented as the entire range from trivial to serious, in conjunction with the estimates of likelihood. The DES averages meteriological conditions in its consideration of accidents, 5.9.4.5. Because atmospheric inversions and quiet air are a very common feature in this region, accident consequences should be calculated for the extreme condition of inversion and very slow air movement.

In the matter of assessing serious accidents, the environmental assumptions are complex and again do not appear to consider extreme weather, p. 5-37. The DES, which differs from the CP FES in considering severe accidents, is at fault in not considering the full range of radiological impacts by not considering extreme, but frequently encountered, weather conditions.

18. The DES considers interdiction to reduce the radiological impact from severe accidents, p. 5-40. The costs of interdiciton are considered in figure 5.7 and Table 5.11. However, an evaluation of the availability of facilities for relocation and the non-monetary impacts of the location are not considered. This topic was not addressed in the CP FES and is not adequately considered in the DES.

10

19. Failure to evaluate the environmental costs of operation of Catawba as a storage facility for spent fuel from other Duke nuclear facilities and transportation of that irradiated fuel to Catawba compromises the validity of the favorable cost-benefit balance struck at the construction permit phase of this proceeding. Since the CP stage hearing, Duke Power has considerably expanded the Catawba spent fuel pool capacity and provided for denser storage of irradiated fuel. FSAR Table 1.2.2-1. Applicants intend to use Catawba for storage of irradiated fuel from the McGuire and Oconee nuclear facilities of Duke Power Company. FSAR 9.1.2.4, OL Application, pp. 11 - 12.

The "Environmental Impact Appraisal performed by NRC Staff, pp. G-1, G-2 and G-3 of the DES is totally inadequate to provide a basis for agency approval of the licenses sought. The staff totally fails to analyze or even assert the need for the transhipment and storage of spent fuel from other plants at Catawba, to evaluate either quantitatively or qualitatively the "benefit" to be derived from this action; grossly underestimate the environmental costs and other impacts from the proposed action such as the risks of plainly credible very severe accidents in transhipment under conditions more severe than described in Appendix B to 10 CFR Part 70 or involving defective casks which can not withstand those conditions; and, further the Staff totally fails to analyze or consider the alternatives available for reducing or avoiding these adverse effects such as on site rod consolidation, storage in dry casks, in drywells beneath grade, in concrete storage silos or in air-cooled vaults — alternatives which are easily available at lower total cost.

"Preliminary Assessment of Alternative Dry Storage Methods for the Storage of Commercial Spent Nuclear Fuel", DOE/ET/47929-1 (UC-85) E.R. Johnson Associates, Inc. (November, 1981).

20. The favorable cost/benefit analysis struck at the CP stage is fatally compromised by the failure of the NRC Staff to calculate costs and benefits based upon substantially reduced levels of operation due to defective Westinghouse Model D steam generators which have experienced rapid tube wear caused by flow-induced vibrations which pose the threat of tube weakening, leakage or rupture, as well as the costs associated with repair and replacement with very high worker exposure rates and the increased risk of radiation exposure to the public. Duke Power Company's McGuire Unit 1, Catawba's sister plant, has operated at severely reduced power levels since declared commercial December, 1981 due to premature tube wear experienced during very brief high power level operation. V.C. Summer Unit 1 operating license will restrict power levels to below 50% until this premature tube wear problem in its Model D steam generators is solved. The Staff does not acknowledge or weigh these costs in the DES.

21. The long term somatic and genetic health effects of radiation releases from the facility during normal operations, and from the uranium fuel cycle have been underestimated by the NRC Staff in the DES, pp. 5-22 and Appendix C, even where such releases are within existing guidelines. The Staff relies on the BEIR I study for the risk estimators it employs in the DES, p. 5-17 and BEIR III for establishment of its "upper limit" for health effects, p. 5-18. The work of K.Z. Morgan, Bernd Franke of Heidelberg, and others calls into serious question the analysis relied upon. For example, BEIR III's reliance on the linear hypothesis may seriously understate health effects at lower level dose rates; and the commission's food chain analysis may minimize the uptake of soil borne radiation by plants and thereby underestimate concentrations in milk and meat. Such questions suggest that the Staff has seriously underestimated the health effects from facility operation.

12

#22(a) The NRC Staff has failed to adequately assess the impacts of serious accidents at the facility, beyond design basis. The FBS-CP made no analysis of such serious accidents and the DES analysis, required by the Commission's Statement of Interim Policy, 45 F.R. 40101 (June 13, 1980) seriously underestimates the probability and consequences of plainly credible site-specific serious accidents and is deficient in many respects.

The probabilistic analysis employed in the Reactor Safety Study (WASH 1400) has been so seriously criticized as to make its use in licensing prodeedings as a basis for decision-making entirely inappropriate. "The consequence model used in WASH 1400 should be substantially improved, and its sensitivities explored, before it is used in the regulatory process." NUREG CR·0400, "Risk Assessment Review Group Report to the U.S. Nuclear Regulatory Commission, H.W. Lewis, Chairman," p. xi. The Staff continues to rely on the "consequence model used in the RSS," p. 5-37. While the Staff acknowledges the "substantial uncertainties" in the probabilities derived from the quantification of human error and estimates of component failure rates, p. 5-36, it nonetheless relies on this same probabalistic analysis on the basis of its "qualitative judgement...that the uncertainty bounds could be well over a factor of 10, but not as large as a factor of 100." p. 5-46.

#22(b) The Staff claims to address the criticisms of the RSS by "eliminating the 'smoothing technique'" and by the evaluation of "individual dominant accident sequences" rather than grouping them. p. B-1. Yet it still relies only on the probabilities shown for four RSS scenarios, Table 5.10, and represents the probability of such an accident at the facility as the sum of the probabilities for these events alone. p. 5-45.

The design of this facility differs from that of the reference reactor considered in WASH 1400 in such significant manner as to adversely affect

13

the probabilistic risk assessment employed in that study and relied upon by the Staff. "Reactor Safety Study Methodology Application Program: Sequoyah #1 PWR Power Plant," NUREG CR 1659/1 of 4 (February, 1981), ER - OL 7.1-1. The Staff notes "the importance of hydrogen control measures for reducing the liklihood of failing the ice condensor containment," but relies on the assertion that "(t)he applicant for Catawba has plans to satisfy the Commission's requirement on hydrogen control," p. E-1, without further analysis of the significance of this design feature for accident impacts.

#22(c) The Staff's serious accident analysis is further flawed by its reliance, without basis, upon a flawless execution of the most unrealistic emergency plan — assuming complete evacuation of the plume pathway and relocation of all persons in the pathway out to 25 miles and the full availability of medical care for all persons exposed in excess of 200 rems. Appendix F. Although not specified by the Staff this means the downwind populations of Charlotte, North Carolina — 310,794 people in 1980, 11 miles northeast of the site, p. 5-33 and Figure 5.9. Since no emergency plans have been published and the Staff has no plan for the facility to review as a basis for its optimism, it can only promise to supplement this environmental analysis if it concludes from such a review that accident impacts will be "significantly larger." p. 5-34. Such a revised analysis should be performed now.

23. The evaluation of costs and benefits of the facility under NEPA conducted at the CP stage was inaccurate since the costs associated with the back end of the nuclear fuel cycle were not given sufficient consideration. The NRC Staff continues to rely on the Table S - 3 rule to assess the costs associated with reprocessing, storage and disposal of spent fuel and other nuclear waste, p. 5-47 and Appendix C, despite the recent invalidation of the rule by the U.S. Court of Appeals.

14

"Because they failed to allow for proper consideration of the uncertainties concerning the long term isolation of high level and transuranic waste..." Natural Resources Defense Council, NRC, No. 74-1586. Slip Op. at 11 (D.C. Cir. April 27, 1982). The Staff must do more than simply assert that such wastes "are to be buried at a Federal repository and that no release to the environment is associated with such disposal." p. C-6. Such a dismissal of environmental effects is meaningless in light of the known uncertainties associated with the back end of the fuel cycle. These costs must be fully evaluated and considered in the cost/benefit balance.

WHEREFORE: having supplemented their Petitions to Intervene with this list of contentions, and the bases therefore, Intervenors Palmetto Alliance and Carolina Environmental Study Group request that these contentions be admitted as issues for litigation in this proceeing, that they be heard in support of their interest as herein asserted, and that the Application of Duke Power Company, et al., for licenses with respect to the Catawba Nuclear Station, Units 1 and 2, be denied, or so conditioned as to protect the health, safety and economic interest of the Intervenors and the public.

Jesse L. Riley / RG

Jesse L. Riley
Carolina Environmental Study Group
854 Henley Place
Charlotte, North Carolina 28207

Robert Guild

Robert Guild
314 Pall Mall
Columbia, South Carolina
Attorney for Palmetto Alliance

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
DUKE POWER COMPANY, et al.	)	Docket No. 50-413
	)	50-414
(Catawba Nuclear Station,	)	
Units 1 and 2)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of Palmetto Alliance and Carolina Environmental Study Group Supplement to Petitions to Intervene Regarding Draft Environmental Statement

in the above captioned matters, have been served upon the following by deposit in the United States mail this 22nd day of Sept., 1982.

James L. Kelley, Chairman
Atomic Safety and Licensing
Board Panel
U.S. Nuclear Regulatory
Commission
Washington, D.C. 20555

Dr. A. Dixon Callihan
Union Carbide Corporation
P.O. Box Y
Oak Ridge, Tennessee 37830

Dr. Richard R. Foster
P.O. Box 4263
Sunriver, Oregon 97701

Chairman
Atomic Safety and Licensing
Board Panel
U.S. Nuclear Regulatory
Commission
Washington, D.C. 20555

George E. Johnson, Esq.
Office of the Executive Legal
Director
U.S. Nuclear Regulatory
Commission
Washington, D.C. 20555

William L. Porter, Esq.
Albert V. Carr, Jr., Esq.
Ellen T. Ruff, Esq.
Duke Power Company
P.O. Box 33189
Charlotte, North Carolina 28242

Richard P. Wilson, Esq.
Assistant Attorney General
State of South Carolina
P.O. Box 11549
Columbia, South Carolina 29211

Chairman
Atomic Safety and Licensing
Appeal Board
U.S. Nuclear Regulatory
Commission
Washington, D.C. 20555

Henry A. Presler
Charlotte-Mecklenburg
Environmental Coalition
943 Henley Place
Charlotte, North Carolina 28207

J. Michael McGarry, III, Esq.
Debevoise & Liberman
1200 Seventeenth St., N.W.
Washington, DC 20036

Jesse L. Riley
854 Henley Place
Charlotte, North Carolina 28207

Scott Stucky
Docketing and Service Station
U.S. Nuclear Regulatory
Commission
Washington, D.C. 20555

Robert Guild
Attorney for Palmetto Alliance

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

ER 82/1412

SEP 30 1982

50-413
50-414

Elinor G. Adensam, Chief
Licensing Branch No. 4
Division of Licensing
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Ms. Adensam:

Thank you for your letter of August 16, 1982, transmitting copies of the draft environmental statement for the Catawba Nuclear Station, Units 1 and 2, York County, South Carolina. Our comments are presented according to the format of the statement or by subject.

#1

Historic and Archeologic Impacts

We are concerned that the Catawba-Ripp 230 kV line passes within a half mile of the Kings Mountain National Military Park as noted on page 4-17. Though the statement asserts on page 5-12 that this will have no adverse effect on the park, we would like additional information concerning the exact location of this proposed line so that we may make a determination of impacts from its construction and operation.

The Nuclear Regulatory Commission should coordinate this issue with Mr. Robert Baker, Regional Director, Southeast Region, National Park Service, 75 Spring Street, S.W., Atlanta, Georgia 30303, Telephone: 404-221-5185; FTS 242-5185.

#2

Water Quality

This section indicates that under worst-case and average conditions, certain areas would not be in compliance with water quality standards. Further, the NPDES permit issued for the Catawba Nuclear Station does not limit either the station discharge temperature during operation or the resulting area of Lake Wylie subject to temperatures higher than those specified by State water quality standards.

This lack of a specific permit limitation, however, does not invalidate the temperature standard nor relieve the applicant of its responsibility to maintain that standard. The South Carolina Department of Health and Environmental Control indicates that no discharger may violate a State water quality standard, whether that particular standard is addressed in the NPDES permit or not. Thus, it appears that operation of the proposed Catawba Nuclear Station will be in violation of State water quality standards and the Clean Water Act (P.L. 92-500) under which those standards were developed.

C002

The projected annual loss of 27,000 gizzard shad due to impingement may be insignificant when considered alone. However, these losses may not be insignificant when considered in conjunction with losses at the existing Allen Steam Plant, other intakes on Lake Wylie, and natural mortality including cold-induced mortality. We believe the possibility that "many of these individuals" might be lost as a result of natural, cold-induced mortality is not a valid reason for determining that impingement losses will not impact the lake fishery. Only by monitoring impingement impacts after operation is begun can a determination be made regarding the significance of impingement losses. Also, an accurate accounting of actual losses is needed in order to determine cumulative impacts associated with present and future use of Lake Wylie and to adequately manage the lake's aquatic resources. We recommend an appropriate monitoring program be developed and presented in the final statement.

Entrainment

The determination that phytoplankton and zooplankton mortality as a result of entrainment is not expected to be significant seems premature, especially in light of the fact that 82,000 to 170,000 gpm of Lake Wylie's flow will pass through the station. Even if this alone were not significant, cumulative effects of all intakes on the lake must be considered. Actual impacts from the Catawba station can only be determined after operation begins—post-operational monitoring of entrainment is vital to maintenance of the aquatic resources of Lake Wylie. A detailed monitoring program to document entrainment losses should be included in the final statement.

Thermal Discharge

#3

The statement indicates the thermal plume would cover about 105 acres in Lake Wylie under certain conditions. Although 105 acres is a small percentage of Lake Wylie, it represents considerable aquatic habitat which will become unavailable for fish and other aquatic species. The potential for fish kills is much enhanced when water temperatures exceed 90°F, as is the loss of eggs and larvae, incidences of diseases, and reduction in forage foods. Even though the overall fish population of Lake Wylie may not be threatened by the Catawba station's thermal discharge, a 105-acre area may become devoid of indigenous species. A program to monitor thermal effects of the Catawba Nuclear Station should be implemented following plant start-up.

Post-Operational Monitoring

The draft statement concludes that entrainment and impingement of aquatic organisms resulting from operation of the Catawba Nuclear Station will not detrimentally affect any species inhabiting Lake Wylie. Likewise, it concludes that the thermal plume for the station's operation will not detrimentally affect any species inhabiting Lake Wylie. Consequently, neither the applicant nor the U.S. Nuclear Regulatory Commission proposed post-operational monitoring programs of entrainment/impingement or thermal effects. While the above conclusions may prove accurate, post-operational monitoring to document actual impacts on aquatic organisms is necessary to ensure adequate protection of aquatic resources. Monitoring of operational impacts is particularly

#3 cont. important due to the volume of water that will be required by the Catawba Nuclear Station (from 82,000 to 170,000 gallons per minute); and the area of water that may exceed water quality standards for temperature.

We hope these comments will be helpful to you.

Sincerely,

Bruce Blanchard, Director
Environmental Project Review

THE PENNSYLVANIA STATE UNIVERSITY
104 DAVEY LABORATORY
UNIVERSITY PARK, PENNSYLVANIA 16802

College of Science
Department of Physics

Area Code 814

6 October 1982

U.S. Nuclear Regulatory Commission
Washington, D.C., 20555

Attention:

Director, Division of Licensing

Dear Director:

Enclosed are my comments on the Draft Environmental Statement related to the operation of the Catawba Plant units 1 and 2, NUREG-0921. Please note that the opinions and calculations presented do not necessarily reflect the position of the Pennsylvania State University.

I will be looking forward to the Final Environmental Statement. Would you also please send me a copy of that Final EIS when it is available.

Sincerely,

William A. Lochstet

Wm. A. Lochstet, Ph.D.

C002

Some Health Consequences
of Catawba 1 and 2
by

William A. Lochstet, Ph.D.
The Pennsylvania State University*
October 1982

#1 The Nuclear Regulatory Commission (NRC) has attempted to evaluate the health consequences of the operation of the Catawba nuclear power plants in the Draft Environmental Statement, NUREG-0921 (Ref. 1). The health consequences of the radon-222 released from the mill tailings and mines needed to fuel the plant, are evaluated for the first 1000 years in Appendix C. This evaluation states that the radon emissions increase with time (Page C-4, Ref. 1), and there us no suggestion that there is any reason to believe that these emissions will stop after 1000 years, or emen to decrease.

In fact, these emissions continue for a very long time, being governed by the 80,000 year half life of the thorium-230, and the 4.5 billion year half lifeof the uranium-238 in the mill tailings. The amount of material covering the tailings also effects the amount of radon released to the atmosphere. The thorium situation has been adequately discussed by Pohl (Ref. 2) in 1976. The impact of the uranium-238 as a source of radon was recognized by the NRC in GESMO (Ref. 3), which is one of the references of Appendix C of this Draft Report (Ref. 1).

Appendix C of this Draft (Ref. 1) is written on the presumption of a 1000-MWe LWR plant operated at an 80% capacity factor (Page C-1). This will require about 29 metric tons of reactor fuel. With uranium enrichment plants operating at a

* Affiliation for identification purposes only.

0.2% tails assay, 146 metric tone of natural uranium will be required, and 117 metric tons of depleted uranium will be left over. With a uranium mill which extracts 96% of the uranium from the ore, a total of 90,000 metric tons of ore is mined, containing 152 metric tons of uranium (Ref. 4). The uranium mill tailings will contain 2.6 kilograms of thorium-230 and 6 metric tons of uranium. As Pohl has pointed out (Ref.2), the thorium decays to radium-226, which in turn decays to radon-222. This process results in the generation of 3.9×10^{8} curies of radon-222, on a time scale determined by the 8×10^{4} year half life of thorium-230.

#1 cont

The 6 metric tons of uranium contained in the mill tailings decays by several steps thru thorium-230 to radon-222. This process occurs on a time scale governed by the 4.5×10^{9} year half life of the uranium-238, the major isotope present(99.3%). The total amount of radon-222 which will result from this decay is 8.6×10^{11} curies.

The 117 metric tons of depleted uranium from the enrichment process is also mainly uranium-238, which also decays. The decay of these enrichment tails results in a total of 1.7×10^{13} curies of radon-222. The impact of these decays were listed by the NRC in GESMO (Ref. 3).

The population at risk is taken to be a stabilized USA at its present level and present distribution. This is similar to that taken by the Draft (Page C-3, Ref. 1). The NRC has suggested that a release of 4,800 curies of radon-222 from the mines would result in 0.023 excess deaths (Ref. 5). This provides a ratio of 4.8×10^{-6} deaths per curie.

At present some recent uranium mill tailings piles have two feet of dirt covering. In this case, the EPA estimate (Ref. 4) is that about 1/20 of the radon produced escapes into the air. Thus, of the 3.9×10^{8} curies of radon from the thorium in the

#1 cont.

mill tailings, only 1.9 x 10^7 curies will get into the air. With the estimate of 4.8 x 10^{-6} deaths per curie, this results in a total of 90 deaths.

The 8.6 x 10^{11} curies of radon produced by the uranium in the mill tailings will similarly have 1/20 escape to the air. With the same method as was used above, the result is 200,000 deaths.

The uranium enrichment tailings are presently located in the eastern part of the USA. If these are buried near their present location it is taken that 1/100 of the radon will escape to the air, due to the higher moisture content of the covering soil. An additional reduction factor of 2 is taken to account for the more eastern location, and the fewer people downwind, to the east of the sites. Witn the NRC estimate of 4.8 x 10^{-6} deaths per curie, the result is 400,000 deaths.

The NRC estimate is about 2 deaths in the draft (Ref. 1) is thus more than 100,000 times too low as compared to the sum of 600,000 deaths as shown above. This is due largely to the arbitrary, erronious, immoral, incorrect procedure of stopping at the end of the first 1000 years.

The fact that these doses and death rates are less than background is interesting (Page C-4, Ref. 1), but absolutely irrelevant. The major federal action to be considered by the the NRC is not whether or not to license background radiation, but whether or not to license the Catawba plants. This is what NEPA requires.

#2

Rebaselining:

The NRC has attempted to evaluate the impact of "class 9" accidents which might occur at Catawba. Unfortunately, the few pages of this report (Ref. 1) devoted to this topic are not adequate to describe the calculation that was modified from the presentation in the eight volumes of the Reactor Safety Study (RSS), WASH-1400 (Ref. 6). It should be noted that for severe accidents, the assessment is carried out considering the entire population within radii of 80 km (50 mi) and 563 km (350 mi)(Ref.1, Section 5.9.4.5 (2)). It is unclear what evaluation is considered outside 563 km, considering the population statement on page 5-37 (Ref. 1). It is necessary to use very large radii. At larger distances, the exposure per person is less, but the number of people exposed increases. Thus, it was recognized in the 1975 APS study (Ref. 7) that the major health impact may be located at larger distances from the reactor site.

#2 cont

The present study (Ref. 1) seems to be based on the RSS (Ref. 6) with modifications to include improvements since the publication of the RSS. In its January 1979 statement of policy, the NRC took the following action:

> The Peer Review Process:The Commission agrees that the peer review process followed in the publishing of WASH-1400 was inadequate and that the proper peer review is fundamental to making sound, technical decisions. The Commission will take whatever corrective action is necessary to assure that effective peer review is an integral feature of the NRC's risk assessment program.
>
> Accident Probabilities: The Commission accepts the Review Group Report's conclusion that absolute values of risks presented by WASH-1400 should not be used uncritically either in the regulatory process or for public policy purposes and has taken and will continue to take steps to assure that any such use in the past will be corrected appropriately. In particular, in light of the Review Group conclusions on accident probabilities, the Commission does not regard as reliable the Reactor Safety Study's numerical estimate of the overall risk of a reactor accident.
>
> (Ref. 8, page 3).

The second statement would preclude the use of the results from the RSS in this action. The first requires a thorough peer review process for any such study. It is here suggested that the "rebaselining" has undergone less peer review than the RSS of 1975.

#2 cont The present work is too incomplete for any attempt at peer review of it. It is suggested that the NRC publish a new version of the "rebaselined" RSS. Thorough peer review would be needed on the scale of the 1975 RSS.

It is hoped that these comments are useful in preparing the Final EIS.

6

References

1 Draft Environmental Statement related to the operation of Catawba Nuclear Station, Units 1 and 2.; NUREG-0921, Draft, NRC, August 1982

2 R.O. Pohl, "Health Effects of Radon-222 from Uranium Mining", Search, 7(5), 345 - 350 (August 1976)

3 "Final Generic Environmental Statement on the Use of Recycled Plutonium in Mixed Oxide Fuel in Light Water Cooled Reactors", NUREG-0002, NRC, (August 1976)

4 "Environmental Analysis of The Uranium Fuel Cycle, Part I - Fuel Supply" EPA-520/9-73-003-B, U.S. E.P.A., (October 1973)

5 "Health Effects Attributable to Coal and Nuclear Fuel Cycle Alternatives" NUREG-0332, Draft, U.S. N.R.C., (September 1977)

6 "Reactor Safety Study", WASH-1400, (NUREG-75/014), 1975

7 "Report to the American Physical Society by the Study Group on light - water reactor safety", H.W. Lewis, et al., Reviews of Modern Physics, Vol 47, Supp. No. 1, Summer 1975

8 "NRC Statement on Risk Assessment and the Reactor Safety Study Report (WASH-1400) In light of the Risk Assessment Review Group Report", NRC, January 18, 1979.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IV
345 COURTLAND STREET
ATLANTA, GEORGIA 30365

4PM-EA/JM

OCT 06 1982

Dr. Kahtan N. Jubbour
Project Manager
Division of Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Dr. Jubbour:

We have reviewed the Draft Environmental Impact Statement (DEIS) related to the operation of Catawba Nuclear Station Units 1 and 2 in York County, South Carolina. Our review of the DEIS indicates the document does an adequate job in discussing the environmental impacts of the proposed Catawba facility. Additionally, our review indicated that the Catawba facility should be capable of operating within the limitations of Section 40 CFR (19a) (Environmental Radiation Standards for Nuclear Power Facilities Operation), and should have only a minimal impact on water quality. In this latter area, our attached technical comments are of an editorial nature.

Therefore, we have rated the DEIS LO-1; i.e., we do not believe the normal operation of the facility will have a significant impact on the environment and we do not need any additional information to complete our review.

Sincerely yours,

Sheppard N. Moore

Sheppard N. Moore, Chief
Environmental Review Section
Environmental Assessment Branch

Enclosure

C002

8210130117 821006
PDR ADOCK 05000413
D PDR

Technical Comments

#1

1. The applicable NPDES outfall serial number should be added to those sections of the DEIS discussing the specific waste source. This will allow the reviewer to more readily compare the NPDES permit requirements with the text. This includes:

(a) Section 4.2.5, page 4-5; NPDES No. 005.

(b) Section 4.2.6.2, page 4-6; NPDES No. 001.

(c) Section 4.2.6.3, page 4-7; NPDES No. 002.

(d) Section 4.2.6.4, page 4-8, NPDES No. 003.

(e) Table 4.4, page 4-28; NPDES Nos. 001 and 002.

(f) Table 4.5, page 4-29; NPDES No. 002.

#2

2. Section 4.2.6.2, page 4-7. Applicant's plan to holdup cooling tower blow-down should assure compliance with South Carolina's water quality standards. In this regard, we suggest modification of the NPDES permit condition at reissuance to allow release of total residual chlorine for more than two hours per day.

#3

3. Appendix 2 (also Table of Contents) should be relabled "NPDES Permit" since it is an effective permit and not a "preliminary draft."

South Carolina
Department of
Health and
Environmental
Control

2600 Bull Street
Columbia, S.C. 29201

October 7, 1982

Dr. Kahtan N. Jabbour
Project Manager
Division of Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

RE: Draft Environmental Impact Statement
Catawba Nuclear Station, Units 1 & 2
Docket Nos. 50-413 and 50-414
Duke Power Company, et.al.

Dear Dr. Jabbour:

We have reviewed this Draft Environmental Statement and offer the following comments on its content:

#1

Section 5.3.2.2, Surface Waters, discusses the impacts of heated water discharges on Lake Wylie and the National Pollutant Discharge Elimination System permit issued by DHEC for the discharge. Page 5-4, paragraph 1, indicates that certain portions of Lake Wylie would violate State water quality standards due to heated water discharges. This is not the case.

Section C-7 of Regulation 61-68, Water Classification-Standards System for the State of South Carolina, allows establishment of mixing zones for thermal discharges on a case-by-case basis. During the NPDES review for the Catawba Station, the effects of the thermal discharges were noted, and while no formal mixing zone delineations were made in the permit, the modelling information supplied by Duke Power Company was considered sufficient and the area impacted by the discharge consistent with the State's mixing zone policy. Therefore, we recommend that the second sentence in the first full paragraph on page 5-4 be reworded as follows: "Thus, the areas given above for the station under worse-case and average conditions represent the areas of Lake Wylie that are considered mixing zones which are allowed by the South Carolina State regulations."

8210130506 821007
PDR ADOCK 05000413
D PDR

C002

Dr. Kahtan N. Jabbour
October 7, 1982
Page Two

#1 cont'd

Additionally we feel that sentences 4 and 5 in the same paragraph should be reworded as follows:

> "The permit does not specifically limit the station discharge temperature during operation nor delineate specific mixing zones since the station design, consisting of a closed cycle cooling system with 'cold side blowdown' (diversion of blowdown at a point in the flow path beyond passage through the cooling towers), will tend to minimize discharge of heated water from the facility."

#2

Section 5.9.4.5, Accident Risk and Impact Assessment, Number 5, Releases to Groundwater, page 5-42, states that, "There would be one major municipal water user affected by contamination of the Catawba River System." We feel that this statement is incorrect and that more information needs to be included regarding downstream water users. There are currently a number of users, both industrial and municipal, which are considered major water users by DHEC's Bureau of Water Supply. Also, the City of Rock Hill, South Carolina, is presently in the process of obtaining necessary approvals to construct a major drinking water intake structure in Lake Wylie, downstream from the Catawba Plant. I am attaching a list of water users, in downstream order, that could be impacted by an accident at the plant and request that you include this information as part of the final environmental statement.

#3

Page 5-42, paragraph 4 also states that the City of Charleston, South Carolina, "draws about 10% of its water from Lake Moultrie." This is incorrect. Charleston currently withdraws water from the Edisto River. Construction is underway to allow the City to withdraw water from the Back River Reservoir which receives water from the Cooper River below Lake Moultrie via Durham Canal. While some of the water to be utilized by Charleston according to their future plans will have been discharged from Lake Moultrie, the City of Charleston has no intake in the lake itself.

Thank you for the opportunity to comment on this draft environmental statement. I trust our comments and suggestions will be included in the final environmental statement to be issued for the project. If you have any questions concerning these comments, please contact me at (803) 758-5496.

Sincerely,

Larry E. Turner

Larry E. Turner
Impact Analysis & Standards Section
Water Quality Assessment & Enforcement Div.
Bureau of Water Pollution Control

LET:bg
Enclosure

WATER USERS DOWNSTREAM OF THE CATAWBA NUCLEAR STATION

System	*Remarks**
Springs Ft. Mill	*M*
Celanese Fibers (Rock Hill)	*I*
Rock Hill	*M*
Bowaters Carolina	*I*
Chester Metro Water District	*M*
Springs Grace Bleachery (Lancaster)	*I & M*
Lugoff Water District	*M*
E.I. Dupont Company (Camden)	*I*
S.C.E.&G. (Wateree)	*I*
S.C.E.&G. (Williams)	*I*
Charleston	*M*

**M - Municipal Drinking Water Supply*

**I - Industrial (Employees Only) Drinking Water Supply*

DUKE POWER COMPANY
P.O. BOX 33189
CHARLOTTE, N.C. 28242

HAL B. TUCKER
VICE PRESIDENT
NUCLEAR PRODUCTION

TELEPHONE
(704) 373-4531

October 7, 1982

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. Darrell G. Eisenhut, Director
Licensing Branch No. 4

Re: Catawba Nuclear Station
Docket Nos. 50-413 and 50-414

Dear Sir:

Please refer to your letter of August 16, 1982 enclosing the Notice of Availability of the NRC Draft Environmental Statement for Catawba Nuclear Station.

Pursuant to 10 CFR Part 51, please find enclosed our comments on the subject document.

We appreciate the opportunity to comment on the Draft Environmental Statement and trust that the Commission will include these comments in the Final Environmental Statement.

Very truly yours,

H.B. Tucker / RW

Hal B. Tucker

ROS/php
Attachment

cc: Mr. James P. O'Reilly, Regional Administrator
U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street, Suite 3100
Atlanta, Georgia 30303

Mr. P. K. Van Doorn
NRC Resident Inspector
Catawba Nuclear Station

Mr. Robert Guild, Esq.
Attorney-at-Law
314 Pall Mall
Columbia, South Carolina 29201

C002 B

cc: Palmetto Alliance
2135½ Devine Street
Columbia, South Carolina 29205

Mr. Jesse L. Riley
Carolina Environmental Study Group
854 Henley Place
Charlotte, North Carolina 28207

Mr. Henry A. Presler, Chairman
Charlotte-Mecklenburg Environmental Coalition
943 Henley Place
Charlotte, North Carolina 28207

#1

4.2.4.5 Nuclear Service Water System

Page 4-5

The DES states that sanitary waste will pass through the station discharge structure.

Comment

The sanitary waste discharge does not pass through the combined service water discharge structure; it discharges into the discharge canal adjacent to the discharge structure.

4.2.6.2 Cooling Water System

#2

Page 4-6

The DES implies that maximum concentration values are shown in Table 4.4.

Comment

The maximum concentration values for cooling tower blowdown are not listed in Table 4.4.

#3

Page 4-7

The DES states that the fire protection system uses chlorinated filtered water as input.

Comment

The fire protection system uses chlorinated filtered water when makeup to the system is from the jockey pumps. However, when the main fire pumps run, water input to the system is unchlorinated lake water.

4.2.6.3 Conventional Waste-Water-Treatment System

#4

Page 4-8

The DES states that the discharge flow rate from the CWWTS will be small compared to other station discharges to Lake Wylie and will average about 760 l/min. (200 gpm).

Comment

The CWWTS discharge will average 300 gpm and this will still be small compared to other station discharges.

4.2.6.4 Sanitary- Waste-Treatment Systems

#5

Page 4-8

The DES states that the estimated volume of waste influent to the system is 6.4×10^4 l/day (17,000 gal/day).

#5 Cont

Comment

The 17,000 gal/day estimate for the sanitary treatment system is incorrect. The design flow rate is 50,000 gal/day (CNS-ER/OLS section 3.7.1). Flow rates in excess of 50,000 gal/day are being experienced and the system is being upgraded to 80,000 gal/day.

#6

Page 4-8

The DES states that the sanitary waste treatment system effluent will not be chlorinated.

Comment

The sanitary waste treatement system is chlorinated via a Sanuril chlorinator (CNS-ER/OLS Section 3.7.1). This chlorination was required by the state to adhere to the state NPDES permit.

4.3.2 Water Quality

#7

Page 4-10

The DES states that a program is the second 1-year-long study.

Comment

For clarity, the sentence should read, "The Second Year Preoperational Study is the second 1-year-long study...."

#8

Page 4-10

The DES states that the applicant does an analysis of data from a study but does not clarify which study.

Comment

For clarity, the sentence should read, "The applicant's analysis of the data from the interim study indicates....".

#9

Page 4-10

The DES states that data did not conclude reasons for immediate concern to the fishery resources of the lake.

Comment

The word "immediate" should be eliminated because it implies that a tenuous situation exists in Lake Wylie which would cause harm to the fishery.

#10

Page 4-11

The DES states that only nutrients, especially phosphorus, consistently occured at "higher than desirable concentrations."

Comment

This statement can be very confusing if compared to the statement made on p. 4-10 (DES Section 4.3.2, 1st paragraph, item #3), which indicates that Lake Wylie

#10 Cont
is phosphorus limited. These apparent contradictory statements need clarification. The DES should include a statement to the effect of, "although phosphorus is relatively abundant in Lake Wylie, it has been implicated as limiting nutrient because of the high nitrogen/phosphorus ratio."

4.3.4.2 Aquatic Biology, Fish

#11
Page 4-14

The DES states "... dominant species are...quillback...longnose gar."

Comment

Quillback and longnose gar are not really dominant species from an abundance standpoint. There are a few large individuals but a low percent of the total fish collected have been represented by these two species.

#12
Page 4-14

The DES states that threadfin shad account for 27.6% of the total collected.

Comment

Although this value (27.6%) was extracted correctly from the text (the text was incorrect) of CNS-ER/OLS. The correct value should be 27.2% as correctly reported in CNS-ER/OLS Table 2.2.2-11.

#13
Page 4-15

The DES uses the spelling Destr<u>i</u>tification.

Comment

The spelling is destr<u>a</u>tification

Figure 4.3 Nonradiological Release Points

#14
Page 4-21

The DES labels the waste water treatment facility discharge as the "water chemical system discharge."

Comment

The discharge label should be changed to "Conventional Wastewater Treatment System Discharge" to be consistent with the text. The figure should be modified to clearly indicate where the discharge point is located. Additionally, the flows through the discharge structure should be clarified: flows include nuclear service water, low pressure service water, and cooling tower blowdown. The sanitary treatment system discharge is into the discharge canal adjacent to the structure but not through the structure.

#15
Table 4.4 Catawba Nuclear Station Waste Water Discharge

Page 4-28

The DES uses ER-OL Table 3.6.1-2 from the ER-OL as a source for Table 4.4.

#15

Cont

Comment

Table 4.4 was derived from ER-OL Table 3.6.1-2 but has been modified incorrectly. Footnotes 1 and 3 of Table 4.4 apply to portions of ER-OL Table 3.6.1-2 that were excluded when Table 4.4 was created. Correct footnotes for DES Table 4.4 are:

1) Alkalinity is treated with sulfuric acid
2) Incremental concentrations in the discharge cove estimates average station wastes in a flow of 56,200 gpm (125.2 cfs).
3) Incremental concentrations in Lake Wylie are based on average station waste discharges and a flushing flow through the reservoir. The maximum incremental concentration is based on the 7-Q 10 flow of 648 cfs, and average incremental concentration is based on the average flow of 4445 cfs.

5. ENVIRONMENTAL CONSEQUENCES AND MITIGATING ACTIONS

5.1 Resume

Page 5-1

The DES lists 5 requirements established by the EPP.

Comment

#16 For clarity these five items should read "...(1) notify NRC of major changes in plant design or operation, or if tests or experiments affecting the environment are performed; provided that such changes, tests, or experiments involve an unreviewed environmental question; (2) maintain specific environmentally related records in the form of communications with appropriate local state and/or Federal Agencies; (3) report violations of conditions stated in the NPDES permit or State Certification pursuant to Section 401 of the Clean Water Act by copy of memo to the lead agency; (4) report unusual or important environmental events by copy of memo to the lead agency; and (5) monitor to detect any changes which may arise from cooling tower drift."

These changes will help define the otherwise broad five requirements for non-radiological monitoring.

5.3.2.2 Surface Water

Page 5-3

#17 The DES indicates discharges of 2249 l/sec (29,800 gpm) in the winter and 3242 l/sec (51,400 gpm) in the summer.

Comment

These numbers are incorrect and should read 1,199 (19,000 gpm) winter and 3532 l/sec (56,000 gpm) summer discharge flow rates.

Page 5-3

#18 The DES quotes numbers from Table 5.3 which are incorrect. See later comments Page 5-68. It uses a 1.1% of total lake area for the worst-case isotherm and 0.7% of lake area for average winter isotherm.

Comment

These numbers should be 0.9% for worst case total lake area effects and 0.6% for average winter total lake effects.

5.5.2.1 Impingement and Entrainment, Impingement

Page 5-8

#19 The DES states that with both units operating at full capacity the amount of water withdrawn through the Low Pressure Service Water intake will be a maximum of 6.4 m^3/sec (227cfs).

19 cont

Comment

The values of 6.4 m^3/sec and 227 cfs do not agree with average and maximum values given in the EROL. After the appropriate conversion of 99,000 GPM, (EROL Figure 3.3.1-1) these values should be 6.2 m^3/sec and 221 cfs, respectively.

5.5.2.2 Thermal Discharge

20

Page 5-10

The DES states that 42.5 ha (105 acres) are part of the worst case condition from Table 5.3.

Comment

This table is incorrect. Comments are on Page 5-68. The worst-case condition is for 40.0 ha (100 acres).

5.9.1 Regulatory Requirements

21

Page 5-12

The DES states that the permissible levels of radiation are recorded in 10CFR20.

Comment

For clarity, "contained" may be a better word than "recorded".

22

Page 5-13

The DES states that requirements of 10CFR50.36a that are to be imposed on licensees.

Comment

The words "to be" should be deleted. The requirements are imposed on licensees.

23

Page 5-13

The DES states that applicants for permits to construct and for licenses to operate a LWR shall provide reasonable assurance that the following calculated dose design objectives will be met for all unrestricted areas.

Comment

This area needs to be rewritten to clarify that the specified dose design objectives are for a single reactor and Catawba will be allowed double the stated values since it is a two (2) reactor station.

5.9.3.1.1 Occupational Radiational Exposure for PWR's

24

Page 5-15

The first paragraph is confusing and needs to be clarified.

#24 Cont. Comment

The wording may be confusing to the public. It should be rewritten to clarify the meaning.

#25 Page 5-17

In the third paragraph the collective occupational doses is confusing.

Comment

Clarification of "doses" (annual or lifetime) should be made.

5.9.3.4.1 Radiological Monitoring, Preoperational

#26 Page 5-23

The DES states that the preoperational program will continue up to initial criticality.

Comment

The statement should be changed to read "the preoperational program will continue to just before initial criticality..."

5.9.4.3 Accident Experience and Observed Impacts

#27 Pages 5-29, 5-31

The DES states that accidents have occurred at several nuclear facilities.

Comment

Specific reference should be made to the Brown's Ferry fire and the fact that there was no core damage or any radiation released in the fire.

5.9.4.4 Mitigation of Accident Consequences, (2) Site Features

#28 Page 5-33

In the second paragraph the DES used 34,968 for the population of Rock Hill and 310,794 for the population of Charlotte.

Comment

The population of Rock Hill and Charlotte are 35,344 and 314,477, respectively.

5.9.4.5 Accident Risk and Impact Assessment

#29 Page 5-37

The DES states "The quantitative characteristics of the evacuation model used for the Midland site...".

29 Cont

Comment

Midland is incorrect; it should be the Catawba site.

5.14.2 Aquatic Monitoring

30

Pages 5-50, 5-51

In the last sentence of 5-50 and its completion on 5-51 the environmental protection plan requirements are discussed.

Comment

The sentence needs to be clarified to indicate that programs are set up for notification through permits and commitments to other agencies. Also, the word "on" should be changed to "or".

5.14.3 Atmospheric Monitoring

31

Page 5-51

The DES states that the applicant is considering .... of measuring wind speed and direction on a temporary mast at a height of one tower width above the top of the structural component.

Comment

This statement is inaccurate. The height of the temporary mast is not the same as the width of the tower which is 6.4 m (21 ft). The correct wording should be: "The applicant is considering measuring windspeed and direction on a temporary mast at a height of 3.9 m (12' 8") above the top structural component.

Table 5.3 Maximum Thermal Plume Extent Under Average and Worst-Cast Conditions for the Four Seasons*

32

Page 5-68

This table used** 5041 ha as full pond and derived several numbers on the attached table from this basis.

Comment

See Attachment 1.

ATTACHMENT 1

Table 5.3 Maximum Thermal Plume Extent Under Average and Worst-Case Conditions for the Four Seasons*

	Average Conditions				Worst-Case Conditions			
Season	Area to 2.8°C (5°F) above ambient isotherm, ha (acre)	% total** lake area	Area to 32.2°C (90°F) isotherm, ha (acre)	% total** lake area	Area to 2.8°C (5°F) above ambient isotherm, ha (acre)	% total*** lake area	Area to 32.2°C (90°F) isotherm, ha (acre)	% total*** lake area
Spring	32(80)	0.6	≈ 0	≈ 0	36(90)	1.0	≈ 0	≈ 0
Summer	2(5)	0.1	2(5)	0.1	14(35)	0.4	40(100)	1.1
Fall	20(50)	0.4	≈ 0	≈ 0	24(60)	0.7	≈ 0	≈ 0
Winter	30(75)	0.6	≈ 0	≈ 0	34(85)	0.9	≈ 0	≈ 0

* From ER Table 5.1.2-1.

** Based on full pond surface area of 5036 ha (12,445 acres).

*** Based on maximum drawdown 3m (10 ft.), area of 3724 ha (9,203 acres).

Appendix D. Examples of Site Specific Dose Assessment Calculations

Table D.6 Annual Dose Commitments to Maximally Exposed Individual near the Catawba Nuclear Station

Page D-10

33 The DES lists the nearest drinking water at Bay City.

Comment

These is no Bay City near Catawba Nuclear Station.

Table D.8 Calculated RM-50-2 Dose Commitments to a Maximally Exposed Individual From Operation of Catawba Nuclear Station

Page D-12

Footnote 3 adds Carbon-14 and tritium to the radioiodines and particulates category.

34 Comment

Carbon-14 and tritium should be listed separately rather than included under bone dose. Additionally, doses shown in Table D.8 differ considerably from those shown in CNS-ER/OLS Table 5.2.4-1. The tables need to be reconciled.

Appendix F

Pages F-1 through F-5

Consequence Modeling Considerations

Comment

Appendix F, "Consequence Modeling Considerations makes assumptions regarding evacuation and relocation distances, following low-probability accidents, well beyond those distances required in 10 CFR 50.33 and 10 CFR 50.47(c)(2). Appendix F assumes evacuation to 15 miles and relocation to 25 miles, which is well outside the "about 10 miles" distance required for the plume exposure pathway emergency planning zone (EPZ).

35

EPZs are defined as areas for which planning is needed to assure that prompt and effective actions can be taken to protect the public in the event of an accident. The 10 mile size represents a judgement by the EPA/NRC Task Force which authored NUREG-0396 on the extent of detailed planning which must be performed to assure an adequate response base. For most major emergency situations protective actions would be confined to small parts of the plume exposure EPZ. Only in the most serious accidents could protective actions potentially extend beyond the "about 10 mile" area.

The consequence analysis in Appendix F makes no distinction between the area in which a planning base exists and the area outside the base where ad hoc actions might be necessary, drawing upon the well developed capability inside 10 miles. In essence this Appendix requires that detailed planning capable of alerting, notifying, transporting, and accomodating residents in those areas outside 10 miles be available and in-place prior to such a situation existing.

In summary, the capability for rapid evacuation of the public around nuclear facilities is only required to "about 10 miles". The consequence analysis should not assume otherwise.

Appendix G

Pages G-1 through G-4

Environmental Impact Appraisal for Transshipment of Spent Fuel from Oconee and McGuire to Catawba Nuclear Station.

Comment

The transportation of radioactive materials to and from the Catawba Nuclear Station is within the scope of 10 CFR 51.20. Pursuant to these regulations, environmental risks associated with transportation are considered to be as
36 set forth in Table S-4.

In a prior proceeding involving Duke Power Company, the environmental impacts associated with transshipment of spent fuel from Oconee to McGuire were considered. This analysis concluded that the impacts were within the values set forth in Table S-4. Inasmuch as the Oconee and McGuire shipments to Catawba are similar to the Oconee shipment to McGuire, no separate appraisal of transshipment of spent fuel is necessary and, therefore, Appendix G should be withdrawn. At most, Table G merely confirms Table S-4.

Appendix G, 1-1, pg. G-1

The DES calculates an annual cumulative exposure to the drivers of the spent fuel truck shipments for spent fuel shipped from Oconee to Catawba to be about 19 person-rems per reactor year. For McGuire to Catawba shipments the drivers were found to receive about 16 person-rems of cumulative exposure.

Comment

Duke Power Company's plans and positions regarding the proposed shipments of spent fuel from Oconee and McGuire were detailed in an April 2, 1982 letter from Mr. W. O. Parker, Jr. to Mr. H. R. Denton, NRC/ONRR. The letter was written
in response to Ms. Elinor G. Adensam's letter of March 8, 1982 which requested additional information related to the storage of non-Catawba fuel at the Catawba Nuclear Station. The applicable response was to question #14.

37 In addition, the numbers used by the Staff in their calculations are extremely overly conservative and do not reflect actual conservative assumptions. Duke Power Company's experience with shipping spent fuel from Oconee to McGuire showed that the radiation levels 2m(6ft) from the truck bed were less than 3 mrem/hr (as opposed to the Staff's assumption of the legal limit of 10 mrem/hr). The actual radiation levels inside the cab were less than .05 mrem/hr (as opposed to the 2 mrem/hr legal limit assumed by the Staff). Thus, using conservative radiation levels acquired from actual experience the truck drivers would have received less than 3.3 mrem of exposure during each shipment. For the postulated 300 shipments of spent fuel from Oconee to Catawba the resultant annual cumulative exposure to the drivers would be less than 2 person-rems. For shipments from McGuire to Catawba the annual cumulative exposure would be even less, given the shorter route. Thus, not only is Table S-4 controlling, it is conservative.

South Carolina
Project Notification & Review System

U. S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D. C. 20555

STATE APPLICATION IDENTIFIER
SC820811-034
(CONTROL NUMBER)

50-413
50-414

The A-95 review process has been completed for your project notification on Draft Environmental Statement Related to Operation of Catawba Nuclear Station, Units 1 And 2.
The comments received during the A-95 review process should be taken into consideration in developing this project. Any significant changes in the project notification must be reported to the Clearinghouse.

This letter and its enclosures must be attached to your formal application. This clearance is valid for one year.

STATE CLEARINGHOUSE
Grant Services
Office of the Governor
1205 Pendleton Street, 4th Floor
Columbia, South Carolina 29201
Telephone: (803) 758-2417

Danny L. Cromer

By Danny L. Cromer

Date October 8, 1982

REGIONAL CLEARINGHOUSE

By ______________________

Date ______________________

CLEARINGHOUSE COMMENTS:

ENCLOSURES: State Agencies:

Local Agencies:

C002

SCPNRS Form 6A

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Food and Drug Administration
Rockville MD 20857

OCT 12 1982

50-413

Dr. Kahtan N. Jabbour
Project Manager
Division of Licensing
Office of Nuclear Reactor Regulations
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Dr. Jabbour:

The Bureau of Radiological Health staff has reviewed the Draft Environmental Statement (DES) related to the operation of the Catawba Nuclear Station, Units 1 and 2, NUREG-0921, dated August 1982.

In reviewing the DES, we note that (1) the application for a construction permit is dated July 1972, (2) the Final Environmental Statement-Construction Phase (FES-CP) was issued in December 1973, (3) after a safety review, evaluation by the ACRS, and a public hearing, the construction permits were issued in August 1975, and (4) as of May 1982, the construction of Unit 1 was about 90 percent complete. The Bureau of Radiological Health staff has evaluated the public health and safety impacts associated with the proposed operation of the plant and has the following comments to offer:

1. The numerical guidance on dose-design objectives of 10 CFR 50, Appendix I to meet ALARA requirements, the Uranium Fuel Cycle standards of EPA's 40 CFR 190, and the applicant's proposed radioactive waste management system (Section 4.2.5) provide adequate assurance that the effluents will be maintained as low as reasonably achievable (ALARA). It appears that the calculated doses to individuals and to populations resulting from effluent releases are within current radiation protection standards.

2. The environmental pathways identified in Section 5.9.3, and shown schematically in Figure 5.1, cover all possible emission pathways that could impact on the population in the environs of the facility. The dose computational methodology and models (Appendix D and E) used in the estimation of radiation doses to individuals and populations within 80 km. of the plant have provided the means to make reasonable estimates of the doses resulting from normal operations and accident situations at the plant. Results of the calculations are shown in Appendix D, Tables D.6, D.7, D.8 and D.9 and confirm that the calculated doses meet the design objectives.

C002

#1 3. Discussion in Section 5.9.4 on the environmental impact of postulated accidents is considered to be an adequate assessment of the radiation exposure pathways depicted in Figure 5.1 and the dose and health impacts of atmospheric releases. However, in Section 5.9.4.2(2), two additional possible pathways are mentioned. These are (1) radioactive fallout onto open bodies of water, and (2) the "China Syndrome" that creates the potential for release of radioactive materials into the hydrosphere through contact with ground water. A discussion of this latter pathway has been included in Section 5.9.4.5(5). It would be helpful in understanding the consequences of the former, if some discussion of that pathway could also be included in an appropriate section, possibly in Section 5.9.4.5(5).

#2 No mention is made in Section 5.9.4(3) of an Emergency Operation Facility (EOF) being planned for location on-site to coordinate activities needed to mitigate the consequences of serious accidents. Designation of such a facility would indicate one of the positive steps taken since the TMI-2 accident to improve reactor safety.

4. The radiological monitoring program as presented in Section 5.9.3.4, and summarized in Table 5.7, appears to provide adequate sampling frequency in critical exposure pathways. The analyses for specific radionuclides are considered sufficiently inclusive to (1) measure the extent of emissions from the plant, and (2) verify that such emissions meet applicable radiation protection standards.

#3 It is noted that the NRC is considering proposals to require real time monitors that can provide useful, timely information to implement the offsite protection actions following an accident. In view of some of the monitoring problems identified during the TMI-2 accident, we suggest that the system, which is being studied by a consultant, include reevaluation of the airborne radioiodine sampling and analysis program, and, if appropriate, include the finding in the proposed system. We are particularly concerned about the problem of monitoring radiohalogens (specifically radioiodine) in the presence of radionoble gases.

5. Section 5.10 and Appendix C contain descriptions of the environmental impact of the Uranium Fuel Cycle (UFC). The population dose commitments and health effects presented are a reasonable assessment of the environmental effects from liquid and gaseous radioactive effluent releases from the UFC (excluding reactors, but including radon-222 and technicium-99).

Thank you for the opportunity to review and comment on this Draft Environmental Statement.

Sincerely yours,

John C. Villforth

John C. Villforth
Director
Bureau of Radiological Health

(Carolina Environmental Study Group)

October 22, 1982
854 Henley Place
Charlotte, NC 28207

Dr. Kahtan N. Jabbour, Project Manager
Division of Licensing
Office of Nuclear Reactor Regulation
U. S. Nuclear Regilatory Commission
Washington, DC 20555

Dear Dr. Jabbour:

Will you please see that the following comments are transmitted, as appropriate, in the agency.

Jesse L. Riley

Jesse L. Riley

cc: Robert Guild, Esq.
Palmetto Alliance
Henry A. Presler
Hal B. Tucker
Judge Kelly
Judge Foster
Judge Callahan
Al Carr, Esq.

C002B

8210260150 821022
PDR ADOCK 05000413
D PDR

CAROLINA ENVIRONMENTAL STUDY GROUP

COMMENTS: DRAFT ENVIRONMENTAL STATEMENT--NUREG-0921

The summary of the benefits and costs for the operation of the Catawba nuclear station is given in Table 6.1, p. 6-4, of the Draft Environmental Statement, NUREG-0921. There are, in our opinion, deficiencies on which we comment as follows:

#1

COST-BENEFIT (6-1 to 5)

Two benefits are described as "large", 1) the supply of 12 billion kWh/yr of electrical energy and 2) reduced generating costs of $47-310 million/yr (1986).

There are neither "large" nor "moderate" off-setting costs. The DES fails to recognize that the disuse or forced retirement of generating plants of equivalent capacity is a cost and the magnitude, defined by the claimed benefit, is "large".

A second off-setting cost will be the requirement on the customers of the Applicant to pay earnings on the Applicant's equity in Catawba. The inclusion of Catawba in the rate base will result in a request for an increase in rate which, if the past is precedent, will be granted. The consequent cost will be "large", using the scale provided by the characterization of the generating cost benefit.

These large costs should be considered in the cost-benefit balancing and may well change that balance in the view of the Atomic Safety and Licensing Board which is required by law to take into proper account all possible approaches to a particular project which would alter environmental impact and cost-benefit balance. NEPA of 1969, § 102 (2) (C,D), 42 U.S.C.A. § 4332(2) (C, D).

Additionally there is a large error in the magnitude of the electrical energy which, with reasonable assurance, the plant can be expected to provide. At the CP stage the FES anticipated energy production of 14.214 billion kWh/yr, having assumed a capacity factor of 70% and operation at 100% of rated power. Table 10.1, p. 10-2. The DES, assuming a 60% capacity factor, estimates 12 billion kWh/yr. The DES fails to consider that McGuire-1, a sister plant, is presently limited to 50% of rated power by steam generator deficiencies. Catawba-1, which has steam generators of the same Westinghouse, D- series, preheater type, may more reasonably be expected to provide 3 billion kWh/yr. There is not yet a sufficient basis to say how long this situation will prevail, nor what energy output, if any, will be attributable to Catawba-2.

Given this circumstance it appears reasonable to suggest that the energy benefit of Catawba-1 will be "moderate".

The lowered output of the plant will cause a corresponding reduction in the benefit to reduced generating costs, quite possibly placing them in the "moderate" category.

ALTERNATIVES (3-1)

The DES, under an amendment to 10 CFR 51, does not consider alternative energy sources. There are, however, reasonable, environmentally significant alternatives, not directly relating to alternative energy sources, which require considertaion.

Catawba-2 is at about a 40% level of completion. Applicant initially projected that Catawba-1 would be on line in 1979 and Catawba-2 in 1980. Fuel loading for Catawba-1 is now scheduled for 1984 and commercial operation for 1985. No corresponding dates have recently been announced for Catawba-2. The diminished growth in electrical use supports the conclusion that it is presently not possible to soundly project a time for placing Catawba-2 on line. Indeed, if recent trends in growth rate persist and some contemporary views are correct (Chemical Week, Sept. 15, 1982, p. 53, "Similar views . . .") and the spate of plant cancellations are reliable testimony, Catawba-2 may never operate. There is clearly the alternative that the further construction, at this time, of Catawba-2 weighs unfavorably in the environmental balance, and that construction should stop until and unless at some future date there is reasonable indication that the balance has changed. This view is consistent with the requirement of the NEPA that

#2

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

be made the subject of a detailed statement by the responsible official. There is, further, the holding by the D.C. Circuit that "to the fullest extent possible" "appropriate" consideration be given to environmental amenities and values; that the agency decision maker has before him and takes into proper account all possible approaches to a particular project which would alter environmental impact and cost-benefit balance. Id.

Another alternative would be the withholding of an operating license for both Catawba units until and unless it were apparent that the operation of Catawba-1 would result in a favorable cost-benefit balance.

ADVERSE RADIOLOGICAL HEALTH EFFECTS (6-5)

#3

The cost-benefit summary considers the radiological costs of reactor operation (Sec. 5.9.3), the balance of the fuel cycle (Sec. 5.10) and accident risks (Sec. 5.9.4), "small". "Uncertain" would be a better characterization. Cancers and genetic effects are slow to manifest and debatable to relate to source; fuel cycle consequences will occur over a period of time which dwarfs the human scale-there is no way of knowing; and the accident costs can only be made to appear acceptable by associating them with extremely low calculated, as opposed to experiential, probabilities. It would seem that the only reasonable conclusion is that, based on present information, these costs are indeterminate.

J.J. Riley

DEPARTMENT OF THE ARMY
CHARLESTON DISTRICT, CORPS OF ENGINEERS
P. O. BOX 919
CHARLESTON, S.C. 29402

REPLY TO ATTENTION OF
SACEN-E

17 November 1982

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

Dear Sir:

This is in response to a letter dated 16 August 1982 transmitting a draft Environmental Statement for the operation of the Catawba Nuclear Station, Units 1 and 2.

We have reviewed the draft statement within the scope of our designated areas of responsibility and expertise and have no comments.

Sincerely,

Arthur P. Crouse, Jr.
ARTHUR P. CROUSE, JR.
Chief, Engineering Division

Copy furnished:
Regional Interdisciplinary Environmental
Assessment Team
Room 834
Richard B. Russell Federal Building
75 Spring Street, S. W.
Atlanta, GA 30303

Division Engineer, South Atlantic
ATTN: SADPD-R

Office, Chief of Engineers
ATTN: DAEN-CWP-V
WASH, DC 20314

DUKE POWER COMPANY
P.O. BOX 33189
CHARLOTTE, N.C. 28242

HAL B. TUCKER
VICE PRESIDENT
NUCLEAR PRODUCTION

TELEPHONE
(704) 373-4531

November 19, 1982

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Ms. E. G. Adensam, Chief
Licensing Branch No. 4

Re: Catawba Nuclear Station
Docket Nos. 50-413, 50-414

Dear Mr. Denton:

In regard to Ms. Elinor G. Adensam's November 8, 1982 letter which transmitted comments received by the NRC on the Draft Environmental Statement for the Catawba Nuclear Station, please find attached Duke Power Company's response to those comments.

Very truly yours,

H.B. Tucker/ftd

Hal B. Tucker

RWO/php
Attachment

cc: Mr. P. K. Van Doorn
NRC Resident Inspector
Catawba Nuclear Station

Mr. Robert Guild, Esq.
Attorney-at-Law
P. O. Box 12097
Charleston, South Carolina 29412

Palmetto Alliance
2135½ Devine Street
Columbia, South Carolina 29205

Mr. Jesse L. Riley
Carolina Environmental Study Group
854 Henley Place
Charlotte, North Carolina 28207

DUKE POWER COMPANY

RESPONSES TO

FEDERAL, STATE, AND LOCAL AGENCY

COMMENTS ON

DRAFT ENVIRONMENTAL STATEMENT

CATAWBA NUCLEAR STATION

DOCKET NOS. 50-413 and 50-414

NOVEMBER 19, 1982

S. C. Department of Archives and History, letter dated August 27, 1982 and the University of South Carolina, Institute of Archeology and Anthoropology, letter dated September 9, 1982.

Agency Comment:

State reasons for the recommendation that for archaeological site 37YK72 "no further investigation of the site was recommended" and add the condition that further investigation of the site (38YK72) is recommended if construction impacts to the site cannot be avoided.

Duke Response:

Duke Power Company agrees with the statements of Mr. Lee and Dr. Stephenson concerning any further impact on site 38YK72. If any additional construction is done on or near the location of site 38YK72, Duke Power Company will take the appropriate steps to thoroughly evaluate any impact to the archeological significance of this area.

United States Department of Interior, letter dated September 30, 1982

Historic and Archeologic Impacts

Agency Comment:

Additional information concerning the exact location of the Catawba - Ripp Line in relation to Kings Mountain National Military Park is needed to enable the DOI to determine the impacts of construction and operation of the proposed line on the park.

Duke Response:

Duke has been responsive to requests from NRC concerning the location of the Catawba-Ripp Line and, therefore, feels that sufficient information on the location of the line, to satisfy the concerns of the Department of the Interior is available. Duke agrees with the NRC statement (CNS-construction EIS page4-9), that of all routes considered for the Catawba-Ripp Line, the selected route exerts the least impact upon sensitive areas of the park.

Water Quality

Agency Comment:

"Thus it appears that operation of the proposed Catawba Nuclear Station will be in violation of State water quality standards and the Clean Water Act (P.L. 92-500) under which those standards were developed."

Duke Response:

The Nuclear Regulatory Commission (NRC) has recognized that the Environmental Protection Agency (EPA) is the federal agency with the duty to protect water quality under the Clean Water Act and that it has the requisite expertise to perform this function. The EPA has delegated permit issuing authority under the National Pollutant Discharge Elimination System (NPDES) permitting program to the South Carolina Department of Health and Environmental Control (DHEC).

The NRC, recognizes the responsibilities of DHEC to protect water quality and aquatic biota as stated in the DES Section 5.14.2.

Post-Operational Monitoring

Agency Comment:

"Consequently, neither the applicant nor the U. S. Nuclear Regulatory Commission proposed post-operational monitoring programs of entrainment/impingement or thermal effects."

Duke Response:

Duke feels that the entrainment/impingement discussion in the DES, Section 5.5.2.1 adequately addresses the concerns and in light of all impingement rate and the DES projections on entrainment, the programs proposed by the Interior Department are not warranted. In the discussion on thermal discharge effects the suggestion that a program to monitor thermal effects following plant start up is not warranted. The Allen 316 (a) Demonstration and recent scientific research demonstrate that 90°F is not an abrupt threshold, as implied in the USDI letter. A 105 acre zone of Lake Wylie devoid of indigenous species has been disproven not only at Plant Allen [316(a)] but also at Marshall and, nationwide by UWAG's Thermal Discharge Reports which were submitted to EPA in June, 1978.

The Post-Operational Monitoring proposed in the USDI letter is not justified based on actual operating experience effects on aquatic biota in the Duke system and results of studies conducted on operating power plants in the Southeast in general.

Jesse L. Riley letter dated October 22, 1982

Duke Response:

Recent Commission rulings (47 FR 12940, March 26, 1982) obviate the requirement for inclusion of "need for power" and "alternative energy sources" in operating license proceedings. It is Duke's position that the summary of benefits and costs for operation of Catawba Nuclear station meets all regulatory requirements.

Duke will resolve recent problems with Westinghouse steam generators prior to commercial operation of Catawba Nuclear Station.

Department of Health and Human Services letter dated October 12, 1982

Agency Comment:

No mention is made in Section 5.9.4(3) of an Emergency Operation Facility (EOF) being planned for location on-site to coordinate activities needed to mitigate the consequences of serious accidents.

Duke Response:

An Emergency Operations Facility (entitled the Crisis Management Center or CMC) is located onsite in the Catawba Nuclear Station administration building. Duke has made provisions for an alternate EOF at the corporate headquarters in Charlotte, NC. The EOF is addressed in detail in the Emergency Response Plan.

Agency Comment:

It is noted that the NRC is considering proposals to require real time monitors that can provide useful, timely information to implement the off site protection actions following an accident. In view of some of the monitoring problems identified during the TMI-2 accident, we suggest that the system, which is being studied by a consultant, include reevaluation of the airborne radioiodine sampling and analysis program, and, if appropriate, include the finding in the proposed system. We are particularly concerned about the problem of monitoring radiohalogens (specifically radioiodine) in the presence of radionoble gases.

Duke Response:

Duke's offsite radiological monitoring system to be used in response to emergency conditions is described in Section 1 of the Catawba Emergency Plan, Rev. 1, December, 1981. This system meets the standards set out in NUREG-0654 and Regulatory Guide 1.97. In the event of emergency conditions TLDs used in conjunction with field monitoring teams equipped with instrumentation, including real time monitors, provide the necessary dose rate, integrated dose, and radioiodine concentrations for dose assessment.

Communications with the NRC on the subject of offsite radiological monitoring systems to measure offsite dose rates during emergency conditions are as follows:

Catawba Emergency Plan, Rev. 1, Decmeber, 1981
Duke Power Company Crisis Management Plan
CNS FSAR Sections 11.3.3, 11.5, 12.5.2, Volume 13, Section 810

APPENDIX B

NEPA POPULATION-DOSE ASSESSMENT

Population-dose commitments are calculated for all individuals living within 80 km (50 mi) of the Catawba facility, employing the same dose calculation models used for individual doses (see Regulatory Guide (RG) 1.109, Rev 1), for the purpose of meeting the as low as reasonably achievable (ALARA) requirements of 10 CFR 50 Appendix I. In addition, dose commitments to the population residing beyond the 80-km region, associated with the export of food crops produced within the 80-km region and with the atmospheric and hydrospheric transport of the more mobile effluent species, such as noble gases, tritium, and carbon-14, are taken into consideration for the purpose of meeting the requirements of the National Environmental Policy Act (NEPA) of 1969. This appendix describes the methods used to make these NEPA population dose estimates.

1. Iodines and Particulates Released to the Atmosphere

Effluent nuclides in this category deposit onto the ground as the effluent moves downwind; thus, the concentration of these nuclides remaining in the plume is continuously being reduced. Within 80 km of the facility, the deposition model in RG 1.111, Rev 1, is used in conjunction with the dose models in RG 1.109, Rev 1. Site-specific data concerning production and consumption of foods within 80 km of the reactor are used. For estimates of population doses beyond 80 km it is assumed that excess food not consumed within the 80-km area would be consumed by the population beyond 80 km. It is further assumed that none, or very few, of the particulates released from the facility will be transported beyond the 80-km distance; thus, they will make no significant contribution to the population dose outside the 80-km region, except by export of food crops.

2. Noble Gases, Carbon-14, and Tritium Released to the Atmosphere

For locations within 80 km of the reactor facility, exposures to these effluents are calculated with a constant mean wind-direction model according to the guidance provided in RG 1.111, Rev 1, and the dose models described in RG 1.109, Rev 1. For estimating the dose commitment from these radionuclides to the U.S. population residing beyond the 80-km region, two dispersion regimes are considered. These are referred to as the first-pass-dispersion regime and the world-wide-dispersion regime. The model for the first-pass-dispersion regime estimates the dose commitment to the population from the radioactive plume as it leaves the facility and drifts across the continental United States toward the northeastern corner of the United States. The model for the world-wide-dispersion regime estimates the dose commitment to the U.S. population after the released radionuclides mix uniformly in the world's atmosphere or oceans.

(a) First-Pass Dispersion

For estimating the dose commitment to the U.S. population residing beyond the 80-km region as a result of the first pass of radioactive pollutants, it is assumed that the pollutants disperse in the lateral and vertical directions along the plume path. The direction of movement of the plume is assumed to be from the facility toward the northeast corner of the United States. The extent of vertical dispersion is assumed to be limited by the ground plane and the stable atmospheric layer aloft, the height of which determines the mixing depth. The shape of such a plume geometry can be visualized as a right cylindrical wedge whose height is equal to the mixing depth. Under the assumption of constant population density, the population dose associated with such a plume geometry is independent of the extent of lateral dispersion, and is only dependent upon the mixing depth and other nongeometrical related factors (NUREG-0597). The mixing depth is estimated to be 1000 m, and a uniform population density of 62 persons/km^2 is assumed along the plume path, with an average plume-transport velocity of 2 m/sec.

The total-body population-dose commitment from the first pass of radioactive effluents is principally a result of external exposure from gamma-emitting noble gases and of internal exposure from the inhalation of air containing tritium and from the ingestion of food containing C-14 and tritium.

(b) World-Wide Dispersion

For estimating the dose commitment to the U.S. population after the first-pass, world-wide dispersion is assumed. Nondepositing radionuclides with half-lives greater than 1 year are considered. Noble gases and C-14 are assumed to mix uniformly in the world's atmosphere (3.8×10^{18} m^3), and radioactive decay is taken into consideration. The world-wide-dispersion model estimates the activity of each nuclide at the end of a 20-year release period (midpoint of reactor life) and estimates the annual population-dose commitment at that time, taking into consideration radioactive decay and physical removal mechanisms (for example, C-14 is gradually removed to the world's oceans). The total-body population-dose commitment from the noble gases is mainly a result of external exposure from gamma-emitting nuclides, whereas from C-14 it is mainly a result of internal exposure from ingestion of food containing C-14.

The population-dose commitment as a result of tritium releases is estimated in a manner similar to that for C-14, except that after the first pass, all the tritium is assumed to be immediately distributed in the world's circulating water volume (2.7×10^{16} m^3) including the top 75 m of the seas and oceans, as well as the rivers and atmospheric moisture. The concentration of tritium in the world's circulating water is estimated at the time after 20 years of releases have occurred, taking into consideration radioactive decay; the population-dose commitment estimates are based on the incremental concentration at that time. The total-body population-dose commitment from tritium is mainly a result of internal exposure from the consumption of food.

3. Liquid Effluents

Population-dose commitments resulting from effluents in the receiving water within 80 km of the facility are calculated as described in RG 1.109, Rev 1. It is assumed that no depletion by sedimentation of the nuclides present in the receiving water occurs within 80 km. It also is assumed that aquatic biota concentrate radioactivity in the same manner as was assumed for the ALARA evaluation for the maximally exposed individual. However, food-consumption values appropriate for the average, rather than the maximum, individual are used. It is further assumed that all the sport and commercial fish and shellfish caught within the 80-km area are eaten by the U.S. population.

Beyond 80 km, it is assumed that all the liquid-effluent nuclides except tritium have deposited on the sediments so that they make no further contribution to population exposures. The tritium is assumed to mix uniformly in the world's circulating water volume and to result in an exposure to the U.S. population in the same manner as discussed for tritium in gaseous effluents.

4. References

U. S. Nuclear Regulatory Commission, NUREG-0597, "User's Guide to GASPAR Code," June 1980.

---, RG 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Rev 1, October 1977.

---, RG 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Reactors," Rev 1, July 1977.

APPENDIX C

IMPACTS OF THE URANIUM FUEL CYCLE

The following assessment of the environmental impacts of the light-water-reactor (LWR)-supporting fuel cycle as related to the operation of the proposed project is based on the values given in Table S-3 (see Section 5.10 of the main body of this report) and the NRC staff's analysis of the radiological impact from radon and technetium releases. For the sake of consistency, the analysis of fuel-cycle impacts has been cast in terms of a model 1000-MWe light-water-cooled reactor operating at an annual capacity factor of 80%. In the following review and evaluation of the environmental impacts of the fuel cycle, the staff's analysis and conclusions would not be altered if the analysis were to be based on the net electrical power output of the Catawba Nuclear Station.

1. Land Use

The total annual land requirement for the fuel cycle supporting a model 1000-MWe LWR is about 460,000 m^2 (113 acres). Approximately 53,000 m^2 (13 acres) per year are permanently committed land, and 405,000 m^2 (100 acres) per year are temporarily committed. (A "temporary" land commitment is a commitment for the life of the specific fuel-cycle plant, such as a mill, enrichment plant, or succeeding plants. On abandonment or decommissioning, such land can be used for any purpose. "Permanent" commitments represent land that may not be released for use after plant shutdown and/or decommissioning.) Of the 405,000 m^2 per year of temporarily committed land, 320,000 m^2 are undisturbed and 90,000 m^2 are disturbed. Considering common classes of land use in the United States,* fuel-cycle land-use requirements to support the model 1000-MWe LWR do not represent a significant impact.

2. Water Use

The principal water-use requirement for the fuel cycle supporting a model 1000-MWe LWR is that required to remove waste heat from the power stations supplying electrical energy to the enrichment step of this cycle. Of the total annual requirement of 43×10^6 m^3 (11.4×10^9 gal), about 42×10^6 m^3 are required for this purpose, assuming that these plants use once-through cooling. Other water uses involve the discharge to air (for example, evaporation losses in process cooling) of about 0.6×10^6 m^3 (16×10^7 gal) per year and water discharged to the ground (for example, mine drainage) of about 0.5×10^6 m^3 per year.

On a thermal effluent basis, annual discharges from the nuclear fuel cycle are about 4% of those from the model 1000-MWe LWR using once-through cooling. The consumptive water use of 0.6×10^6 m^3 per year is about 2% of that from the

*A coal-fired plant of 1000-MWe capacity using strip-mined coal requires the disturbance of about 810,000 m^2 (200 acres) per year for fuel alone.

model 1000-MWe LWR using cooling towers. The maximum consumptive water use (assuming that all plants supplying electrical energy to the nuclear fuel cycle used cooling towers) would be about 6% of the model 1000-MWe LWR using cooling towers. Under this condition, thermal effluents would be negligible. The staff finds that these combinations of thermal loadings and water consumption are acceptable relative to the water use and thermal discharges of the proposed project.

3. Fossil Fuel Consumption

Electrical energy and process heat are required during various phases of the fuel cycle process. The electrical energy is usually produced by the combustion of fossil fuel at conventional power plants. Electrical energy associated with the fuel cycle represents about 5% of the annual electrical power production of the model 1000-MWe LWR. Process heat is primarily generated by the combustion of natural gas. This gas consumption, if used to generate electricity, would be less than 0.3% of the electrical output from the model plant. The staff finds that the direct and indirect consumptions of electrical energy for fuel-cycle operations are small and acceptable relative to the net power production of the proposed project.

4. Chemical Effluents

The quantities of chemical, gaseous, and particulate effluents associated with fuel-cycle processes are given in Table S-3. The principal species are sulfur oxides, nitrogen oxides, and particulates. On the basis of data in a Council on Environmental Quality (CEQ) report (1976), the staff finds that these emissions constitute an extremely small additional atmospheric loading in comparison with the same emissions from the stationary fuel-combustion and transportation sectors in the United States; that is, about 0.02% of the annual national releases for each of these species. The staff believes that such small increases in releases of these pollutants are acceptable.

Liquid chemical effluents produced in fuel cycle processes are related to fuel-enrichment, -fabrication, and -reprocessing operations and may be released to receiving waters. These effluents are usually present in dilute concentrations such that only small amounts of dilution water are required to reach levels of concentration that are within established standards. The flow of dilution water required for specific constituents is specified in Table S-3. Additionally, all liquid discharges into the navigable waters of the United States from plants associated with the fuel-cycle operations will be subject to requirements and limitations set forth in the national pollution discharge elimination system (NPDES) permit.

Tailings solutions and solids are generated during the milling process. These solutions and solids are not released in large enough quantities to have a significant impact on the environment.

5. Radioactive Effluents

Radioactive effluents estimated to be released to the environment from reprocessing and waste-management activities and certain other phases of the fuel-cycle process are set forth in Table S-3. Using these data, the staff has calculated for 1 year of operation of the model 1000-MWe LWR, the 100-year involuntary environmental dose commitment* to the U.S. population from the LWR-supporting fuel cycle.

It is estimated from these calculations that the overall involuntary total-body gaseous dose commitment to the U.S. population from the fuel cycle (excluding reactor releases and the dose commitment due to radon-222 and technetium-99) would be approximately 400 person-rems for each year of operation of the model 1000-MWe LWR (reference reactor year, or, RRY). Based on Table S-3 values, the additional involuntary total-body dose commitments to the U.S. population from radioactive liquid effluents (excluding technetium-99) as a result of all fuel-cycle operations other than reactor operation would be about 100 person-rems per year of operation. Thus, the estimated involuntary 100-year environmental dose commitment to the U.S. population from radioactive gaseous and liquid releases due to these portions of the fuel cycle is about 500 person-rems (whole-body) per RRY.

At this time the radiological impacts associated with radon-222 and technetium-99 releases are not addressed in Table S-3. Principal radon releases occur during mining and milling operations and as emissions from mill tailings; whereas principal technetium-99 releases occur from gaseous diffusion enrichment facilities. The staff has determined that radon-222 releases per RRY from these operations are as given in Table C.1. The staff has calculated population-dose commitments for these sources of radon-222 using the RABGAD computer code described in Volume 3 of NUREG-0002, Appendix A, Chapter IV, Section J. The results of these calculations for mining and milling activities prior to tailings stabilization are listed in Table C.2.

When added to the 500 person-rem total-body dose commitment for the balance of the fuel cycle, the overall estimated total-body involuntary 100-year environmental dose commitment to the U.S. population from the fuel cycle for the model 1000-MWe LWR is approximately 640 person-rems. Over this period of time, this dose is equivalent to 0.00002% of the natural-background total-body dose of about 3 billion person-rems to the U.S. population.**

The staff has considered the health effects associated with the releases of radon-222, including both the short-term effects of mining and milling, and active tailings, and the potential long-term effects from unreclaimed open-pit mines and stabilized tailings. The staff has assumed that after completion of active mining, underground mines will be sealed, returning releases of radon-222 to background levels. For purposes of providing an upper bound impact assessment, the staff has assumed that open-pit mines will be unreclaimed and has calculated that if all ore were produced from open-pit mines, releases from them would be 110 Ci per RRY. However, because the distribution of uranium-core reserves available by conventional mining methods is 66% underground and 34% open pit (Department of Energy, 1978), the staff has further assumed that uranium to fuel LWRs will be produced by conventional mining methods in these

*The 100-year environmental dose commitment is the integrated population dose for 100 years; that is, it represents the sum of the annual population doses for a total of 100 years.

**Based on an annual average natural-background individual dose commitment of 100 mrems and a stabilized U.S. population of 300 million.

proportions. This means that long-term releases from unreclaimed open-pit mines will be 0.34 x 110 or 37 Ci per year per RRY.

Based on the above, the radon released from unreclaimed open-pit mines over 100- and 1000-year periods would be about 3700 Ci and 37,000 Ci per RRY, respectively. The total dose commitments for a 100- to 1000-year period would be as shown in Table C.3.

These commitments represent a worst-case situation in that no mitigating circumstances are assumed. However, state and Federal laws currently require reclamation of strip and open-pit coal mines, and it is very probable that similar reclamation will be required for open-pit uranium mines. If so, long-term releases from such mines should approach background levels.

For long-term radon releases from stabilized tailings piles, the staff has assumed that these tailings would emit, per RRY, 1 Ci per year for 100 years, 10 Ci per year for the next 400 years, and 100 Ci per year for periods beyond 500 years. With these assumptions, the cumulative radon-222 release from stabilized-tailings piles per RRY would be 100 Ci in 100 years, 4090 Ci in 500 years, and 53,800 Ci in 1000 years (Gotchy, 1978). The total-body, bone, and bronchial epithelium dose commitments for these periods are as shown in Table C.4.

Using risk estimators of 135, 6.9, and 22 cancer deaths per million person-rems for total-body, bone, and lung exposures, respectively, the estimated risk of cancer mortality resulting from mining, milling, and active-tailings emissions of radon-222 is about 0.11 cancer fatality per RRY. When the risk from radon-222 emissions from stabilized tailings over a 100-year release period is added, the estimated risk of cancer mortality over a 100-year period is unchanged. Similarly, a risk of about 1.2 cancer fatalities per RRY is estimated over a 1000-year release period. When potential radon releases from reclaimed and unreclaimed open-pit mines are included, the overall risks of radon-induced cancer fatalities per RRY change as follows:

0.11 to 0.19 fatality for a 100-year period
0.19 to 0.57 fatality for a 500-year period
1.2 to 2.0 fatalities for a 1000-year period

To illustrate: A single model 1000-MWe LWR operating at an 80% capacity factor for 30 years would be predicted to induce between 3.3 and 5.7 cancer fatalities in 100 years, 5.7 and 17 in 500 years, and 36 and 60 in 1000 years as a result of releases of radon-222.

These doses and predicted health effects have been compared with those that can be expected from natural-background emissions of radon-222. Using data from the National Council on Radiation Protection and Measurements (NCRP) (1975), the staff calculates the average radon-222 concentration in air in the contiguous United States to be about 150 pCi/m^3, which the NCRP estimates will result in an annual dose to the bronchial epithelium of 450 mrems. For a stabilized future U.S. population of 300 million, this represents a total lung-dose commitment of 135 million person-rems per year. Using the same risk estimator of 22 lung-cancer fatalities per million person-lung-rems used to predict cancer fatalities for the model 1000-MWe LWR, the staff estimates that lung-cancer fatalities alone from background radon-222 in the air can be calculated to be about 3000 per year, or 300,000 to 3,000,000 lung-cancer deaths over periods of 100 to 1000 years, respectively.

The staff is currently in the process of formulating a specific model for analyzing the potential impact and health effects from the release of technetium-99 during the fuel cycle. However, for the interim period until the model is completed, the staff has calculated that the potential 100-year environmental dose commitment to the U.S. population from the release of technetium-99 should not exceed 100 person-rems per RRY. These calculations are based on the gaseous and the hydrological pathway model systems described in Volume 3 of NUREG-0002, Chapter IV, Section J, Appendix A. When these figures are added to the 640 person-rem total-body dose commitment for the balance of the fuel cycle, including radon-222, the overall estimated total-body involuntary 100-year environmental dose commitment to the U.S. population from the fuel cycle for the model 1000-MWe LWR is about 740 person-rems. Over this period of time, this dose is equivalent to 0.00002% of the natural-background total-body dose of about three billion person-rems to the U.S. population.*

The staff also considered the potential health effects associated with this release of technetium-99. Using the modeling systems described in NUREG-0002, the major risks from technetium-99 are from exposure of the gastrointestinal (GI) tract and kidney, although there is a small risk from total-body exposure. Using organ-specific risk estimators, these individual organ risks can be converted to total-body risk equivalent doses. Then, by using the total-body risk estimator of 135 cancer deaths per million person-rems, the estimated risk of cancer mortality due to technetium-99 releases from the nuclear fuel cycle is about 0.01 cancer fatality per RRY over the subsequent 100 to 1000 years.

In addition to the radon- and technetium-related potential health effects from the fuel cycle, other nuclides produced in the cycle, such as carbon-14, will contribute to population exposures. It is estimated that an additional 0.08 to 0.12 cancer death may occur per RRY (assuming that no cure for or prevention of cancer is ever developed) over the next 100 to 1000 years, respectively, from exposures to these other nuclides.

The latter exposures can also be compared with those from naturally occurring terrestrial and cosmic-ray sources. These average about 100 mrems. Therefore, for a stable future population of 300 million persons, the whole-body dose commitment would be about 30 million person-rems per year, or 3 billion person-rems and 30 billion person-rems for periods of 100 and 1000 years, respectively. These natural-background dose commitments could produce about 400,000 and 4,000,000 cancer deaths during the same time periods. From the above analysis, the staff concludes that both the dose commitments and health effects of the LWR-supporting uranium fuel cycle are very small when compared with dose commitments and potential health effects to the U.S. population resulting from all natural-background sources.

6. Radioactive Wastes

The quantities of buried radioactive waste material (low-level, high-level, and transuranic wastes) associated with the uranium fuel cycle are specified

*Based on an annual average natural-background individual dose commitment of 100 mrems and a stabalized U.S. population of 300 million.

in Table S-3. For low-level waste disposal at land-burial facilities, the Commission notes in Table S-3 that there will be no significant radioactive releases to the environment. The Commission notes that high-level and transuranic wastes are to be buried at a Federal repository and that no release to the environment is associated with such disposal. NUREG-0116, which provides background and context for the high-level and transuranic Table S-3 values established by the Commission, indicates that these high-level and transuranic wastes will be buried and will not be released to the biosphere. No radiological environmental impact is anticipated from such disposal.

7. Occupational Dose

The annual occupational dose attributable to all phases of the fuel cycle for the model 1000-MWe LWR is about 200 person-rems. The staff concludes that this occupational dose will have a small environmental impact.

8. Transportation

The transportation dose to workers and the public is specified in Table S-3. This dose is small in comparison with the natural-background dose.

9. Fuel Cycle

The staff's analysis of the uranium fuel cycle did not depend on the selected fuel cycle (no recycle or uranium-only recycle), because the data provided in Table S-3 include maximum recycle-option impact for each element of the fuel cycle. Thus the staff's conclusions as to acceptability of the environmental impacts of the fuel cycle are not affected by the specific fuel cycle selected.

10. References

Council on Environmental Quality, "The Seventh Annual Report of the Council on Environmental Quality," Figs. 11-27 and 11-28, pp. 238-239, September 1976.

Department of Energy, "Statistical Data of the Uranium Industry," GJO-100(8-78), January 1978.

Gotchy, R., testimony from "In the Matter of Duke Power Company (Perkins Nuclear Station)," U.S. Nuclear Regulatory Commission, Docket No. 50-488, filed April 17, 1978.

National Council on Radiation Protection and Measurements, NCRP, "Natural Background Radiation in the United States," NCRP Report No. 45, November 1975.

U. S. Nuclear Regulatory Commission, NUREG-0002, "Final Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light-Water-Cooled Reactors," August 1976.

---, NUREG-0116 (Supplement 1 to WASH-1248), "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," October 1976.

Table C.1 Radon releases from mining and milling operations and mill tailings for each year of operation of the model 1000-MWe LWR*

Radon source	Quantity released
Mining**	4060 Ci
Milling and tailings*** (during active mining)	780 Ci
Inactive tailings*** (before stabilization)	350 Ci
Stabilized tailings*** (several hundred years)	1 to 10 Ci/year
Stabilized tailings*** (after several hundred years	110 Ci/year

*After three days of hearings before the Atomic Safety and Licensing Appeal Board (ASLAB) using the Perkins record in a "lead case" approach, ASLAB issued a decision on May 13, 1981 (ALAB-640) on the radon-222 release source term for the uranium fuel cycle. The decision, among other matters, produced new source term numbers based on the record developed at the hearings. These new numbers did not differ significantly from those in the Perkins record which are the values set forth in this table. Any health effects relative to radon-222 are still under consideration before the ASLAB. Because the source term numbers in ALAB-640 do not differ significantly from those in the Perkins record, the staff continues to conclude that both the dose commitments and health effects of the uranium fuel cycle are insignificant when compared with dose commitments and potential health effects to the U.S. population resulting from all natural background sources. Subsequent to ALAB-640, a second ASLAB decision (ALAB-654, issued September 11, 1981) permitted intervenors a 60-day period to challenge the Perkins record on the potential health effects of radon-222 emissions. Such challenge was made, and a decision thereon is pending before the Appeal Board.

**R. Wilde, NRC transcript of direct testimony given "In the Matter of Duke Power Company (Perkins Nuclear Station)," Docket No. 50-488, April 17, 1978.

***P. Magno, NRC transcript of direct testimony given "In the Matter of Duke Power Company (Perkins Nuclear Station)" Docket No. 50-488, April 17, 1978.

Table C.2 Estimated 100-year environmental dose commitment per year of operation of the model 1000-MWe LWR

Radon source	Radon-222 releases (Ci)	Dosage (person-rems) Total body	Bone	Lung (bronchial epithelium)
Mining	4100	110	2800	2300
Milling and active tailings	1100	29	750	620
Total	5200	140	3600	2900

Table C.3 Population-dose commitments from unreclaimed open-pit mines for each year of operation of the model 1000-MWe LWR

Time span (years)	Radon-222 releases (Ci)	Population dose commitments (person-rems) Total body	Bone	Lung (bronchial epithelium)
100	3,700	96	2,500	2,000
500	19,000	480	13,000	11,000
1,000	37,000	960	25,000	20,000

Table C.4 Population-dose commitments from stabilized-tailings piles for each year of operation of the model 1000-MWe LWR

Time span (years)	Radon-222 releases (Ci)	Population dose commitments (person-rems) Total body	Bone	Lung (bronchial epithelium)
100	100	2.6	68	56
500	4,090	110	2,800	2,300
1,000	53,800	1,400	37,000	30,000

APPENDIX D

EXAMPLES OF SITE-SPECIFIC DOSE ASSESSMENT CALCULATIONS

1. Calculational Approach

As mentioned in the main body of this report the quantities of radioactive material that may be released annually from the Catawba facility are estimated on the basis of the description of the radwaste systems in the applicant's ER and FSAR and by using the calculational models and parameters developed by the NRC staff in NUREG-0017. These estimated effluent release values for normal operation, including anticipated operational occurrences, along with the applicant's site and environmental data in the ER and in subsequent answers to NRC staff questions, are used in the calculation of radiation doses and dose commitments.

The models and considerations for environmental pathways that lead to estimates of radiation doses and dose commitments to individual members of the public near the plant and of cumulative doses and dose commitments to the entire population within an 80-km (50-mi) radius of the plant as a result of plant operations are discussed in detail in Regulatory Guide (RG) 1.109, Rev 1. Use of these models with additional assumptions for environmental pathways that lead to exposure to the general population outside the 80-km radius are described in Appendix B of this Final Environmental Statement.

The calculations performed by the staff for the releases to the atmosphere and hydrosphere provide total integrated dose commitments to the entire population within 80 km of this facility based on the projected population distribution in the year 2000. The dose commitments represent the total dose that would be received over a 50-year period, following the intake of radioactivity for 1 year under the conditions existing at the approximate midpoint of station operation. For younger persons, changes in organ mass metabolic parameters with age after the initial intake of radioactivity are accounted for.

Annual average relative concentration (χ/Q) and relative depositon (D/Q) values were calculated using the straight-line Gaussian atmospheric dispersion model described in RG 1.111, modified to reflect spatial and temporal variations in airflow using the correction factors contained in NUREG-0324. Releases through the two unit vents have been considered as ground level with mixing in the turbulent wake of plant structures in accordance with the criteria contained in RG 1.111, that is, releases through vents with elevations below the tops of adjacent structures are assumed not to escape from the building wake. All other releases also have been considered as ground level, and all releases were considered to be continuous.

A 2-year period of record (12/17/75-12/16/77) of onsite meteorological data was used for this evaluation. Windspeed and direction data were based on measurements made at the 10-m (33-ft) level, and atmospheric stability was defined by the vertical temperature gradient measured between the 10-m (33-ft) and 40-m (132-ft) levels. The results of the additional information asked for concerning tower interference on the measurement of windspeed and direction at the 40-m level and on the representativeness of the location of the 10-m tower have changed the conclusions based on currently available meteorological data.

Tritium released through a vent stack will most likely be deposited through precipitation scavenging (washout), although tritium may also deposit through contact with soil, vegetation, and surface water. Once deposited, however, tritium can reevaporate from soil, vegetation, and water surfaces and be subsequently transported and deposited downwind, continuing the cycle of deposition, reevaporation, and transport. Tritium can reach surface waters through several different pathways: directly through precipitation scavenging; through molecular exchange between the atmosphere and water surface; and, indirectly through runoff or influx of groundwater. Washout of tritium by precipitation probably occurs at a rate similar to that for radioiodines. Although washout is a much more efficient mechanism for removal of material from the atmosphere than dry deposition, precipitation only occurs a small fraction of the time over an annual cycle resulting in deposited amounts comparable to those estimated for dry deposition. Assuming a representative D/Q of 1×10^{-9} m^{-2} for all atmospheric deposition processes for the vicinity of the Charlotte Water Intake (approximately 11 km (7 mi) north-northeast of the plant) and estimating an affected surface water area of 9×10^6 m^2, the amount of tritium deposited is expected to be less than 1% of the gaseous tritium releases. Similarly, assuming a representative D/Q of 1×10^{-9} m^{-2} for the vicinity of the Lake Wylie Dam (approximately 6.4 km (4 mi) east-southeast of the plant) and estimating an affected surface water area of 6.75×10^6 m^2, the amount of tritium deposited is expected to be less than 1% of the gaseous tritium releases. The amount of tritium that reaches surface water through runoff or influx of groundwater is expected to be even less than that deposited directly from the atmosphere because of retention by soil and vegetation and subsequent reevaporation and atmospheric transport.

The NRC staff estimates of the expected liquid releases (listed in Table D.4), along with the site hydrological considerations (summarized in Table D.5) were used to estimate radiation doses and dose commitments from liquid releases. The staff used the "no-recirculation" mixing model rather than the completely mixed model for calculating the doses to a maximally exposed individual from ingesting fish. The maximally exposed individual was assumed to eat fish caught in the vicinity of the plant discharge. The hydrologic models used to calculate dilution, for the purposes of fish consumption, considered the discharge of the plant, the freshwater flow rate in Big Allison Creek, the exchange of water between the discharge embayment and Lake Wylie, and the interaction of radioactive cesium with sediment.

The staff used the LADTAP model (NUREG/CR-1276) in the completely mixed mode for estimating doses to the maximally exposed individual ingesting water. Virtually the entire dose to the maximally exposed individual from ingesting water is caused by exposure to radionuclides whose half-lives are much greater than the flushing time of Lake Wylie, which is estimated to be about 46 days.

As illustrated in Section 5, Appendix A, of RG 1.113, the calculated concentrations of radionuclides in water are very insensitive to the choice of impoundment mixing models if the ratio of half-life to flushing time is large. Therefore, the completely mixed model is adequate for estimating doses from drinking water.

(a) Radiation Dose Commitments to Individual Members of the Public

As explained in the text, calculations are made for a hypothetical individual member of the public (that is, the maximally exposed individual) who would be expected to receive the highest radiation dose from all pathways that contribute. This method tends to overestimate the doses because assumptions are made that would be difficult for a real individual to fulfill.

The estimated dose commitments to the individual who is subject to maximum exposure at selected offsite locations from airborne releases of radioiodine and particulates, and waterborne releases are listed in Tables D.6, D.7, and D.8. The maximum annual total body and skin dose to a hypothetical individual and the maximum beta and gamma air dose at the site boundary are presented in Tables D.6, D.7, and D.8.

The maximally exposed individual is assumed to consume well above average quantities of the potentially affected foods and to spend more time at potentially affected locations than the average person as indicated in Tables E-4 and E-5 of Rev 1 of RG 1.109. The 20-year period was chosen for these calculations as representing the midpoint of plant operation and factors into the dose models by allowing for buildup of long-lived radionuclides in the soil. It affects the estimated doses primarily for radionuclides ingested by humans that have half-lives greater than a few years.

(b) Cumulative Dose Commitments to the General Population

Annual radiation dose commitments from airborne and waterborne radioactive releases from the Catawba facility are estimated for two populations in the year 2000: (1) all members of the general public within 80 km (50 mi) of the station (Table D.7) and (2) the entire U.S. population (Table D.9). Dose commitments beyond 80 km are based on the assumptions discussed in Appendix B. For perspective, annual background radiation doses are given in the tables for both populations.

3. References

U.S. Nuclear Regulatory Commission, NUREG-0016, "Calculation of Radioactive Materials in Gaseous and Liquid Effluents from Boiling Water Reactors," Revision 1, January 1979.

---, NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWR-GALE Code)," April 1976.

---, NUREG-0324, "XOQDOQ Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations," Draft, September 1977.

---, NUREG/CR-1276, "User's Manual for LADTAP II - A Computer Program for Calculating Radiation Exposure to Man From Routine Release of Nuclear Reactor Liquid Effluents," Oak Ridge National Laboratory, May 1980.

---, RG 1.109, "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Rev 1, October 1977.

---, RG 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Reactors," Rev 1, 1977.

---, RG 1.113, "Estimating Aquatic Dispersion of Effluents From Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," Rev 1, April 1977.

Table D.1 Calculated releases of radioactive materials in gaseous effluents from Catawba (Ci/yr/reactor)

Nuclides	Reactor building stack (continuous)	Auxiliary building stack (continuous)	Waste gas processing system (continuous)	Turbine building vent (continuous)	Air ejector exhaust (continuous)	Total*
Ar-41	25	a	a	a	a	25
Kr-83m	a	a	a	a	a	a
Kr-85m	1	3	a	a	2	6
Kr-85	5	a	263	a	a	268
Kr-87	a	2	a	a	a	2
Kr-88	2	5	a	a	3	10
Kr-89	a	a	a	a	a	a
Xe-131m	6	a	9	a	a	15
Xe-133m	12	2	a	a	2	16
Xe-133	1100	120	14	a	73	1300**
Xe-135m	a	a	a	a	a	a
Xe-135	8	8	a	a	5	21
Xe-137	a	a	a	a	a	a
Xe-138	a	1	a	a	a	1
Total noble gases						1600**
Mn-54	0.00017	0.00018	0.0045	b	b	0.0049
Fe-59	0.000057	0.00006	0.0015	b	b	0.0016
Co-58	0.00057	0.0006	0.015	b	b	0.016
Co-60	0.00026	0.00027	0.007	b	b	0.0075
Sr-89	0.000013	0.000013	0.00033	b	b	0.00036
Sr-90	0.0000023	0.0000024	0.00006	b	b	0.000065
Cs-134	0.00017	0.00018	0.0045	b	b	0.0049
Cs-137	0.00029	0.0003	0.0075	b	b	0.0081
Total particulates						0.043
I-131	0.0057	0.0045	a	0.00065	0.0028	0.014
I-133	0.0016	0.0068	a	0.00098	0.0039	0.014
H-3	a	710	-	a	-	710
C-14	1	a	7	a	a	8

*Based on the staff's review of the information submitted by Duke Power Company on April 2, 1982, the staff has included releases resulting from spent fuel from Catawba and the spent fuel from Oconee and McGuire that may be stored at Catawba.

**Sum is truncated.

Notes:
a = less than 1.0 Ci/yr for noble gases and C-14, less than 10^{-4} Ci/yr for iodine.
b = less than 1% of total for this nuclide.

Table D.2 Summary of atmospheric dispersion factors (χ/Q) and relative deposition values for maximum site boundary and receptor locations near the Catawba Nuclear Station*

Location**	Source	X/Q (sec/m^3)	Relative deposition (m^{-2})
Nearest effluent-control boundary (0.7 km, NNE)	A***	3.5×10^{-5}	1.3×10^{-7}
Nearest residence and garden (0.8 km, S)	A***	2.5×10^{-5}	7.2×10^{-8}
Nearest milk cow (4.5 km, SW)	A***	4.3×10^{-7}	1.1×10^{-9}
Nearest meat animal (2.2 km, NW)	A***	1.5×10^{-6}	3.0×10^{-9}

*The values presented in this table are corrected for radioactive decay and cloud depletion from deposition, where appropriate, in accordance with Regulatory Guide 1.111.

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

*** A - Reactor, auxiliary and turbine buildings, waste gas processing system, and air ejector exhaust are all continuous release sources.

Table D.3 Nearest pathway locations used for maximally exposed individual dose commitments for the Catawba Nuclear Station

Location	Sector	Distance (km)
Nearest effluent-control boundary*	NNE	0.7
Residence and garden**	S	0.8
Milk cow	SW	4.5
Meat animal	NW	2.2

*Beta and gamma air doses, total body doses, and skin doses from noble gases are determined at the effluent-control boundaries in the sector where the maximum potential value is likely to occur.

**Dose pathways including inhalation of atmospheric radioactivity, exposure to deposited radionuclides, and submersion in gaseous radioactivity are evaluated at residences. This particular location includes doses from vegetable consumption as well.

Table D.4 Calculated release of radioactive materials in liquid effluents from Catawba Nuclear Station, Units 1 and 2

Nuclide	Ci/yr/reactor*	Nuclide	Ci/yr/reactor*
Corrosion and Activation Products		Fission products (cont'd)	
Cr-51	0.00026	Te-129m	0.0002
Mn-54	0.00007	Te-129	0.00013
Fe-55	0.00029	I-130	0.00006
Fe-59	0.00015	Te-131m	0.00003
Co-58	0.0027	I-131	0.027
Co-60	0.00045	Te-132	0.00091
Zr-95	0.00001	I-132	0.0015
Nb-95	0.00002	I-133	0.013
Np-239	0.00004	I-134	0.00001
		Cs-134	0.027
		I-135	0.0037
Fission Products		Cs-136	0.007
		Cs-137	0.02
Br-83	0.00003	Ba-137m	0.024
Rb-86	0.00005	Ba-140	0.00002
Sr-89	0.00006	La-140	0.00002
Sr-91	0.00001	Ce-144	0.00006
Y-91	0.00001		
Mo-99	0.022	All others	0.00008
Tc-99m	0.016		
Ru-106	0.00003	Total (except H-3)	0.17
Te-127m	0.00005	H-3	710
Te-127	0.00006		

*Nuclides whose release rates are less than 10^{-5} Ci/yr/reactor are not listed individually but are included in "all others."

Table D.5 Summary of hydrologic transport and dispersion for liquid releases from the Catawba Nuclear Station*

Location	Transit time (hours)	Dilution factor of plant discharge	
		1 unit	2 unit
Nearest drinking-water intake (Rock Hill**)	0	51†	26†
Nearest sport-fishing location (discharge area)***	0	2.2	1.7
Nearest shoreline (bank near discharge area)***	0	2.2	1.7

*See Regulatory Guide 1.113.

**Based on completely mixed hydrological model for Lake Wylie.

***The staff used the "no-recirculation" model (i.e., a plug flow model) rather than the completely mixed model to estimate doses to the maximally exposed individual from ingestion of fish and from shoreline recreation. Doses from the two preceding pathways account for the majority of the estimated doses to the maximally exposed individual to radioactive liquid effluents (see Table D.6).

†Equivalent dilution factor for the "no-recirculation" model.

Table D.6 Annual dose commitments to a maximally exposed individual near the Catawba Nuclear Station

Location	Pathway	Dose (mrem/yr/unit, except as noted)			
		Noble Gases in Gaseous Effluents			
				Air Dose (mrad/yr/unit)	
		Total Body	Skin	Gamma	Beta
Nearest site boundary (0.70 km NNE)*	Direct radiation from plume	0.62	1.8	1.0	2.3
		Iodine and Particulates in Gaseous Effluents**			
		Total Body	Organ		
Nearest site boundary (0.70 km NNE)*	Ground deposition	1.3	1.3		
	Inhalation	1.0 (adult)	1.2 (adult) (thyroid)		
Nearest residence and garden (0.8 km S)***	Ground deposition	0.7	0.7		
	Inhalation	0.6 (child)	<0.1 (child) (bone)		
	Vegetable consumption	3.5 (child)	6.6 (child) (bone)		
Nearest milk cow (4.5 km SW)	Ground deposition	<0.1	<0.1		
	Inhalation	<0.1	<0.1		
	Cow milk consumption	<0.1 (infant)	0.3 (infant) (thyroid)		
Nearest meat animal (2.2 km, NW)	Meat consumption	<0.1	<0.1		
		Liquid Effluents**			
		Total Body	Organ		
Nearest drinking water at Rock Hill	Water ingestion	<0.1	<0.1		
Nearest fish at plant-discharge area	Fish consumption	1.7 (adult)	2.3 (adult) (liver)		
Nearest shore access to plant-discharge area	Shoreline recreation	<0.1	<0.1		

*That site boundary location where the highest radiation doses as a result of gaseous effluents have been estimated to occur.

**Doses are for the age group and organ that results in the highest cumulative dose for the location.

***The location where the highest radiation dose to an individual from all applicable pathways has been estimated.

Table D.7 Calculated Appendix I (10 CFR 50) dose commitments to a maximally exposed individual and to the population from operation of Catawba nuclear facility

	Annual Dose per Reactor Unit	
	Individual	
	Appendix I Design Objectives*	Calculated Doses**
Liquid effluents		
Dose to total body from all pathways (mrem)	3	1.8
Dose to any organ from all pathways (mrem)	10	2.4 (liver)
Noble-gas effluents (at site boundary)		
Gamma dose in air (mrad)	10	1.0
Beta dose in air (mrad)	20	2.3
Dose to total body of an individual (mrem)	5	0.6
Dose to skin of an individual (mrem)	15	1.8
Radioiodines and particulates***		
Dose to any organ from all pathways (mrem)	15	7.3 (bone)
	Population Within 80 km	
	Total Body	Thyroid
Natural-background radiation (person-rem)†	160,000	
Liquid effluents (person-rem)	3.0	3.0
Noble-gas effluents (person-rem)	0.4	0.4
Radioiodine and particulates (person-rem)	5.1	6.5

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

**Numerical values in this column were obtained by summing appropriate values in Table D.6. Locations resulting in maximum doses are represented here.

***Carbon-14 and tritium have been added to this category.

†"Natural Radiation Exposure in the United States," U.S. Environmental Protection Agency, ORP-SID-72-1, June 1972; using the average background dose for South Carolina of 97 mrems/yr, and year 2000 projected population of 1,700,000.

Table D.8 Calculated RM-50-2 dose commitments to a maximally exposed individual from operation of the Catawba nuclear facility*

Effluent and dose commitment	Annual dose per site: RM-50-2 design objective**	Annual dose per site: Calculated dose
Liquid effluents		
Dose to total body or any organ from all pathways (mrem)	5	3.0
Activity-release estimate, excluding tritium (Ci)	10	0.3
Noble-gas effluents (at site boundary)		
Gamma dose in air (mrad)	10	2.0
Beta dose in air (mrad)	20	4.6
Dose to total body of an individual (mrem)	5	1.2
Dose to skin of an individual (mrem)	15	3.6
Radioiodines and particulates***		
Dose to any organ from all pathways (mrem)	15	14.6 (bone)
I-131 activity release (Ci)	2	0.03

*An optional method of demonstrating compliance with the cost-benefit Section (II.D) of Appendix I to 10 CFR 50.

**Annex to Appendix I to 10 CFR 50.

***Carbon-14 and tritium have been added to this category.

Table D.9 Annual total-body population dose commitments, year 2000 (both units)

Category	U.S. population dose commitment (person-rem/yr)
Natural background radiation*	26,000,000*
Catawba Nuclear Station Units 1 and 2 (combined) operation	
Plant workers	960
General public:	
Liquid effluents**	6.0
Gaseous effluents	70
Transportation of fuel and waste	6

*Using the average U.S. background dose (100 mrems/yr) and year 2000 projected U.S. population from "Population Estimates and Projections," Series II, U.S. Department of Commerce, Bureau of the Census, Series P-25, No. 704, July 1977.

**80-km (50-mi) population dose.

APPENDIX E

REBASELINING OF THE RSS RESULTS FOR PWRs

The results of the Reactor Safety Study (RSS) have been updated. The update was done largely to incorporate results of research and development conducted after the October 1975 publication of the RSS and to provide a baseline against which the risk associated with various LWRs could be consistently compared.

Primarily, the rebaselined RSS results (NUREG/CR-1659) reflect use of advanced modeling of the processes involved in meltdown accidents, i.e., the MARCH computer code modeling for transient and LOCA initiated sequences and the CORRAL code used for calculating magnitudes of release accompanying various accident sequences. These codes* have led to a capability to predict the transient and small LOCA initiated sequences that is considerably advanced beyond what existed at the time the Reactor Safety Study was completed. The advanced accident process models (MARCH and CORRAL) produced some changes in the staff's estimates of the release magnitudes from various accident sequences in WASH-1400. These changes primarily involved release magnitudes for the iodine, cesium, and tellurium families of isotopes. In general, a decrease in the iodines was predicted for many of the dominant accident sequences; some increases in the release magnitudes for the cesium and tellurium isotopes were predicted.

The Reactor Safety Study Methodology Applications Program (RSSMAP) has resulted in a review of dominant accident sequences for several plants. The Sequoyah RSSMAP risk assessment indicates the importance of hydrogen control measures for reducing the likelihood of failing the ice condenser containment following severe accidents; Catawba has an ice condenser containment like Sequoyah. The applicant for Catawba has plans to satisfy the Commission's requirement on hydrogen control. Therefore, the use of the Surry rebaselined sequences is appropriate since a Catawba plant-specific assessment of accident sequence is not available.

As noted in Section 5.9.4.5(2), the probability of accident sequences from the Surry plant were used to give a perspective of the societal risk at Catawba because, although the probabilities of particular accident sequences may be substantially different and even improved for Catawba, the overall effect of all sequences taken together is likely to be within the uncertainties.

Entailed in this rebaselining effort for the sequences as used here was the evaluation of individual dominant accident sequences as the staff understands them to evolve rather than the technique of grouping large numbers of accident

*It should be noted that the MARCH code was used on a number of scenarios in connection with the TMI-2 recovery efforts and for post-TMI-2 investigations to explore possible alternative scenarios that TMI-2 could have experienced.

sequences into encompassing, but synthetic, release categories as was done in WASH-1400. The rebaselining of the RSS also eliminated the "smoothing technique" that was criticized in the report by the Risk Assessment Review Group (sometimes known as the Lewis Report), NUREG/CR-0400. In both of the RSS designs (PWR and BWR), the likelihood of an accident sequence leading to the occurrence of a steam explosion (α) in the reactor vessel was decreased. This was done to reflect both experimental and calculational indications that such explosions are unlikely to occur in those sequences involving small-size LOCAs and transients because of the high pressures and temperatures expected to exist within the reactor coolant system during these scenarios. Furthermore, if such an explosion were to occur, there are indications that it would be unlikely to produce as much energy and the massive missile-caused breach of containment as was postulated in WASH-1400.

For rebaselining of the RSS PWR design, the release magnitudes for the risk dominating sequences, e.g., Event V, TMLB' δ, γ, and $S_2C\delta$ (described later) were explicitly calculated and used in the consequence modeling rather than being lumped into release categories as was done in WASH-1400. The rebaselining led to a small decrease in the predicted risk to an individual of early fatality or latent cancer fatality relative to the original RSS-PWR predictions. This result is believed to be largely attributable to the decreased likelihood of occurrence for sequences involving severe steam explosions (α) that breached containment. (In WASH-1400, the sequences involving severe steam explosions (α) were artificially elevated in their risk significance (i.e., made more likely) by use of the "smoothing technique.")

In summary, the rebaselining of the RSS results led to small overall differences from the predictions in WASH-1400. It should be recognized that these small differences due to the rebaselining efforts are likely to be far outweighed by the uncertainties associated with such analyses.

The accident sequences which are expected to dominate risk from the RSS-PWR design are described below. Accident sequences are designated by strings of identification characters in the same manner as in the RSS (see the table of these symbols, Table E-1). Each of the characters represents a failure in one or more of the important plant systems or features that ultimately would result in melting of the reactor core and a significant release of radioactive materials from containment.*

Probabilities and release fractions of accidents involving the spent fuel pool were roughly estimated in the RSS. It can be concluded by comparison of data in Appendix I and the main report of WASH-1400 that the probabilities and release fractions are orders of magnitude less than the accidents involving the reactor itself. Further, since the melting of the fuel and release of activity is determined basically by the freshly discharged fuel (less than 1-year cooling time), the total contents of the pool in terms of assemblies with long cooling times does not change that conclusion. Hence, impacts of these types of accidents are expected to be well below the impacts of the reactor accidents presented here, but certainly are within the uncertainties even for pessimistic assumptions.

*For additional information detail see Appendix V of WASH-1400.

Event V (Interfacing System LOCA)

During the Reactor Safety Study a potentially large-risk contributor was identified because of the configuration of the multiple check valve barriers used to separate the high-pressure reactor coolant system from the low design pressure portions of the ECCS (i.e., the low pressure injection subsystem - LPIS). If these valve barriers were to fail in various modes, such as a leak in one valve and rupture of the other or rupture of both valves, and suddenly exposed the LPIS to high overpressures and dynamic loadings, the RSS judged that a high probability of LPIS rupture would exist. Since the LPIS is largely located outside of containment, the Event V scenario would be a LOCA that bypassed containment and those mitigating features (e.g., sprays) within containment. The RSS assumed that if the rupture of LPIS did not entirely fail the LPIS makeup function (which would ultimately be needed to prevent core damage), the LOCA environment (flooding, steam) would. Predictions of the release magnitude and consequences associated with Event V have indicated that this scenario represents one of the largest risk contributors from the RSS-PWR design. The NRC has recognized this RSS finding, and has taken steps to reduce the probability of occurrence of Event V scenarios in both existing and future LWR designs by requiring periodic surveillance testing of the interfacing valves to assure that these valves are properly functioning as pressure boundary isolation barriers during plant operations. Accordingly, Event V predictions for the RSS-PWR are likely to be conservative relative to the design and operation of the Catawba PWR plants.

TMLB'-δ, γ

This sequence essentially considers the loss and nonrestoration of all ac power sources available to the plant along with an independent failure of the steam turbine driven auxiliary feedwater train which would be required to operate to remove shutdown heat from the reactor core. The transient event is initiated by loss of offsite ac power sources which would result in plant trip (scram) and the loss of the normal way that the plant removes heat from the reactor core (i.e., via the power conversion system consisting of the turbine, condenser, the condenser cooling system, and the main feedwater and condensate delivery system that supplies water to the steam generators). This initiating event would then demand operation of the standby onsite emergency ac power supplies (two diesel generators) and the standby auxiliary feedwater system, two trains of which are electrically driven by either onsite or offsite ac power. With failure and nonrestoration of ac and the failure of the steam turbine driven auxiliary feedwater train to remove shutdown heat, the core would ultimately uncover and melt. If restoration of ac was not successful during (or following) melt, the containment heat removal and fission product mitigating systems would not be operational to prevent the ultimate overpressure (δ, γ) failure of containment and a rather large, energetic release of activity from the containment. Next to the Event V sequence, TMLB'δ, γ is predicted to dominate the overall accident risks in the RSS-PWR design.

S_2C-δ (PWR 3)

In the RSS the S_2C-δ sequence was placed into PWR release Category 3 and it actually dominated all other sequences in Category 3 in terms of probability and release magnitudes. The rebaselining entailed explicit calculations of the consequences from S_2C-δ and the results indicated that it was next in overall risk importance following Event V and TMLB'δ, γ.

The S_2C-δ sequence included a rather complex series of dependencies and interactions that are believed to be somewhat unique to the containment systems (subatmospheric) employed in the RSS PWR design.

In essence, the S_2C-δ sequence included a small loss-of-coolant accident occurring in a specific region of the plant (reactor vessel cavity); failure of the recirculating containment heat removal systems (CSRS-F) because of a dependence on water draining to the recirculation sump from the LOCA and a resulting dependence imposed on the quench spray injection system (CSIS-C) to provide water to the sump. The failure of the CSIS(C) resulted in eventual overpressure failure of containment (δ) due to the loss of CSRS(F). Given the overpressure failure of containment, the RSS assumed that the ECCS functions would be lost, either because of the cavitation of ECCS pumps or from the rather severe mechanical loads that could result from the overpressure failure of containment. The core was then assumed to melt in a breached containment leading to a significant release of radioactive materials.

Approximately 20% of the iodines and 20% of the alkali metals present in the core at the time of release would be released to the atmosphere. Most of the release would occur over a period of about 1.5 hours. The release of radioactive material from containment would be caused by the sweeping action of gases generated by the reaction of the molten fuel with concrete. Since these gases would be initially heated by contact with the melt, the rate of sensible energy release to the atmosphere would be moderately high.

PWR 7

This is the same as the PWR release category #7 of the original RSS which was made up of several sequences such as S_2D-ε (the dominant contributor to the risk in this category), S_1D-ε, S_2H-ε, S_1H-ε, AD-ε, AH-ε, TML-ε, and TKQ-ε. All of these sequences involved a containment basemat melt-through as the containment failure mode. With the exception of TML-ε and TKQ-ε, all involve the potential failure of the emergency core cooling system following occurrence of a LOCA with the containment ESFs continuing to operate as designed until the basemat was penetrated. Containment sprays would operate to reduce the containment temperature and pressure as well as the amount of airborne radioactivity. The containment barrier would retain its integrity until the molten core proceeded to melt through the concrete containment basemat. The radioactive materials would be released into the ground, with some leakage to the atmosphere occurring upward through the ground. Most of the release would occur continuously over a period of about 10 hours. The release would include approximately 0.002% of the iodines and 0.001% of alkali metals present in the core at the time of release. Because leakage from containment to the atmosphere would be low and gases escaping through the ground would be cooled by contact with the soil, the energy release rate would be very low.

References

U.S. Nuclear Regulatory Commission, WASH-1400 (NUREG-75/014), "Reactor Safety Study--An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants," October 1975.

---, NUREG/CR-1659, "Reactor Safety Study Methodology Applications Program," Vol. 1, Sandia National Laboratories, February 1981.

Table E.1 Key to PWR accident sequence symbols

A	- Intermediate to large LOCA.
B	- Failure to recover either onsite or offsite electric power within about 1 to 3 hr following an initiating transient which is a loss of offsite ac power.
C	- Failure of the containment spray injection system.
D	- Failure of the emergency core cooling injection system.
H	- Failure of the emergency core cooling recirculation system.
K	- Failure of the reactor protection system.
L	- Failure of the secondary system steam relief valves and the auxiliary feedwater system.
M	- Failure of the secondary system steam relief valves and the power conversion system.
Q	- Failure of the primary system safety relief valves to reclose after opening.
S_1	- A small LOCA with an equivalent diameter of about 2 to 6 in.
S_2	- A small LOCA with an equivalent diameter of about 1/2 to 2 in.
T	- Transient event.
V	- Low-pressure injection system.
α	- Containment rupture resulting from a reactor vessel steam explosion.
β	- Containment failure due to hot rod drop.
γ	- Containment failure resulting from hydrogen burning.
δ	- Containment failure resulting from overpressure.
ε	- Containment vessel melt-through.

APPENDIX F

CONSEQUENCE MODELING CONSIDERATIONS

F.1 Evacuation Model

"Evacuation," used in the context of offsite emergency response in the event of substantial amount of radioactivity release to the atmosphere in a reactor accident, denotes an early and expeditious movement of people to avoid exposure to the passing radioactive cloud and/or to acute ground contamination in the wake of the cloud passage. It should be distinguished from "relocation" which denotes a postaccident response to reduce exposure from long term ground contamination. The Reactor Safety Study (RSS) (WASH-1400) consequence model contains provision for incorporating radiological consequence reduction benefits of public evacuation. The benefits of a properly planned and expeditiously carried out public evacuation would be well manifested in a reduction of early health effects associated with early exposure; namely, in the number of cases of early fatality (see Section F.2) and acute radiation sickness which would require hospitalization. The evacuation model originally used in the RSS consequence model is described in WASH-1400 as well as in NUREG-0340. However, the evacuation model which has been used herein is a modified version (SAND 78-0092) of the RSS model and is, to a certain extent, oriented toward site emergency planning. The modified version is briefly outlined below.

The model utilizes a circular area with a specified radius (such as a 10-mi plume exposure pathway emergency planning zone (EPZ)), with the reactor at the center. It is assumed that people living within portions of this area would evacuate if an accident should occur involving imminent or actual release of significant quantities of radioactive material to the atmosphere.

Significant atmospheric releases of radioactive material would in general be preceded by one or more hours of warning time (postulated as the time interval between the awareness of impending core melt and the beginning of the radioactive release from the containment building). For the purpose of calculation of radiological exposure, the model assumes that all people who live in a fan-shaped area (fanning out from the reactor), within the circular zone with the downwind direction as its median--those people who would potentially be under the radioactive cloud that would develop following the release--would leave their residences after a specified delay* and then evacuate. The delay time is reckoned from the beginning of the warning time and is recognized as the sum of the time required by the reactor operators to notify the responsible authorities, time required by the authorities to interpret the data, decide to evacuate, and direct the people to evacuate, and time required for the people to mobilize and get under way.

*Assumed to be of a constant value which would be the same for all evacuees.

The model assumes that each evacuee would move radially out in the downwind direction* with an average effective speed** (obtained by dividing the zone radius by the average time taken to clear the zone after the delay time) over a fixed distance** from the evacuee's starting point.

This distance is selected to be 15 mi (which is 5 mi more than the 10-mi plume exposure pathway EPZ radius). After reaching the end of the travel distance, the evacuee is assumed to receive no further radiation exposure.

The model incorporates a finite length of the radioactive cloud in the downwind direction which would be determined by the product of the duration over which the atmospheric release would take place and the average windspeed during the release. It is assumed that the front and the back of the cloud formed would move with an equal speed which would be the same as the prevailing windspeed; therefore, its length would remain constant at its initial value. At any time after the release, the concentration of radioactivity is assumed to be uniform over the length of the cloud. If the delay time were less than the warning time, then all evacuees would have a head start, i.e., the cloud would be trailing behind the evacuees initially. On the other hand, if the delay time were more than the warning time, then depending on initial locations of the evacuees there are possibilities that (1) an evacuee will still have a head start, or (2) the cloud would be overhead when an evacuee starts to leave, or (3) an evacuee initially would be trailing behind the cloud. However, this initial picture of cloud-people disposition would change as the evacuees travel depending on the relative speed and positions between the cloud and people. The cloud and an evacuee might overtake one another one or more times before the evacuee would reach his or her destination. In the model, the radial position of an evacuating person, either stationary or in transit, is compared to the front and the back of the cloud as a function of time to determine a realistic period of exposure to airborne radionuclides. The model calculates the time periods during which people are exposed to radionuclides on the ground while they are stationary and while they are evacuating. Because radionuclides would be deposited continually from the cloud as it passed a given location, a person who is under the cloud would be exposed to ground contamination less concentrated than if the cloud had completely passed. To account for this, at least in part, the revised model assumes that persons are: (1) exposed to the total ground contamination concentration which is calculated to exist after complete passage of the cloud, after they have been completely passed by the cloud; (2) exposed to one-half the calculated concentration anywhere under the cloud; and (3) not exposed when they are in front of the cloud. Different values of the shielding protection factors for exposures from airborne radioactivity and ground contamination have been used.

Results shown in Section 5.9.4.5 for accidents involving significant release of radioactivity to the atmosphere were based on the assumption that all people within the 10-mi plume exposure pathway EPZ would evacuate as per the evacuation scenario described above. It is not expected that detailed inclusion of any special facility near a specific plant site, where not all persons would be

---

*In the RSS consequence model, the radioactive cloud is assumed to travel radially outward only, and the evacuees travel with the wind, thereby tending to result in higher calculated doses.

**Assumed to be of a constant value which would be the same for all evacuees.

quickly evacuated, would significantly alter the conclusions. For the delay time before evacuation, a value of 1 hour was used. The staff believes that such a value appropriately reflects the Commission's emergency planning requirements. The staff estimated the effective evacuation speed to be 6.7 mph (3 m/sec) based upon the applicant's estimate of the time to clear the 10-mi zone. As an additional emergency measure for the Catawba site for certain sensitivity calculations, it was also assumed that all people beyond the evacuation distance who would be exposed to the contaminated ground would be relocated after the plume passed. For these people outside of the evacuation zone and within 25 mi, a reasonable relocation time span of 8 hours has been assumed, during which each person is assumed to receive additional exposure to the ground contamination. Beyond the 25-mi distance the usual assumption of the RSS consequence model regarding the period of ground exposure was used--which is that if the calculated ground dose to the total marrow over a 7-day period would exceed 200 rems, then this high dose rate would be detected by actual field measurements following the plume passage, and people from those regions would then be relocated immediately. For this situation the model limits the period of ground dose calculation to 24 hours; otherwise, the period of ground exposure is limited to 7 days for calculation of early dose.

Figure F.1 shows a pessimistic case for which no early evacuation is assumed and all persons are assumed to be exposed for the first 24 hours following an accident and are then relocated, and a case for which evacuation, at the same speed as above, was assumed to take place to 15 mi. For evacuation to 20 mi, the calculation would predict near zero early fatalities.

The model has the same provision for calculation of the economic cost associated with implementation of evacuation as in the orginal RSS model. For this purpose, the model assumes that for atmospheric releases of durations 3 hours, or less, all people living within a circular area of 5-mi radius centered at the reactor plus all people within a 45° angular sector within the plume exposure pathway EPZ and centered on the downwind direction will be evacuated and temporarily relocated. However, if the duration of release would exceed 3 hours, the cost of evacuation is based on the assumption that all people within the entire plume exposure pathway EPZ would be evacuated and temporarily relocated. For either of these situations, the cost of evacuation and relocation is assumed to be $125 (1980 dollar) per person which includes cost of food and temporary sheltering for a period of 1 week.

F.2 Early Health Effects Model

The medical advisors to the Reactor Safety Study (WASH-1400) proposed three alternative dose-mortality relationships that can be used to estimate the number of early fatalities that might result in an exposed population. These alternatives characterize different degrees of postexposure medical treatment from "minimal," to "supportive," to "heroic," and are more fully described in NUREG-0340.

The calculational estimates of the early fatality risks presented in the texts of Section 5.9.4.5(3) and Section F.1 of this appendix used the dose-mortality relationship that is based upon the supportive treatment alternative. This implies the availability of medical care facilities and services for those exposed in excess of about 200 rems. At the extreme low probability end of the spectrum, i.e., at the 1 chance in 100 million per reactor-year level, the number of persons involved might exceed the capacity of facilities for such services, in which case the number of early fatalities might have been somewhat underestimated. To gain perspective on this element of uncertainty, the staff has also performed calculations using the most pessimistic dose-mortality relationship based upon minimal medical treatment and using identical assumptions regarding early evacuation as made in Section 5.9.4.5(3). This shows 100 early fatalities at the 1 chance in 1 million per reactor-year level, an increase from 19,000 to 24,000 early fatalities at the 1 chance in 100 million per reactor-year level (see Table 5.12), and an overall doubling of the annual risk of early fatalities (see Table 5.13). The major fraction of the increased risk of early fatality in the absence of supportive medical treatment would occur within 32 km (20 mi) and virtually all would be contained within 137 km (85 mi) of the Catawba site.

F.3 References

Sandia Laboratories, SAND-78-0092, "A Model of Public Evacuation for Atmospheric Radiological Releases," June 1978.

U.S. Nuclear Regulatory Commission, WASH-1400 (NUREG-75/014), "Reactor Safety Study--An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants," October 1975.

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

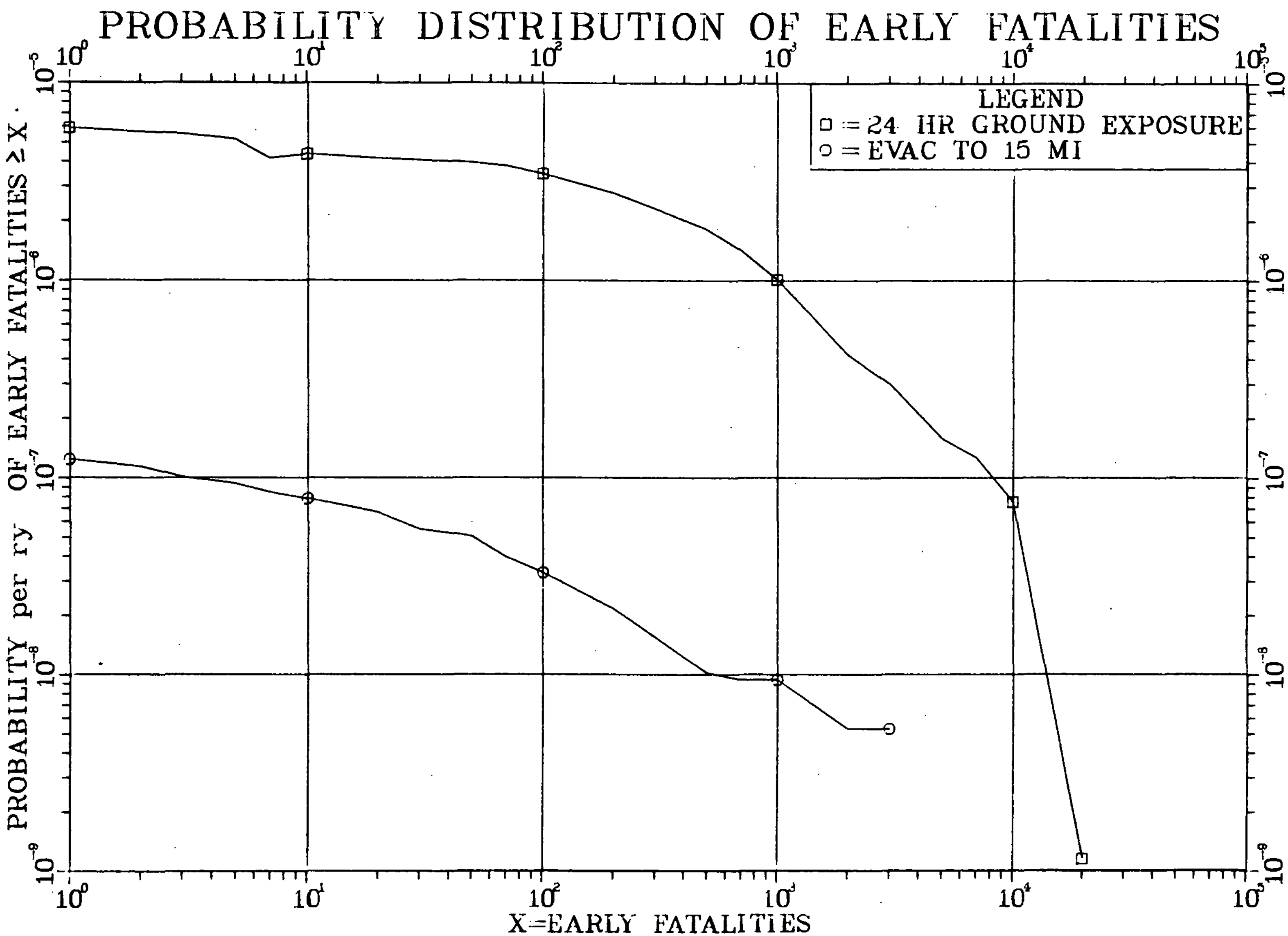

Figure F.1 Probability distribution of early fatalities (see Section 5.9.4.5(7) for a discussion of uncertainties in risk estimates)

APPENDIX G

ENVIRONMENTAL IMPACT OF SHIPPING SPENT FUEL FROM OCONEE AND McGUIRE TO CATAWBA NUCLEAR STATION

The environmental impacts of transporting spent fuel from McGuire and Oconee reactors were analyzed at the time those reactors were licensed (NUREG-0063, April 1976, and the "Final Environmental Statement Related to Operation of Oconee Nuclear Station Units 1, 2, and 3," March 1972).

The assumptions underpinning the earlier assessments of environmental impacts satisfactorily bound the parameters involved in the applicant's proposal to ship Oconee and McGuire spent fuel to Catawba for storage. Because no new environmental impacts are introduced by the proposed transshipments and because the environmental impacts of transporting spent fuel from McGuire and Oconee have already been factored into the licensing of those facilities, no environmental impacts for spent fuel transportation have been factored into the cost-benefit balancing for Catawba.

If such spent fuel transshipment had not been previously considered and accounted for, the environmental impact values attributable thereto would be properly found in Table S-4, Title 10, Code of Federal Regulations, Section 51.20 (g), which provides a generic determination of the environmental impact of transportation of fuel to and from a light-water-cooled nuclear power reactor. The impacts set forth therein are supported by data in WASH-1238 ("Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," Atomic Energy Commission, December 1972.) These supporting data are predicted on assumptions of 60 spent-fuel shipments per reactor per year, each shipment route being 1,000 mi in length, and the fuel being cooled for only 150 days.

APPENDIX H

LETTERS FROM STATE ARCHEOLOGIST, UNIVERSITY OF SOUTH CAROLINA, AND STATE HISTORIC PRESERVATION OFFICER, SOUTH CAROLINA DEPARTMENT OF ARCHIVES AND HISTORY

UNIVERSITY OF SOUTH CAROLINA

COLUMBIA, S. C. 29208

INSTITUTE OF ARCHEOLOGY AND ANTHROPOLOGY

(803) 777-8170

May 28, 1981

Mr. Charles E. Lee
South Carolina Department
of Archives and History
P. O. Box 11669
Columbia, SC 29211

RE: Archeological Clearance for Duke Power Company's Catawba Transmission Lines

Dear Mr.Lee:

I have reviewed the enclosed report entitled, "Test Pits in the Piedmont: An Archeological Survey of Duke Power Company's Proposed Catawba Transmission Lines." I concur with the findings of this report.

Briefly, Paul Brockington conducted a field survey of the Catawba Ripp and Catawba-Newport transmission lines in 1978. Of the twenty-seven archeological sites located, one was recommended as eligible for the National Register of Historic Places. A testing program of this site, 38YK72, was conducted by Veletta Canouts in 1979. The excavated materials provided artifact frequency, density, and compositional data for .1% of this site area. Although the information potential of this site has not been exhausted, no further investigation of the site is recommended in conjunction with the Catawba transmission line project. Even though the site will continue to sustain impacts from cultivation and possible tower or transmission line maintenance, if the site continues to be managed as it has been, sufficient data should remain available for future investigators.

I, therefore, recommend archeological clearance be granted for the project.

Sincerely yours,

Robert L. Stephenson
Director and State Archeologist

RLS:dsw

Enclosure

cc: Mr. R. Andrew Cloninger ✓
Duke Power Company

South Carolina Department of Archives and History
1430 Senate Street
Columbia, S. C.
P.O. Box 11,669
Capitol Station 29211
803-758-5816

RECEIVED
NOV 10 1981
U.S. NUCLEAR REGULATORY COMMISSION

November 5, 1981

Mr. Robert L. Tedesco
Assistant Director for Licensing
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Re: Catawba Nuclear Station,
Units 1 and 2
Docket Nos: 50-413 and 50-414
York County

Dear Mr. Tedesco:

Thank you for your letter of July 29, 1981, which we received on September 21, 1981, regarding operation of the Catawba Nuclear Station. We have also received under separate cover from the Institute of Archeology and Anthropology a copy of the archeological survey report for the transmission line corridor.

Our letter of January 26, 1973, stated that "the reactor project will have no adverse effects from the historical viewpoint." Since in the immediate vicinity of the proposed project there are no properties included in the National Register of Historic Places or determined eligible for inclusion by the Secretary of the Interior, we have not altered this opinion.

The report prepared by the Institute (Brockington, 1980) indicated that twenty-seven archeological sites were located in the transmission line corridor. Of these only one, 38YK72 was recommended as potentially eligible for inclusion in the National Register of Historic Places. Additional testing of 38YK72 indicated that the site does have the potential for yielding additional information, but since the site will be avoided during construction, additional investigation seems unnecessary. We recommend that corridor maintenance take care to avoid possible future effects.

The Federal procedures for the protection of historic properties (36CFR800) require that the Federal agency official in charge of a federally funded or licensed project consult with the appropriate State Historic Preservation Officer. The procedures do not relieve the Federal agency official of the final responsibility for reaching an opinion of his own as to whether or not historic values have been adequately taken into account in allowing the project to proceed. The opinion of the State Historic Preservation Officer is not definitive, either by law or by established Federal procedure. In reaching a conclusion of his own,

C062
5
1/0

the Federal agency official may well wish to consult other experts.

Sincerely,

Charles E. Lee
State Historic Preservation Officer

CEL/vdw
CC: Mr. Andrew R. Cloninger
Environmental Affairs
Duke Power Company
P.O. Box 33189
Charolotte, N. C. 28242

Dr. Robert L. Stephenson, Director
Institute of Archeology and Anthropology
University of South Carolina
Columbia, S. C. 29208

APPENDIX I

NPDES PERMIT

South Carolina
Department of
Health and
Environmental
Control

Permit No. SC0004278

AUTHORIZATION TO DISCHARGE UNDER THE
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Pollution Control Act of South Carolina (S.C. Sections 48-1-10 et seq., 1976) and with the provisions of the Federal Clean Water Act (PL 92-500, as amended by PL 95-217, Titles III, IV and V) 33 U.S.C. 1251 et seq., the "Act,"

Duke Power Company/Catawba Nuclear Station

is authorized to discharge from a facility located at

Lake Wylie, York County, South Carolina

to receiving waters named

Lake Wylie

in accordance with effluent limitations, monitoring requirements and other conditions set forth in Parts I, II, and III hereof.

This permit shall become effective on JUN 29 1981

This permit and the authorization to discharge shall expire at midnight,

June 30, 1981

signed: JUN 29 1981

Robert G. Gross, P.E.
Bureau of Wastewater and Stream
Quality Control

EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on the effective date and lasting through the expiration date, the permittee is authorized to discharge from outfall(s) serial number(s) 001, cooling tower blowdown and other once through non-contact cooling water (service water) discharged to Lake Wylie.

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day (lbs/day)		Other Units (Specify)			
	Daily Avg.	Daily Max.	Daily Avg.	Daily Max.	Measurement Frequency	Sample Type
Flow-m^3/Day (MGD)	-	-	-	-	Hourly	Recorder or Pump log
Temperature °C (°F)	-	-	-	-	1/Week	Grab &/or calculati
Chlorine Residual	-	-	See Below		1/Week	Multiple grabs

After start up free available chlorine shall not exceed an average concentration of 0.2 mg/l and a maximum instantaneous concentration of 0.5 mg/l at the cooling tower discharge.

Neither free available chlorine nor total residual chlorine may be discharged from any unit for more than two hours in any one day and not more than one unit may discharge free available or total residual chlorine at any one time unless the permittee can demonstrate to the S.C.D.H.E.C. that the unit(s) cannot operate effectively at or below this level of chlorination.

Permittee shall conduct an internal evaluation of practicable methods to reduce total residual chlorine levels fromthe combined discharge of cooling tower blowdown, conventional service water and nuclear service water. A summary of this evaluation shall be submitted to the S.C. Department of Health & Environmental Control and the Environmental Protection Agency fifteen months after the commercial operation of Unit I.

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored: once per week by grab sample.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s). Chlorine at the discharge from the cooling tower prior to mixing with other waste streams. Flow, temp., and pH prior to discharge to Lake Wylie.

EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on the effective date and lasting through the expiration date, the permittee is authorized to discharge from outfall(s) serial number(s) 002, Wastewater treatment system discharged to Lake Wylie.

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day (lbs/day)		Other Units (Specify)			
	Daily Avg.	Daily Max.	Daily Avg.	Daily Max.	Measurement Frequency	Sample Type
Flow-m^3/Day (MGD)	-	-	-	-	1/Week	Weir or Recorde
Oil and Grease (mg/l)	16.3(36.0)	21.8(48.0)	15 mg/l	20 mg/l	2/Month	Grab
Total Suspended Solids	32.7(72.0)	109(240)	30 mg/l	100 mg/l	2/Month	Grab

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored: once per week by grab sample.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): discharge from the wastewater treatment system prior to mixing with any other waste stream.

EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on the effective date and lasting through the expiration date, the permittee is authorized to discharge from outfall(s) serial number(s) 003, Sewage treatment plant discharged to Lake Wylie.

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations kg/day (lbs/day) Daily Avg.	Discharge Limitations kg/day (lbs/day) Daily Max.	Other Units (Specify) Daily Avg.	Other Units (Specify) Daily Max.	Monitoring Requirements Measurement Frequency	Monitoring Requirements Sample Type
Flow-m^3/Day (MGD)	-	-	-	-	1/Month	during sampling
BOD_5	-	-	30 mg/1	45 mg/1	1/Quarter	Grab
Total Suspended Solids	-	-	30 mg/1	45 mg/1	1/Quarter	Grab
Fecal Coliform Bacteria	-	-	200/100 ml	400/100 ml	1/Quarter	Grab

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored; 1/Week by grab sample.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): Sewage treatment plant discharge prior to mixing with any other waste stream.

EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on the effective date and lasting through the expiration date, the permittee is authorized to discharge from outfall(s) serial number(s) 005, Radwaste system discharged to Lake Wylie via 001.

Such discharges shall be limited and monitored by the permittee as specified below:

This discharge is regulated by the Nuclear Regulatory Commission and is monitored and reported to the Nuclear Regulatory Commission.

EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on the effective date and lasting through the expiration date, the permittee is authorized to discharge from outfall(s) serial number(s) 006* - Metal cleaning discharged from station settling basin(s) (Discharge 002).

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic		Discharge Limitations		Monitoring Requirements	
		Daily Avg.	Daily Max.	Measurement Frequency	Sample Type
Flow-m^3/Day (MGD)		-	-	1/Batch	Instantaneous and/or calculatic
Copper	Quantities shall not exceed the concentrations shown to the right multiplied by the flow.	1.0 mg/l	1.0 mg/l	1/Batch	Grab
Iron		1.0 mg/l	1.0 mg/l	1/Batch	Grab

Metal cleaning wastes shall mean any cleaning compounds, rinse waters, or any other waterborne residues derived from cleaning and metal process equipment including, but not limited to steam generator tube.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): Settling basin(s) discharge prior to mixing with any other waste streams.

*Serial number assigned for monitoring and identification purposes.

B. SCHEDULE OF COMPLIANCE

1. The permittee shall achieve compliance with the effluent limitations specified for discharges in accordance with the following schedule:

   N/A

2. No later than 14 calendar days following a data identified in the above schedule of compliance, the permittee shall submit either a report of progress or, in the case of specific actions being required by identified dates, a written notice of compliance or noncompliance. In the latter case, the notice shall include the cause of noncompliance, any remedial actions taken, and the probability of meeting the next scheduled requirement.

C. MONITORING AND REPORTING

1. *Representative Sampling*

Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge.

2. *Reporting*

Monitoring results obtained during the previous 3 months shall be summarized for each month and reported on a Discharge Monitoring Report Form (EPA No. 3320-1), postmarked no later than the 28th day of the month following the completed reporting period. The first report is due on OCT 28 1981 Duplicate signed copies of these, and all other reports required herein shall be submitted to the state at the following address:

South Carolina Department of Health and Enviornmental Control.
ATTN: NPDES Permits Section
2600 Bull Street
Columbia, S.C. 29201

3. *Definitions*

a. The "daily average" discharge means the total discharge by weight during a calendar month divided by the number of days in the month that the production or commercial facility was operating. Where less than daily sampling is required by this permit, the daily average discharge shall be determined by the summation of all the measured daily discharges by weight divided by the number of days during the calendar month when the measurements were made.

b. The "daily maximum" discharge means the total discharge by weight during any calendar day.

4. *Test Procedures*

Test procedures for the analysis of pollutants shall conform to regulations published pursuant to Section 304(g) of the Act, under which such procedures may be required.

5. *Recording of Results*

For each measurement or sample taken pursuant to the requirements of this permit the permittee shall record the following information:

a. The exact place, date, and time of sampling;

b. The dates the analyses were performed;

c. The person(s) who performed the analyses;

d. The analytical techniques or methods used; and

e. The results of all required analyses.

6. *Additional Monitoring by Permittee*

If the permittee monitors any pollutant at the location(s) designated herein more frequently than required by this permit, using approved analytical methods are specified above, the results of such monitoring shall be included in the calculation and reporting of the values required in the Discharge Monitoring Report Form (EPA No. 3320-1). Such increased frequency shall also be indicated.

7. *Records Retention*

All records and information resulting from the monitoring activities required by this permit including all records of analyses performed and calibration and maintenance of instrumentation and recordings from continuous monitoring instrumentation shall be retained for a minimum of three (3) years, or longer if requested by the Department of Health and Environmental Control.

A. MANAGEMENT REQUIREMENTS

1. *Change in Discharge*

All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant identified in this permit more frequently than or at a level in excess of that authorized shall constitute a violation of the permit. Any anticipated facility expansions, production increases, or process modifications which will result in new, different, or increased discharges of pollutants must be reported by submission of a new NPDES application or, if such changes will not violate the effluent limitations specified in this permit, by notice to the permit issuing authority of such changes. Following such notice, the permit may be modified to specify and limit any pollutants not previously limited.

2. *Noncompliance Notification*

If, for any reason, the permittee does not comply with or will be unable to comply with any daily maximum effluent limitation specified in this permit, the permittee shall provide the Department of Health and Environmental Control with the following information, in writing, within five (5) days of becoming aware of such condition:

a. A description of the discharge and cause of noncompliance; and

b. The period of noncompliance, including exact dates and times; or, if not corrected, the anticipated time the noncompliance is expected to continue, and steps being taken to reduce, eliminate and prevent recurrence of the noncomplying discharge.

3. *Facilities Operation*

The permittee shall at all times maintain in good working order and operate as efficiently as possible all treatment or control facilities or systems installed or used by the permittee.

4. *Adverse Impact*

The permittee shall take all reasonable steps to minimize any adverse impact to navigable waters resulting from noncompliance with any effluent limitations specified in this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge.

5. *Bypassing*

Any diversion from or bypass of facilities necessary to maintain compliance with the terms and conditions of this permit is prohibited, except (i) where unavoidable to prevent loss of life or severe property damage, or (ii) where excessive storm drainage or runoff would damage any facilities necessary for compliance with the effluent limitations and prohibitions of this permit. The permittee shall promptly notify the Department of Health and Environmental Control in writing of each such diversion or bypass.

6. *Removed Substances*

Solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters shall be disposed of in a manner such as to prevent any pollutant from such materials from entering navigable waters.

7. *Power Failures*

In order to maintain compliance with the effluent limitations and prohibitions of this permit, the permittee shall either:

a. In accordance with the Schedule of Compliance contained in Part I, provide an alternative power source sufficient to operate the wastewater control facilities;

or, if such alternative power source is not in existence, and no date for its implementation appears in Part I,

b. Halt, reduce or otherwise control production and/or all discharges upon the reduction, loss, or failure of the primary source of power to the wastewater control facilities.

B. RESPONSIBILITIES

1. *Right of Entry*

The permittee shall allow the Commissioner of the Department of Health and Environmental Control, the Regional Administrator, and/or their authorized representatives, upon the presentation of credentials:

a. To enter upon the permittee's premises where an effluent source is located or in which any records are required to be kept under the terms and conditions of this permit; and

b. At reasonable times to have access to and copy any records required to be kept under the terms and conditions of this permit; to inspect any monitoring equipment or monitoring method required in this permit; and to sample any discharge of pollutants.

2. *Transfer of Ownership or Control*

In the event of any change in control or ownership of facilities from which the authorized discharges emanate, the permittee shall notify the succeeding owner or controller of the existence of this permit by letter, a copy of which shall be forwarded to the Department of Health and Environmental Control.

3. *Availability of Reports*

Except for data determined to be confidential under Section 308 of the Act, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the Department of Health and Environmental Control and the Regional Administrator. As required by the Act, effluent data shall not be considered confidential. Knowingly making any false statement on any such report may result in the imposition of criminal penalties as provided for in Section 309 of the Act.

4. *Permit Modification*

After notice and opportunity for a hearing, this permit may be modified suspended, or revoked in whole or in part during its term for cause including, but not limited to, the following:

a. Violation of any terms or conditions of this permit;

b. Obtaining this permit by misrepresentation or failure to disclose fully all relevant facts; or

c. A change in any condition that required either a temporary or permanent reduction or elimination of the authorized discharge.

5. *Toxic Pollutants*

Notwithstanding Part II, B-4 above, if a toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under Section 307(a) of the Act for a toxic pollutant which is present in the discharge and such standard or prohibition is more stringent than any limitation for such pollutant in this permit, this permit shall be revised or modified in accordance with the toxic effluent standard or prohibition and the permittee so notified.

6. *Civil and Criminal Liability*

Except as provided in permit conditions on "bypassing" (Part II, A-5) and "Power Failures" (Part II, A-7), nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance.

7. *Oil and Hazardous Substance Liability*

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under Section 311 of the Act.

8. *State Laws*

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities or penalties established pursuant to any applicable State law of regulation under authority preserved by Section 510 of the Act.

9. *Property Rights*

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

10. *Severability*

The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

PART III

OTHER REQUIREMENTS

A. This permit shall be modified, or alternatively, revoked and reissued, to comply with any applicable effluent standard or limitation issued or approved under sections 301 (b) (2) (C), and (D), 304 (b)(2), and 307 (a) (2) of the Clean Water Act, if the effleunt standard or limitation so issued or approved:

(1) Contains different conditions or is otherwise more stringent than any effluent limitation in the permit; or

(2) Controls any pollutant not limited in the permit.
The permit as modified or reissued under this paragraph shall also contain any other requirements of the Act then applicable.

B. In the event that waste streams from various sources are combined for treatment or discharge, the quantity of each pollutant or pollutant property attributable to each controlled waste source shall not exceed the specified limitation for that waste source.

C. If the permittee, after monitoring for at least six months, determines that he is consistently meeting the effluent limits contained herein, the permittee may request of the S. C. D. H. E. C. that the monitoring requirements be reduced to a lesser frequency or be eliminated.

D. There shall be no discharge of polychlorinated byphenyl compounds such as those commonly used for transformer fluid.

E. The company shall notify the S. C. D. H. E. C. in writing not later than sixty (60) days prior to instituting use of any additional biocide or chemical used in cooling systems, other than chlorine, which may be toxic to aquatic life other than those previously reported to the Environmental Protection Agency. Such notification shall include:

1. Name and general composition of biocide of chemical.
2. Frequency of use.
3. Quantities used.
4. Proposed effluent limitations.
5. EPA registration number.

F. Intake screen wash water may be discharged without limitations or monitoring requirements.

G. Copies of Environmental Reports required by the Nuclear Regulatory Commission which are pertinant to water quality in Lake Wylie or the Catawba River shall be submitted to the Regional Administrator and the State.

H. Yard drains may be discharged without limitations or monitoring requirements.

I. Low volume wastes (wastewater from all sources except those for which specific limitations are otherwise required in this permit, including, but not limited to waste waters from wet scrubber air pollution control systems, ion exchange water treatment systems, water treatment evaporator blowdown, laboratory and sampling streams, floor drainage, cooling tower basin cleaning wastes and blowdown from recirculating house service water systems) shall be discharged to the wastewater treatment system. Permittee shall continue established procedures designed to minimize oil and grease discharges.

NRC FORM 335 (7-77) U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

1. REPORT NUMBER (Assigned by DDC): NUREG-0921

4. TITLE AND SUBTITLE (Add Volume No., if appropriate)
Final Environmental Statement related to the operation of Catawba Nuclear Station, Units 1 and 2

2. (Leave blank)

3. RECIPIENT'S ACCESSION NO.

7. AUTHOR(S)

5. DATE REPORT COMPLETED

MONTH	YEAR
January	1983

DATE REPORT ISSUED

MONTH	YEAR
January	1983

9. PERFORMING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code)
U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D. C. 20555

6. (Leave blank)

8. (Leave blank)

12. SPONSORING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code)
Same as 9 above

10. PROJECT/TASK/WORK UNIT NO.

11. CONTRACT NO.

13. TYPE OF REPORT

PERIOD COVERED (Inclusive dates)

15. SUPPLEMENTARY NOTES
Docket Nos. 50-413 and 50-414

14. (Leave blank)

16. ABSTRACT (200 words or less)
This Final Environmental Statement contains the second assessment of the environmental impact associated with the operation of the Catawba Nuclear Station, Units 1 and 2, pursuant to the National Environmental Policy Act of 1969 (NEPA) and 10 CFR 51, as amended, of the NRC regulations. This statement examines: the affected environment, environmental consequences and mitigating actions, and environmental and economic benefits and costs. Land use and terrestrial and aquatic-ecological impacts will be small. Operational impacts to historic and archaeological sites will be negligible. The effects of routine operations, energy transmission, and periodic maintenance of rights-of-way and transmission facilities should not jeopardize any populations of endangered or threatened species. No significant impacts are anticipated from normal operational releases of radioactivity. The risk associated with accidental radiation exposure is very low. The net socioeconomic effects of the project will be beneficial. The action called for is the issuance of operating licenses for Catawba Nuclear Station, Units 1 and 2.

17. KEY WORDS AND DOCUMENT ANALYSIS

17a. DESCRIPTORS

17b. IDENTIFIERS/OPEN-ENDED TERMS

18. AVAILABILITY STATEMENT
Unlimited

19. SECURITY CLASS (This report)
Unclassified

20. SECURITY CLASS (This page)
Unclassified

21. NO. OF PAGES

22. PRICE
S

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983-381-297:2606

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

FIRST CLASS MAIL
POSTAGE & FEES PAID
USNRC
WASH D C
PERMIT No G 67

[redacted]