final

NUREG-0139

environmental statement

related to construction and operation of

CLINCH RIVER BREEDER REACTOR PLANT

PROJECT MANAGEMENT CORPORATION
TENNESSEE VALLEY AUTHORITY
AND
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

FEBRUARY 1977

Docket No. 50-537

U. S. Nuclear Regulatory Commission • Office of Nuclear Reactor Regulation

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: $10.00

SUMMARY AND CONCLUSIONS

This Environmental Statement was prepared by the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, in cooperation with the U.S. Army Corps of Engineers, and the U.S. Environmental Protection Agency.

1. This action is administrative.

2. The proposed action is the issuance of a construction permit to the Project Management Corporation (PMC), the Tennessee Valley Authority (TVA) and the Energy Research and Development Administration (ERDA) for construction and operation of the Clinch River Breeder Reactor Plant (CRBRP), Docket No. 50-537. The proposed location is in Roane County, Tennessee, about 25 miles west of Knoxville, on the north side of the Clinch River. The site is within the city limits of Oak Ridge but it is owned by the United States of America and is presently in the custody of TVA. The United States (ERDA) would also own the plant.* Some delay is anticipated in the original schedule for site preparation to begin in September 1975, completion of construction in 1981, and startup in 1982. Criticality is now scheduled by the applicants for October 1983.

   During the first five years of operation (1984-1988), TVA would operate the CRBRP and purchase its electrical output as a demonstration plant under ERDA's Liquid Metal Fast Breeder Reactor (LMFBR) Program. At the end of that period, TVA would have the option of purchasing the plant for its own use over the remaining operating life of approximately 25 years.

   The CRBRP is designed to use a liquid sodium cooled fast breeder reactor to produce 975 megawatts of thermal energy (MWt) with the initial core loading of uranium and plutonium mixed oxide fuel. This heat would be transferred by heat exchangers to nonradioactive sodium in an intermediate loop, and then to a steam cycle. A steam turbine generator would use the steam to produce 380 megawatts of electrical capacity (MWe). Future core design may result in gross power ratings of 1121 MWt and 439 MWe; these higher ratings are considered in the assessments made in this statement. In-plant uses of electricity would result in a net plant output of approximately 350 MWe initially and 379 MWe in the future.

   Exhaust steam from the turbine-generator would be cooled in condensers utilizing two mechanical draft cooling towers for dissipating heat to the atmosphere. The Clinch River would supply all CRBRP water needs. For maximum power, the annual average water requirement would be about 13 cfs (5835 gpm), of which 5 cfs (2251 gpm) would be returned as blowdown to the river and 8 cfs (3584 gpm) would be consumed, mainly by evaporation.

3. Summary of environmental impacts and adverse effects:

   (a) Some timber would be harvested and other vegetation and animal life would be destroyed on the 195 acres disturbed for construction of the plant facilities and 58 acres of right-of-way for new transmission lines. All but 73 acres would be revegetated after completion of construction (Sections 4.2.1, 4.4.1).

   (b) Erosion of land and minor siltation of the river would result from construction and subsequent rainfall, but planned control practices and revegetation would minimize this effect (Section 4.3).

   (c) Approximately 20,000 m^3 of river bank and bottom would be excavated or dredged to permit installation of cooling water intake and discharge and barge-unloading facilities; part of these areas would be lost temporarily as benthic habitat (Section 4.4.2).

   (d) Access to an Indian mound and Hensley Cemetery onsite would be allowed; these historic and archeologic resources would not be affected by construction activities (Sections 5.1 and 4.2.1).

   (e) Construction noise would be a temporary annoyance to a few residents south of the site (Section 4.5.4).

---

*Legislation was enacted by the Congress in January 1976 which authorized ERDA to acquire ownership and custody of the CRBRP and custody of the associated site area. ERDA became a co-applicant on May 6, 1976.

(f) Construction traffic would add to congestion on local roads, particularly State Road 58, during shift changes (Section 4.5.1).

(g) Tax receipts would not fully compensate for increased public services needed by the additional workforce, particularly during construction (Sections 4.5 and 5.6).

(h) Transmission structures would be concealed by ridges and hills. The plant would not be seen except from Gallaher Bridge and several residences south of the river. The cooling tower plume would usually extend no more than 1.5 miles, but could sometimes extend six miles. Fog resulting from the tower operation could be a minor nuisance on nearby roads a few hours per year (Section 5.3.3).

(i) Deposition of dissolved solids carried with vapor from the cooling tower would have no important effect on vegetation and animals (Section 5.3.3).

(j) Water consumed by the project would be a maximum of 132 gpm during construction and an average of 3584 gpm (8 cfs) during plant operation. Water use during operation represents about 0.2% of the annual average river flow (Sections 4.3 and 5.2).

(k) The average annual radiation dose to an individual living at the site boundary would be 1.6 mrem/yr, and the cumulative dose to the estimated year-2010 population within 50 miles would be 0.3 man-rem/yr. These doses are less than 2% and 0.003%, respectively, of those received from natural radiation (Section 5.7.3).

(l) Risks associated with accidental radiation exposure would be very low (Chapter 7).

4. Major alternatives considered:

- Sites
- Facility systems
- Transmission route.

5. The following Federal, State, and local agencies were asked to comment on the draft environmental statement which was made available in February 1976:

Advisory Council on Historic Preservation
Department of Agriculture
Department of the Army, Corps of Engineers
Department of Commerce
Department of Health, Education and Welfare
Department of Housing and Urban Development
Department of the Interior
Department of Transportation
Energy Research and Development Administration
Environmental Protection Agency
Federal Energy Administration
Federal Power Commission
State of Tennessee
Anderson County, TN
Knox County, TN
Loudon County, TN
Roane County, TN
City of Oak Ridge, TN
City of Knoxville, TN

Except for Knox County, Loudon County and the City of Knoxville, comments on the draft environmental statement were received from all of the above agencies and the following organizations and individuals:

State of North Carolina
East Tennessee Development District
Concerned Californians
Environmental Coalition on Nuclear Power
Geothermal Energy Institute

Natural Resources Defense Council, Sierra Club and
East Tennessee Energy Group
Mr. Brad Neff
Dr. Edward Passerini
Ms. Deborah Hurwitt
Project Management Corporation

6. The final environmental statement was made available to the public, to the Council on Environmental Quality, and to other specified agencies in February 1977.

7. On the basis of the analysis and evaluation set forth in this statement, after the environmental, economic, technical and other benefits of the Clinch River Breeder Reactor Plant have been weighed against environmental and other costs, and after available alternatives have been considered, the staff concludes that the action called for under the National Environmental Policy Act of 1969 (NEPA) and 10 CFR Part 51 is the issuance of a construction permit for the plant subject to the following limitations for the protection of the environment:

   (a) The applicant shall take the necessary mitigating actions, including those summarized in Section 4.6, during construction of the plant and associated transmission lines to avoid unnecessary adverse environmental impacts from construction activities.

   (b) In addition to the preoperational monitoring programs described in Section 6.1 of the Environmental Report, with amendments, the staff recommendations included in Section 6.1 of this document shall be followed.

   (c) The applicant shall demonstrate to the satisfaction of the staff that the realistically analyzed radiological consequences of postulated plant accidents (Table 7.2) will not exceed 15 rem to the bone, 2.5 rem to the whole body and 30 rem to the thyroid of an individual at the site boundary.

   (d) The applicant shall establish a control program that shall include written procedures and instructions to control all construction activities as prescribed herein and shall provide for periodic management audits to determine the adequacy of implementation of environmental conditions. The applicant shall maintain sufficient records to furnish evidence of compliance with all the environmental conditions herein.

   (e) Before engaging in a construction activity not evaluated by the Commission, the applicant will prepare and record an environmental evaluation of such activity. When the evaluation indicates that such activity may result in a significant adverse environmental impact that was not evaluated, or that is significantly greater than that evaluated in the final environmental statement, the applicant shall provide a written evaluation of such activities and obtain approval of the Director of the Office of Nuclear Reactor Regulation prior to undertaking the activities.

   (f) If unexpected harmful effects or evidence of serious damage are detected during plant construction, the applicant shall provide to the staff an acceptable analysis of the problem and a plan of action to eliminate or significantly reduce the harmful effects or damage.

CONTENTS

CONTENTS (Cont'd)

CONTENTS (Cont'd)

CONTENTS (Cont'd)

Note: This page has been revised since the original issuance to include Chapter 11 and additional appendices.

LIST OF FIGURES

LIST OF FIGURES (Cont'd)

LIST OF TABLES

LIST OF TABLES (Cont'd)

FOREWORD

This environmental statement was prepared by the Division of Site Safety and Environmental Analysis, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission (the staff), in accordance with the Commission's regulation 10 CFR Part 51, which implements the requirements of the National Environmental Policy Act of 1969 (NEPA). The U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (the Corps) participated in the preparation of this statement.

NEPA states, among other things, that the continuing responsibility of the Federal Government is to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may:

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

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

(i) the environmental impact of the proposed action,

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

(iii) alternatives to the proposed action,

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

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

An environmental report accompanies each application for a construction permit or a full-power operating license for a nuclear power generating station. A public announcement of the availability of the report is made and any comments on the report by interested persons are considered by the staff. In conducting the required NEPA review, the staff meets with the applicant to discuss items of information in the environmental report, to seek new information from the applicant that might be needed for an adequate assessment, and generally to ensure that the staff has a thorough understanding of the proposed project. In addition, the staff seeks information from other sources that will assist in the evaluation and visits and inspects the project site and surrounding vicinity. Members of the staff may meet with State and local officials who are charged with protecting State and local interests. On the basis of all the foregoing and other such activities or inquiries as are deemed useful and appropriate, the staff makes an independent assessment of the considerations specified in Section 102(2)(C) of the NEPA and 10 CFR 51.

The staff's evaluation leads to the publication of a draft environmental statement by the Office of Nuclear Reactor Regulation which is circulated to Federal, State, and local governmental agencies for comment. A summary notice is published in the Federal Register of the availability of the applicant's environmental report and the draft environmental statement and interested persons are invited to comment.

After receipt and consideration of comments on the draft statement, the staff prepares a Final Environmental Statement which includes: a discussion of concerns raised by the comments; a benefit-cost analysis, which considers the environmental costs of the plant and the alternatives available for reducing or avoiding them, and balances the adverse effects against the environmental, economic, technical, and other benefits of the plant; and a conclusion as to whether the action called for, with respect to environmental issues, is the issuance of the proposed permit, with appropriate conditioning to protect environmental values, or its denial. This Final Environmental Statement and the Safety Evaluation Report prepared by the staff are submitted to the Atomic Safety and Licensing Board for its consideration in reaching a decision on the application.

In accordance with Memoranda of Understanding[1,2] which govern certain interactions of the Nuclear Regulatory Commission with the Environmental Protection Agency and the Corps of Engineers, both of the latter agencies provided input to the NRC for its use as the "lead agency" in preparing the draft environmenal statement. EPA and the Corps have reviewed the comments on the draft statement which are within their areas of responsibility and have worked with the staff in its preparation of this Final Environmental Statement.

Copies of this statement may be obtained as indicated on the inside front cover.

Mr. Paul H. Leech is the NRC Environmental Project Manager for this project. Should there be questions regarding the content of this statement, Mr. Leech may be contacted at the following address or at 301/443-6990.

Division of Site Safety and Environmental Analysis
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

REFERENCES

1. Second Memorandum of Understanding and Policy Statement Regarding Implementation of Certain NRC and EPA Responsibilities, Federal Register, Vol. 40, No. 251, December 31, 1975.

2. Memorandum of Understanding between the U.S. Army Corps of Engineers and the U.S. Nuclear Regulatory Commission on Regulation of Nuclear Power Plants, Federal Register, Vol. 40, No. 165, August 25, 1975.

1. INTRODUCTION

1.1 THE PROPOSED PROJECT

The Clinch River Breeder Reactor Plant (CRBRP) is the demonstration plant proposed by the U.S. Energy Research and Development Administration (ERDA) under its Liquid Metal Fast Breeder Reactor (LMFBR) Program. A discussion of the LMFBR Program and the role of the demonstration plant in that program is included in Chapter 8 of this statement. The major objectives of the CRBRP, as defined in the program final environmental statement (ERDA-1535), are (1) to demonstrate the technical performance, reliability, maintainability, safety, environmental acceptability, and economic feasibility of an LMFBR central station electric power plant in a utility environment, and (2) to confirm the value of this concept for conserving important nonrenewable natural resources.

The CRBRP is designed to be an integrated electric power plant with a liquid-sodium-cooled breeder reactor supplying the thermal energy to produce steam to drive a turbine-generator. With the initial reactor core of uranium and plutonium mixed-oxide fuel, the plant is expected to produce 975 megawatts of thermal energy (MWt) and a net output of 350 electrical megawatts (MWe). Future core designs may result in a gross power of 1121 MWt and a net output of 379 MWe; these higher ratings are considered in the environmental assessments made in this statement.

The proposed location of the plant is in Roane County, Tennessee, on undeveloped land owned by the U.S. Government in the rural southwestern section of the City of Oak Ridge. The 1364-acre site is on a peninsula formed by the Clinch River and bounded on the north by ERDA's Oak Ridge Reservation, which lies between the site and developed areas of the city. Within a two-mile radius of the site, the area consists primarily of woodland; however, small farms and residences are scattered south and west of the Clinch River. The northwest edge of the site is designated for development as an industrial park.

Water needed by the plant would be supplied by the Clinch River. For maximum power, the annual average water requirement would be about 13 cfs (5835 gpm), of which 5 cfs (2251 gpm) would be returned to the river and 8 cfs (3584 gpm) would be consumed, mainly by evaporation from the mechanical-draft wet cooling tower used to cool the spent steam from the turbine-generator.

Two 161-kV transmission lines approximately 3.2 miles long would be constructed from the plant to an existing transmission line owned by the Tennessee Valley Authority (TVA). Nearly all of the right-of-way required would be obtained by widening existing corridors.

Electricity generated by the CRBRP would be purchased by TVA and distributed to loads on its power system. The applicants' plans call for a five-year demonstration period after operational testing of the plant. At the conclusion of the demonstration period, TVA may offer to purchase the plant at a price based upon its value as a power production facility; otherwise, the plant would remain under ERDA ownership for continued operation or decommissioning. If the plant is operated for a total of 30 years, the average capacity factor is estimated to be 68.5% (ER, p. A1-73).

1.2 THE PROJECT PARTICIPANTS

The CRBRP was authorized by Congressional decision as a cooperative effort of industry and government. It was further decided that this demonstration plant should be operated as part of the power generation facilities of an electric utility system. The project began with the acceptance in 1972 of the joint Commonwealth Edison Company (CE)-TVA proposal to work with the AEC (now ERDA) to design, develop, construct and operate the demonstration plant. To implement this proposal, two non-profit organizations, the Breeder Reactor Corporation (BRC) and Project Management Corporation (PMC) were established. BRC serves as the principal liaison between the project and over 700 electric utility organizations throughout the country which are contributing manpower and approximately $250 million. PMC, which is staffed largely with CE and TVA personnel, originally had the overall management responsibility for design, development, construction, testing and operation of the plant during the 5-year demonstration period. By agreement of the project participants the overall management responsibility shifted on May 1, 1976, from PMC to ERDA. ERDA carries out these responsibilities primarily through a project office established in Oak Ridge near the CRBRP site. PMC continues to represent the utilities' interests in the project and participates actively in the project's affairs through the assignment of its personnel to various positions on the project office staff. TVA is responsible for the plant operation and maintenance during the five-year demonstration period, and has an option to purchase the plant from ERDA at the end of that period. Should TVA not exercise its option, ERDA may dispose of the plant, assume operational responsibility itself, or reach agreement with TVA on TVA's continued operation of the plant.

Westinghouse Electric Corporation is the lead reactor designer and manufacturer, with responsibility for the overall nuclear island, reactor system and primary heat transport system. The General Electric Company (GE) is responsible for the intermediate heat transport system and the steam generator systems; Atomic International is responsible for the fuel handling system, maintenance and auxiliary systems. GE is also the turbine-generator supplier.

Burns and Roe, Inc. is the architect-engineer for the project and Stone & Webster Engineering Corporation will manage its construction.

1.3 STATUS OF THE PROJECT

On October 15, 1974, in accordance with the Atomic Energy Act of 1954, as amended, and the Commission's regulations thereunder, PMC and TVA tendered an application to the NRC for a construction permit and a Class 104(b) operating license for the CRBRP. A combined term of 40 years was requested, beginning with the date a construction permit is issued. The Environmental Report (ER) and Chapter 2 of the Preliminary Safety Analysis Report (PSAR) were found deficient by the NRC in several major areas of information and the applicants were so notified November 19, 1974. These deficiencies were satisfied in a series of submittals by the applicants and the application was docketed for environmental review on April 11, 1975. The remaining sections of the PSAR were submitted for acceptance review on April 24, 1975, and the PSAR was docketed on June 13, 1975. The application was amended on May 6, 1976 to add ERDA as an applicant.

With the expectation that the Commission would issue a Limited Work Authorization by September 1975, the applicants submitted with their application a schedule of site preparation activities to begin on that date. Completion of construction was scheduled for late 1981 and initial operation in 1982. However, approximately 15 months of delay are anticipated and reactor criticality is now scheduled for October 1983. On this basis, the 5-year demonstration period would cover the years 1984 through 1988.

1.4 STATUS OF REVIEWS AND APPROVALS

10 CFR Part 51 requires that the Director of Nuclear Reactor Regulation, or his designee, analyze the applicants' environmental report, which was submitted as part of the application, and prepare a detailed statement of environmental considerations. This environmental statement related to construction of the CRBRP has been prepared accordingly.

The major documents used in preparation of this statement were the applicants' Environmental Report and amendments thereto, Chapter 2 of the PSAR, and both the Proposed Final Environmental Statement (WASH-1535) and the Final Environmental Statement on the LMFBR Program (ERDA-1535). Independent calculations and sources of information were also used as bases for assessments of environmental impact. Some of the information was gained by the staff during visits to the site and surrounding areas in January and November of 1975. Although data from all these sources were examined in making assessments, only brief summaries of the most pertinent data are included in this statement. As indicated above, references throughout the statement are indicated by name, agency, or document number in parenthesis; complete reference information is found alphabetically listed in the references section.

As part of its safety evaluation prior to the issuance of construction permits and operating licenses, the Commission makes a detailed evaluation of the applicant's plans and facilities for minimizing and controlling the release of radioactive materials under both normal conditions and potential accident conditions, including the effects of natural phenomena on the facility. Inasmuch as these aspects are considered fully in other documents, only the salient features that bear directly on the anticipated environmental effects are repeated in this environmental statement.

Copies of this environmental statement and the applicants' documents referenced above are available for public inspection at the Commission's Public Document Room, 1717 H Street, N.W., Washington, D.C., and at the public libraries in Oak Ridge and Knoxville, Tennessee.

In Section 12 of the ER, the applicants have provided an extensive listing of licenses and permits that might be applicable to the CRBRP. Since the plant would be titled in the United States and built on Federal land, the project is not required to obtain licenses and permits from State and local authorities. However, the applicants have stated in ER Section 12 that "close coordination and cooperation with these officials and agencies will be maintained to assure that the project is implemented in accordance with applicable regulations and recommended practices." The staff has discussed the project with various State and local officials and has considered the resulting information in the course of preparing this statement.

In addition to the construction permit and operating license required by the NRC, the applicants must obtain the following Federal authorizations:

	Permits and Licenses	Issuing Agencies
1.	Permit to construct water intake and discharge facilities.	U.S. Army Corps of Engineers
2.	Permit to construct barge facilities	U.S. Army Corps of Engineers
3.	Permit to discharge dredge or fill material into navigable waters.	U.S. Army Corps of Engineers
4.	Permit for access road and railroad fills (below normal water level, elevation 741 ft)	U.S. Army Corps of Engineers
5.	Permit for lights used on structures near the navigation channel such as the barge facilities.	U.S. Coast Guard
6.	Permit to discharge under the National Pollutant Discharge Elimination System (NPDES).	U.S. Environmental Protection Agency
7.	Permit for tall structures-necessary for structures 200 ft or more above ground or any structures representing sudden elevation change (cooling tower, meteorological tower).	Federal Aviation Agency
8.	Permit for radio transmitters and associated towers.	Federal Communications Commission
9.	Licenses for radioactive source material and special nuclear material not covered by operating license.	U.S. Nuclear Regulatory Commission
10.	License for radioactive by-product material.	U.S. Nuclear Regulatory Commission
11.	Reactor Operator Licenses.	U.S. Nuclear Regulatory Commission
12.	Permits for transportation of radioactive materials and metallic sodium.	U.S. Department of Transportation
13.	Construction of intake and discharge structures and barge facilities.	Tennessee Valley Authority
14.	Access road and railroad fills (below normal water level, elevation 741 ft)	Tennessee Valley Authority

Both the Corps of Engineers and the Environmental Protection Agency have contributed to this environmental statement, under the "lead agency" concept, in fulfilling their NEPA responsibilities with regard to the permits and licenses listed above for which they are issuing agencies.

The CRBRP is also subject to provisions of the following requirements relative to preservation of cultural, historical, archaeological and architectural resources: The National Historic Preservation Act of 1966 (16 USC §§ 470-70n); Executive Order No. 11593 (3 CFR 560 [1971]); and Public Law 93-291 (May 24, 1974).

2. THE SITE AND ENVIRONS

2.1 GENERAL DESCRIPTION

The proposed CRBRP site is located in Roane County, Tennessee, on the north side of the Clinch River (between CRM 16 and 18) and about 25 miles W of Knoxville (Figure 2.1). Nearby cities are Kingston, 7 miles W; Harriman, 9.5 miles NW, and Oak Ridge, 10 miles NE (Figure 2.2). The site, zoned Industrial 2, is in the remote southwestern corner of the City of Oak Ridge, on undeveloped land which is federally owned and under custody of the Tennessee Valley Authority (TVA). ERDA's Oak Ridge reservation meets the site's northern boundary.

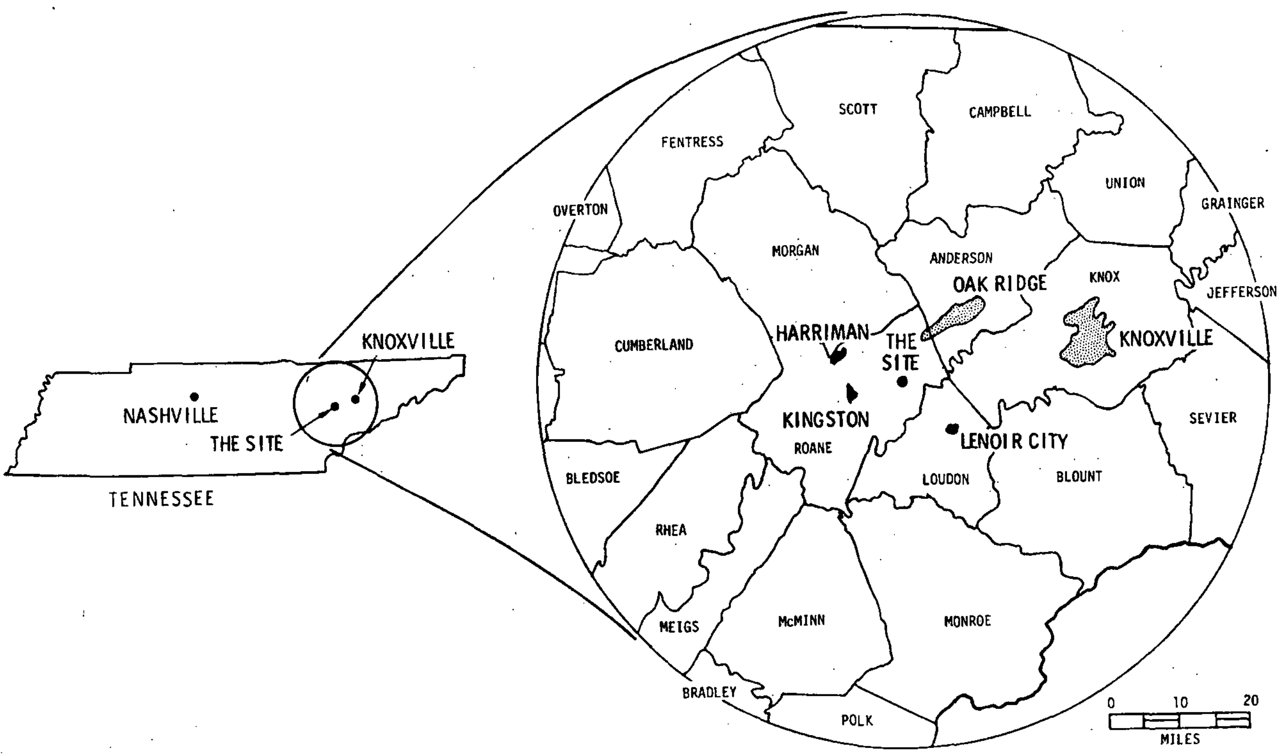


FIGURE 2.1 Site Location

The center of the reactor containment vessel would be located at 35°53'24" N latitude and 84°22'57" W longitude. Grade for principal plant structures would be 74 ft above the mean river water level of 741 ft above MSL. The site location is also shown by photographs in Figures 2.3 and 2.4 (ER, Sec 2.1; and Am I, Part II, G3). The site consists of 1364 acres of which about half of the acreage is taken up by the peninsula where the plant would be located, as shown in Figure 2.3. The site acreage extends northward, as shown partially in Figure 2.3 and completely in Figure 3.3 (on page 3-3).

Steep ridges, hills, and knobs are prevalent in the region. Chestnut Ridge, running through the north portion of the site, is the dominant topographic feature, reaching an elevation of 1100 ft above MSL at the crest (Figure 3.19). Figure 2.5 shows general land use near the site. Woodland dominates within a 2-mi radius of the plant location, although numerous residences and small farms lie immediately south and west of the river (ER, Fig 2.1-7).

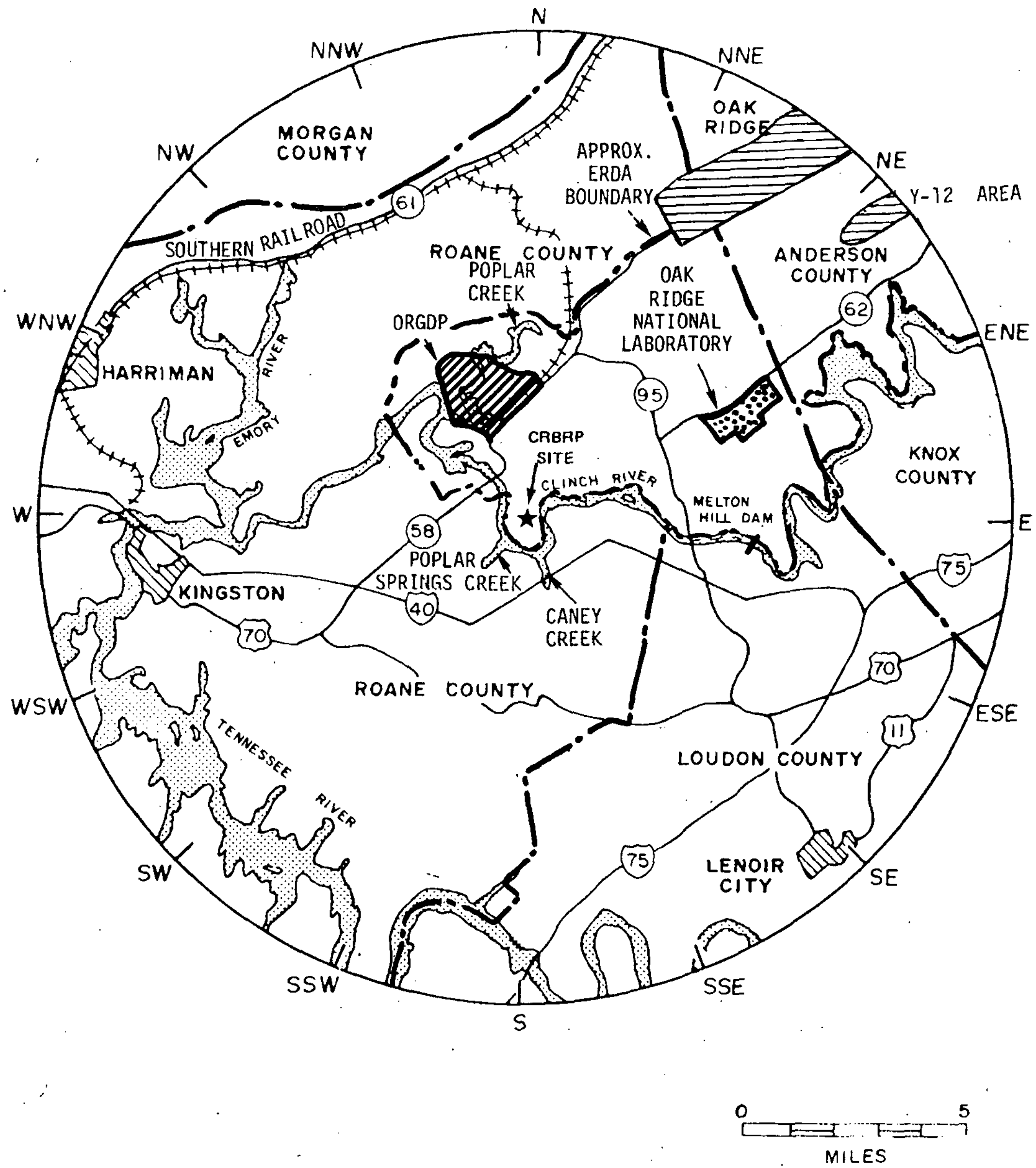


FIGURE 2.2 Local Transportation Routes

The general area within a 10-mi radius of the plant is taken up by residences, farms, recreation, industry, and woodland. Several commercial dairy farms are present in the area, although the trend over recent decades is toward beef production, with its lower labor requirement. Agricultural crops generally are grown in small plots for single family use. While the area has no major sports facility, over 60 recreational sites had, in all, about 7600 people present during the peak hour in 1970, and the staff anticipates 14,000 people during the peak hour in 2010 (ER, Tab. 2.2-14). There are three bank fishing areas within 3 miles of the site. A 30-unit camping and day use area is located about 2-3/4 miles SE of the site. A 100-unit campsite, with plans for fishing, boating and swimming, is on the Caney Creek embayment about 1 mile SE of the site boundary. There are no wildlife preserves or hunting areas within 5 miles of the site. A waterfowl refuge is 8 miles southwest on the Tennessee River, and a wildlife preserve is at Kingston. Principal industrial activities are the Oak Ridge Gaseous Diffusion Plant (ORGDP), the Oak Ridge National Laboratory, the Y-12 Area, and TVA's Melton Hill Dam (Figure 2.2). At the northern end of the site, between Bear Creek Road and Grassy Creek, about 112 acres have been set aside for the Clinch River Consolidated Industrial Park (Figure 2.5). Minerals are not obtained from the site and vicinity. Twenty-two schools are located within the 10-mi radial area, with nearly 8000 students in 1973. Hospitals are located at Harriman and Oak Ridge. The Southern Railroad serves the ORGDP (shown in Figure 2.4) by way of a branch from the line about 4 miles N of the site. The area is served by several highways including I-40, less than 1 mile S of the site boundary, and State routes 58, 62, and 95. There are no airports or military installations in the 10-mi area (ER, Sec. 2.2).

FIGURE 2.3 Aerial View with Plant Location

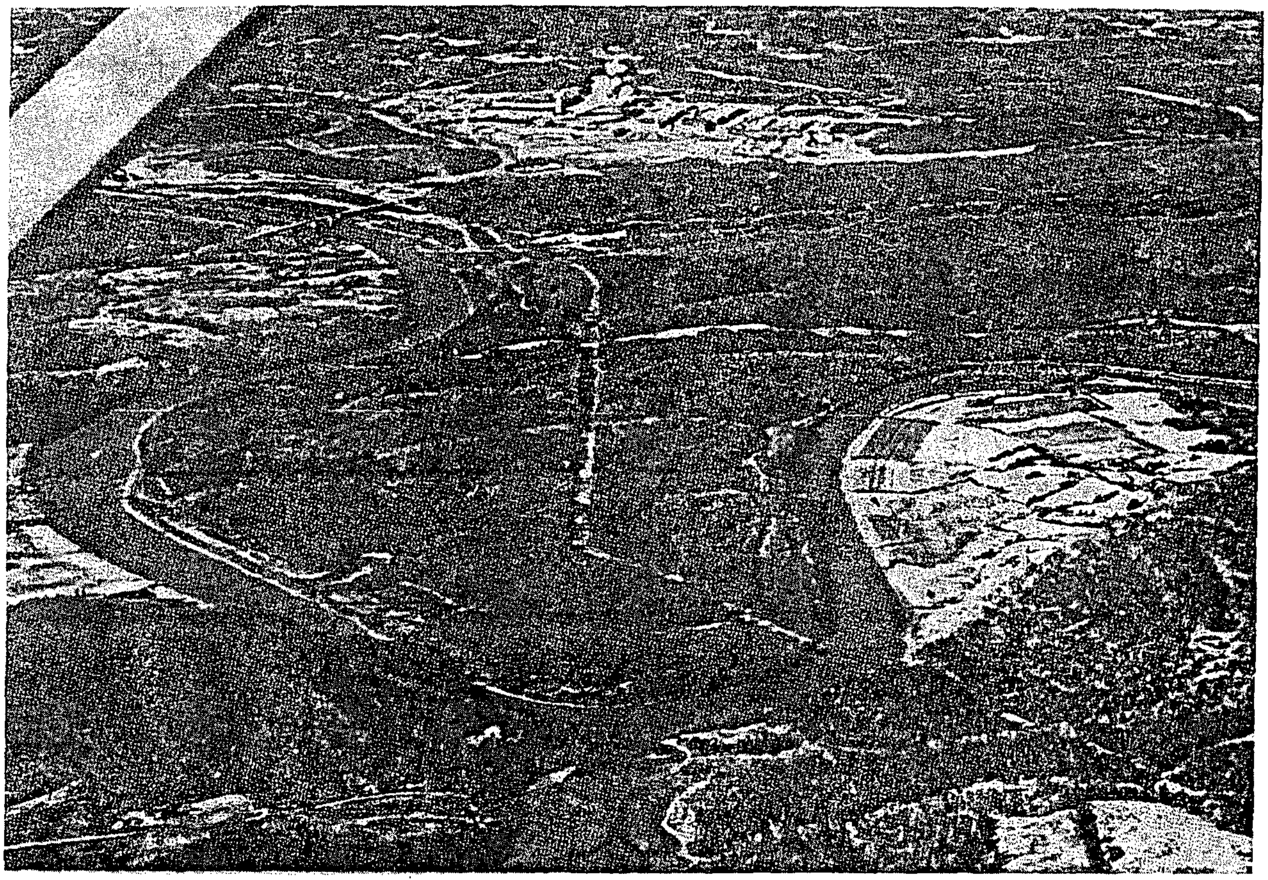


FIGURE 2.4 The Site with the Oak Ridge Gaseous Diffusion Plant in the Background

Within a 20-mi radius of the site, 8 public water systems and 16 industrial systems draw from surface water, including the Clinch River and the Emory River. The closest such withdrawal is by ERDA, 1.6 miles away. Groundwater supplies 17 public systems and many residences within the 20-mi radius. Over 100 such residences are within 2 miles, all located south of the Clinch River. The use of surface water for fishing is considered in Section 2.7. Commercial traffic through the Melton Hill Dam increased from 1000 tons in 1966 to 10,000 tons in 1973. For the same years, the numbers of recreational craft dropped from 1200 to 800 (ER, Sec 2.2).

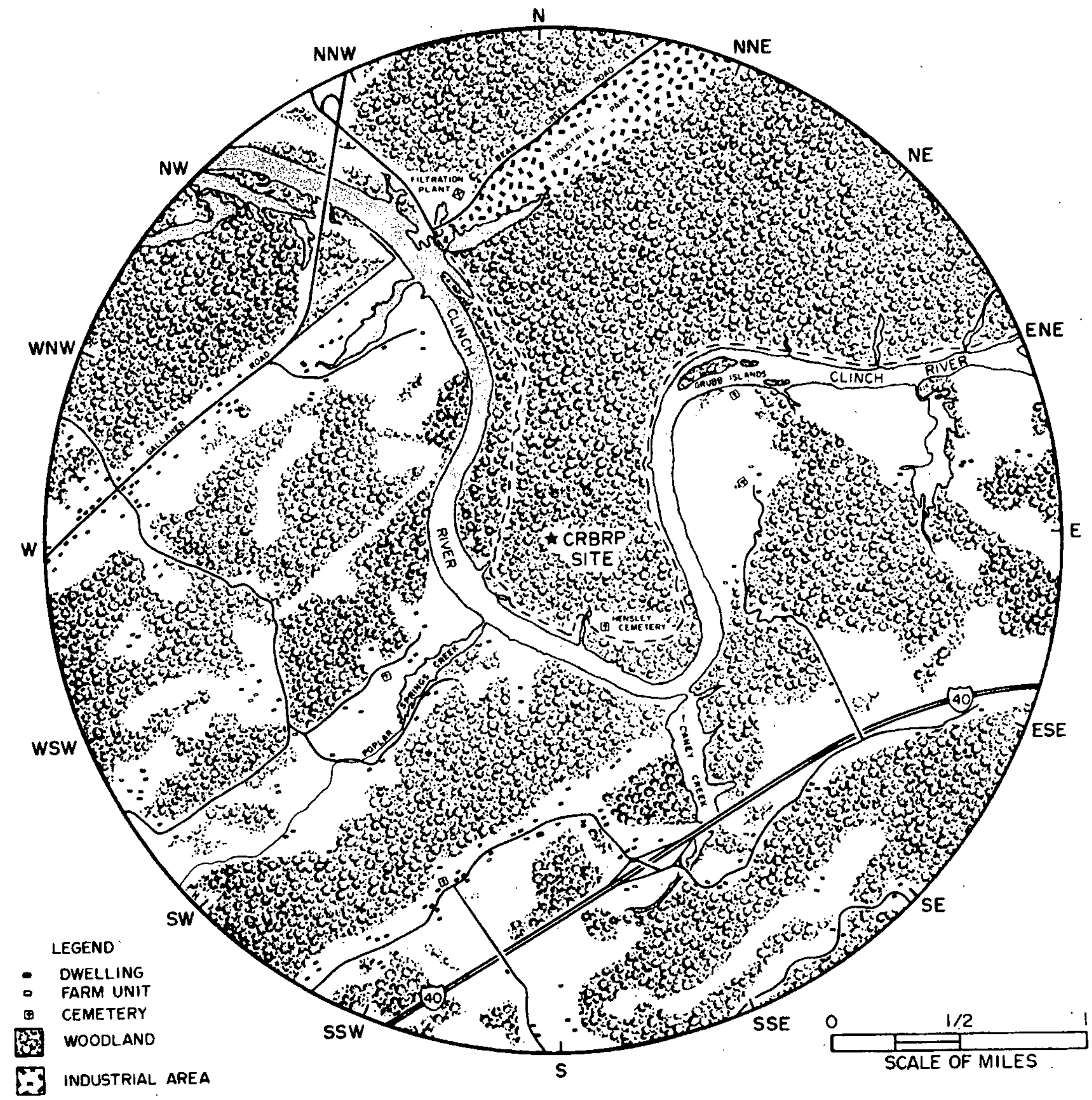
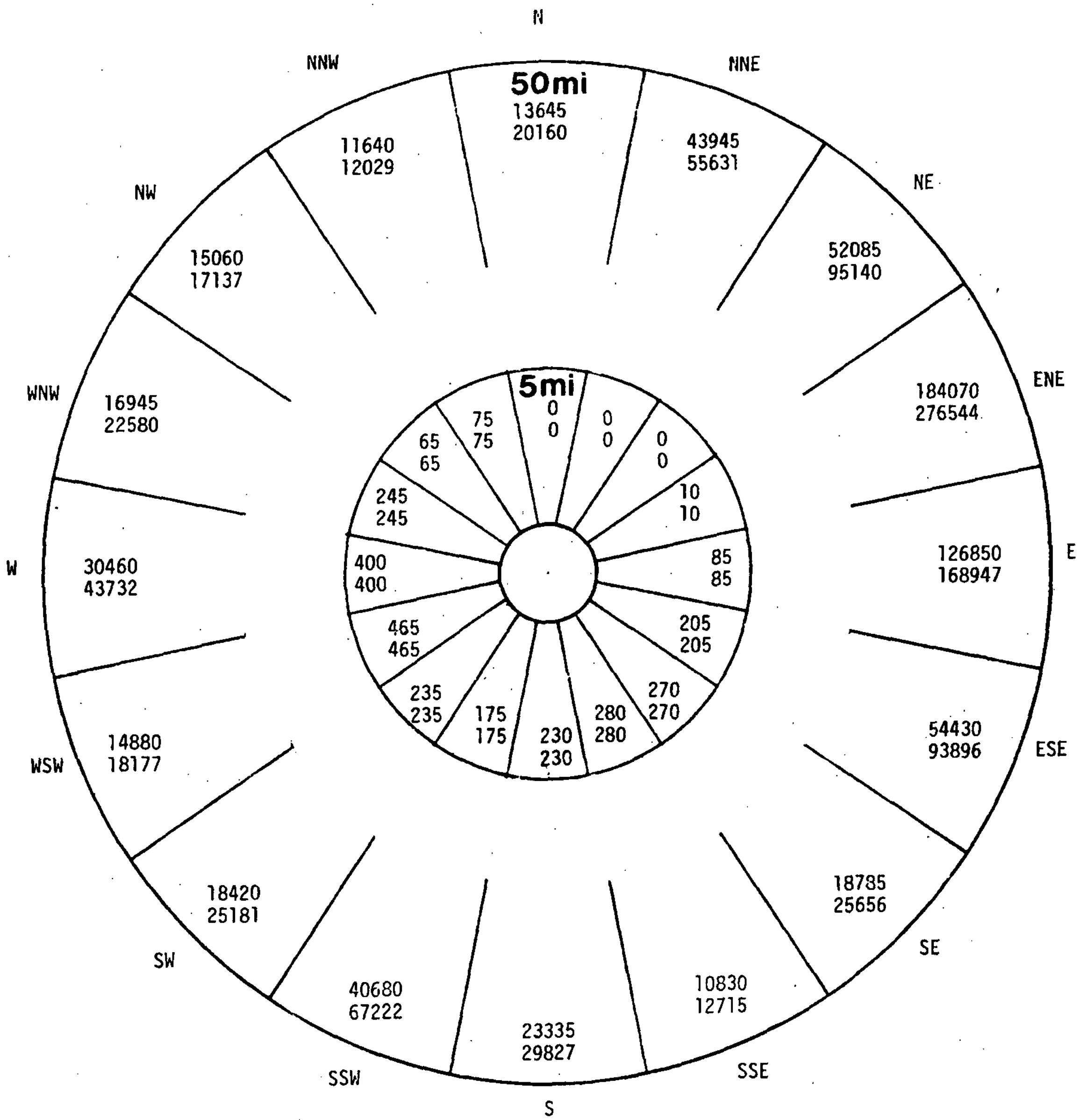


FIGURE 2.5 Land Use Near the Site

2.2 REGIONAL DEMOGRAPHY

Within a 50-mi radius from the plant, Knoxville and Oak Ridge are the largest urban centers, with 1970 populations of 174,587 and 28,319, respectively; 19 other centers had populations between 2500 and 15,000 (ER, Tab 2.2-1). In 1970 the 10-mi radial area had a population of 41,895, and the 50-mi area, 678,800. The corresponding population totals for 1980 are estimated to be 49,500 and 748,000; and for 2010, 65,000 and 987,000. Population distributions for the 1970 and 2010 estimates are shown in Figure 2.6 (ER, Sec 2.2). No growth is projected for the 5-mi radial area since it is remote from growing urban centers and no major development is planned that would increase agricultural intensity and, in turn, population. The 5-mi area provides employment for 4600 people at the ORGDP, 4000 at ORNL, and a smaller number at the Clinch River Consolidated Industrial Park.



Note: Top numbers are 1970 census figures. Bottom numbers are estimates for year 2010.

FIGURE 2.6 Population Distributions for 1970 and 2010 within 5 Miles and 50 Miles of the Site

2.3 HISTORIC AND ARCHAEOLOGICAL SITES AND NATURAL LANDMARKS

The National Register of Historic Places through November 1976 shows four sites within 10 miles of the CRBRP and the proposed transmission lines: the Harriman City Hall, the former County Court House at Kingston, the Southwest Point on the Tennessee River SW of Kingston, and the X-10 Graphite Reactor at ORNL. Within the site boundaries, four farmsteads of potential significance were located and recorded as 40RE120, -121, -122, and -123 (Figure 2.7) (ER, Fig 2.3-1). Only remains are present, except for -122 where the buildings stand in disrepair (Schroedl, 1972 and Thomas, 1973). The Hensley Cemetery, 40RE119 (Figure 2.7), with 5 marked graves is on the property, well beyond the plant construction area.

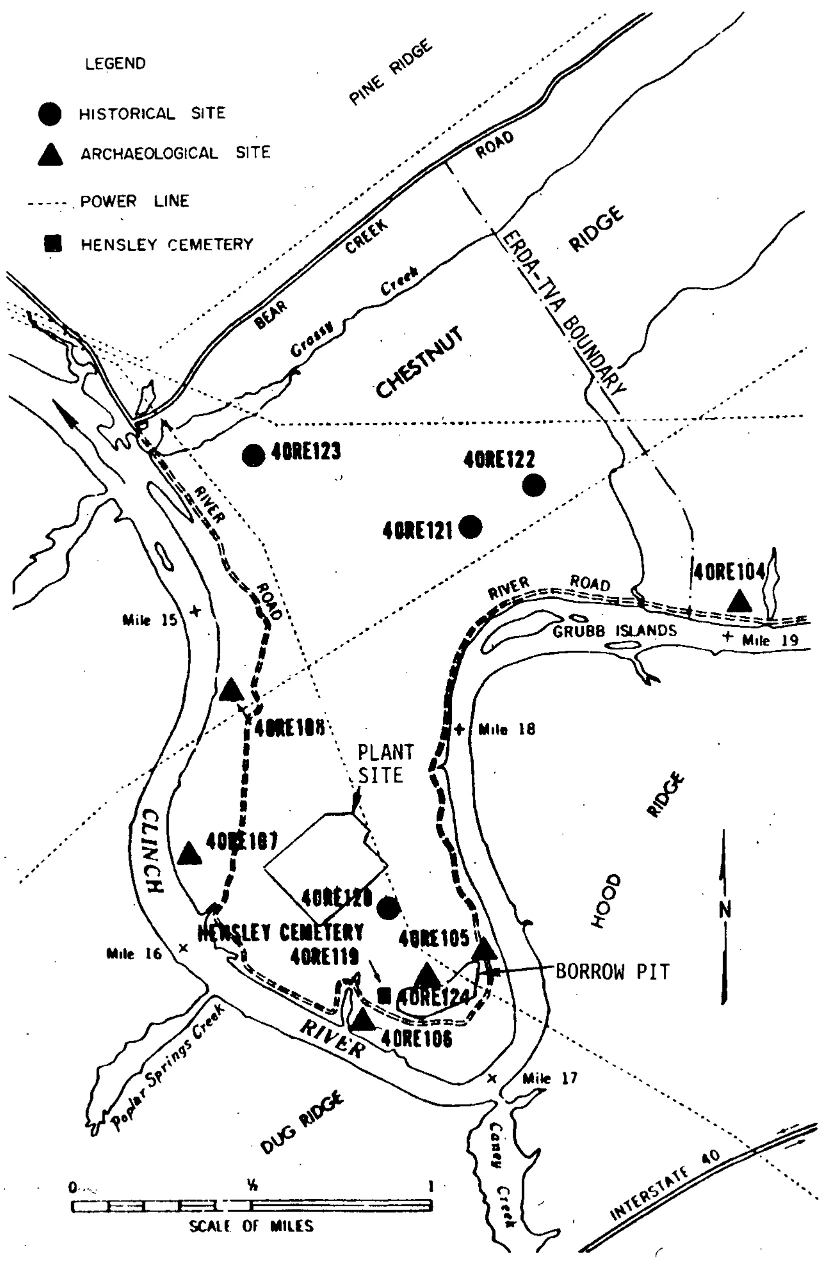


FIGURE 2.7 Archaeological and Historical Sites

Archaeological field work has been completed at 6 other sites, 40RE104, -105, -106, -107, -108, and -124 (Schroedl, 1972 and 1973). Sites 40RE104, -105, and -106 yielded few cultural materials. Finds at -107, -108, and particularly -124 indicated the need for further excavation, analysis, and reporting. Agreement to do the additional work, and complete it before construction, has been reached between TVA and the University of Tennessee (Schroedl, no date). Removal of nearly all sediments down to the premound surface of 40RE124 indicated interment of more than 36 individuals.

No natural landmarks are present on the site or in the immediate vicinity.

2.4 GEOLOGY

The CRBRP site lies in the Valley and Ridge Tectonic Province near the western border of the former Appalachian geosyncline, which was active during most of the Paleozoic Era (more than 230 million years ago). The site is underlain at shallow depths by sedimentary rocks (siltstone and limestone) of Ordovician age. This limestone unit is not prone to extensive Karstic development. The rocks were folded and faulted during the Paleozoic era and are now tilted to the SE at an angle of about 30°. Since then, weathering and erosion have been the dominant geologic processes at the site, with sediment accumulation being restricted to terrace and flood plain deposits of the Clinch River. The area is presently characterized by rugged terrain of subparallel ridges with intervening valleys. In the site vicinity, the major ridges (Chestnut Ridge to the northwest and Dug-Hood Ridge to the southeast) crest between 900 and 1,200 ft. The valley between these ridges, known locally as Poplar Springs Valley and Bethel Valley, consists of rolling hills which range between elevations of 750 and 800 ft. Within the site boundaries, Chestnut Ridge consists of two subordinate ridges, which crest at about 900 ft elevation. In the valley formed by these subridges, a topographic saddle rises to about 800 ft and the valley slopes from this saddle in both the northeasterly and southwesterly directions down to the Clinch River (normal summer pool 741 ft). There are no perennial streams on the site. Flow along valleys and gullies occurs only after heavy rainfall.

The site is situated between the traces of the Copper Creek and Whiteoak Mountain thrust faults. No evidence of any post-Paleozoic activity associated with them has been found. Eleven recorded earthquake epicenters are within a 50-mi radius, 19 epicenters within a 100-mi radius and 44 within a 200-mi radius of the site. The largest earthquake known to have occurred within the tectonic province in which the site is located (southern part of Ridge and Valley Tectonic Province) was on May 31, 1897 in Giles County, Virginia. The effects of such earthquakes on the proposed plant will be considered in the staff's Safety Evaluation Report, in accordance with 10 CFR Part 100, Appendix A.

2.5 HYDROLOGY

2.5.1 Surface Water

In the site vicinity, the Clinch River forms the north leg of the Watts Bar Reservoir, which is part of the TVA system. Its water elevation is controlled by Watts Bar Dam, 55 miles downstream of the proposed plant site, and generally maintained between 735 and 741 ft above MSL. The finished plant grade would be at an elevation 815 ft above MSL, well above the maximum recorded flood level of 764 ft above MSL. In the winter, in the vicinity of the proposed discharge, the river is approximately 612 ft wide and has an average depth of 6.3 ft and average velocity of 1.4 fps. An average river width of 657 ft, depth of 11.6 ft and velocity of 0.6 fps are typical of summer conditions. Norris Dam, 55 miles upstream from the proposed site, regulates the Clinch River flow. However, the immediate influence on water flow at the site is Melton Hill Dam. It is small, but only 5 miles upstream from the proposed site. Since completion of TVA's Melton Hill Dam in 1963, the average year has included a total of 46 days when no water was released.

Based on 1963-1973 discharge records for Melton Hill Dam, the average flow of the river is about 4,800 cfs at the site. The maximum hourly average release was 43,400 cfs, and the maximum daily average release was 26,900 cfs (ER, Sec 2.5.1.2 and PSAR, Sec 2.4.1.2.4). River flow at the site can be upstream, downstream or quiescent, depending on the mode of operation of the Melton Hill Dam, Watts Bar Dam and Fort Loudon Dam (on the Tennessee River). Flow reversal would occur as a result of abrupt shutdown of Melton Hill and Watts Bar Dams and by release of water from Fort Loudon Dam. Zero flow conditions at Melton Hill Dam have been imposed for continuous periods of 29 days, 11 days, and shorter continuous periods for the purposes of controlling the growth of Eurasian water milfoil in the reservoir. However, no extended periods of zero flow are anticipated in the future since TVA will control the milfoil through the use of water level management and supplemental applications of chemical herbicides approved by the EPA and applied in accordance with the Federal Insecticide, Fungicide and Rodenticide Act (Van Nort, April 14, 1976, Encl. 2, p.6). The 1963-1973 flow data for Melton Hill Dam show that nearly all monthly averages exceeded 1000 cfs, except for periods of no flow (ER, Tab 2.5-2). Assessments in Chapter 5 consider both no flow and 1000 cfs.

Water temperatures were measured at Clinch River Mile (CRM) 21.6 between May 1963 and December 1971. The maximum temperature observed during this period of record was 78°F and the minimum, 33°F. Table 2.1 gives the average daily maximum, minimum and mean temperature for each month (ER, Tab 2.5-7). Figure 2.8 illustrates the 1974 seasonal and spacial variation in water temperature of the Clinch River (ER, Am I, Part II, Dla). The water temperatures are vertically uniform except in the summer when stratification is naturally induced. Data on water quality appear in Table 2.2 (Gartrell, 1972). More detailed information is available in the ER, Sec 2.5, and the PSAR, Sec 2.4.

TABLE 2.1 Average Daily Maximum, Minimum and Mean River Temperatures for Each Month (1963-1971)[a]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	44	44	49	57	63	65	66	67	68	66	58	49
Minimum	41	41	45	54	60	62	63	65	66	63	56	47
Mean	43	42	47	55	61	64	64	66	67	64	57	48

(a) Clinch River Mile 21.6; temperatures in °F.

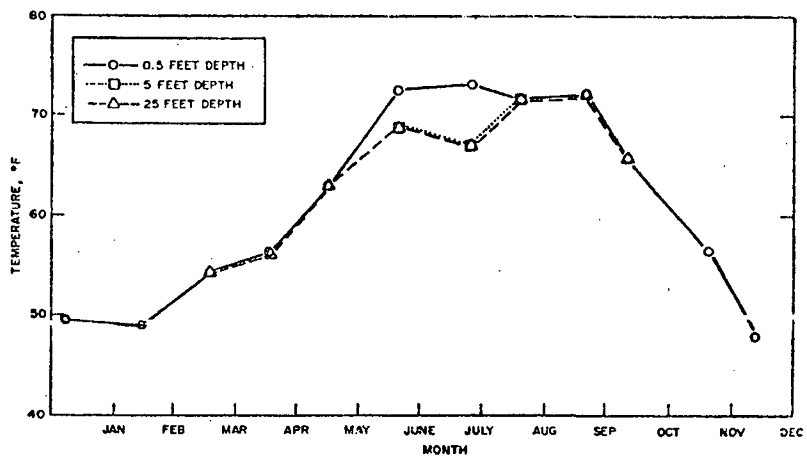


FIGURE 2.8 Water Temperature Survey, Clinch River Mile 14.4 (ER, Am I, Part II, Dla)

TABLE 2.2 Clinch River Water Quality Data[a]

Date	Time ET 24-hr Clock	Location in Stream[b]	Depth (ft)	Stream Discharge (cfs)	Coliforms Fecal (MPN/100 mℓ)	Coliforms Total (MPN/100 mℓ)	Water Temp (°F)	DO (mg/ℓ)	5-Day 20°C BOD (mg/ℓ)	Color (PCU)	Turb (JCU)	Nitrogen[c] Crq (mg/ℓ)	Nitrogen[c] NH_3 (mg/ℓ)	Nitrogen[c] NO_2 (mg/ℓ)	Nitrogen[c] NO_3 (mg/ℓ)	Phosphate Sol (mg/ℓ)	Phosphate Total (mg/ℓ)	pH	Alkalinity ($CaCo_3$) Phen (mg/ℓ)	Alkalinity ($CaCo_3$) Total (mg/ℓ)	Total Hardness ($CaCo_3$) (mg/ℓ)
Clinch River Mile 79.8																					
6/22/67	1055	Tailrace[d]	0.5	6,400	2	62	50.2	7.8	0.5	5	5	0.37	0.00	0.01	0.43	0.01	0.01	7.8	0	89	115
7/27/67	0905	Tailrace	0.5	6,670	130	220	51.8	5.1	0.7	10	28	0.11	0.00	0.01	0.60	0.03	0.03	7.8	0	88	119
8/15/67	1050	Tailrace	0.5	8,500	6	130	57.2	2.9	1.2	15	6	0.08	0.13	0.01	0.48	0.01	0.01	7.6	0	10	129
9/26/67	1120	Tailrace	0.5	8,220	2	6	62.6	0.9	0.2	50	36	0.50	1.18	0.02	0.42	0.07	0.12	7.5	0	105	116
10/18/67	1820	Tailrace	0.5	7,220	11	11,000	64.4	2.3	0.3	30	43	0.27	0.09	0.01	0.23	0.06	0.11	7.7	0	105	128
11/8/67	1515	Tailrace	0.5	2,220	6	23	60.8	6.7	0.3	10	15	0.14	0.18	<0.01	0.19	0.05	0.09	7.6	0	85	101
2/15/68	0920	Tailrace	1.0	6,390	3	23	33.8	11.2	1.2	10	15	0.25	0.06	0.02	0.54	0.04	0.18	8.2	0	103	---
4/24/68	1700	Tailrace	1.0	0	160	620	42.8	10.5	1.0	10	2	0.04	0.05	0.01	0.80	0.05	0.05	7.8	0	92	96
Clinch River Mile 23.1																					
6/23/67	1415	Tailrace[e]	0.5	16,500	94	940	64.6	8.6	0.0	5	14	0.40	0.01	0.02	0.40	0.01	0.11	7.8	0	96	128
7/28/67	1340	Tailrace	0.5	8,600	110	360	66.6	7.7	1.1	10	23	0.01	0.15	0.01	0.52	0.01	0.07	7.9	0	90	112
8/15/67	1535	Tailrace	0.5	15,260	3	230	63.5	7.9	0.9	15	31	0.09	0.09	0.01	0.47	0.05	0.25	7.5	0	92	124
9/26/67	1650	Tailrace	0.5	8,340	36	110	66.7	5.9	0.7	5	2	0.24	0.00	0.02	0.43	0.07	0.14	7.6	0	106	112
10/19/67	1305	Tailrace	0.5	8,340	16	3,400	62.6	6.2	1.6	10	8	0.34	0.17	0.03	0.31	0.06	0.16	7.9	0	100	125
11/8/67	1155	Tailrace	0.5	9,000	62	160	59.0	8.1	0.3	10	9	0.13	0.12	0.01	0.23	0.01	0.13	7.8	0	97	115
2/16/68	0900	Tailrace	1.0	7,500	3	36	41.0	11.7	<1.0	5	10	0.25	0.11	0.02	0.57	0.06	0.12	7.2	0	111	---
4/25/68	1815	Tailrace	1.0	0	<2	50	60.4	9.6	1.3	15	3	0.63	0.03	0.01	0.47	0.05	0.09	8.0	0	92	100

				Ca (mg/ℓ)	Ng (mg/ℓ)	Cl (mg/ℓ)	Na (mg/ℓ)	K (mg/ℓ)	Iron Fe (mg/ℓ)	Iron Total (mg/ℓ)	Mn Total (mg/ℓ)	SO_4 (mg/ℓ)	SiO_2 (mg/ℓ)	Specific Conductance at 25°C (µmhos/cm)	Solids Sus (mg/ℓ)	Solids Dis (mg/ℓ)	Solids Total (mg/ℓ)
Clinch River Mile 79.8																	
6/22/67	1055	Tailrace[d]	0.5	27.8	11.0	11	3.00	1.30	0.10	0.10	0.06	10	4.8	240	0	112	112
7/27/67	0905	Tailrace	0.5	28.8	11.4	3	2.50	1.40	0.01	0.12	0.06	12	3.9	241	13	131	144
8/15/67	1050	Tailrace	0.5	32.8	11.4	3	4.20	1.40	0.01	0.07	0.04	8	3.8	235	26	102	128
9/26/67	1120	Tailrace	0.5	31.0	9.4	7	2.50	1.30	0.01	0.10	0.21	18	3.4	284	4	140	134
10/18/67	1820	Tailrace	0.5	35.0	9.3	2	2.20	1.40	0.02	0.80	0.43	16	4.2	249	1	143	144
11/8/67	1515	Tailrace	0.5	26.0	8.8	3	2.40	1.50	0.02	0.73	0.09	14	---	222	0	129	129
2/15/68	0920	Tailrace	1.0	---	---	2	2.70	1.20	0.05	---	---	12	3.0	210	10	130	140
4/24/68	1700	Tailrace	1.0	23.0	9.5	3	1.70	3.80	0.05	0.06	0.02	10	2.7	240	---	---	---
Clinch River Mile 23.1																	
6/23/67	1415	Tailrace[e]	0.5	27.7	14.4	2	2.00	3.00	---	0.47	0.20	12	4.3	253	27	121	148
7/28/67	1340	Tailrace	0.5	28.8	9.6	5	2.30	1.50	0.01	0.40	0.07	16	4.6	201	2	120	122
8/15/67	1535	Tailrace	0.5	31.8	10.8	9	2.20	1.40	0.00	0.26	0.04	14	3.7	230	20	122	142
9/26/67	1650	Tailrace	0.5	29.5	9.2	18	1.70	1.40	0.01	9.21	0.07	18	3.5	284	63	90	153
10/19/67	1305	Tailrace	0.5	34.0	9.3	2	2.60	1.50	0.01	0.22	0.04	13	3.6	284	8	132	140
11/8/67	1155	Tailrace	0.5	31.0	9.1	3	2.80	1.60	0.02	0.17	0.45	14	---	266	15	98	113
2/16/68	0900	Tailrace	1.0	---	---	3	2.30	1.00	0.05	---	---	14	4.0	240	---	140	140
4/25/68	1815	Tailrace	1.0	26.0	9.0	3	3.00	4.00	0.05	0.19	0.04	12	1.1	230	10	100	110

(a) Gartrell, 1972)
(b) Location in Stream: Percent distance from left bank looking downstream.
(c) Nitrogen: Values shown are mg/ℓ nitrogen in the forms listed.
(d) Tailrace: Norris Dam.
(e) Tailrace: Melton Hill Dam.

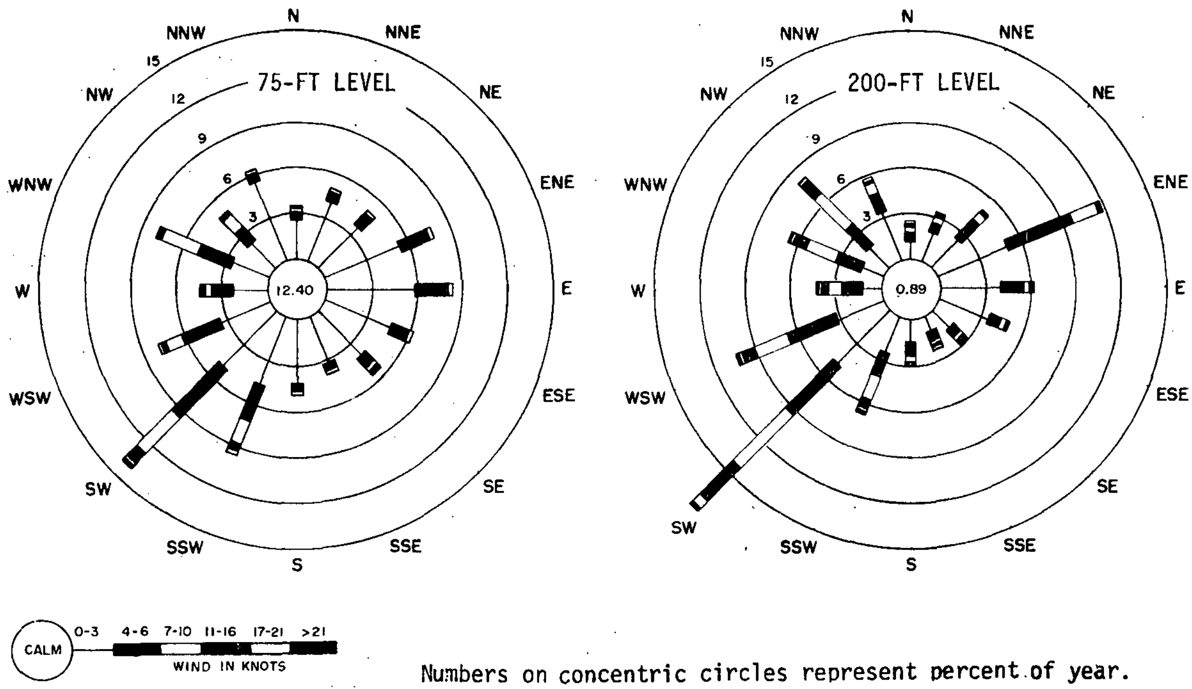
2.5.2 Groundwater

Groundwater occurs at the proposed site primarily in weathered joints and fractures in the subsurface rocks (ER, Sec 2.5.2.4). This zone extends from the ground surface to the top of the continuous rock. Borings made at the proposed site and in the river show that the elevation of the top of continuous rock lies at 700 MSL. All groundwater at the site flows towards the river, generally parallel with the ridges that characterize the region and from topographic highs to topographic lows. Groundwater recharge is primarily derived from precipitation.

2.6 METEOROLOGY

The regional climate, with relatively warm summers and cool winters, is characteristic of continental climatic regions in the southeastern United States. In the winter, cold dry air masses from Canada predominate. They usually are modified and warmed somewhat as the air crosses the ridges of the Cumberlands and moves down the eastern slopes. During the remainder of the year, the anticyclonic circulation of the atmosphere about the Bermuda-Azores high pressure system results in predominance of warm, moist air from the Gulf (Landsberg, 1974; USDC 1; USDC 2). On about 33 days annually, temperatures may be expected to reach 90°F or higher, and temperatures of 0°F or lower may be expected on one day each year. Temperatures of 32°F or lower may be expected to occur on 82 days annually (USDC 1 and USDC 3). Precipitation amounts are greatest during winter and early spring, and are lowest in early autumn. A secondary precipitation maximum, associated with thundershower activity, occurs in July (USDC 1). Relative humidity, on an annual basis, averages 70%. Additional information is presented in Sec 2.6.1 of the ER.

Locally, long-term records show that extreme maximum and minimum Knoxville temperatures are 104°F and -16°F, respectively (USDC 2). At Oak Ridge the extreme maximum and minimum air temperatures, recorded over a shorter period of record, are 105°F and -9°F, respectively (USDC 1). A maximum 24-hr precipitation total of 7.5 inches was recorded at Oak Ridge, and a 24-hr total of 7.75 inches at the X-10 station site (ER, Sec. 2.1.6.2.4). A 24-hr snowfall total of 12 inches was recorded at Oak Ridge and data indicate that heavy fog (visibility 0.25 mile or less) occurs on about 34 days annually at the weather office location (USDC 1). Such occurrences may be more frequent at the plant site, which is nearer the river. Wind speed and direction distributions (wind roses), based on July 1973 to July 1974 data collected onsite at the 75- and 200-ft above ground levels, are presented in Figure 2.9 (ER, Fig 2.6-4 and -9). Onsite data used in determining the dispersion factors for radiological dose assessments (Section 5.7) were collected during the period from June 1, 1974 through May 31, 1975 (Section 6.1.3). The wind direction frequency for the 75-ft wind data for the June 1974 through May 1975 period shows the same pattern as the 75-ft wind direction frequency presented in Figure 2.9. Temperature and precipitation data for the X-10 station site are presented in Table 2.3 (ER, Tab 2.6-4 and -8). Additional local meteorological information is available in Sec 2.6.2 of the ER.



Numbers on concentric circles represent percent of year.

Bars show direction from which the wind blows.

FIGURE 2.9 Annual Onsite Wind Roses (ER, Fig 2.6-4 and -9)

Local severe weather occurrences may be associated with intense, large-scale winter storms or with severe thunderstorms, mainly in the warmer seasons. Remnants of hurricanes or tropical storms occasionally affect the area. Between 1953 and 1974, 54 tornadoes occurred within a 10,000 sq mile area containing the site; this results in a mean annual tornado frequency of 2.5 and a recurrence interval for a tornado at the plant site of 1450 years (USDC 5, 1975; Thom, 1973). There were 15 reports of hail, 0.75 in. diameter or greater, and 46 windstorms with speeds of 50 knots (58 mph) or greater within the one degree latitude-longitude square containing the site during the period 1955 through 1967 (SELS, 1969). During the period 1871-1973, 4 tropical storms or hurricanes passed within 50 miles (Cry, 1965; USDC 4). Freezing precipitation may be expected to occur about 5 times each year and a severe ice storm (accumulation of 1 in. or more) once every 5 years (Tattleman and Gringorton, 1973). High air pollution potential (air stagnation) can be expected to occur on 7 days annually (Gross, 1970; Holzworth, 1972).

Table 2.3 Climatological Temperature and Precipitation - Oak Ridge Area Station X-10[a]

Month		Temperature, 1945-1964: Climatological Standard Normals 1931-1960: Mean Monthly (°F)	Daily Maximum (°F)	Daily Minimun (°F)	Extremes 1945-1964: Highest Temp (°F)	Lowest Temp (°F)	Precipitation, 1944-1964: Monthly Average[b] (in.)	Monthly Maximum (in.)	Monthly Minimum (in.)	Maximum in 24 Hr (in.)
December		40.4	49.4	31.3	76	-5	5.22	10.28	1.98	4.38
January		40.1	48.9	31.2	77	-8	5.24	12.37	1.11	3.96
February		41.7	51.6	31.8	77	0	5.39	10.01	1.89	3.23
	Winter	40.7	50.0	31.4	77	-8	15.85			
March		48.0	58.9	37.0	87	4	5.44	9.69	2.05	3.84
April		58.2	70.0	46.3	89	24	4.14	8.54	1.25	2.39
May		66.9	79.0	54.8	94	32	3.48	7.01	0.90	2.09
	Spring	57.7	69.3	46.0	94	4	13.06			
June		74.7	86.1	63.3	99	41	3.38	7.55	1.18	3.08
July		77.4	88.0	66.7	103	49	5.31	10.19	2.14	3.74
August		76.5	87.4	65.6	99	44	4.02	10.31	0.50	3.31
	Summer	76.2	87.2	65.2	103	41	12.71			
September		71.1	83.0	59.2	103	33	3.59	12.84	0.21	7.75
October		60.0	72.2	47.7	91	21	2.82	6.43	0.00	2.32
November		47.6	58.6	36.5	83	4	3.49	12.00	1.01	3.20
	Fall	59.6	71.3	47.6	103	4	9.90			
	Annual	58.5	69.4	47.6	103	-8	51.52	12.84	0.00	7.75
Oak Ridge City Office Climatological Standard Normals 1941-1970										
	Annual	57.8	68.6	47.0	105[c]	-9[c]				
Knoxville Vicinity Climatological Standard Normals 1941-1970										
	Annual	59.7	69.8	49.5	104[d]	-16[d]				

(a) Source: ER, Tab 2.6-4 and 2.6-8.
(b) Standard climatological normals - 1931-1960.
(c) May 1947 - October 1974.
(d) 1874 - October 1974

2.7 ECOLOGY

2.7.1 Terrestrial Ecology

The site supports moderately diverse plant and animal populations. A mosaic of forest types covers nearly all of the 1364 acres, with 37% in hardwoods, 47% in conifers, 11% in mixed forest, and 5% in nonforested land (ER, Sec 2.7.1.3.1). The mosaic reflects previous land use and present forest management practices on the site. Extensive farming prior to 1942 resulted in erosion and loss of soil fertility on steep slopes. Most of the existing deciduous forests were present as early as 1924, but acreages of conifers doubled from 1940 to 1972 because of natural old field succession and because of recent plantings of pine (McConathy, 1975). Two of the plant communities, so-called "natural areas", on the site are of ecological interest because of their stages of succession and relatively undisturbed condition (ER, Sec 2.7.1.3.3 and Fig 2.7-6). These are 1) less than 28 acres on the east boundary of the site dominated by northern red oak, tulip poplar, and white oak, and 2) about 15 acres of mixed deciduous (beech-mixed oak) forest in the northern part of the site. Plant and animal populations on the site are similar to those of much of the surrounding land (ER, Sec 2.7.1.4). For example, the Oak Ridge Reservation contains 29,443 acres in the various woodland types shown in Table 2.4.

2.7.1.1 Flora

Plant species on the site are largely those expected for land undergoing secondary succession in Eastern Tennessee which has a relatively rich flora (Braun, 1972). Rare plant species (ER, Sec 2.7.1.3.4 and ER Am I, Part II, B7) include Panax quinquefolium (ginseng), Cimicifuga rubifolia (black snakeroot) and Saxifraga careyana (Carey's saxifrage). Also occurring are Cypripedium acaule (Pink lady's slipper), Dicentra canadensis (squirrel corn) and Liparis lilifolia (large twayblade) which are listed as uncommon in southern National Forests (Duncan, 1970). Six species were collected which had not been collected previously in Roane County according to the University of Tennessee Herbarium (ER Am I, Part II, B7). None of the endemic species of the Tennessee cedar glades (Baskin, et al., 1968) was found in cedar glades on the site. Except for those species listed above, no rare or endangered plant species on the Smithsonian Institute list (USDI, 1975) or on the list given by Goff et al. (1975) or by Sharp (1974) have been reported on the site. Maps showing the exact locations of rare plants have been drawn.

TABLE 2.4 Forested Acres of the Oak Ridge Reservation[a]

Community Type	Acres	% of Total
Hardwood	10,876	37
Pine Plantation	5,002	17
Natural Pine	4,888	16
Cedar and Pine	478	2
Hardwood-Cedar	1,660	5
Hardwood-Pine	5,959	20
Hardwood-Cedar-Pine	589	3
	29,443	100

(a) Appendix B.

2.7.1.2 Fauna

2.7.1.2.1 Mammals. Two of the most common small mammals on the site are the white-footed mouse (Peromyscus leucopus) and the golden mouse (Peromyscus nuttali). Mammals providing sport and recreation, those with economic value as furbearers, and those considered rare or threatened are identified below with special reference being made to species found on the site.

1) Mammals Providing Sport and Recreation

- The white-tailed deer population in Roane County is about one deer per 2000 acres although populations at the site may be one per 600 acres or higher (ER Am I, Part II, B5). Roane, Loudon and Knox Counties are closed to deer hunting and the site itself is closed to all hunting (ER, Sec 2.7).

- Eastern cottontail rabbits are common in the open areas of the site, but uncommon in pine areas (ER Am I, Part II, B5). For the four counties near the site (Roane, Loudon, Knox, and Anderson), rabbits are at about one per 3 to 7.5 acres and hunter success is about 0.65 rabbit per hunter trip in east Tennessee as a whole.

- The gray squirrel is common only in mature mixed hardwood areas on site. The four counties near the site have about one squirrel per 1.5 acres and hunter success in east Tennessee is about 1.55 squirrels per hunter trip.

2) Mammals of Economic Value

A number of furbearing mammals occur onsite. Ranked on the basis of price per pelt in descending order, these are red and gray fox, mink, raccoon, skunk, muskrat and opossum. In addition, raccoon, opossum and muskrat are eaten by some people. Red and gray foxes, raccoons, and opossum are popular game mammals in Tennessee.

- Red and gray fox are the most common predators on the site, with probably more red than gray foxes occurring throughout the site.

- Mink occur along the Clinch River where they prey upon both aquatic and shoreline mammals.
- Raccoons are found near water but move around throughout the site.
- Striped skunk are present, especially near aquatic areas, but spotted skunk have not been found.
- Muskrats are found along the Clinch River.
- Opossum are common on the site.

3) Threatened Species

Trapping at 12 different areas on the site, over all four seasons of the year, revealed no small mammal species classified federally as endangered or threatened (ER Am I, Part II, B3). The only mammals listed as endangered (US Dept of Int, 1973 and 1975, and App A) which might occur on the site are the Indiana Bat (Myotis sodalis) and the gray bat (Myotis grisescens) although they have not been found on the site nor on the Oak Ridge Reservation (Howell and Dunaway, 1959). The river otter (Lutra canadensis) may occur on the site (ER, Amendment VI).

2.7.1.2.2 Birds. Birds were censused using transects on representative habitats in late May and in mid-December, with seven counts at each sampling time (ER Am I, Part II, B4). Additional qualitative surveys were conducted in March, May, August, and mid-November (ER, Section 2.7.1.4.2). Of the 125 species observed on the site, the Southern bald eagle (Haliaeetus leucocephalus leucocephalus) and the American osprey (Pandion haliaetus) are on the Federal list of endangered species (U.S. Dept of Int, 1975) and considered endangered by the State of Tennessee (App A). In addition, these three species of hawk, considered by the State to be threatened, have been observed: the sharp-shinned hawk (Accipiter striatus), Cooper's hawk (Accipiter cooperii and marsh hawk (Circus cyaneus). All five rare species are present on the Oak Ridge Reservation (ER, Tab 2.7-15).

Four species of upland game birds occur on the site. Bobwhite quail is the most abundant with six covies (4 to 6 individuals per covey) observed in the spring survey (ER, Am I, Part II, B5). For the four counties near the site (Knox, Loudon, Anderson, and Roane), populations of quail are one covey (about 12 birds) per 50 to 75 acres. The quail populations on the site are less because of the small amount of preferred habitat (open brushy areas) on the site. Quail harvest for east Tennessee is about 1.3 quail per hunter trip. Mourning doves are present; nine individuals were observed in the spring and summer surveys. The surrounding four-county area does not generally have large dove populations because there is not much small grain. Current harvest figures for east Tennessee as a whole indicate 4.2 birds per hunter trip. The ruffed grouse was also observed; five individuals were reported from the spring and summer survey periods. The American woodcock was found in wet fields and border areas; five individuals were identified during the survey (ER, Am I, Part II, B5).

2.7.1.2.3 Reptiles and Amphibians. Herptofaunal species are relatively abundant on the site because of the variety of habitats available, especially in mixed oak forests and in wet places. None of the species listed in Table 2.7-20 of the ER and on the State list is federally classified as threatened. The bull frog is classified as a game animal in the State.

2.7.2 Aquatic Ecology

Physical and chemical characteristics of the Clinch River near the site are discussed in Section 2.5. Water quality seems similar to that of southeastern U.S. rivers (Geraghty, 1973). Total and fecal coliform counts (Section 2.5) are well below the maximum allowable limit of 5000/100 mℓ (total fecal) for any one water sample required by the State of Tennessee (TWQCB, 1973) for the protection of fish and aquatic life. The higher counts in March can be attributed to pollution by agricultural run-off, especially from fecal contamination by farm animals (ER, Sec 2.7.2.4.1).

The phytoplankton community sampled from March 1974 through April 1975 is represented by 157 species. The diatoms (Chrysophyta) were the most numerous division from March through May; they decreased in June and July, and increased during August and September. The blue-green algae (Cyanophyta) were present in May, increased in June and July to become the most numerous division, and decreased in August and September. The green algae (Chlorophyta) comprised a small percentage of the total population from May through July and increased significantly in August and September. Two other divisions of phytoplankton, euglenoids (Euglenophyta) and dinoflagellates (Pyrrophyta) were present but in relatively low numbers. From September to April, all five plant divisions were present. Phytoplankton densities ranged from 1.9×10^5 to 2.9×10^6 cells/ℓ, in the range given for TVA water bodies (Taylor, 1971). Diversity indices (Shannon-Wiener) were not significantly different among stations and sampling periods. Mean chlorophyll a concentration for June through April was 3.6 mg/m^3 and ranged from 2.2 to 6.0 mg/m^3, typical of TVA water bodies (Taylor, 1971). A mean ratio of 1.3 was determined for the pheophytin a content of the phytoplankton. Pheophytin a is the natural degradation product of chlorophyll a. The ratio of pheophytin a to chlorophyll a is the ratio of optical densities before and after acidifying pigment extract. A ratio of 1.0 indicates the presence of only pheophytin a, whereas a ratio of 1.7 indicates that the samples are free of pheophytin a (EPA, 1973).

A total of 81 zooplankton species were identified from March 1974 through April 1975, of which 57 species were rotifers and 24 arthropods. The arthropods consisted mainly of cladocerans and copepods. The number of zooplankters ranged from 1/ℓ to 206/ℓ, with biomass estimates ranging from 13 to 639 μg/ℓ, typical of the nation's rivers (Pennak, 1963). Highest densities were recorded in May with lowest densities occurring in March. Seasonal variations in the Clinch River zooplankton are as follows: rotifers dominate numerically during early spring and summer, but decrease during the colder months; cladocerans are abundant from March through October; copepods are present throughout most of the year, even though not abundant, except possibly during the warmer months (ER, Sec 2.7.2.4.3). Diversity indices were not significantly different between stations but June-September mean diversity indices were higher than those for March or May. Some vertical stratification does occur among the rotifer species, but little among the arthropod species. Rotifers were two to four times more abundant in the surface samples than in the bottom samples.

Periphyton (attached algae) samples were collected from March 1974 through May 1975 with 149 species present representing 5 Phyla. Diatoms were the most numerous periphyton organisms with green algae, blue-green algae, euglenoids and dinoflagellates in decreasing order of abundance. The mean number of algal cells (no./cm^2) ranged from 1.1×10^5 to 3.9×10^6. Diversity indices showed no apparent differences between stations or seasons. The seasonal pattern of abundance is quite typical for these organisms. Diatoms had high densities in spring and lower densities during the summer. The blue-greens increased during the summer and reached highest densities in October. During the fall and winter, green and blue-green algae, as expected, decreased with blue-greens being nearly absent in winter. Diatoms were the numerically dominant form in the winter months with green algae being present in small amounts. Abundance and seasonal patterns are typical for Tennessee over the past seven years (ER, Sec 2.7.2.4.4). Mean values of chlorophyll a ranged from 8.4 to 55.8 mg/m^2 for the period between May 1974 and May 1975. The mean value for pheophytin a for all samples analyzed was 1.6, indicating a nondecaying photosynthetically active community.

The distribution and abundance of macrophytes in the site area were sparse. A few strands of Eurasian water milfoil were collected, but their origin could not be identified. The sparse growth of macrophytes is attributed to limited light penetration in the water, steep shorelines, hard substrate, and a fluctuating river water level (ER, Sec 2.7.2.4.6).

The benthic macroinvertebrates (benthos) collected by dredging were numerically dominated by insect larvae (chiromonids), representing over 50% of all species collected. Other important groups included mollusks, annelids, flatworms and coelenterates. A total of 82 species were collected from March 1974 through May 1975. Densities of the benthos ranged from 75 to 784 organisms/m^2 and diversity indices were low. Substrate type is a significant factor affecting benthos distribution (EPA, 1973). Three types of substrates, fine sand, sand, and gravels, were identified for the Clinch River near the site. Annelids, mainly Limnodrilus, were the dominant form in the fine sediments with the mollusk Corbicula and the coelenterate Hydra dominant in the coarse sand and gravel, respectively. Biomass, expressed as composite blotted and ash-free dry weight, were estimated for Corbicula alone and for all other organisms combined. Corbicula biomass estimates ranged from 2 to 11,400 mg/m^2 and for the other organisms, 0 to 165 mg/m^2.

Artificial substrates were also used to assess the macroinvertebrates. Chironomid larvae represented over 50% of the 67 species identified. Biomass values ranged from 39 to 1,260 mg/m^2. Chironomids have been classified as biological indicators of water quality (EPA, 1973). Ten species of chironomids collected in the dredge samples and 8 species collected on artificial substrates are listed by EPA as being intolerant to decomposable organic waste. The presence of those species implies that the study area around the site is not widely contaminated with decomposable organic waste. The Asiatic clam, Corbicula, was the dominant macroinvertebrate collected in terms of biomass. (For more detailed biomass values, lengths, and life history of this clam, refer to the ER, Sec 2.7.2.4.5.)

A total of 34 fish species representing 14 families were collected by electroshocking and gill netting from March 1974 through January 1975 (Table 2.5). The species collected have been divided into general categories of game, rough, and forage fishes. In terms of numbers, the forage fishes represented 63% of the total catch with the threadfin shad being the most numerous. The rough fish (so-called "commercial" fish) comprised about 21% of the total catch of which skipjack herring were most numerous. The game fishes include centrachids (sunfishes), perichthyids (temperate basses) and percids (perches). They comprised about 14% of the total catch. Bluegills were the most numerous game fish. Largemouth bass and white crappie are the most desired game fish in the area, and if introduced striped bass become plentiful, they will be prized highly by sport fishermen (Hatcher, 1975). In terms of weight, rough fish were most abundant, representing about 70% of the total fish weight with forage and game fish comprising 17 and 12%, respectively.

TABLE 2.5 Fish Species - Relative Abundance Clinch River[(a)]
Collected March 28, 1974 - January 17, 1975

General Category	Family	Genus and Species	Common Name	Total No. Collected	% of Total No.	Total Weight (g)	% Total Weight
Game	Centrachidae	Amblopites rupestris	Rock bass	13	1.1	744	0.4
		Lepomis auritus	Redbreast sunfish	5	0.4	452	0.2
		Lepomis macrochirus	Bluegill	79	7.0	4,815	2.5
		Lepomis megalotis	Longear sunfish	2	0.2	168	0.1
		Lepomis microlophus	Redear sunfish	4	0.4	514	0.3
		Micropeterus punctulatus	Spotted bass	14	1.2	92	<0.1
		Micropterus salmonides	Largemouth bass	20	1.8	8,124	4.3
		Pomoxis annularis	White crappie	3	0.3	315	0.2
	Percidae	Perca flavescens	Yellow perch	2	0.2	320	0.2
		Stizostedion canadense	Sauger	18	1.6	7,935	4.2
	Percichthyidae	Morone chrysops	White bass	19	1.7	9,025	4.8
		Morone saxatilis	Striped bass	1	0.1	128	0.1
Forage	Atherinidae	Labidesthes sicculus	Brook silverside	8	0.7	9	<0.1
	Clupeidae	Dorosoma cepedianum	Gizzard shad	128	17.3	25,619	13.6
		Dorosoma petenense	Threadfin shad	383	33.8	14,192	7.5
	Cottidae	Cottus carolinae	Banded sculpin	7	0.6	48	<0.1
	Cyprinidae	Hybopsis storeriana	Silver chub	4	0.4	231	0.1
		Notemigonus crysoleucas	Golden shiner	6	0.5	32	<0.1
		Notropis ardens	Rosefin shiner	1	0.1	8	<0.1
		Notropis atherinoides	Emerald shiner	154	13.5	824	0.4
		Pimephales notatus	Bluntnose minnow	17	1.5	27	<0.1
	Percidae	Etheostoma blennioides	Greenside darter	1	0.1	2	<0.1
		Percina caprodes	Logperch	5	0.4	108	0.1
Rough	Catostomidae	Carpiodes cyprinus	Quillback carpsucker	14	1.2	10,215	5.4
		Hypentelium nigricans	Northern hogsucker	2	0.2	270	0.1
		Ictiobus bubalus	Smallmouth buffalo	11	1.0	15,215	8.1
		Moxostoma carinatum	River redhorse	6	0.5	6,900	3.7
		Moxostoma duquesnei	Black redhorse	2	0.2	1,295	0.7
		Moxostoma erythrurum	Golden redhorse	50	4.4	22,823	11.7
	Clupeidae	Alosa chrysochloris	Skipjack herring	74	6.5	28,503	15.1
	Cyprinidae	Cyprinus carpio	Carp	3	2.9	22,358	11.9
	Hiodontidae	Hiodon tergisus	Mooneye	16	1.4	2,848	1.5
	Ictaluridae	Ictalurus punctatus	Channel catfish	12	1.0	3,065	1.6
	Sciaenidae	Aplodinotus grunniens	Freshwater drum	20	1.8	1,823	1.0
			TOTAL	1,134	100	188,247	100.0

(a) Classification is based on Bailey, R.M., et al., A List of Common and Specific Names of Fishes From the United States and Canada, third edition, American Fisheries Society Special Publication No. 6, Washington, 1970.

The 1972 commercial fish catch in Watts Bar Reservior contained the following species: catfish, buffalo, carp, drum and paddlefish with a total weight of approximately 100,000 lb, and a commercial value of about $15,000. About 1000 lb or 1% of the total catch for Watts Bar Reservoir was harvested within a 10-mi radius of the site (ER, Am I, Part II C2).

Information on the sport fishing around the site is very limited. During the baseline monitoring program, approximately 280 hours were spent on the water collecting samples and less than 10 fishing parties were observed. According to TVA biologists, the best fishing in the area is in the tailwaters of Melton Hill Dam, approximately 6 miles upstream of the site (ER, Am I, Part II, C3).

Ichthyoplankton (fish eggs and larvae) were sampled from late March through August 1974. Approximately 300 unidentified fish eggs and 14 larvae were collected; 93% of the fish eggs were collected on May 16 and June 23, 1974. The 14 larvae were identified as to family (1 percidae and 13 clupeidae). Spawning habits of the 7 most abundant species are described in Appendix 2.7 of the ER.

Stomach content analysis was performed on the 7 most abundant fish species present from March through January 1975. ER Table 2.7 classified the individual fish species whose stomachs contained food according to food groups. The major food items varied with fish species but included fish, zooplankton, benthic invertebrates, aquatic insects, detritus and bottom material.

No species designated as rare or endangered by any governmental agency were collected or observed in the baseline ecological survey performed from March 1974 through January 1975. A more complete description of the physical, chemical and biological parameters including complete taxonomic lists, data analysis and life histories is in the ER, Sec 2.7.2.

2.8 SOCIAL AND COMMUNITY CHARACTERISTICS

TVA activity in the thirties brought a significant change in the region's life style. From a setting of farms, coal mines, and small towns, land was transferred to the Federal domain for constructing Norris Dam. Later, Norris Lake was formed, inundating much of the appropriated acreage.

Since that time, the Oak Ridge reservation has been a center for construction and operation of manufacturing and scientific/engineering facilities supporting the nation's nuclear energy activity. Most of the manufacturing consists of increasing the ^{235}U content of uranium to values ranging from slightly above the 0.7% naturally occurring to contents exceeding 90%. Early in the period, the enrichment was done electromagnetically as well as by gaseous diffusion. Today only the latter process is used, employing about 4600 people at the Oak Ridge Gaseous Diffusion Plant. The Oak Ridge National Laboratory (ORNL) employs about 4000 people. The Y-12 area employing about 6500 people, provides engineering/fabrication support to the nuclear weapons effort, ORNL, and Federal agencies. ERDA's Oak Ridge Operations Office, with a complement of several hundred employees, is south of Oak Ridge Turnpike in the Oak Ridge residential area.

Construction employees usually have resided outside of Oak Ridge since low cost housing is scarce in the city and an ordinance forbids mobile homes. The incoming CRBRP force probably would follow that pattern, settling in nearby areas south and west of the site (Section 4.5.1). Local services in Anderson County and surrounding counties would be strained by any influx of workers, particularly during construction peaks. Since the industrial facilities are located on federally owned land, the customary property tax revenues have not come to local communities. To meet needs for schools, highways, and other services, as well as to compensate for the dedication of land to usage for industrial facilities, Anderson and Roane Counties have sought and obtained federal payments in lieu of property taxes. In the opinion of many county residents, the payments are considerably below tax revenues that would accrue from the same facilities on private land. For convenience, school enrollment data are placed in Section 4.5.3, along with the assessment of construction impacts.

The City of Oak Ridge, representing about half of Anderson County's population, is characterized by relatively high incomes. Schools have 11% unused capacity (Sect. 4.5.3). Outside Oak Ridge, the area is mostly rural, with the exception of the Knoxville region and schools generally are at capacity or somewhat in excess of it (Sect. 4.5.3). Because of the relatively low value of taxable property, Anderson County levies a property tax about double that of East Tennessee counties having a similar amount of industry and in the same population range (Tax Study, 1971). Based upon 1969 data, 15% of the Anderson County households had poverty level incomes, increasing to 18% in Loudon County and Roane County (ER, Tab 8.1-11).

3. FACILITY DESCRIPTION

3.1 EXTERNAL APPEARANCE

The most prominent CRBRP feature would be the dome-capped reactor containment building, rising 169 ft above the grade set for principal plant structures. Metal curtain walls, finished to blend with the environment, would enclose the turbine building, the steam generator maintenance bay, the shop and warehouse, and the radwaste building. Textured masonry would cover the one-story plant service building. Concrete construction, having exposed design patterns coordinated with other buildings, would be used for the control building, the reactor service building, the overflow heat removal service area, the diesel generator building, the steam generator and auxiliary bay building, and the intermediate bay. The two mechanical draft wet cooling towers would each be 250 ft long, 70 ft wide, and 60 ft high. The emergency cooling tower structure would consist of a concrete basin having two 32 ft diameter mechanical draft wet cooling towers, each about 40 ft high.

Two switchyards are planned, a generation yard and a startup reserve yard, each occupying less than one acre. High steel structures would be painted in dark neutral colors and low-lying equipment would be painted in bright colors for contrast.

A conceptual architectural rendering of the plant as viewed from the west is shown in Figure 3.1; the plant layout, in Figure 3.2; and the plant with access to it, in Figure 3.3 (ER, Sec 3.1; Am I, Part II, G5 and G10; PSAR, Fig 2.1-5). Forest and natural terrain would limit views of the plant, although part of the containment building would be visible from Gallaher Bridge and about 10 homes south of the river would have a view of some of the plant. The security fence would enclose the plant buildings and the switchyards within an area of about 37 acres (Figure 3.2). The exclusion area would include the full width of the river touching the site property and the full 1364 acre site except for the 112 acres in the Clinch River Consolidated Industrial Park (Figure 3.3).

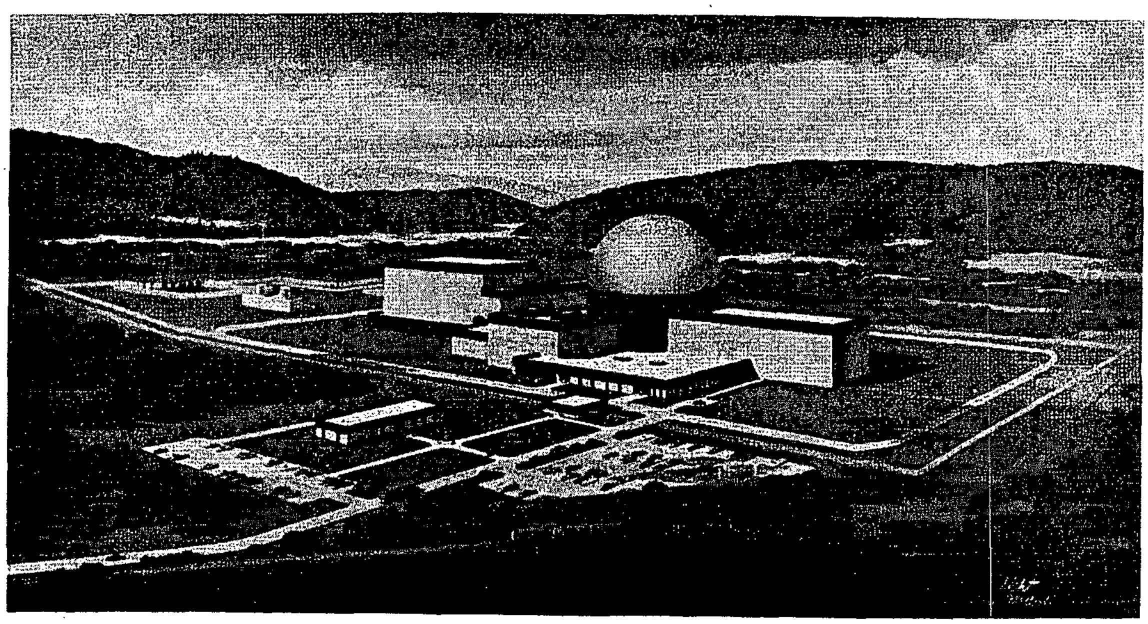


FIGURE 3.1 A Conceptual Architectural Rendering of the CRBRP

3.2 REACTOR AND STEAM-ELECTRIC SYSTEM

The CRBRP would be a single-unit electric power plant with a liquid sodium-cooled loop-type breeder reactor utilizing a ceramic fuel of mixed uranium-plutonium dioxides (UO_2-PuO_2). With the initial reactor core the gross power rating would be 975 megawatts thermal (MWt) and 380 megawatts electrical (MWe). Future core designs may achieve a maximum rating of 1121 MWt and 439 MWe. In-plant uses of power would result in a net plant output of approximately 350 MWe initially and a maximum of 379 MWe with future cores. The anticipated gross thermal efficiency is 39% and the net plant efficiency is estimated to be 36%.

The mixed-oxide fuel would be in the form of sintered pellets encapsulated in stainless steel rods. Two different plutonium fractions, in the range of 18.7 to 32%, would be used in the two core zones. The 14-in long axial blanket sections above and below the 36-in active middle section of each rod would contain depleted UO_2 pellets with 99.8% ^{238}U and 0.2% ^{235}U. Each of the 198 fuel assemblies

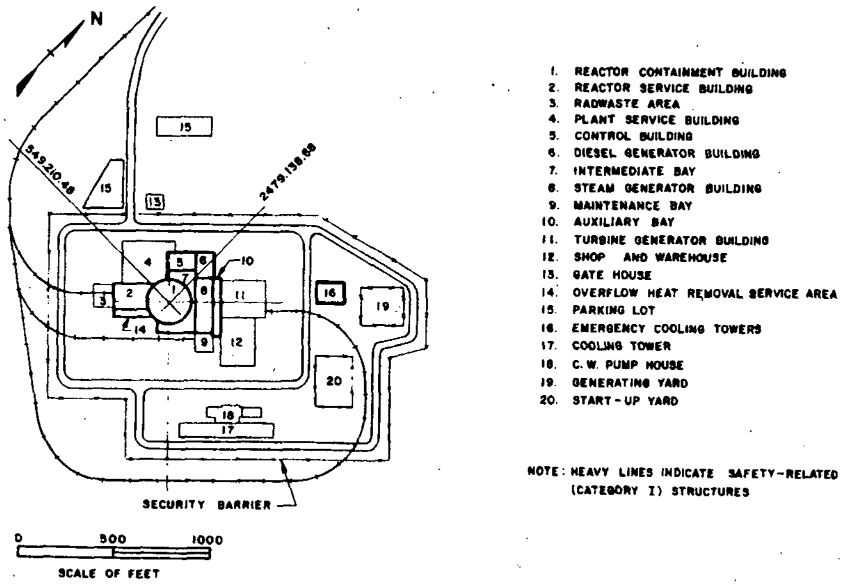


FIGURE 3.2 Layout of CRBRP Structures

(Figure 3.4) in the reactor core would have 217 of these fuel rods. Surrounding the core would be a radial blanket consisting of 150 assemblies, each with 61 rods containing depleted UO_2 pellets. Figure 3.4 shows a partial cross section of the reactor indicating how the fuel assemblies are positioned (WASH-1535, Fig 4.2-3; ER, Fig 3.8-1). During the 5-year pre-equilibrium demonstration period of operation, an average of 102 core fuel assemblies and 13 radial blanket assemblies would be replaced annually. In the succeeding equilibrium cycles over the remaining plant life of approximately 25 years, about 66 core assemblies and 30 blanket assemblies would be replaced annually.

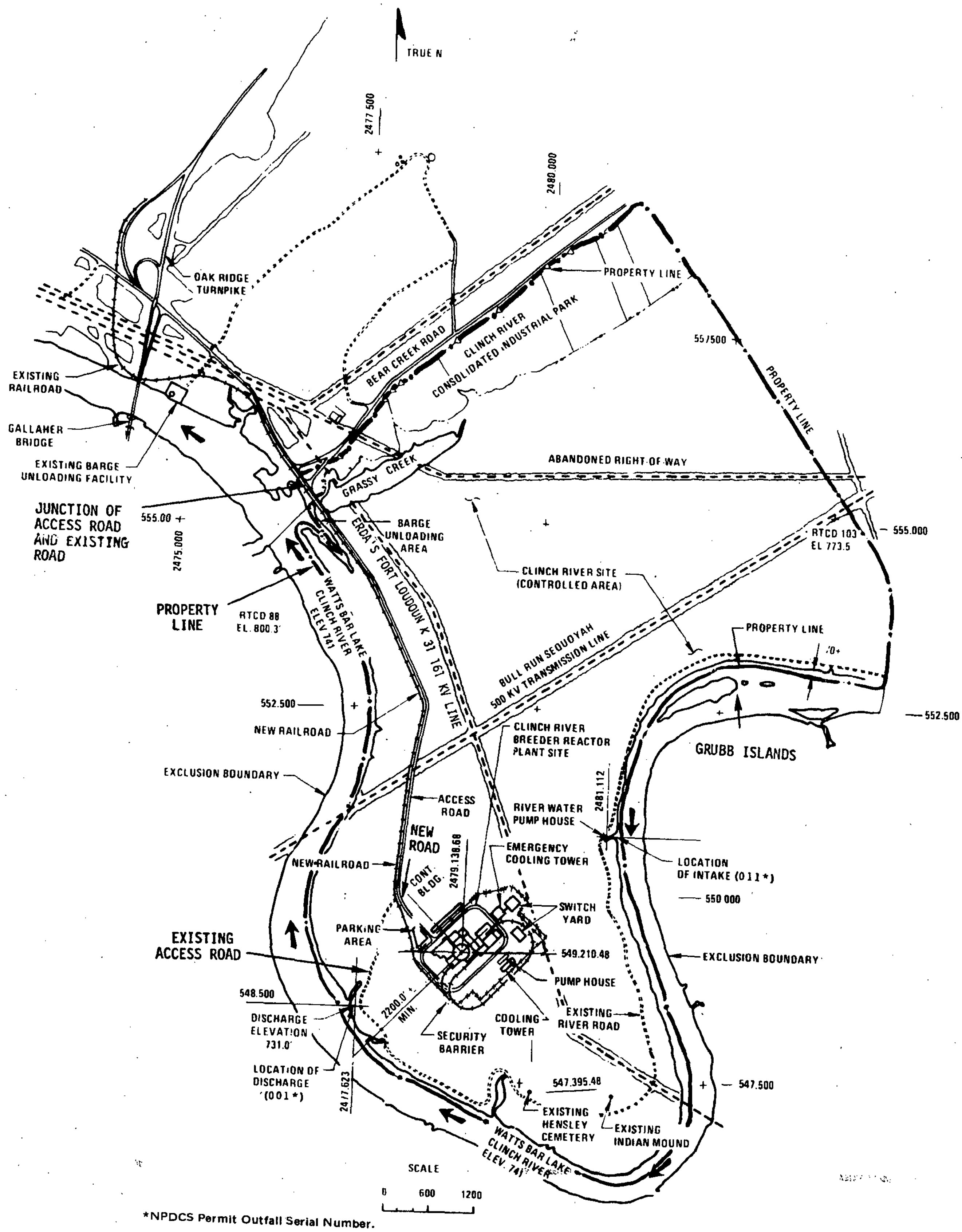
During operation of the reactor, a portion of the fertile ^{238}U in the axial and radial blankets would be converted to ^{239}Pu. When conversion exceeds the consumption of fissile material in the core, that action is known as breeding. A breeding ratio of 1.21 is expected with the initial core, and 1.20 with the equilibrium core (ER, p. 3.2-7).

Heat would be removed from the reactor core and the radial blanket by the primary sodium coolant, as shown in Figure 3.5 (ER, Fig. 3.2-1). The primary system would operate with an inlet temperature of 730°F and a mixed mean reactor outlet temperature of 999°F. Heated sodium would flow in each of the three primary loops from the reactor vessel outlet through a 36-in dia. pipe to a pump, and then through a 24-in dia. pipe to the shell side of an intermediate heat exchanger (IHX), from which it would return through a 24-in dia. pipe to the reactor core inlet. Each primary pump, rated at 33,500 gpm, would be driven normally by a 5,000-hp variable speed motor to provide load-following capability. The primary pumps and intermediate heat exchangers would be located in concrete vaults within the reactor containment building and a nitrogen atmosphere would be maintained within these vaults to minimize the consequences of sodium fires if they should occur.

The heat would be transferred in the intermediate heat exchangers from the radioactive primary sodium to the non-radioactive sodium in three secondary (intermediate) systems. The 29,500-gpm pumps providing the driving force for the sodium flow would be in the cold legs of the intermediate loops. These pumps would be located outside the reactor containment. The operating pressure in the intermediate loops would be slightly higher than the pressure in the primary loops, so as to minimize leakage of radioactive sodium into the intermediate loops.

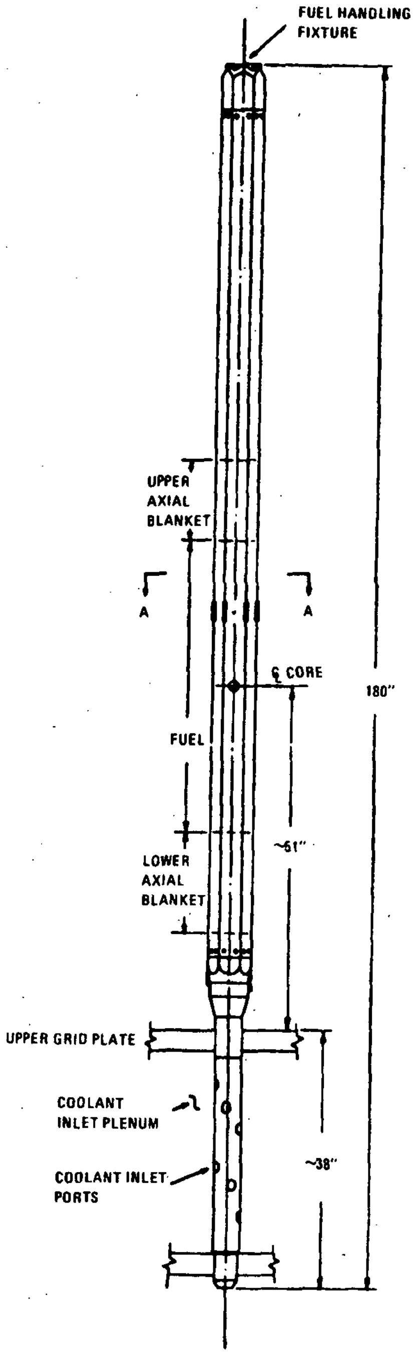
The intermediate sodium would circulate through evaporators and superheaters in the steam generation system, which would also be located outside the containment building. Heat from the sodium would convert the feedwater passing through the evaporators into a mixture of water and steam (50% quality) at 621°F and 1750 psig, which would be directed to the steam drum where the water would be mechanically separated from the steam. The dry steam would flow to the superheaters where additional heat from the intermediate sodium system would superheat the steam to 900°F at 1450 psig. The 436.8 MWe turbine-generator driven by this steam would generate electricity at 22 to 24 kV. The voltage would be stepped up by transformers in the switchyard to 161 kV for delivery to the TVA system.

Waste heat released by condensation of exhaust steam from the turbine would be rejected to the atmosphere through the cooling towers and to the Clinch River in the cooling tower blowdown, as described in Section 3.4.

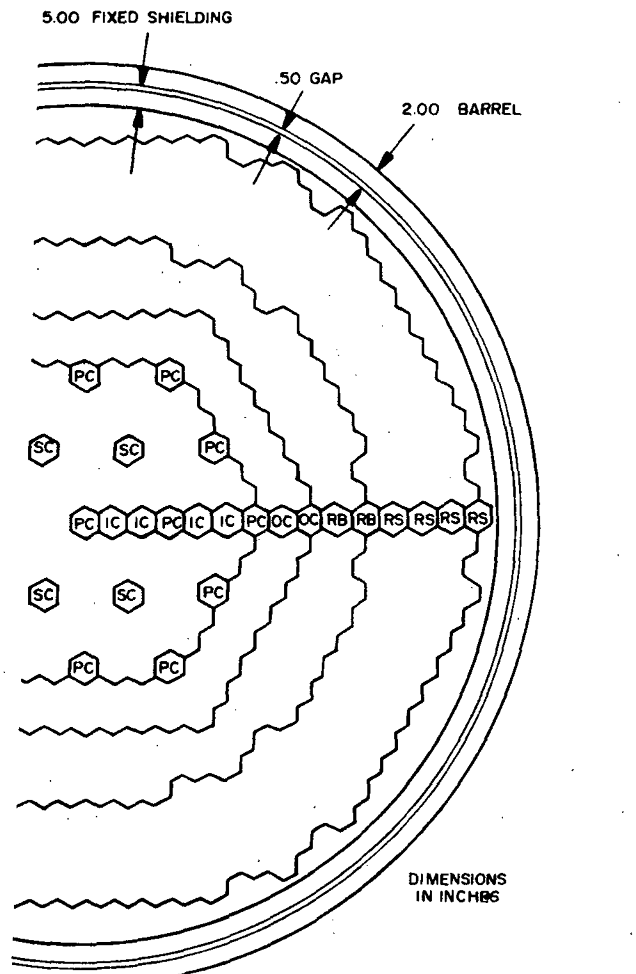


*NPDCS Permit Outfall Serial Number.

FIGURE 3.3 Site Location and Access



FUEL ASSEMBLY



QUANTITY	SYMBOL	COMPONENT NAME
108	IC	INNER ZONE FUEL ASSEMBLY
90	OC	OUTER ZONE FUEL ASSEMBLY
150	RB	RADIAL BLANKET ASSEMBLY
324	RS	RADIAL SHIELD ASSEMBLY
15	PC	PRIMARY SYSTEM CONTROL ASSEMBLY
4	SC	SECONDARY SYSTEM CONTROL ASSEMBLY

REACTOR CORE CROSS-SECTION

FIGURE 3.4 Fuel Assembly and Reactor Core

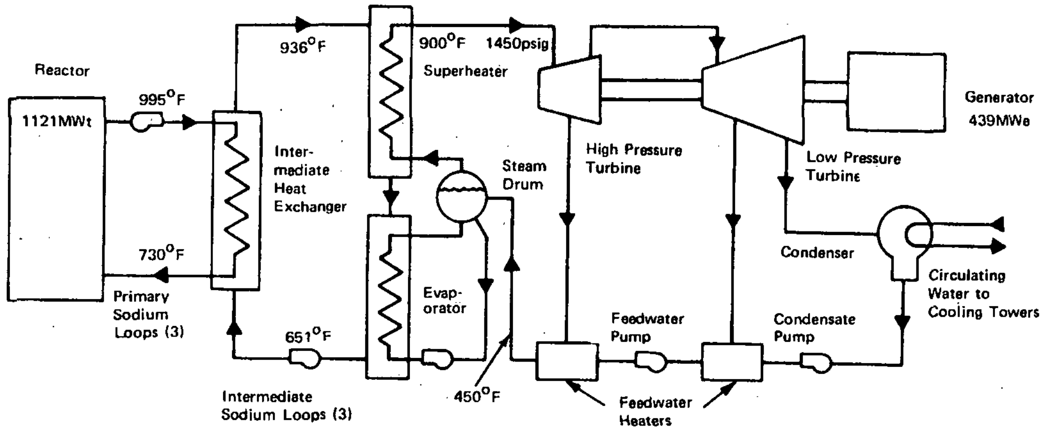
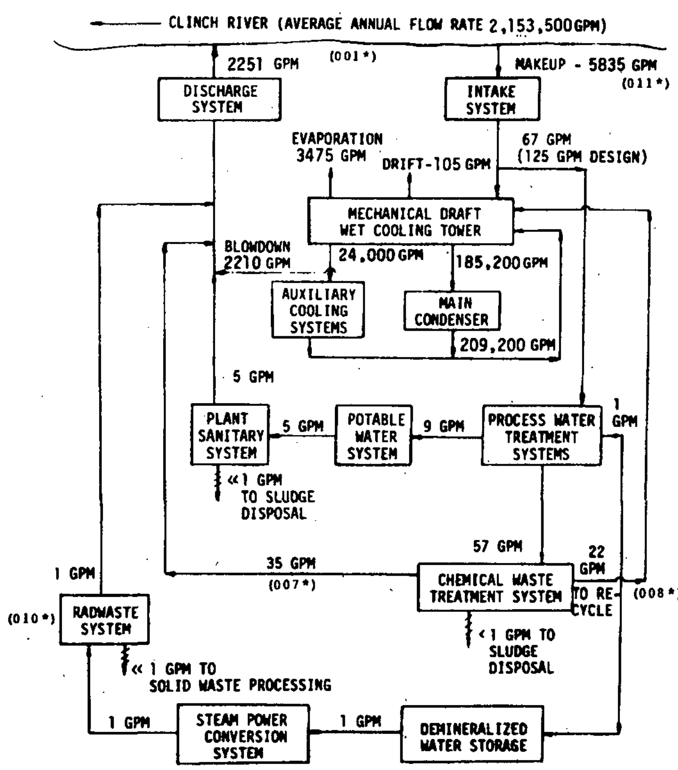


FIGURE 3.5 The CRBRP Cycle

3.3 WATER REQUIREMENTS

All water for operation would be supplied by the Clinch River. For maximum power, the anticipated annual average water makeup requirement would be 13 cfs (5835 gpm). An average of 5 cfs (2251 gpm) would be returned to the river as blowdown (2210 gpm) and effluent from other plant systems (41 gpm). (The volume of blowdown shall be limited as specified in NPDES Permit Part III, Item E, page 18 of Appendix H). Approximately 8 cfs (3584 gpm) would be consumed through evaporation, drift, and plant water usage. Figure 3.6 is a water usage flow diagram for the plant (ER, Fig. 3.3-1). The greatest consumptive water use, representing about 0.2% of the river's annual average flow rate, would take place in the heat dissipation system.



NOTE: COOLING TOWER FLOWRATES ARE ANNUAL AVERAGES AT MAX. POWER OPERATION
*NPDES Permit Discharge Number (See Appendix H).

FIGURE 3.6 Average Annual Water Use

3.4 HEAT DISSIPATION SYSTEM

3.4.1 Cooling System

The proposed power output rating for the initial core is 3.34 x 10^9 Btu/hr. Subsequent cores would have design capability for a power output rating of 3.83 x 10^9 Btu/hr. At the higher output the full load heat rejection rate over the main condenser would be 2.34 x 10^9 Btu/hr. To dissipate that amount of heat, 185,200 gpm of cooling water would be circulated between the steam condensers and the cooling towers during maximum power operation.

The plant would employ two mechanical draft wet cooling towers with 14 cells. Each tower would be 70 ft x 60 ft x 250 ft long and have a rated heat dissipation capacity of 2.17 x 10^9 Btu/hr. Cooling water would be pumped from the tower basins to the turbine steam condensers. Temperature rise of the water passing through the cooling system would be about 22°F after which the heated water would be pumped back to the tower and evenly distributed at its top. The water would cascade down over the tower's fill as the air induced by the cooling tower fans flows across the fill. Evaporation cooling accounts for 60-70% of the heat dissipation, and convective cooling for the remainder. The system is designed for a drift rate of 0.05%. Table 3.1 lists expected monthly operating conditions and tower performance (ER, Table 3.4-4). The maximum outfall flow temperature of 90.5°F is expected during July. During the winter a 61.5°F minimum temperature is expected. Cooling tower blowdown is a function of evaporation which is dependent upon the wet bulb temperature. Figure 3.7 illustrates the relationship between wet bulb temperature and the blowdown rate (ER, Fig. 3.4-4).

TABLE 3.1 Water Temperatures of the Clinch River and the Cooling Tower Blowdown[(a)] (ER, Table 3.4-4)

	River Water[(b)]			Mechanical Wet Cooling Tower Blowdown		
	Average	Average Maximum	Average Minimum	Average	Daily Maximum	Daily Minimum
Jan	42.7	48.0	37.9	66	68	61.5
Feb	42.1	48.0	37.6	67	68.5	61.5
Mar	47.0	54.9	40.9	70	72	63.5
Apr	55.1	62.3	48.1	74.5	77	66.5
May	60.9	66.4	56.0	79.5	83	70.5
Jun	63.5	69.9	58.5	85	88.5	75
Jul	64.4	69.4	60.3	86.5	90.5	77.5
Aug	65.7	70.1	61.9	86	90	77
Sep	66.9	70.4	63.4	82.5	87.5	73.5
Oct	64.6	68.7	60.2	76	80.5	68
Nov	57.0	63.4	50.4	70	72.5	63.5
Dec	47.7	53.8	43	66.5	68.5	61.5

(a) All temperatures are in °F.
(b) June 1963 to October 1972, Whitewing Bridge temperature data from TVA.

The auxiliary cooling water systems would be designed to provide 24,000 gpm of cooling water at 95°F or less. The systems would cool auxiliary plant equipment during normal operating conditions, and would function in parallel with the main circulating water system discussed above.

3.4.2 The Intake

All plant water requirements would be met by water supplied from the river through two submerged perforated pipes located approximately 26 ft from the existing shoreline (Figure 3.8). Figure 3.9 shows the location of the intake structure (ER, Am I, Part II, D18). The pipes would be positioned parallel to the river flow and supported off the river bottom as shown in Figure 3.10 and Figure 3.11 (ER, Fig. 3.4-7 and 3.4-6). Note that the top of the perforated pipe is 8 ft above river bottom (Figure 3.11). The overall length of each intake assembly would be about 24 ft. Because of the low inlet velocity of 0.3 to 0.5 fps, the applicant anticipates no substantial accumulation of trash on the perforated pipe; therefore trash racks and screens would not be necessary. However, removal of debris from the inlet pipe can be accomplished by flow reversal in the intake piping (ER, Am I, Part II, C16).

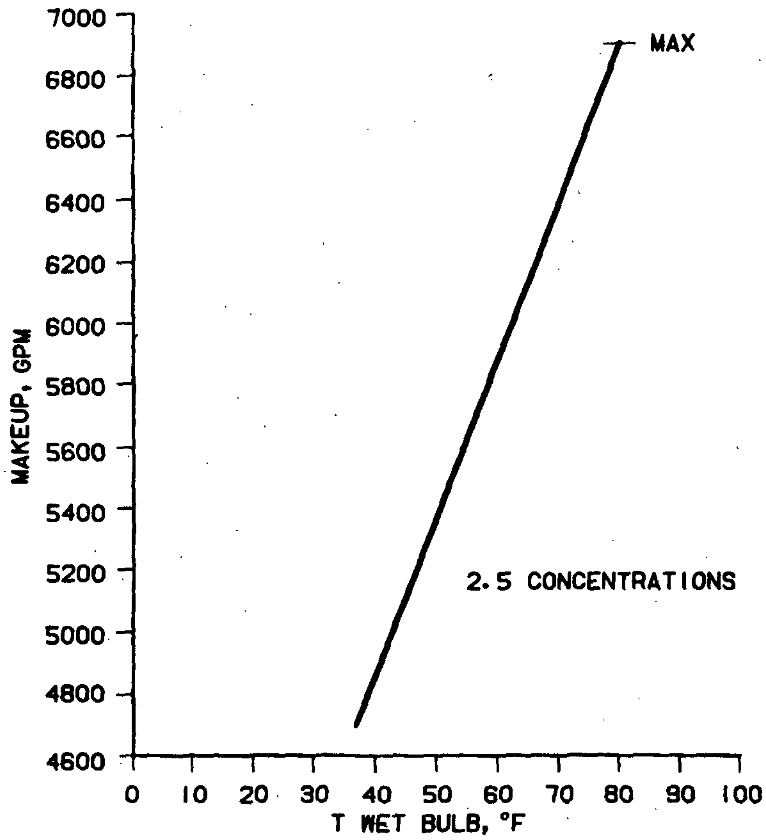


FIGURE 3.7 Mechanical Draft Wet Tower Blowdown (Constant Humidity)

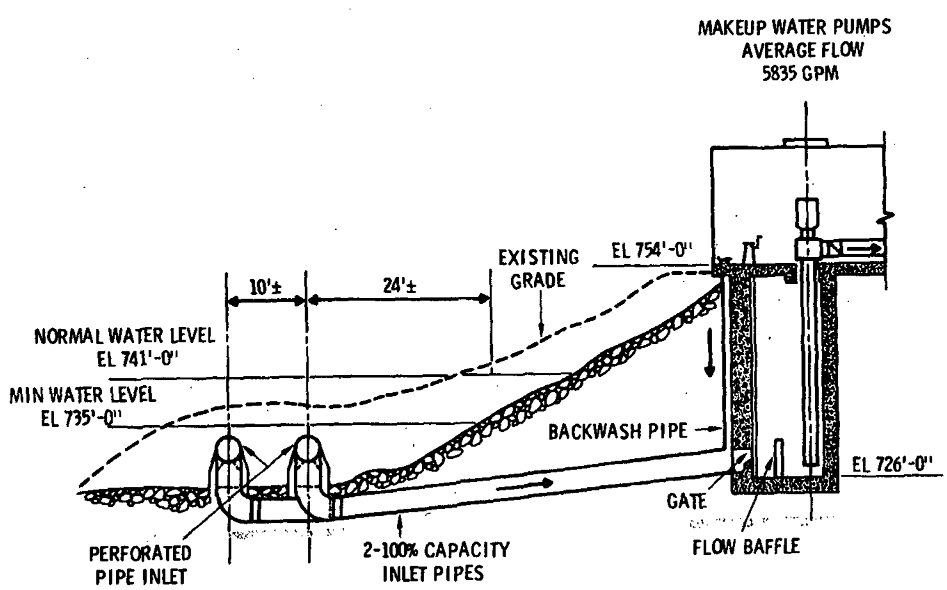


FIGURE 3.8 Intake Pipe

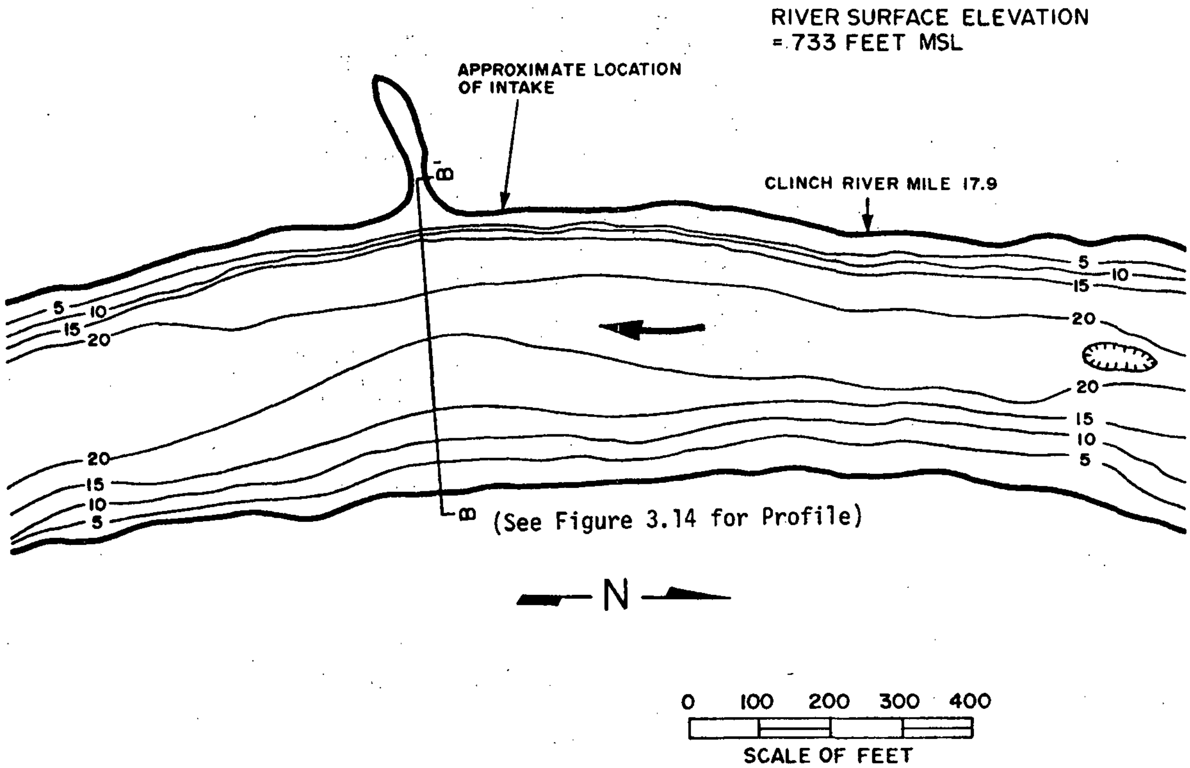


FIGURE 3.9 Bathymetry Near the Intake

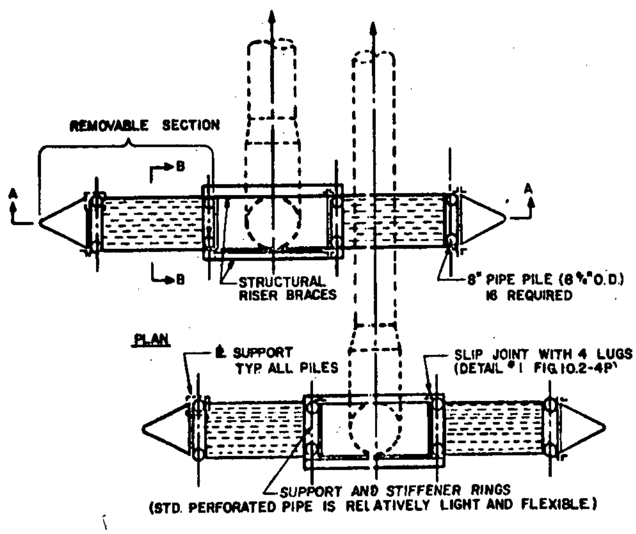


FIGURE 3.10 Intake Connections to Pumphouse

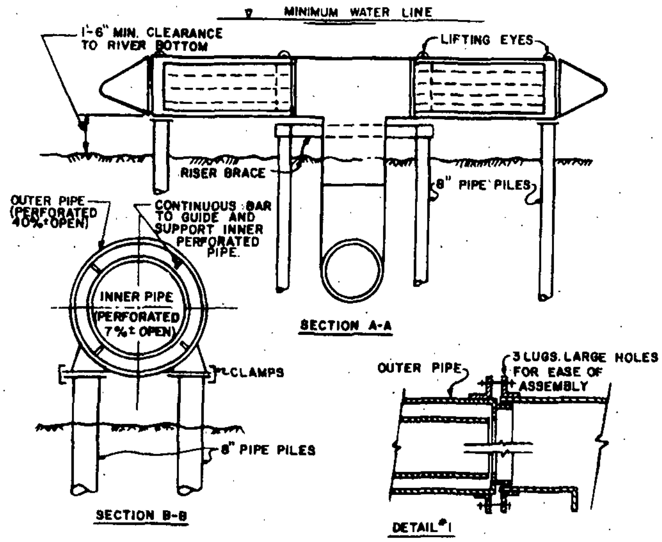


FIGURE 3.11 Intake Supporting Framework

Two river pumps would supply makeup water to the cooling tower basin. The system is designed for flow rates of 2,500 gpm to 10,000 gpm. A recirculation line would be provided to prevent pump damage when the cooling tower basin is at a high water level and the other plant demands are less than the minimum flow requirements of the pump.

3.4.3 The Discharge

A submerged single-port discharge structure as shown in Figure 3.12 would be constructed to dispose of the cooling tower blowdown. A small channel would be cut into the bank so that the outfall would be generally flush with the existing riverbank. The elevation of the discharge pipe would be at 731 above MSL and discharge normal to the river flow. The discharge pipe would have a minimum free board of 4 ft at low water (elevation 735) and a 2 ft clearance from the bottom. The blowdown would be discharged at a minimum rate of 1900 gpm to a maximum rate of 2600 gpm at full power.

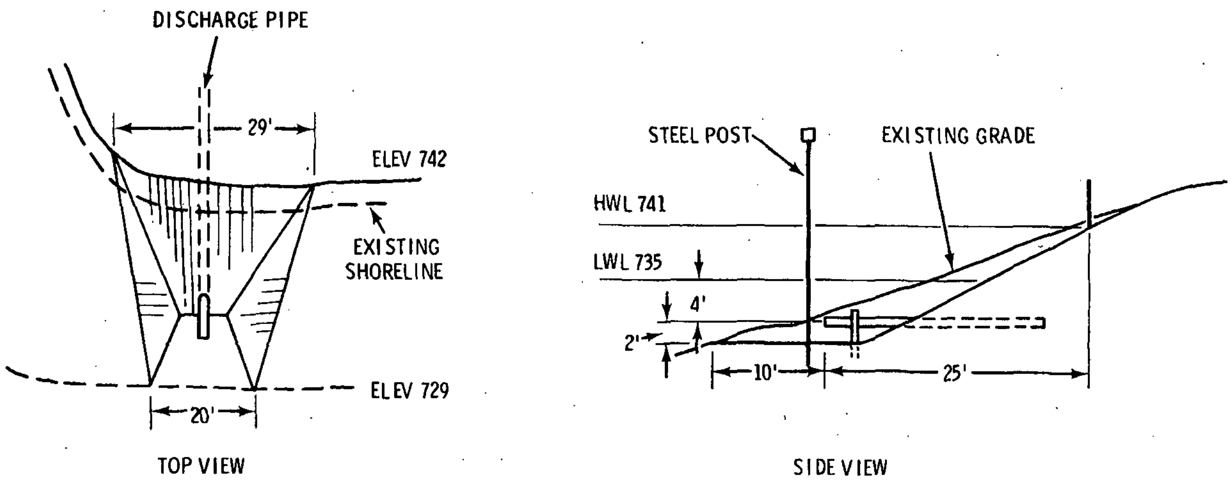


FIGURE 3.12 Submerged Discharge

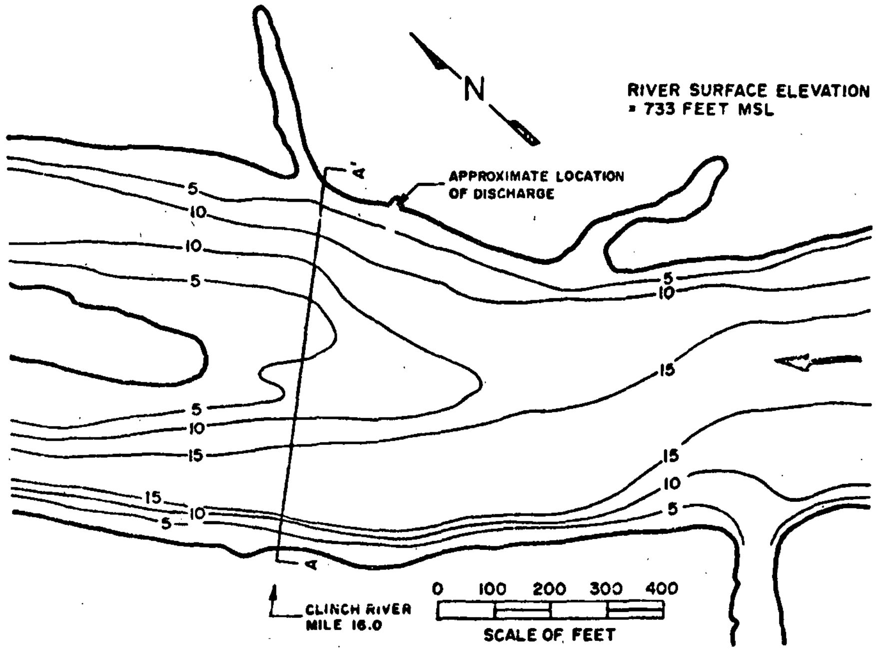


FIGURE 3.13 Bathymetry Near the Discharge

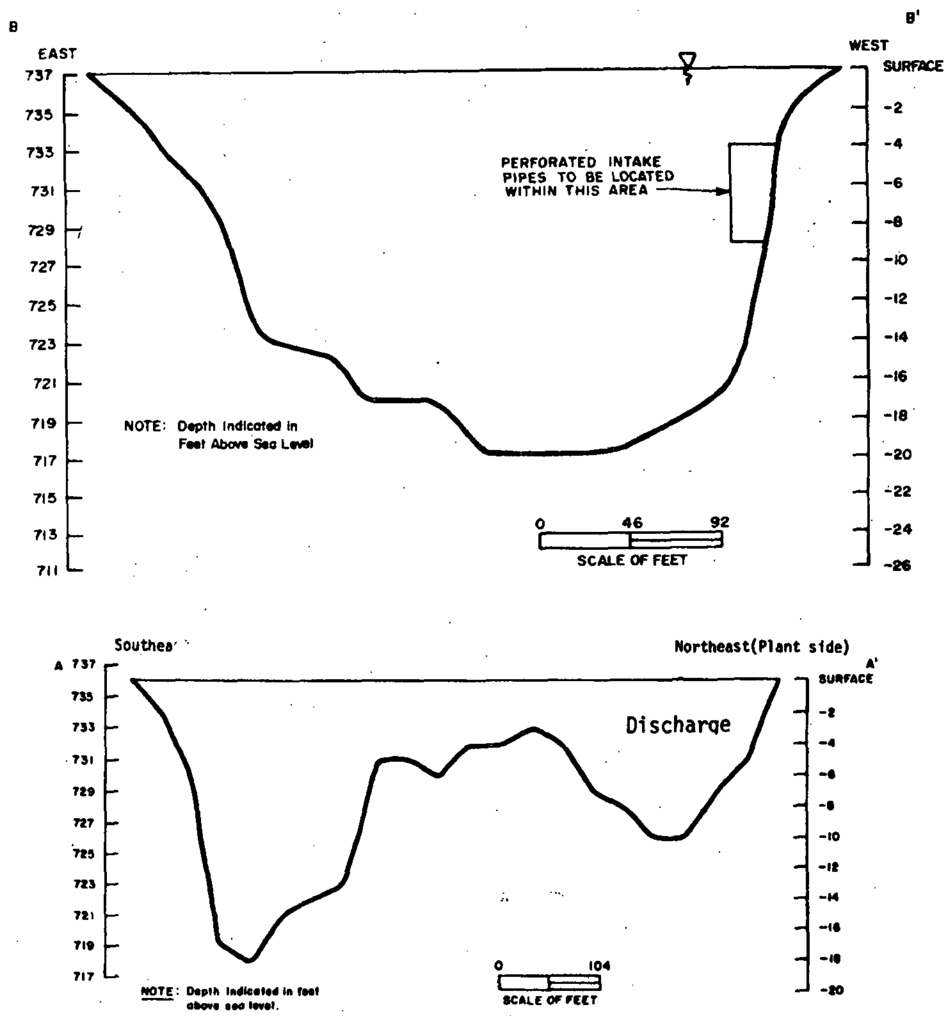


FIGURE 3.14 Cross-Sectional Profile of Clinch River Near the Intake and Discharge

3.5 RADIOACTIVE WASTE SYSTEMS

During operation, radioactive materials would be produced by fission in the core and blanket assembly fuel rods and by neutron activation of the sodium primary coolant and its trace impurities, the argon cover gas, and the corrosion products in the primary coolant. Tritium would be produced by neutron interaction with boron in the control assemblies and with lithium contaminant in the primary sodium, in addition to production by fission. Small amounts of the product materials would enter the waste streams as liquid and gaseous radioactive wastes. Aqueous liquid waste would be generated from the treatment of sodium spillage and contaminated plant components. Waste streams would be processed and monitored to reduce the quantities of radionuclides ultimately released to the atmosphere and into the river. Plant waste handling and treatment systems are discussed in the PSAR and ER; these documents contain the results of an analysis of the systems and an estimate of the expected annual release of radioactive effluents.

In the following paragraphs, the waste treatment systems are described, and an analysis based on a model of the applicant's proposed radioactive waste systems is given.

The staff's liquid and gaseous source terms were calculated by the PWR-GALE code, described in Draft Regulatory Guide 1.BB modified to apply to LMFBRs. The principal parameters used in the source term calculations are given in Table 3.2. The bases for the staff's parameters were determined from several different sources: 1) from Draft Regulatory Guide 1.BB, as applicable, 2) from a review of the literature, and 3) from the staff's evaluation and concurrence with the applicant's source term parameters.

The staff recognizes that Appendix I of 10 CFR Part 50 is applicable only to light-water-cooled nuclear power reactors. However, because of a lack of an operating experience data base for liquid metal fast breeder reactors and for lack of any other numerical guidance, the staff believes that the design objective levels of Appendix I should be considered in determining whether CRBRP radioactive releases would be "as low as reasonably achievable." Thus, as a basis for evaluation, the staff compared the calculated releases of radioactive material in liquid and gaseous effluents and the corresponding doses with the somewhat more restrictive numerical guides for design objectives of proposed Appendix I (1974). The staff's evaluation of the waste management systems of the CRBRP is given in the following sections.

3.5.1 Liquid Waste

Radioactive liquid waste would be processed on a batch basis to permit optimum control of releases. Prior to release, samples would be analyzed to determine the types and amounts of radioactivity present. On the basis of the results, the waste would be retained for further processing, recycled for reuse in the plant, or released under controlled conditions to the cooling tower blowdown. A radiation monitor automatically would terminate the liquid waste discharge if radiation measurement exceeds a predetermined level in the discharge line. A simplified diagram of the liquid radioactive waste treatment systems is given in Figure 3.15.

3.5.1.1 Intermediate Activity System

The Intermediate Activity System (IAS) would process aqueous radioactive waste generated from the washing of contaminated plant components in the Large Component Cleaning Cell (LCCC) and the Intermediate Component Cleaning Cell (ICCC). Prior to decontamination in the cells, components would be allowed to decay for a minimum of 10 days. Components would be contaminated with a film of sodium containing deposits of fission products, corrosion products, tritium, and plutonium. Based on the applicant's projected component maintenance schedule, the cleaning process would produce an average volume of 146,000 gallons of aqueous waste per year, an estimate with which the staff concurs.

The intermediate activity system would consist of two collection tanks, two filters, an evaporator, two polishing demineralizers, and two monitoring tanks for liquid analysis after processing. The aqueous waste would be collected in one of the 20,000-gal collection tanks at an input flow rate of 400 gpd. The staff calculated the collection time to be 40 days. After collection, the waste would be processed batchwise by filtration, evaporation (10 gpm) and demineralization prior to collection in one of the 22,000-gal monitoring tanks. The staff calculated the decay time during processing to be 1.3 days. The decontamination factors listed in Table 3.2 were applied for radionuclide removal in the IAS. The liquid in the monitor tank would be sampled, analyzed, and then recycled to the LCCC and ICCC for reuse in the decontamination procedure.

The applicant does not plan to release any liquid from the IAS monitoring tank to the environment. The staff assumed that approximately 90% of the monitor tank inventory would be recycled for reuse in the plant and that the remaining 10% would be discharged to the environment through the low activity system monitoring tanks. The concentrated bottoms from the IAS evaporator would be directed to the radioactive solid waste system for solidification and disposal by burial offsite.

TABLE 3.2 Principal Parameters Used in Estimating CRBRP Radioactive Releases

Parameter	Extent
Thermal Power Level	1,121 MWt
Plant Capacity Factor	0.80
Mass of Primary Sodium	1.4. x 10^6 lbs
Percent Fuel with Cladding Defects	0.50%
Component Decay Time Prior to Decon in LAS	10 days
Sodium Decay Prior to Collection in LAS	2 days
Mass of Sodium Processed in IAS	100 lbs/yr
Mass of Sodium Processed in LAS	200 lbs/yr
Fraction of Primary System Area Decontaminated	0.03
Radwaste Dilution Flow	2,700 gpm
Cover Gas Purge Flow Rate	1.75 scfm
Cover Gas Volume	409 ft^3
Cover Gas Leak Rate to Head Access Area	0.012 scc/min
Buffered Seal Leak Rate to Head Access Area	7.0 scc/min
Cover Gas Leak Rate to CAPS	1.0 scc/min
RAPS/CAPS Leak Rate to CAPS	1.0 scc/min
RAPS Charcoal Adsorber Beds Dynamic Adsorption Coefficients	
Krypton	1,800 scc/gm
Xenon	115,000 scc/gm
Argon	82 scc/gm
Flow Rate of Argon Through RAPS Beds	25 scfm
Mass of Charcoal in RAPS Beds	2,500 lbs
Fraction Argon Removed in RAPS Cryostill	0.20
Noble Gas Holdup Time in RAPS Prior to Release	70 days
CAPS Charcoal Adsorber Beds Dynamic Adsorption Coefficients	
Krypton	2,200 scc/gm
Xenon	146,000 scc/gm
Argon	92 scc/gm
Mass of Charcoal in CAPS Beds	1,250 lbs
Flow Rate of Carrier Gas Through CAPS Beds	50 scfm

Liquid Waste Processing Systems

System	Input Flow Rate (GPD)	Decontamination Factors I	Cs, Rb	Others
IAS	400	10^4	10^5	10^5
LAS	850	10^4	10^5	10^5

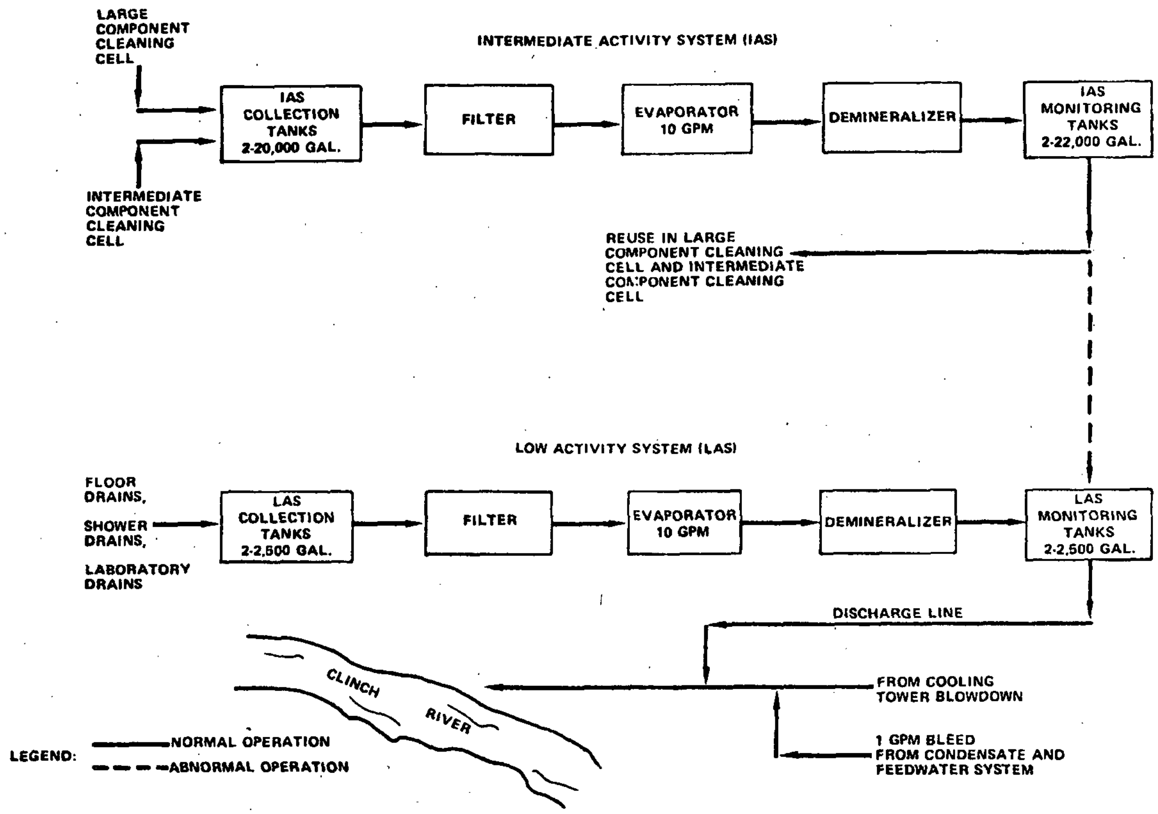


FIGURE 3.15 Liquid Radioactive Waste System

3.5.1.2 Low Activity System

The Low Activity System (LAS) would process the aqueous waste effluents from the floor drains, shower drains, and laboratory drains located in the plant and reactor service buildings. The activity in the floor drains and laboratory drains would be derived from sodium removed from the reactor for chemical analysis and from spills and cleanup during normal plant operations. To allow for decay during material handling, the staff assumed a waste decay time of two days prior to collection for subsequent processing in the LAS. The applicant estimates that an annual average drainage stream of 310,000 gallons would be input to the LAS. Considering the sources constituting the drainage system, the estimate is reasonable and the staff concurs. The low activity system would consist of two collection tanks, two filters, an evaporator, two polishing demineralizers, and two monitoring tanks for liquid analysis after processing. The waste would be collected in one of the 2,500-gal collection tanks at an input flow rate of 850 gpd. The staff calculated the collection time to be 2.4 days. After collection, the waste would be processed batchwise by filtration, evaporation (10 gpm) and demineralization prior to collection in one of the 2,500-gal monitoring tanks. The staff calculated the decay time during processing to be 0.17 day. The decontamination factors listed in Table 3.2 were applied for radionuclide removal in the LAS. The liquid in the monitor tank would be sampled, analyzed, and then as indicated by the analysis, discharged to the environment via the cooling tower blowdown stream or recycled for further processing. The staff, as well as the applicant, assumed that all of the waste from the LAS monitoring tank would be discharged to the environment. The concentrated bottoms from the LAS evaporator would be directed to the radioactive solid waste system for solidification and disposal by offsite burial at approved locations.

3.5.1.3 Balance of Plant Releases

Tritium would enter the steam-water system by diffusion from the primary to intermediate heat transport system and from the intermediate to steam-water system. Other radionuclides would not enter the steam-water system because of the pressure differentials between the primary and intermediate systems and between the intermediate and steam-water systems. To control the buildup of tritium in the steam-water system, the applicant would provide a 1-gpm bleed from the condensate and feedwater system which would be discharged to the environment via the cooling tower blowdown. The applicant estimated a tritium release of approximately 330 Ci/yr. Considering the rate of diffusion of tritium into the steam-water system, the estimate appears reasonable and the staff agrees with it.

3.5.1.4 Liquid Waste Summary

Based on the staff's evaluation of the radioactive liquid waste treatment systems, using the parameters listed in Table 3.2, the staff calculated the release of radioactive materials in the liquid waste effluent to be approximately 0.016 Ci/yr, excluding tritium and dissolved gases. In comparison, the applicant estimated a radioactive liquid release of 6.1 x 10^{-5} Ci/yr, excluding tritium and dissolved gases. The results differ from those of the applicant because of the staff's use of different values for assumed defective fuel, plant capacity factor, the volume of waste released from the IAS, the quantity of radioactive sodium waste input to the LAS, the decay time prior to collection in the LAS, and the evaporator decontamination factor for iodine. The staff's model also included a normalization factor of 10 to account for anticipated operational occurrences and equipment downtime. The staff believes that a normalization factor of 10 is justifiable due to the lack of operating data and experience with liquid metal fast breeder reactors.

The radionuclides expected to be released annually from each source, as well as from the plant, are given in Table 3.3.

TABLE 3.3 Estimated Annual CRBRP Releases of Radioactive Materials in Liquid Effluents

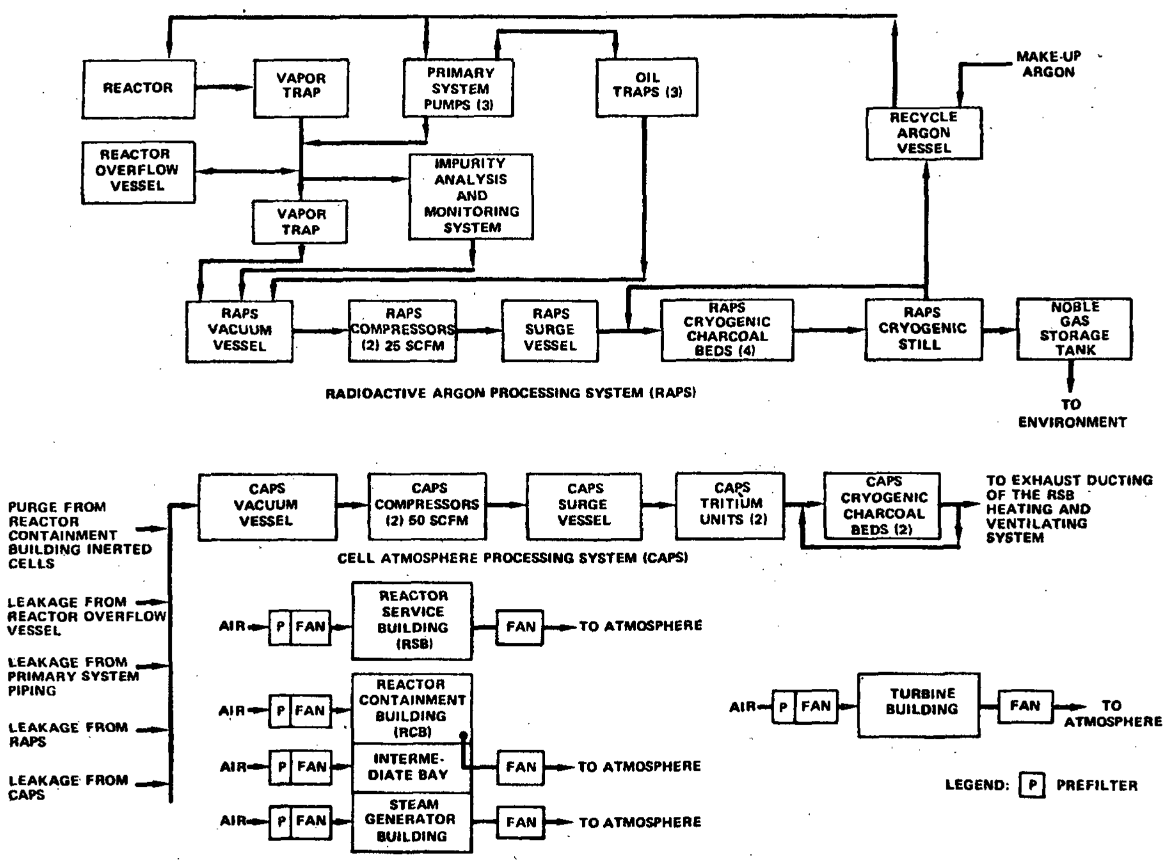
	Release (Ci/yr)(a)			
Radionuclide	Intermediate Activity System	Low Activity System	Balance of Plant	Total
^{134}Cs	(a)	(a)		(a)
^{136}Cs	1.1 x 10^{-6}	7.6 x 10^{-5}		7.7 x 10^{-5}
^{137}Cs	1.3 x 10^{-5}	2.6 x 10^{-4}		2.7 x 10^{-4}
^{131}I	1.6 x 10^{-5}	2.1 x 10^{-3}		2.1 x 10^{-3}
^{125}Sb	1.2 x 10^{-7}	2.5 x 10^{-6}		2.6 x 10^{-6}
^{129m}Te	4.3 x 10^{-4}	3.5 x 10^{-6}		4.4 x 10^{-4}
^{129}Te	4.4 x 10^{-4}	3.5 x 10^{-6}		4.4 x 10^{-4}
^{132}Te	4.9 x 10^{-5}	9.3 x 10^{-6}		5.8 x 10^{-5}
^{132}I	4.9 x 10^{-5}	9.3 x 10^{-6}		5.8 x 10^{-5}
^{89}Sr	8.1 x 10^{-5}	5.5 x 10^{-7}		8.2 x 10^{-5}
^{90}Sr	4.5 x 10^{-5}	2.1 x 10^{-7}		4.6 x 10^{-5}
^{90}Y	4.5 x 10^{-5}	2.1 x 10^{-7}		4.6 x 10^{-5}
^{91}Y	2.4 x 10^{-5}	1.6 x 10^{-7}		2.5 x 10^{-5}
^{95}Zr	4.7 x 10^{-5}	2.9 x 10^{-7}		4.7 x 10^{-5}
^{95}Nb	4.7 x 10^{-5}	2.9 x 10^{-7}		4.7 x 10^{-5}
^{99}Mo	5.9 x 10^{-7}	1.7 x 10^{-7}		7.6 x 10^{-7}
^{103}Ru	5.5 x 10^{-5}	4.1 x 10^{-7}		5.5 x 10^{-5}
^{106}Ru	6.0 x 10^{-5}	3.0 x 10^{-7}		6.0 x 10^{-5}
^{106}Rh	6.0 x 10^{-5}	3.0 x 10^{-7}		6.0 x 10^{-5}
^{111}Ag	5.2 x 10^{-7}	(a)		5.4 x 10^{-7}
^{140}Ba	1.7 x 10^{-5}	2.9 x 10^{-7}		1.7 x 10^{-5}
^{140}La	1.7 x 10^{-5}	2.9 x 10^{-7}		1.7 x 10^{-5}
^{141}Ce	4.6 x 10^{-5}	3.8 x 10^{-7}		4.6 x 10^{-5}
^{144}Ce	4.7 x 10^{-5}	2.4 x 10^{-7}		4.7 x 10^{-5}
^{144}Pr	4.7 x 10^{-5}	2.4 x 10^{-7}		4.7 x 10^{-5}
^{143}Pr	1.5 x 10^{-5}	2.4 x 10^{-7}		1.6 x 10^{-5}
^{147}Nd	5.4 x 10^{-6}	1.1 x 10^{-7}		5.5 x 10^{-6}
^{147}Pm	2.7 x 10^{-5}	1.3 x 10^{-7}		2.7 x 10^{-5}
^{155}Eu	3.5 x 10^{-6}	(a)		3.5 x 10^{-6}
^{58}Co	1.6 x 10^{-4}	1.0 x 10^{-7}		1.6 x 10^{-4}
^{60}Co	2.7 x 10^{-4}	1.3 x 10^{-7}		2.7 x 10^{-4}
^{54}Mn	3.1 x 10^{-4}	1.6 x 10^{-7}		3.1 x 10^{-4}
^{51}Cr	2.9 x 10^{-5}	(a)		2.9 x 10^{-5}
^{59}Fe	1.2 x 10^{-6}	(a)		1.2 x 10^{-6}
^{182}Ta	3.5 x 10^{-5}	(a)		3.5 x 10^{-5}
^{238}Pu	3.9 x 10^{-7}	3.4 x 10^{-7}		7.3 x 10^{-7}
^{239}Pu	1.1 x 10^{-7}	(a)		2.0 x 10^{-7}
^{240}Pu	1.4 x 10^{-7}	1.2 x 10^{-7}		2.6 x 10^{-7}
^{241}Pu	1.7 x 10^{-5}	1.5 x 10^{-5}		3.2 x 10^{-5}
^{22}Na	7.5 x 10^{-7}	1.5 x 10^{-5}		1.6 x 10^{-5}
^{24}Na	(a)	1.1 x 10^{-2}		1.1 x 10^{-2}
TOTAL	2.5 x 10^{-3}	1.3 x 10^{-2}		1.6 x 10^{-2}
H-3			330	330

(a) Radionuclides released in amounts less than 1.0 x 10^{-7} are considered negligible and are not listed.

Based on the staff's evaluation of the radioactive liquid waste releases, the proposed system would be capable of limiting the release of radioactive materials in liquid effluents to less than 5 Ci/yr, excluding tritium and dissolved gases, and the whole-body and critical organ doses would be less than 5 millirems per year at or beyond the site boundary (see Table 5.12). The staff concludes that the liquid waste treatment system would reduce radioactive liquid effluents to as low as is reasonably achievable in accordance with 10 CFR Part 50, and the staff, therefore, concludes that the system is acceptable.

3.5.2 Gaseous Waste

The radioactive gaseous waste and plant ventilation systems would collect, store, process, monitor, recycle or discharge potentially radioactive gaseous waste generated during normal operation of the station. The gaseous waste would consist of noble gas radionuclides and tritium produced by fission and neutron activation. Xenon and krypton would result from fission in the fuel and would migrate into the primary sodium coolant by way of assumed fuel element defects. Argon and neon would result from neutron activation of the sodium coolant and potassium impurity in the sodium. Tritium would be produced from ternary fission as well as from neutron activation of coolant impurities. The staff's evaluation model of the applicant's proposed systems assumed that radioactive gaseous waste would be released from the radioactive argon processing system, cell atmosphere processing system, reactor service building ventilation system, reactor containment building ventilation system, intermediate bay ventilation system, and turbine building ventilation system. The gaseous waste and plant ventilation systems are shown in Figure 3.16.



<u>FIGURE 3.16</u> Gaseous Radioactive Waste Systems and CRBRP Ventilation

3.5.2.1 Radioactive Argon Processing System

The Radioactive Argon Processing System (RAPS) would continuously process and recycle the primary sodium system cover gas (argon) and provide a source of low radioactivity gas for use in reactor seals. The argon cover gas would be contaminated with noble gases and small quantities of tritium which would be produced from fission and neutron activation and migrate to the cover gas space. Most of the tritium generated would form a hydride in the primary sodium. The RAPS would consist of a vacuum vessel, two compressors, a surge vessel, four cryogenic charcoal beds, a cryogenic still, a noble gas storage tank, and a recycle argon vessel.

The RAPS would continuously draw radioactive cover gases from the spaces in the reactor, reactor overflow vessel, and primary system pumps. The gases would be collected in the vacuum vessel and transferred by a compressor to the surge vessel where they would be stored under pressure. The gases would be treated in a series of four cryogenically cooled charcoal decay beds, each containing 625 lbs of charcoal. The flow rate through the beds would be 25 scfm, made up of 21.75 scfm of recirculated throughput and 3.25 scfm of input from the surge vessel. The charcoal beds would be operated at 30 psig and an average temperature of -130°F.

Using the dynamic adsorption coefficients listed in Table 3.2, a total mass of 2,500 lbs of charcoal in the beds, and a bed flow rate of 25 scfm, the staff calculated that the decay times provided would be about 2 days for krypton, 127 days for xenon, and 0.09 days for argon. The effluent gases from the cryogenic charcoal beds would enter a cryogenic still containing liquid argon in the still bottom. The liquid argon would absorb the radioactive krypton and xenon isotopes and permit their separation from the bottoms by periodically draining, evaporating, and transferring to the noble gas storage vessel. The purified argon would be directed to the charcoal beds as recirculation throughput (21.75 scfm) and to the recycle argon vessel (3.25 scfm) for reuse in the primary system as cover gas. Although the applicant proposes to bottle gases from the noble gas storage vessel for temporary onsite storage and eventual offsite shipment to a licensed burial facility, the staff model assumes that the contents of the storage vessel would be released to the environment.

3.5.2.2 Cell Atmosphere Processing System

The Cell Atmosphere Processing System (CAPS) would collect and process the gaseous radioactivity that may leak or diffuse into the cells (containing nitrogen atmosphere) which house the reactor, Primary Heat Transfer System (PHTS), PHTS pumps and reactor overflow vessel. The CAPS also would collect and process any leakage of gases in the nitrogen or air atmosphere cells housing the RAPS and CAPS components. The major input to the CAPS would consist of nitrogen containing trace quantities of contaminated argon cover gas and tritium diffused through PHTS piping and components.

The CAPS would consist of a vacuum vessel, two compressors, a surge vessel, two tritium oxidizer units, and two cryogenic charcoal beds. The nitrogen/air gas bleeds and purges from the cells would be collected in the CAPS vacuum vessel and transferred by a compressor to the surge vessel where they would be stored under pressure. The gases would be passed through one of the tritium oxidizer units where the tritium would be converted to tritiated steam. The steam would be condensed and sent to the radioactive solid waste system for solidification for ultimate offsite disposal. The dried tritium-free gases would be treated in a series of two cryogenically cooled charcoal delay beds, each containing 625 lbs of charcoal. Although the flow input to the CAPS would be variable, the flow rate through the beds would be maintained at a constant 50 scfm by a variable-flow recirculation loop automatically controlled. The staff assumed that the charcoal beds would be operated at 35 psig and an average temperature of -140°F. On the basis of the dynamic adsorption coefficients listed in Table 3.2, a total mass of 1,250 lbs of charcoal in the beds, and a bed flow rate of 50 scfm, the staff calculated that the decay times provided would be approximately 0.61 day for krypton, 40 days for xenon, and 0.025 day for argon. The effluent gases from the cryogenic charcoal beds would be discharged to the environment through the exhaust ducting of the reactor service building heating and ventilating system at a flow rate of 3,000 cfm.

3.5.2.3 Reactor Containment Building Ventilation System

Radioactive gases would be released into the head access area of the Reactor Containment Building (RCB) by leakage from two sources. The major source of radioactive contamination to the head access area atmosphere would stem from reactor cover gas leakage through the reactor head seals. Additional leakage of recycled argon gas (from RAPS) through the buffered reactor head seals and subsequent diffusion into the head access area would add trace quantities of radionuclides into the RCB atmosphere. The atmosphere in the head access area would be ventilated by an air stream of 12,000 cfm exhausted to the environment through the RCB ventilation system without treatment. Prior to release, the air flow from the head access area would be mixed with ventilation exhaust from other areas of the RCB and the Intermediate Bay (IB). The total flow rates from the release point, located on the IB, would be 100,000 cfm.

3.5.2.4 Intermediate Bay Ventilation System

Tritium that diffuses from the Primary Heat Transfer System (PHTS) into the Intermediate Heat Transfer System (IHTS) also would diffuse at a small but finite rate through the IHTS piping and components into the IB cell atmospheres. The cell atmospheres would be vented to the environment through the IB ventilation system having a total flow rate of 50,000 cfm. As described in the previous section, the IB ventilation flow would be mixed with ventilation air from the RCB and Steam Generator Building (SGB) prior to release through a common point.

3.5.2.5 Turbine Building Ventilation System

A small quantity of tritium produced in the PHTS would diffuse into the IHTS and pass into the steam-water system by diffusion through the steam generators. Tritium would be in the steam-water system in the form of tritiated water. A small quantity of tritiated water vapor would be removed by the mechanical vacuum pumps of the condenser offgas system along with noncondensable gases. The gases would be discharged into the exhaust plenum of the turbine building ventilation system having a total flow rate of 120,000 cfm.

3.5.2.6 Gaseous Waste Summary

Based on the staff's evaluation of the radioactive gaseous waste treatment and ventilation systems, using the parameters listed in Table 3.2, the staff calculated the release of radioactive materials in gaseous effluents would be about 389 Ci/yr for noble gases and 3.1 Ci/yr for tritium. In comparison, the applicant estimated a total release of 6.4 Ci/yr for noble gases and 3.1 Ci/yr for tritium. The difference between the staff's and applicant's noble gas release estimate is due to the staff's assumed release of the RAPS noble gas storage tank inventory to the environment. The staff also used a different parameter for defective fuel.

The radionuclides expected to be released annually from each source, as well as from the plant, are given in Table 3.4. No releases of iodine and plutonium in gaseous effluents are expected from normal plant operation. From its evaluation of the applicant's proposed gaseous radioactive waste treatment systems, the staff calculates that the annual air dose due to gamma radiation (total body) at or beyond the site boundary would not exceed 10 millirads, the annual air dose due to beta radiation (skin) at or beyond the site boundary would not exceed 20 millirads, the annual thyroid dose to an individual would not exceed 15 millirems (Table 5.12), and the total quantity of ^{131}I released annually would not exceed 1 Ci. These are the design objective levels of proposed Appendix I.

TABLE 3.4 Estimated Annual CRBRP Releases of Radioactive Materials in Gaseous Effluents

Radionuclide	Release (Ci/yr)[a] RAPS	CAPS	RCB	IB	TB	TOTAL
^{131m}Xe						
^{133m}Xe						
^{133}Xe		2	3			5
^{135m}Xe						
^{135}Xe			11			11
^{138}Xe						
^{83m}Kr						
^{85m}Kr		11				11
^{85}Kr	340					340
^{87}Kr						
^{88}Kr		5	1			6
^{23}Ne			2			2
^{39}Ar	13		1			14
^{41}Ar						
TOTAL	353	18	18			389
H-3				0.6	2.5	3.1

(a) Radionuclides released in amounts less than 1.0 Ci/yr for noble gases are considered negligible and are not listed.

The staff's calculations indicate that the radioactive gaseous waste treatment systems would reduce radioactive effluents to as low as is reasonably achievable in accordance with 10 CFR Part 50, and the staff, therefore, concludes that the system is acceptable.

3.5.3 Solid waste

The solid radwaste system would be designed to handle, collect, and process five types of waste: 1) concentrated liquids, 2) noncompactible solids, 3) metallic sodium, 4) sodium contaminated components, and 5) compactible solids.

Concentrated liquids would consist of evaporator bottoms from the liquid radwaste system and tritium from the CAPS tritium oxidizer units. This waste would be solidified in drums prior to offsite shipment for burial at a licensed facility. The staff estimated that approximately 1,000 ft^3 of processed concentrated liquids containing 300 Ci of activity would be shipped offsite annually. The applicant estimated that approximately 1,000 ft^3 of solidified liquid radwaste containing 56 Ci of activity would be shipped offsite annually.

Noncompactible solids would include tools, contaminated filters, spent resins, metal component parts, valves, and vapor traps. This waste would be placed in drums, capped, decontaminated, and placed in temporary storage prior to offsite shipment. The sources of spent resins would be the four 10 ft^3 polishing demineralizers in the liquid radwaste system. The staff estimated that approximately 1,500 ft^3 of noncompactible solid waste containing 500 Ci of activity would be shipped offsite annually. The applicant estimated that approximately 1,500 ft^3 of noncompactible solid waste containing 100 Ci of activity would be shipped annually.

Metallic sodium would be generated from fuel handling operations. If the sodium should be processed onsite, it would be converted to aqueous sodium nitrate solution and evaporated. The evaporator bottoms would be solidified for offsite shipment and burial. If not processed onsite, the sodium would be shipped offsite in a suitable container for processing by a licensed contractor. The staff estimated that approximately 42 ft^3 of processed sodium containing 50 Ci of activity would be shipped offsite annually. The applicant estimated that approximately 42 ft^3 of sodium waste containing 10 Ci of activity would be shipped offsite annually.

The sodium contaminated components would include the primary, intermediate, and ex-vessel storage tank cold traps. Handling of the cold traps would include placing the trap into a removal cask for subsequent offsite shipment in a special container. The final disposition of the cold traps has not yet been determined; however, the CRBRP would utilize the research and development efforts of the Fast Flux Test Facility concerning the packaging, transport and disposition of sodium contaminated waste. The staff estimated that approximately 240 ft^3 of sodium bearing waste containing 2.3×10^4 Ci of activity would be shipped offsite annually. The applicant estimated that approximately 240 ft^3 of sodium bearing waste containing 1.9×10^4 Ci of activity would be shipped offsite annually.

Compactible solids would consist of rags, paper, and rubber seals. This waste would be placed in drums and compacted by a hydraulic machine prior to offsite shipment. The staff estimated that approximately 1,000 ft^3 of compacted waste containing 5 Ci of activity would be shipped offsite annually. The applicant estimated that approximately 290 ft^3 of compacted waste containing less than 1 Ci of activity would be shipped offsite annually.

For all five types of solid waste, the staff's estimates of activity shipped offsite annually differ from those of the applicants because of the staff's higher assumed value for defective fuel (Table 3.2).

3.5.3.1 Solid Waste Summary

On the basis of its evaluation of the solid waste system, the staff concludes that the designed system would accommodate the waste expected during normal operations, including anticipated operational occurrences. The waste would be packaged and shipped to a licensed burial site in accordance with NRC and Department of Transportation regulations. From those findings the staff concludes that the solid waste system is acceptable.

3.6 CHEMICAL EFFLUENTS

Normal operation would require the use of certain chemicals, some of which would ultimately be discharged to the Clinch River via the cooling tower blowdown line. The chemicals serve various functions including: 1) production of high purity water, 2) corrosion control, 3) decontamination and cleaning, 4) laboratory uses, and 5) biological growth control in the cooling water circuits.

TABLE 3.5 Chemicals or Chemical Species Expected to be in CRBRP Discharge

	Concentration of Chemicals in CRBRP Waste Streams: Cooling Tower Blowdown[a]		Neutralized Plant Wastes[b]		Sanitary Wastes	Discharge to River			Ambient Conditions[e] in Clinch River		Maximum Chemical Concentration In River Under No Flow Conditions			
	Based on Average River Concentration (mg/l)	Based on Maximum River Concentration (mg/l)	Based on Average Discharge-3.7 gpm (mg/l)	Based on Maximum Discharge-3.5 gpm (mg/l)	Based on the Design Loading (mg/l)	Mass Discharge (lb/yr)	Concentration[d] Average (mg/l)	Concentration[d] Maximum (mg/l)	Average Concentration (mg/l)	Maximum Concentration (mg/l)	Concentration 25 ft from Discharge (mg/l)	Percent Increase	Concentration 100 ft from Discharge (mg/l)	Percent Increase
Total Alkalinity (as $CaCO_3$)	240	290	<50	<50	--	--	240	290	96	114	120	5.1	117	2.5
Ammonia Nitrogen (as N)	0.70	2.5	--	--	0.5	4,700	0.7	2.50	0.28	1.00	1.05	5.0	1.03	2.5
BOD	5.3	15	--	--	12	35,000	5.3	15.0	2.1	6.0	6.3	5.0	6.2	2.5
Calcium	85	108	224	96	--	570,000	85.4	110	34	43	45	5.1	44	2.5
Chloride	11.8	32.5	43	21	--	78,000	11.9	32.8	4.7	13.0	13.7	5.0	13.3	2.5
Chlorine Residual	0.2	0.5	--	--	1.0	1,300	0.20	0.50	<0.05[f]	<0.05	<0.05	--	<0.05	--
COD	16.8	40.0	--	--	25	118,000	16.8	40.0	6.7	16.00	16.8	5.0	16.4	2.5
Total Dissolved Solids (TDS)	355	435	11,100	11,900	--	2,490,000	373	612	142	174	186	7.0	180	3.5
Total Iron	0.95	1.72	--	--	--	6,300	0.95	1.72	0.38	0.68	0.714	5.0	0.697	2.5
Magnesium	19.5	21.3	75	32	--	130,000	19.6	21.8	7.8	8.5	8.9	5.1	8:7	2.5
Manganese	0.13	0.18	1.0	0.4	--	860	0.13	0.18	0.05	0.07	0.074	5.1	0.072	2.5
Copper	0.20	0.93	--	--	--	1,300	0.20	0.93	<.005	<0.01	<.029	>186	<0.019	>93
Zinc	0.05	0.08	--	--	--	330	0.05	0.08	0.02	0.03	0.032	5.3	0.031	2.6
Nickel	0.02	0.11	--	--	--	130	0.02	0.11	<.01	<0.01	<0.012	>220	<0.011	>110
Lead	<0.03	<0.03	--	--	--	<200	<0.03	<0.03	<0.03	<0.03	<0.03	--	<0.03	--
Nitrate (NO_3)	3.3	5.5	3.2	1.0	66	23,000	3.40	5.60	1.3	2.2	2.31	5.1	2.26	2.5
pH	7.9	7.9	6-8	6-8	6-9	--	6.5-8.5	6.5-8.5	7.9	8.3	--	--	--	--
Total Phosphate	0.13	1.00	1.0	0.4	5.0	870	0.14	1.01	0.05	0.4	0.42	5.1	0.41	2.5
Potassium	3.5	4.8	15	7	--	23,000	3.50	4.80	1.4	1.9	2.0	5.1	1.95	2.5
Silica (SiO_2)	9.8	15.3	27	12	--	65,000	9.80	15.3	3.9	6.1	6.4	5.0	6.3	2.5
Sodium	5.3	6.3	3,200[h]	3,700[i]	--	71,000	10.6	64.6	2.1	2.5	3.8	52	3.1	26
Sulfate	38	58	7,500	8,000[i]	--	335,000	50.5	184	15	23	26.7	16	24.8	8.0
Total Suspended Solids (TSS)	33	115	<30	<30	5.0	219,000	33	115	13	46	48.3	5.3	47.2	2.6

(a) Includes several minor recycled waste streams (make-up water system equipment rinses, backwashes and blowdown, nonradioactive floor drains). Also includes metallic products resulting from corrosion/erosion of condenser tubing and other piping.
(b) Includes make-up water demineralizer and steam condensate polisher regeneration wastes, auxiliary boiler blowdown, and non-radioactive lab and sampling wastes.
(c) Computed as follows: Quantity from cooling tower blowdown = (Concentration)(Annual Average Blowdown = 2210 gpm)(Plant Load Factor = 68.5%) + Quantity from neutralized plant waste = (Concentration)(Flow = 35 gpm)(24 hr/day operation)(26 operating days/yr) + Quantity from sanitary waste = (Concentration)Flow = 5 gpm) (24 hr/day operation)(365 operation days/yr).
(d) Computed as $\frac{\Sigma(conc)flow)}{\Sigma(flow)}$, where average concentration is based on average river concentration (cooling tower blowdown) and average discharge flow (neutralized plant waste) and maximum concentration is based on maximum river concentration and maximum discharge flow.
(e) Based on 6 monthly samplings (March-September, 1974).
(f) Field test using the orthotolidine colorimetric.
(g) Based on maximum chemical concentrations in the CRBRP discharge and maximum ambient concentrations in the Clinch River.
(h) Concentration of sodium ion equivalent to sulfate ion after correction for other ions in solution.
(i) Concentrations based on maximum regenerant consumption (ER, Sec 3.6.3).
(j) Based on maximum chemical concentrations in the CRBRP discharge and maximum ambient concentrations in/the Clinch River. Dilution is computed from the staff's revised plume analysis with a second cooling tower and smaller cooling water needs.

Chemicals or chemical species expected to be present in the plant's discharge are tabulated in Table 3.5 (ER, Am I, Part II, El). The ambient levels of the same chemical species in the river prior to discharge are also provided in the table.

A comparison of the quality of plant cooling tower blowdown with Federal effluent limitations and state water quality criteria is given in Table 3.6. The plant cooling water discharge would comply with applicable Federal and State regulations. The potential effects of this discharge on the aquatic ecosystem are discussed in Section 5.4.1. A discussion of the significant chemical waste effluents is given below.

3.6.1 Circulating Water System Output

Consumptive use of water at the plant would be essentially the result of evaporation in the cooling towers. As shown in Figure 3.6, an average of 3475 gpm would be evaporated in the tower out of a makeup stream of 5835 gpm.

Concentration of dissolved salts by evaporation would constitute one of the major effects on the quality of the water passing through the plant. Dissolved solids in the water would be concentrated about 2.5 times ambient levels in the river as shown in Table 3.5. The dissolved solids in the cooling system blowdown would be diluted rapidly to near ambient levels in the river even under the conservative condition of no flow in the river.

Sulfuric acid addition would be provided on the cooling water system in the event that an unexpected increase in pH occurs beyond pH 8.5. The feed rate for the sulfuric acid cannot be determined at this time since available water quality data do not indicate that the pH will exceed 8.5. Should the pH of the blowdown extend beyond the acceptable 6.5 to 8.5 range, the blowdown valve would close automatically until the condition is corrected (ER, Sec 3.6.2).

Since wood would not be used in the cooling towers, no chemical preservatives would be added to the circulating water. In addition, the use of chemical corrosion inhibitors would not be required (ER, Sec 3.6.2).

3.6.2 Chemical Biocides

The circulating water would be chlorinated periodically to control the growth of biological slimes flourishing at times on the warm heat exchanger surfaces, restricting the flow of cooling water through the equipment and reducing the effectiveness of the heat transfer surfaces. Control of algal growths may also be needed in the cooling towers to prevent short-circuiting of water through the cooling towers. About 450 lb of hypochlorite would be injected periodically into the circulating water line upstream of the main condenser for biocide treatment of the condenser, the cooling towers, and plant auxiliary cooling equipment. Injection of hypochlorite equivalent to 2 to 5 mg/ℓ of chlorine is planned for a 20- to 30-min period 3 or 4 times daily (ER, Sec 3.6.2).

Provisions are also being made to inject hypochlorite into the intake at the river water pumphouse to control the growth of Asiatic clams in the cooling water system. The necessity for chlorination at that point and the amount of chlorine and time required have not been established.

Chlorination of the circulating water system, regardless of the point of injection, would be accomplished in compliance with Federal effluent limitations and State Water Quality criteria (ER, Sec 3.6.1). If the chlorine concentration, as measured by a recording analyzer, should exceed a preset value, alarms would sound and the blowdown would automatically be terminated. No discharge of blowdown would occur until reestablishment of acceptable levels of chlorine residuals. Total residual chlorine in the blowdown would be limited to a maximum of 0.5 mg/ℓ and an average of 0.2 mg/ℓ not to exceed 2 hours in any one day.

3.6.3 Water Treatment Waste

Approximately 96,000 gal of raw river water would be treated each day to meet the plant's domestic and process water needs. The raw river water would be treated by coagulation/sedimentation and filtration to remove particulate matter. Waste sludges (300 to 3,600 gpd) would be dewatered on gravity sludge drying beds and the dried sludge (50 to 600 lb/day) would be trucked offsite by a licensed contractor (ER, Sec 10.4.1.1.1).

An average of approximately 1440 gpd of the clarified water from the process water treatment systems would be treated further by ion exchange to produce demineralized water for the steam cycle. The ion exchange demineralization process would require a maximum of about 3,400 lb/day

TABLE 3.6 Comparison of Chemical Concentrations in Station Effluents with Federal Effluent Limitations and State Water Quality Criteria

Regulation	EPA Effluent Limitation[a] Maximum 1-day Concentration	EPA Effluent Limitation[a] Maximum 30 Consecutive-day Daily Avg	Tennessee General Water Quality Critieria[b]	Expected in CRBRP Discharge
All Discharges Part 423.15(a) & (b)				
pH	6.0-9.0 (range)[f]		pH in the range of 6.5 to 8.5, and shall not fluctuate more than 1.0 unit in a 24 hour period.	6.5-8.5 pH ranges. pH controlled to meet criterion.
Polychlorinated biphenyl Compounds	None		No toxic substances added that affect man or animals.	None
Low-volume waste sources Part 423.15(c)			None specified.	
Total suspended solids	100 mg/ℓ	30 mg/ℓ	Footnote[g]	Meets state limitations
Oil and grease	20 mg/ℓ	15 mg/ℓ		<15 mg/ℓ
Metal-cleaning waste discharges Part 423.15(f)			None specified.	None discharged.
Total suspended solids	100 mg/ℓ	30 mg/ℓ		
Oil and grease	20 mg/ℓ	15 mg/ℓ		
Total copper	1.0 mg/ℓ	1.0 mg/ℓ		
Total iron	1.0 mg/ℓ	1.0 mg/ℓ		
Boiler blowdown discharges Part 423.15(g)			None specified.	
Total suspended solids	100 mg/ℓ	30 mg/ℓ		<30 mg/ℓ
Oil and grease	20 mg/ℓ	15 mg/ℓ		<15 mg/ℓ
Total copper	1.0 mg/ℓ	1.0 mg/ℓ		<1 mg/ℓ
Total iron	1.0 mg/ℓ	1.0 mg/ℓ		<1 mg/ℓ
Cooling tower blowdown discharges				
Free available chlorine[e] Part 423.15(i)	<0.5 mg/ℓ (max)	<0.2 mg/ℓ (avg)	No toxic substances added that affect man or animals	<0.5 mg/ℓ (max) Total <0.2 mg/ℓ (avg) Total
Total residual chlorine Part 423.15(j)	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 in any plant may discharge free available or residual chlorine at any one time.		No toxic substances added that affect man or animals	Less than detection limits (<0.005 mg/ℓ) outside of 2 hour time limit
Corrosion inhibitors Part 423.15(i)	No detectable amount added.		No toxic substances added that affect man or animals.	None discharged
Dissolved Oxygen (D.O.)	None specified.		Minimum dissolved oxygen content of 5.0 mg/ℓ or 3.0 mg/ℓ in vicinity of discharge measured at a depth of 5 feet.	6.8 mg/ℓ
Turbidity or color	None specified.		There shall be no turbidity or color added in amounts or characteristics that cannot be reduced to acceptable concentrations by conventional water treatment processes.	No detectable turbidity or color added[d]
Suspended solids Oil and Grease	None specified		There shall be no visible solids, scum, foam, oil slick, etc.	No visible solids[d] <5 mg/ℓ oil and grease
Total dissolved solids	None specified		The total dissolved solids shall at no time exceed 500 mg/ℓ	<500 mg/ℓ in receiving water[d]

(a) 40 CFR 423, Steam Electric Power Generating Source Category, Federal Register, Vol 39, No. 196. 8 October 1974.
(b) Refers to the receiving water after a reasonable zone of mixings (ER, 14.1, Apendix to Section 2.5).
(c) Maximum and average free residual chlorine concentrations are at any given time. One-day and thirty-day averages do not apply to these limitations.
(d) After dilution in mixing zone of river.
(e) Refer to Appendix H NPDES permit pages 2 and 3.
(f) Surge and neutralization tank limited to pH 7.0 - 9.0.
(g) The State of Tennessee has placed more stringent limitations on effluents from the surge and neutralization tank and the neutralization and settling facility (see NPDES Permit, Appendix H, pages 6 and 7).

of sulfuric acid and 2,200 lb/day of sodium hydroxide to regenerate the ion exchange beds (ER, Sec 3.6.3). The regenerant wastewater would be neutralized and filtered in the chemical waste treatment system prior to discharge in the cooling system blowdown. The chemical waste treatment system effluent would contain predominantly sodium sulfate as a dissolved salt, with smaller ionic concentrations of Ca^{++}, Mg^{++}, and Cl^-. The average and maximum concentrations of selected constituents of the wastewater are given in Table 3.5. Total suspended solids would be reduced to less than 20 mg/ℓ and oil and grease would be below 20 mg/ℓ.

Figure 3.17 shows the flow of the water treatment waste and all other waste streams discussed in the following paragraphs (ER, Fig 10.4-1).

3.6.4 Steam Generator System Waste Discharges

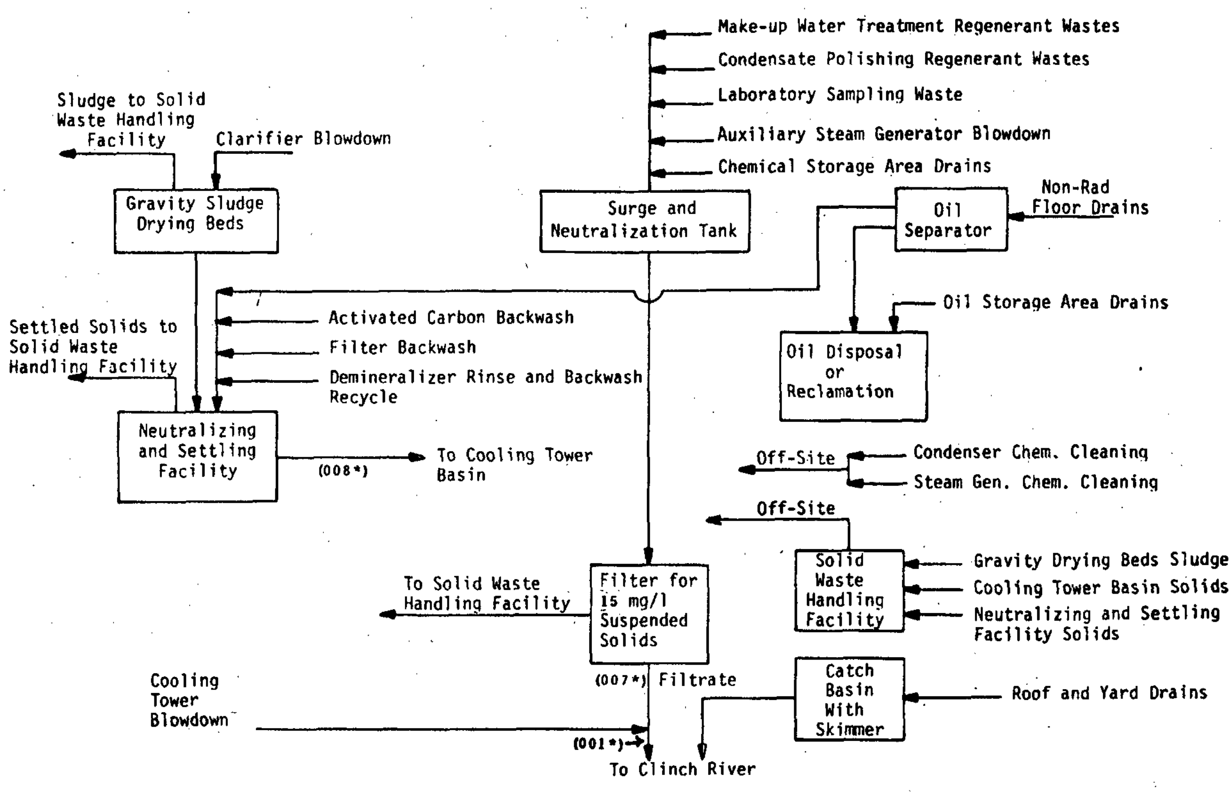
Blowdown from the steam power conversion system would consist of high purity water subjected to ion exchange and filtration in the condensate treatment system. Anticipated concentrations of total suspended solids, oil and grease, copper and iron would be below the EPA effluent limitations (ER, Sec 3.6.1), which are 30 mg/ℓ, 15 mg/ℓ, 1 mg/ℓ, and 1 mg/ℓ, respectively.

The condensate polishing system would generate from approximately 3,000 to 40,000 gpd of high solids waste water consisting of rinses, backwashes and spent regenerants. The wastewater would be similar to the demineralizer waste and also would be treated in the chemical waste treatment system (ER, Sec 10.4.1.1.1).

During startup, an auxiliary steam generator would be used, generating about 1 gpm of blowdown. The blowdown would be alkaline (pH 9.0-9.5) and contain about 200 mg/ℓ dissolved solids and 0.5 mg/ℓ ammonia. Hydrazine would be present in the blowdown but it would decompose rapidly to produce ammonia. Dilution of steam generator blowdown in the circulating water would reduce the added dissolved constituents to less than detectable levels (ER, Sec 10.4.1.1.1).

3.6.5 Chemical Cleaning Waste

Large components of the plant would require periodic chemical cleaning. The cleaning frequently would be done in several stages and the chemicals used would depend on the type of metal being cleaned. A typical procedure would involve alkaline and acid washes and rinses. The waste generated by those cleaning procedures would be disposed of offsite by a licensed contractor (ER, Sec 3.6.3).



*NPDES Permit Outfall Number (See Appendix H).

FIGURE 3.17 Chemical Waste Treatment System

3.6.6 Oily Waste

The recycled wastewater treatment subsystem would provide pretreatment of oil contaminated wastewater. Plant waste streams would be collected and segregated as to source and chemical composition. If oil contamination should be detected, the waste stream would be sent to an oil separator. The major input to the oil separator would come from the nonradioactive floor drains. Subsequent to treatment the aqueous wastes would be routed to the chemical waste treatment system and the collected oils either would be reclaimed or disposed of offsite by a licensed contractor (ER, Sec 10.4.1.1.1).

3.6.7 Polychlorinated Biphenyls

Polychlorinated biphenyls (PCBs) may be used in transformers and other electrical equipment. Any such use would be within plant buildings and the equipment containing the material would be surrounded by dikes. Spillage would be collected in a special sump and either reused or returned to the manufacturer for reprocessing or disposal (see NPDES requirement in Appendix H, Part III, item C).

3.6.8 Chemical and Oil Storage

Oil would be stored in accordance with the December 1973 Environmental Protection Agency Regulations on Oil Pollution Prevention (40 CFR 110, 38 FR 34164) to minimize potential impact on the environment. Storage of chemicals would be accomplished with appropriate diking and catchment basins to prevent loss of the chemicals to the environment (ER, Sec 5.4.4 and 7.2.1).

3.6.9 Storm Drainage

Storm drainage collected by the roofs of buildings and the yard would be routed to a catch basin for discharge to the Clinch River. A portable oil skimmer would be available to treat the storm drainage in the event of a visible oil slick on the surface of the water (ER, Sec 10.4.1.1.2).

3.6.10 Cooling Tower Drift

Drift, consisting of a fine spray from the cooling tower, would be deposited in the immediate vicinity around the tower. The anticipated rate of drift would be about 105 gpm. The chemical composition of the drift would be similar to that of the circulating water as shown in Table 3.5.

3.6.11 Nonradioactive Chemical Coolants

Waste materials such as chemically contaminated Dowtherm, sodium, and sodium-potassium alloy would accumulate in specially designed tanks and be shipped offsite periodically for treatment and/or disposal (ER, Sec 3.6.3).

3.7 SANITARY AND OTHER WASTE

3.7.1 Sanitary Waste

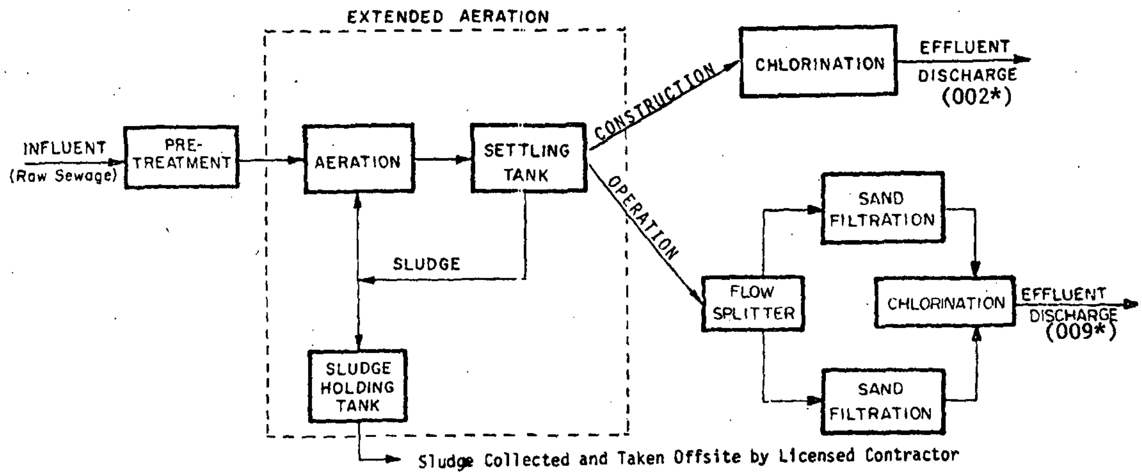
Facilities for treating sanitary waste would be provided during both construction and normal plant operations. The sanitary waste treatment system for the construction period would be sized for handling the needs of 2,450 persons. The maximum daily sanitary waste flow would be 61,250 gal. based on 25 gpd/person (ER, Sec 3.7.1). The expected peak construction crew of nearly 2800 persons includes 350 technical persons who would work in Oak Ridge and visit the site occasionally (Table 4.1).

Prior to issuing the construction permit, sanitary waste generated by personnel participating in site preparation would be treated by an 8,000 gpd capacity extended aeration, activated sludge, sewage treatment unit. A screening basket and influent comminutor would be provided with the unit for pretreatment of the wastewater. The effluent from the unit would be chlorinated prior to discharge to the river. Upon issuance of the construction permit a larger extended aeration unit with a capacity of 53,250 gpd would be installed. The total treatment capacity of the two units would be 61,250 gpd. Figure 3.18 shows the general arrangement of the sanitary waste system (ER, Fig 3.7-1). Portable toilets would also be used in remote areas during the construction period. The 53,250-gpd unit would be removed upon completion of construction.

The 8000 gpd extended aeration unit described above would remain for treating the wastes produced during normal plant operation. During operating periods the maximum projected number of operating personnel is 179 and the maximum number needed during annual shutdowns is 210. In addition, a group of technical persons would be employed at the project office in Oak Ridge. The expected waste generation rate for each man is 35 gpd; therefore, about 7350 gpd of waste would be generated, which is within the capacity of the unit.

Operation of the 8000 gpd unit during normal plant operating periods would involve slow sand filtration, as shown in Figure 3.18 (ER, Fig 3.7-2), to remove additional suspended solids after biological treatment. The extended aeration unit alone is expected to remove 60 to 90% of the suspended solids and 75 to 95% of the biochemical oxygen demand. Filtration of the biological effluent is anticipated to produce a final effluent with the characteristics given in Table 3.7 (ER, Tab 3.7-1). State effluent criteria are also given for comparison to show that the final effluent would be within limits (see NPDES permit limitations presented in Appendix H, page 8).

The filtered extended aeration unit effluent would be chlorinated prior to discharge in the cooling tower blowdown to give a chlorine residual complying with the State limits of 0.5 to 2.0 mg/ℓ. The dosage of chlorine to meet the above limits would be determined during startup.



* NPDES Permit Outfall Number (see Appendix H).

Figure 3.18. Sanitary Waste System, Construction and Plant Operation (ER, Fig 3.7-1 and -2)

TABLE 3.7 Plant Sanitary Waste System Estimated Effluent Characteristics (ER, Tab 3.7-1)

	Sanitary Waste Effluent (mg/l)	State of Tennessee Criteria[a] (mg/l)
Suspended Solids	5	40[b]
BOD	12	30[b]
COD	25	--
Total Phosphate (as PO_4)	5	--
Nitrate Nitrogen (as N)	15	--
Residual Chlorine	1	0.5-2.0
Amonia Nitrogen (as N)	0.5	5.0
pH	6.0-9.0	--

[a] Source: R. A. Unger

[b] EPA requirement is 30 mg/ℓ as a 30-day average and 45 mg/ℓ as a 7-day average (see Appendix H).

3.7.2 Other Waste

The only nonradioactive gaseous effluents discharged into the atmosphere would be those in the exhaust from emergency operation or periodic testing of the 2 diesel generators, which serve the plant in case of power failure, and the diesel-driven fire pump. The generators would use 95 lb/hr of No. 2 fuel oil with these emission rates: SO_2, 0.17 lb/hr; NO_x, 1.7 lb/hr; Co, 0.34 lb/hr; particulates, 0.17 lb/hr; and heat, 1.9 million Btu/hr (ER, p 5.5-4). Testing frequency would be once per month for two hours or until normalization of operating conditions, whichever is sooner.

Trash from the plant and solid, nonradioactive chemical wastes would be disposed of offsite by a licensed contractor.

3.8 POWER TRANSMISSION SYSTEM

Two 161 kV single-circuit transmission lines would be built to loop into the TVA-owned 161 kV Ft. Loudoun K-33 line, which passes 2.8 miles east of the site. The two new lines would parallel each other and existing transmission lines, as shown in Figure 3.19 (ER, Sec 3.9). A total of 3.2 miles of corridor would be widened to accommodate the new lines.

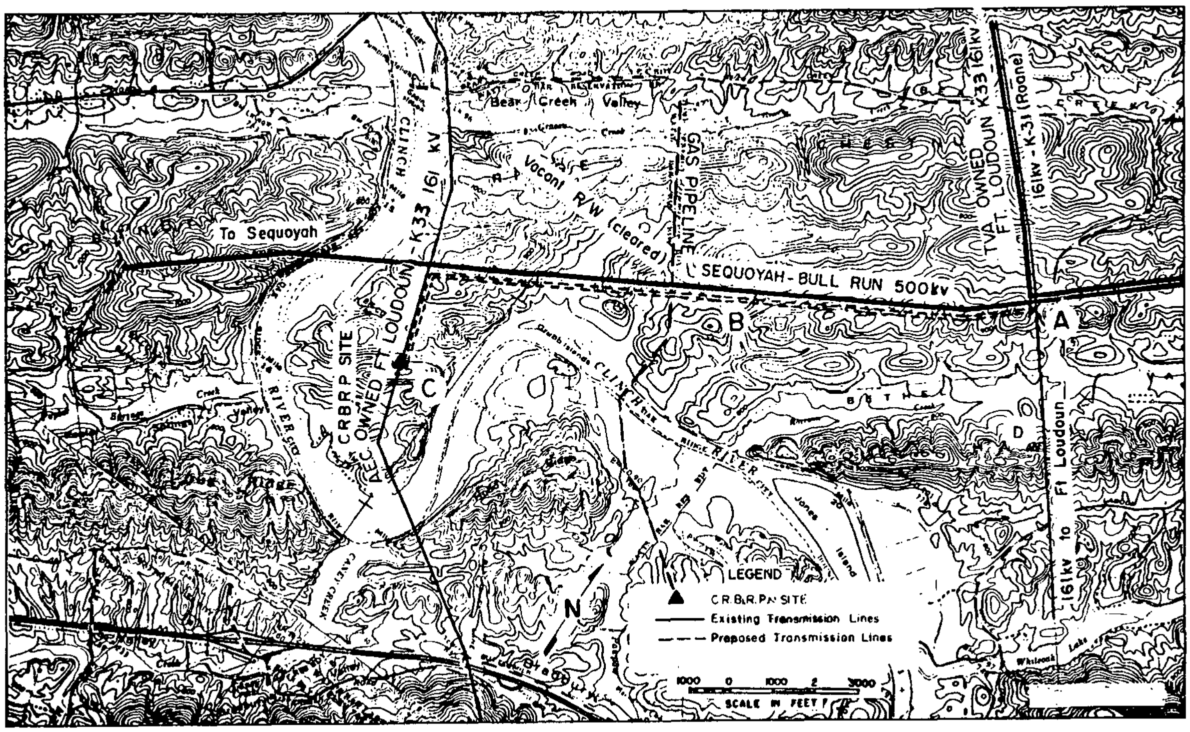


FIGURE 3.19 Proposed Transmission Line Route

Beginning at the plant switchyard, the route would follow the existing ERDA-owned 161 kV circuit in a northwesterly direction for 0.5 mile. The new lines would be installed parallel to and on the eastern edge of the existing line. There would be 75 ft between lines and a 50 ft right-of-way on the eastern edge of the corridor. The route would then turn eastward to parallel the Sequoyah-Bull Run 500 kV line for 2.7 miles. The new lines would be installed south of the present 500 kV line. There would be 100 ft separating the 500 kV line and the inner 161 kV line, 75 ft between the two 161 kV lines, and 50 ft of right-of-way on the southern edge. The existing corridor would be widened by a total of 125 ft.

About 56 galvanized steel towers 85 ft high would be used at 600 ft intervals to support the conductors. Cross arms would be of fiberglass, supporting gray insulators. The tower bases, taking up less than a total of one acre, would consist of precast concrete sections for installation in holes made 8 to 10 ft deep with augers mounted on rubber tired vehicles.

The transmission lines would pass between Chestnut Ridge and Haw Ridge and cross two small streams draining into the river near CRM 18 (ER, Sec 3.9.2). There are no railroad, highway or public road crossings, and no inhabited, cultivated, or recreational areas along this route. The area has been closed to hunting in the recent past (ER, Sec 3.9.3). No historical or archaeological sites listed in the National Register of Historic Places are in the proposed corridor. Should archaeological investigations presently underway reveal any significant site in the proposed transmission line corridor, relocation of the route or of specific towers will be considered (ER, Sec 3.9.6).

Both construction and maintenance probably would be done using access roads presently in use for existing lines (ER, Sec 4.2.1 and Fig 3.9-2). Where necessary, temporary drainage ditches, terracing and ground cover would be placed along access roads to prevent excessive soil erosion caused by heavy construction equipment (ER, Sec 4.2.1). The roads would be restored or upgraded after construction to be equal to or better than the original condition.

Nearly 54 acres of the 58-acre right-of-way would be shear cleared mechanically without any use of herbicides (ER, Sec 4.2.2). The right-of-way is 40% hardwood, 40% pine, 10% mixed, and 8% unforested (ER, Tab 4.2-1). Open burning for disposal of cleared vegetation would be done in compliance with State and Federal air pollution guidelines.

Soils of the corridor are moderately erodible, with estimates of erodibility as follows: 16.7% slight, 66.6% slight to moderate, and 16.7% moderate to severe (ER, Sec 4.2.3). Erosion control would be affected by limiting the usage of heavy equipment near streams and in areas of high erosion potential, by diverting runoff from exposed lands into settling ponds, by keeping vegetation on the land surfaces as long as possible before construction, and, where possible, scheduling construction to coincide with dry weather seasons. The applicant anticipates that some erosion and siltation would occur during construction on both the access roads and the right-of-way. However, adverse effects from erosion and siltation would be minimized by prompt restoration of land surfaces (ER, Sec 4.2.3). The right-of-way would be restored by grading and terracing where needed, temporary drainage ditches, fertilizing and seeding with fescue for initial cover, and allowing invasion of native species thereafter.

The applicant states that applicable portions of these guidelines were followed in selecting the routing: U.S. Department of Interior/Agriculture's Environmental Criteria for Electric Transmission Systems and the Federal Power Commission's Electric Power Transmission and the Environment (ER Am I, Part II, G7).

4. ENVIRONMENTAL IMPACTS DUE TO CONSTRUCTION

4.1 CONSTRUCTION SCHEDULE AND MANPOWER

Site preparation was planned to begin in September 1975; however, the construction start now is estimated for mid-1977 and the data presented herein should be considered accordingly. The applicant requested a Limited Work Authorization (LWA), effective 11 months prior to the anticipated date of the Construction Permit (CP). Clearing and grubbing would occur first, followed by excavation several weeks later. During the last seven months the following facilities would be installed: site access roads and onsite temporary roads, railroads and spurs, construction parking areas, work and storage area, construction power and lights, concrete batch plant, sewage treatment plant and toilet facilities, construction office and warehouse, fire protection system, storm drainage system, and barge unloading facility (Application, April 1975).

During a 4-year period the applicant may prepare and operate an onsite quarry, occupying in all about 25 acres one-half mile north of the reactor (Figure 4.1). The quarry would be excavated from the side of an existing hill, going 50 to 75 ft below the present grade. Access would be gained by improving an existing 0.6 mi road from the quarry to the river road (Buhl, Sept. 24, 1976).

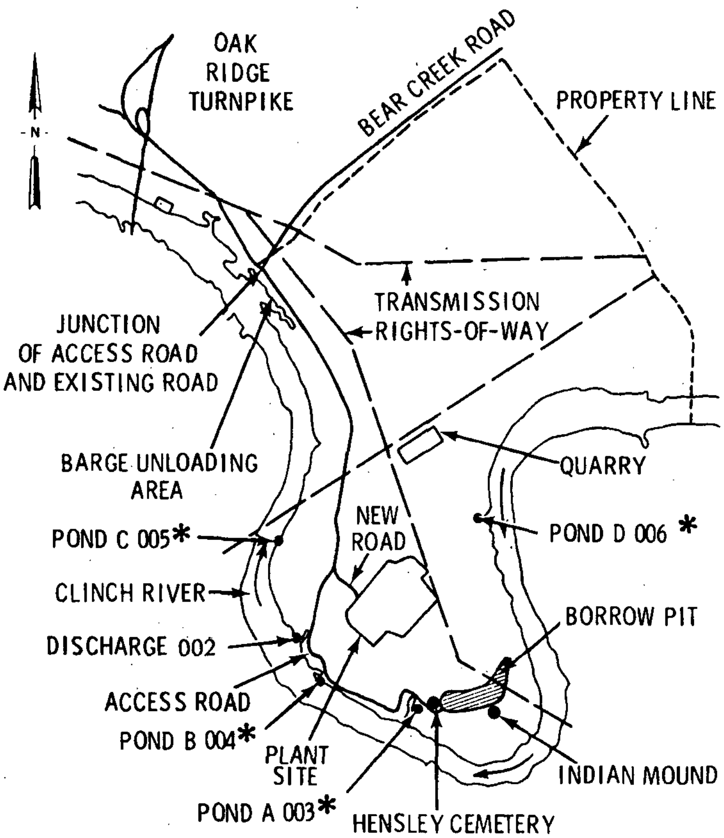


FIGURE 4.1 Construction Features

The construction period under the CP is expected to be 6.5 years. Assuming similarity with schedules for light water reactors, most major elements of construction would begin within one year, and construction of the cooling towers and transmission lines would begin at the start of the fourth year.

There would be three components of the CRBRP workforce: construction personnel, operations personnel, and the applicant's technical personnel. Since substantial numbers of the latter two classifications would be on site during the construction period, their presence is noted as a construction period effect. The time distribution of the work force expressed as yearly average is given in Table 4.1 (ER, Tab 8.2-1). If start of construction is delayed beyond early 1977, the labor build up would be delayed a corresponding amount. At the peak of construction activity in 1981-2 there would be about 2800 workers on the project. Predicting the fraction that are permanent residents prior to construction is a complicated matter and does not lend itself to scientific preciseness. Factors such as current size of labor pool, competition by other projects, ease of commuting, and cost of relocating enter into the judgment.

TABLE 4.1 CRBRP Direct and Induced Employment (man-yr)

FY	CRBRP Personnel Construction	Operations	Technical	Total	Induced Personnel
1975	-	-	258	258	190
1976	70	-	330	400	280
1977	260	-	370	580	400
1978	670	3	370	1,040	600
1979	1,400	15	360	1,800	1,000
1980	2,100	60	300	2,460	1,300
1981	2,400	120	280	2,800	1,500
1982	1,400	200	240	1,840	1,200
1983	600	180	200	980	800
1984	-	190	140	330	300
1985	-	190	100	290	200
1986	-	180	80	260	200
1987	-	180	70	250	200
1988	-	180	60	240	200

In the Oak Ridge area during the same period, there may be two additional large projects in competition for construction labor: Centar (a proposed centrifuge enrichment plant) and Exxon's proposed fuel reprocessing plant. If these projects are scheduled for the same time period as CRBRP, the peak construction employment in the area could possibly be 7000-8000 workers. Although it is unlikely that the labor peaks for the three projects would coincide, it is nonetheless probable that they will overlap to a degree that would produce employment for construction trades considerably exceeding that shown for the CRBRP alone. Competition for workers in the region can also be expected from TVA's proposed Phipps Bend Nuclear Plant 70 miles northeast of Knoxville, which would reach its peak employment of 2500 in the years 1980-82.

The total construction labor force in the Oak Ridge vicinity in 1970 was estimated by multiplying total labor force by the fraction that is classed as construction industry. The results, shown in Table 4.2, indicate that sufficient numbers of construction workers are unlikely to be available in the impact area. Therefore, the large demand for construction workers for the CRBRP, Centar, and Exxon projects in relation to the total labor pool could result in extensive in-migration.

TABLE 4.2 Construction Industry Labor June, 1970[a]

County	Construction Workers as % of Labor Force	Total Labor Force		Estimated Number Of Construction Workers
Anderson	7.9	22,805		1,700
Knox	6.5	107,823		7,000
Loudon	7.9	9,847		800
Roane	7.1	15,493		1,100
			Total	10,600

(a) "Data on Counties and Selected Cities in Tennessee," February 1974 (reprinted from "Bureau of Census County & City Data Book, 1972").

The resident construction labor force will supply part of the demand through release of workers as other projects terminate, through normal growth of the unions, and through lessening of unemployment. The analysis used by the applicant (ER Am VI) discusses a range of 27-40% in-movers, with 27% being used for the final cost-benefit analysis. The staff analysis in the DES used a 44% value, which is retained in the FES. This value was originally selected from TVA experience, and is further reinforced by the labor supply statistics referenced above as being a probable value upon which to estimate impacts. (In selecting a single value for this factor, the staff does not wish to imply that it is very precise. While 44% is in the upper range of probable values, the staff believes that its evaluation of the impacts on this basis is warranted by the number of projects being planned for the same construction period. If the Exxon and Centar projects are delayed or cancelled, the in-mover rate would not be as high as assumed.) Based on a 44% in-mover rate, about 1230 construction workers would move into the area by construction peak. Nearly 1600 would commute from current residences.

Additional employment would be induced by the presence of a large labor force on the CRBRP project. The effect would be felt in the entire region, but nowhere so concentrated as in the immediate project area. Induced employment would arise because the purchasing power of the CRBRP labor force would create a demand for goods and services. The applicant references an Appalachian Regional Commission study (ER, p 8.2-4) showing, for Anderson County, that every economic base job generates an additional 0.75 job in local service and production activities. The staff adopted the 0.75 multiplier to calculate induced labor effects from the operating force (Sec. 5.6) and 0.5 for the construction workers (Sec. 4.5.2). A lower value is used for construction because of its temporary nature. Based upon an analysis similar to that used by the staff in Section 5.6, about 1000 additional school-age children would be present in the area at the peak of construction, deriving from the 1230 directly employed workers moving into the area.

Other large construction projects in the area currently are modifications of the Kingston Steam Plant, the Watts Bar Nuclear Power Plant, and those of ERDA at Oak Ridge. Completion of work at the two power plants is scheduled for 1977 and 1980, respectively, while the ERDA construction is expected to continue at least through 1985 (Brewington, April 30, 1976). The Kingston Steam Plant involves construction activities with a total workforce of about 160, and it is expected that this workforce will be reduced to about 50 workers by early 1977. Some of the released workers might find employment on the new construction projects in the Oak Ridge area.

Tapering off of construction at the Watts Bar Plant would also release some construction workers for the new projects. Watts Bar is about 50 miles southeast of the CRBRP; in 1974, it attracted about 440 workers (out of a total of 1500) from the communities analyzed in this report. The construction force for the various ERDA projects (except CRBR) is expected to reach a peak of about 3200 by 1977 and taper off to 1,000 or less by 1981.

4.2. IMPACTS ON LAND USE

4.2.1 Onsite and Immediate Vicinity

Construction of the CRBRP and related facilities would disturb temporarily about 195 acres (including the quarry) of forested land of which about 5% is in hardwood, 21% in pine plantation, 8% in natural pine, 25% in cedar-pine, 15% in hardwood-cedar, 1% in hardwood-pine, and 9% in hardwood-cedar-pine. About half of the acreage, including a 32-acre borrow pit for structural fill (Figure 4.1), would be disturbed temporarily and would be revegetated after construction. About 73 acres would be permanently disturbed (ER, Tab. 4.1-1) including 24 acres for access roads and railroads (both onsite and offsite), 8 acres for settling ponds, 4 acres for principal plant buildings along with 30 acres for associated grading (Section 2.1), 2.5 acres for barge unloading area, 0.5 acre for river intake area, and 4 acres for other structures and laydown areas. The 73 acres represents about 5% of the land on the site and about 0.2% of the forested land on the adjacent Oak Ridge Reservation.

Land to be disturbed would avoid the "natural areas" discussed in Section 2.7.1. The rare wildflowers (Section 2.7.1.1) would not be affected since they are sufficiently distant from the area that would be disturbed by plant construction (ER, Am I. Part II, B7). No rare or endangered animal species occur in the area (ER, Sec 4.1.1.6). The staff concludes that the loss, for the life of the plant, of 73 acres for production of biota would not constitute a significant impact since there are thousands of similarly forested acres in the vicinity (Section 2.7.1).

Timber of commercial value on the construction areas would be harvested and removed from the site in accordance with the ERDA Forest Management Program (Strock, 1975). The remaining plants and brush would be burned in accordance with a fire prevention and protection plan which the applicant intends to develop (ER, Sec 4.1.1.7). Conventional garbage would not be incinerated on the site (ER, Sec. 4.1.1.5) but collected and disposed of offsite by a licensed contractor, or onsite near the borrow pit in compliance with applicable requirements. The staff's opinion is that surrounding forested areas would sustain no significantly adverse effects in view of the applicant's plans for fire prevention control procedures and limited onsite burning in conformance with State and Federal air pollution requirements.

Locations of access roads, railroads, and borrow pits are shown in Figure 4.1. The present access road (River Road) would be used after paving and improvement, and temporary unpaved roads would ring the construction area. The new railroad would pass between the present access road and the river on the west side of the site with spurs going into the construction area. Drainage facilities north of the site will be improved and widened so that the railroad may be constructed and the access road widened. The road and railroad will be constructed on granular fill (approximately 4,500 m^3, including about 220 m^3 of riprap). (Buhl, Sept. 24, 1976)

Top soil on the areas to be excavated would be removed to a depth of 0 to 12 inches and stockpiled on 10 acres southeast of the plant for use in later landscaping. Beneath the topsoil, about half of the excavated materials would satisfy requirements for structural fill. Excess would be stockpiled for backfill. Additional backfill would be obtained from the 32-acre borrow pit (Figure 4.1). Building materials (sand, stone, slate, limestone) would probably be quarried offsite and trucked in. The applicant recently informed the staff (Buhl, July 15, 1976) that it would conduct some test borings at the site during August 1976 with the objective of determining the feasibility of opening an on-site quarry for concrete aggregate. If such a quarry were opened, it would cover about 490,000 ft^2 to 1,000,000 ft^2 (about 10-25 acres) and it would be operated for a period of 4 years. The staff would require an environmental evaluation of the quarry if the applicant decides to proceed with such plans (see Item 7e, Summary & Conclusions). Surface soils of the borrow pit and quarry areas would be stockpiled for revegetation of the pit at the end of construction. Drainage ditches would be constructed around the periphery of all stockpile areas and at the base of all excavation slopes. Drainage water would be collected in sumps for distribution to settling basins about 500 fit from the shoreline west and south of the plant, prior to discharge into the river (ER, Fig. 4.1-3). Seeding, burlap protection and tree planting would be used as appropriate to prevent soil erosion.

After completing construction, surfaces not a part of the permanently committed land would be graded and revegetated. Land undisturbed by construction would be managed, both during and after construction, under the ERDA Oak Ridge Forestry Management Program (ER, Am I, Part II, B6). The program would, however, be terminated at TVA's request for any part of the site needed for development.

Moving construction equipment and disturbing land would result in temporary adverse effects such as erosion, siltation and interferences with some community life patterns. Based upon the staff's review of pertinent plans discussed in the two paragraphs above, the extent of such effects would be at a practicable minimum during the brief periods of their occurrences. The long-term effects would not be significant.

Historic and archaeological resources, except for the Hensley cemetery and the Indian Mound, are at distances sufficient to have no involvement with the construction plan. Borrow pit activity would be restricted so as not to interfere with the two nearby sites (ER, p 4.1-3). The staff's opinion is that they would be unaffected. The State archaeologist's opinion is that the applicant has given adequate consideration to archaeological resources. The State Historic Preservation Officer concurs that no structures of historic interest remain in the area (App C).

4.2.2 Transmission Lines

The staff concludes that erosion and air pollution control practices (Section 3.8) would be adequate to prevent adverse impacts on terrestrial biota in the area and that historical and archaeological resources would be adequately protected. The shift in land use of nearly 54 acres from woodland to open area would have no significant impact on wildlife because of the large area of land with similar woodland vegetation nearby, 1289 acres of forest on the site and 29,443 acres of forest on the Oak Ridge Reservation.

4.3 IMPACTS ON WATER USE

Water for fire protection, sanitary facilities, making concrete and other construction activities would be piped from the nearby Bear Creek Filtration Plant. Water for the quarry would be pumped from the river and would be recycled from settling basins, maximum use during peak crushing would be 40,000 gpd. The maximum requirement is expected to be 190,000 gpd, representing about 0.007% of the river's annual average flow. This small withdrawal is expected to have no significant effect on navigational and recreational uses of the river or on any downstream uses. Tonnage barge shipments for plant construction may exceed during some years the annual commercial tonnage of recent years (Section 2.1). The applicant states that the number of shipments during the construction period would not exceed 20 and that no shipments are planned during operation (Van Nort, 14 April 1976, Enclosure 13). Although individual shipments of plant components, because of relatively large tonnage, may have some adverse impacts on other shipping for a few days at a time, the staff's opinion is that the overall impact would be very small because of the limited number of shipments over the several-year construction period.

For erosion control in dewatering and related activity the applicant plans to use drainage ditches at the base of stockpiles and excavation slopes, a storm water drainage system, and a system of diversion channels leading to settling basins before discharging water to the river. The staff's opinion is that dewatering is expected to have no significant aesthetic or other effect on the river.

The applicant states that 20,000 m^3 of material from the sites of the access road and railroad fills, the water intake and discharge structures, and the barge unloading facility would be placed on a land disposal site near the barge facility. About 10,000 m^3 of fill would be placed at these sites, including 950 m^3 of riprap (Buhl, Sept. 24, 1976). The staff's opinion is that protective measures (Section 4.4.2, par 2) and the plan to do major construction elements in sequence would give protection sufficient to insure only temporary, minor adverse impacts upon the aesthetic quality and navigational and recreational uses of the river.

Transmission line construction is expected to have temporary impacts at stream crossings and these will be minor due to siltation control.

4.4 ECOLOGICAL IMPACTS

4.4.1 Terrestrial

Construction would result in the harvesting of timber and the destruction of some other plant and animal life on 195 acres concerned with the plant and 58 acres in connection with the transmission lines, both on and off the site. The 25 acres for the quarry, under the applicant's restoration plans (Buhl, Sept. 24, 1976), would probably start supporting wildlife about 10 years after restoration and provide habitat equivalent to the present habitat in another 10 years. Of this land, 97 acres in connection with the plant and all 58 acres for the transmission lines, according to the applicant's plans, would be revegetated by the end of the construction period and 73 acres would be disturbed for the life of the plant. In the forested acres, animals would be either killed or displaced to surrounding woodland where they would compete for space and food with populations already present. The net effect of the construction would be a small increase in open, brushy habitat, a decrease in forest habitat with the resultant favoring of wildlife such as quail and rabbits that prefer open areas, and decreases in populations of woodland species. No new "edge" would be created along the transmission line route, since existing corridor merely would be widened. None of the estimated shifts in animal populations is greater than 10% of the corresponding population on the site (ER, Sec 4.1.1.6). No rare or endangered plant or animal species is known to occur on the land affected by construction. The staff's opinion is that the impact on terrestrial biota would be minimal in view of the fact that the amount of land affected would be less than 1% of similar available land onsite and the Oak Ridge Reservation.

The staff's opinion is that the applicant's commitments to restrict erosion (Section 3.8 and 4.2.1) and chemical releases (Section 4.6.1 (3), (16), (17), (18) and (23)) would be adequate to protect the terrestrial ecosystem from significantly adverse effects from those sources.

4.4.2 Aquatic

The staff's opinion is that the precautions to be used in constructing plant buildings and transmission lines (Section 4.2.1 and 3.8) would assure minimum effects upon aquatic resources. No significant effects are anticipated in the river channel, since it would not be modified. (Physical descriptions of the intake, discharge, and barge unloading facilities are in Section 3.4.)

The river pumphouse and intake pipes would be built behind a temporary cofferdam to allow dry excavation for the structures. The staff recommends installation and removal of the cofferdam between August and March when fish are not spawning [consistent with the applicant's plans, Section 4.6.1.2 (2)] or at other times if no adverse effects can be substantiated. Disposal consistent with State and Federal regulations for dredged material and pumped water (TWQCB, 1973 and EPA, 1974) will be required by the staff. The 3440 m^3 of riverbank and bottom to be excavated or dredged would result in a temporary loss of benthic organisms in the disturbed area. The loss would be of minor consequence when compared to the total river biomass and the disturbed area would most likely be quickly repopulated after completion of construction.

The discharge pipe would be constructed with some excavation and dredging taking place (190 m^3); very little disturbance of the river is expected. The staff's opinion is that construction of the discharge pipe would be of little consequence to the aquatic ecosystem.

About 14,500 m^3 of material would be dredged to accommodate the barge-unloading facility to be located adjacent to the proposed railroad and access road (ER, Fig 4.1-3). Disposal procedures would be required to meet all applicable Federal and State regulations. Sequential construction is planned in this order: fill, drive piling as needed, dredge bottom, place stone bottom and platform, and dredge river to needed depth. Approximately 4940 m^3 of granular fill material would be placed on the river bottom within the unloading area to adjust the bottom elevation and facilitate grounding of a barge while unloading major nuclear components. The staff would require that closing and reopening of this facility be done between August and March when fish are not spawning or at other times provided no adverse effects can be shown. All aquatic life would be lost temporarily in the area of the facility. The loss would not be significant since much of the land is dry during parts of the year and upon completion of construction, new habitat would be opened for population by aquatic organisms of the area.

The construction of a railroad and railroad spur near the unloading facility along with the improvement of an existing access road would require the placement of approximately 2585 m^3 of fill material below the normal pool elevation of the Clinch River (Watts Bar Lake). All fill material placed below the normal pool elevation would consist of crushed rock, free from debris and organic matter. Because of the physical characteristics of this material, it would be exempt from the evaluation of chemical-biological interactive effects specified in the Environmental Protection Agency's guidelines pursuant to Section 404(b) of the Federal Water Pollution Control Act Amendments of 1972.

Plans for mitigating the effects of disposing of chemicals, sanitary wastewater and solid waste are discussed in Sections 3.6 and 3.7. The staff's opinion is that disposal of those materials would have insignificant effects upon the aquatic ecosystem.

In summary, the aquatic ecosystem is expected to sustain no significant impact from constructing the plant and transmission lines. To measure impacts, the staff would require monitoring during construction, as specified in Section 6.1.4.

4.5 IMPACTS ON THE COMMUNITY

4.5.1 Review of Applicant's Analysis

Following publication of the DES, the applicant submitted an extensive analysis of the projected socioeconomic impact of CRBRP construction (ER Am VI). The applicant's conclusions concerning net economic effects on the various local governmental entities in the vicinity of the project are shown in Table 4.3.

TABLE 4.3 Economic Impact of CRBRP Construction in the Public Sector (ER, Appendix C)

Government Entity	Economic Benefit ($) 1981	1990
Oak Ridge	9,246	13,457
Clinton	4,707	1,084
Oliver Springs	494	7
Anderson County	28,937	7,923
Kingston	7,225	3,389
Harriman	15,448	3,969
Rockwood	3,088	465
Roane County	5,877	11,128
Knox County	18,912	<7,122>
Lenoir City	11,135	1,273
Loudon Town	2,224	522
Loudon County	<7,874>	1,930

While the applicant cautions that its fiscal analysis is not complete (i.e., does not account for all revenues and expenses), the analysis leaves the impression that the overall financial impact on the public sector is a benefit of the project. If this conclusion is valid, it would be possible to either lower the tax rates or else provide increased governmental services at the existing tax rates. In the experience of the staff, this situation is common for expansions involving taxable (real estate) projects, but projects exempt from local real estate taxes (as is the CRBRP) result in higher tax rates for residents of the communities, not lower tax rates. Whether one is in agreement or not with current practices of raising tax revenues, the fact of the matter is that industrial installations pay a disproportionate share of public sector service costs relative to the benefit they derive. A corollary of this is that simple bedroom communities need to impose higher tax rates in order to provide public sector services equivalent to those provided by communities having taxable industries located within their boundaries. Since we are dealing with a bedroom community effect in the case of the CRBRP, the staff cannot accept the applicant's conclusion that the net economic impact will be positive compared to preproject conditions.

The applicant's analysis is based on a number of factors of judgment, for which the applicant has chosen single values instead of ranges. The result is a final net value to five significant figures in some cases, implying a preciseness not warranted by the data. If a range were used for each of the judgment factors and the analysis were conducted using these ranges, the resulting range in net economic benefit might well have encompassed negative as well as positive values.

The staff also noted that the applicant has not accounted for costs of capital facilities to supply public sector services. The rationale for this approach is that there is currently excess capacity, so that no capital construction costs will be incurred. The staff disagrees with this approach on two counts. First, it is probable that some additional facilities will be required, particularly school facilities, and possibly some sewer and water facilities. Second, even if the growth projection adopted by the staff is not realized and current capacities are not exceeded, it is the judgment of the staff that an economic analysis is incomplete if it does not assign a capital facility cost to expansion into even underutilized facilities. If an in-migrating force has no facilities cost, but uses public facilities, then others had to pay their share of these costs. This situation arises because facilities are added in large increments of capacity and the costs of the underutilized capacity are assessed against current populations to the benefit of future populations. Therefore, the staff's approach is to point out the total facilities required by the new population independent of whether this requires new facility construction, facility replacement, overcrowding in existing facilities, or comfortable utilization of excess capacity.

Another difference between the staff analysis and that of the applicant is in the estimate of the size of the secondary work force during the construction phase. The applicant says there will be a zero population multiplier associated with temporary construction workers and a multiplier of 1.0 associated with project office employment (WESD, 1976). The choice of a zero multiplier results from an analysis by the applicant that the retail trade sector can absorb the in-movers without increasing the employment levels since the normal seasonal variations in sales are already large. In the opinion of the staff, this is a nonsequitur since the pertinent statistic for comparison is retail trade employment, not sales. Furthermore, the analysis neglects non-retail trade service functions such as professional services.

The Appalachian Regional Commission conducted a study (referenced by the applicant in ER Sec. 8.2.2.2) which showed that every economic base job in Anderson County generates an additional 0.75 jobs in the local service sector. The multiplier is a little higher for Roane and Loudon Counties and a little lower for Knox County. In the staff's judgment, it takes a period of time for a multiplier to achieve an equilibrium value since merchants do not immediately hire additional help or expand facilities until the pressure for service builds up. If the increased demand is perceived as temporary, they may meet it with less vigor by, for example, taking on part-time help. Because of these factors, the staff uses a lower than equilibrium value for a multiplier in its analysis (i.e., 0.5 for construction labor) but cannot accept a zero multiplier as being defensible on the basis of economic theory or actual experience in the project influence area.

The staff also uses a different judgment than the applicant in forecasting the fraction of secondary workers that will be in-movers, in support of the project office work force. The applicant concludes that only 10% of the secondary workers will be in-movers and the other 90% will be recruited from the resident (presumably currently unemployed) population. In the staff's judgment, the in-movers could conceivably be this low due to availability of residents just entering the labor force in nonskilled clerical and service positions, but it could also be substantially greater--possibly as high as 40%.

4.5.2 Distribution of In-Mover Construction Labor Force

As discussed in Section 4.1, there might be as many as 1230 construction workers who move into the project area with their dependents by the peak year of construction. This number might also be as low as about 700 if there is only a 25% in-migration rate. The ability to absorb this large temporary population into the existing permanent population will depend to a large degree on the distribution of the new population among the surrounding communities. The average construction worker is willing to commute about 50 miles, if necessary, in order to take a temporary job. However, if the commuting distance is much more than this, he prefers to relocate--often in a mobile home. Once the decision to relocate has been made, nearness to the construction site assumes a large importance in deciding on location. For example, a Knoxville construction worker would accept the commute to the CRBRP; whereas, if the project attracted a Nashville construction worker, he would probably prefer to locate in a mobile home within 10 miles of the site. While not having conducted a very detailed projection of distribution of in-movers, the staff postulates that rural areas in the close vicinity of the site that are suitable for mobile homes will attract a large share of the in-moving construction labor force. Many of the construction labor force will also commute from centers such as Knoxville, and it is the opinion of the staff that most of these will already be residents of these urban centers.

In Figure 4.2 are shown the road mileage distances between the site and nearby population centers. Figure 4.3 shows existing and potential mobile home sites. In the opinion of the staff, the highest concentration of in-mover construction workers will be in the Rockwood-Kingston-Lenoir City strip west of Knox County because this zone combines the factors of nearness to the site and suitability of temporary housing. Restrictions against mobile homes and high housing costs will probably make the City of Oak Ridge a less attractive place to locate than might be inferred from its proximity to the site and its urban attractions.

Along Highway 61 between Clinton and Oliver Springs in Anderson County is considered to be a zone of potential mobile home sites and is within acceptable commuting distance to the site and easy access to shopping centers in Oak Ridge. However, the property tax rate of Anderson County is one of the highest in the state (Anderson County Budget for 1974-1975, Page i) and an in-mover would need to balance the possible advantages against the higher living costs. Lenoir City in Loudon County is only about 20 miles from the site and Loudon only about 26 miles. These would be considered acceptable commuting distances for an in-moving temporary construction worker.

Those in-movers desiring a more urban life might choose to settle in the vicinity of Knoxville despite the 37-mile commute (each way). The staff's judgment is that only a small fraction of construction in-movers will choose to do so. However, even if many did, Knoxville with a 1970 population of 174,587 (ER, Tab 2.2-1) could absorb an influx better than a smaller municipality because the percent change would be much smaller.

4.5.3 Social Effects

Except for possible traffic problems, the construction worker who does not relocate in order to become employed on the project would not cause any social change. He would use the same public and private sector services that he always used. It is the in-movers and their families that cause the major social changes because they put added pressure on housing, schools, and almost all public and private sector services. The following sections address the problems of new, temporary population additions to the four-county area of Anderson, Roane, Loudon, and Knox. While it is recognized that there may be some in-moving construction workers in more distant counties such as Morgan, Cumberland, Scott, Campbell, Blount, Monroe, McMinn, Meigs and Rhea, in the opinion of the staff they will be so few in number as to constitute a negligible impact.

School Systems

Enrollment statistics for county and city school systems are provided in Tables 4.4 and 4.5. This data includes enrollments for the 1975-6 school year and the projected enrollments for the peak construction year 1981.

Generally, the school systems within the CRBRP impact area are currently at full utilization, using the staff criteria that full utilization requires 10% excess capacity. The 10% contingency is allowed for future planning considerations to handle such factors as changes in mix of primary and secondary students, shifting of population within the school district from one school area to another, and modest overall growth. As shown in Table 4.4, in the school year 1975-6 the only school systems with any appreciable capacity over this contingency factor are Clinton, Harriman and Lenoir City.

The State of Tennessee also establishes criteria for what it considers overcrowding in school systems and requires those school systems that exceed the standards to file waivers with the

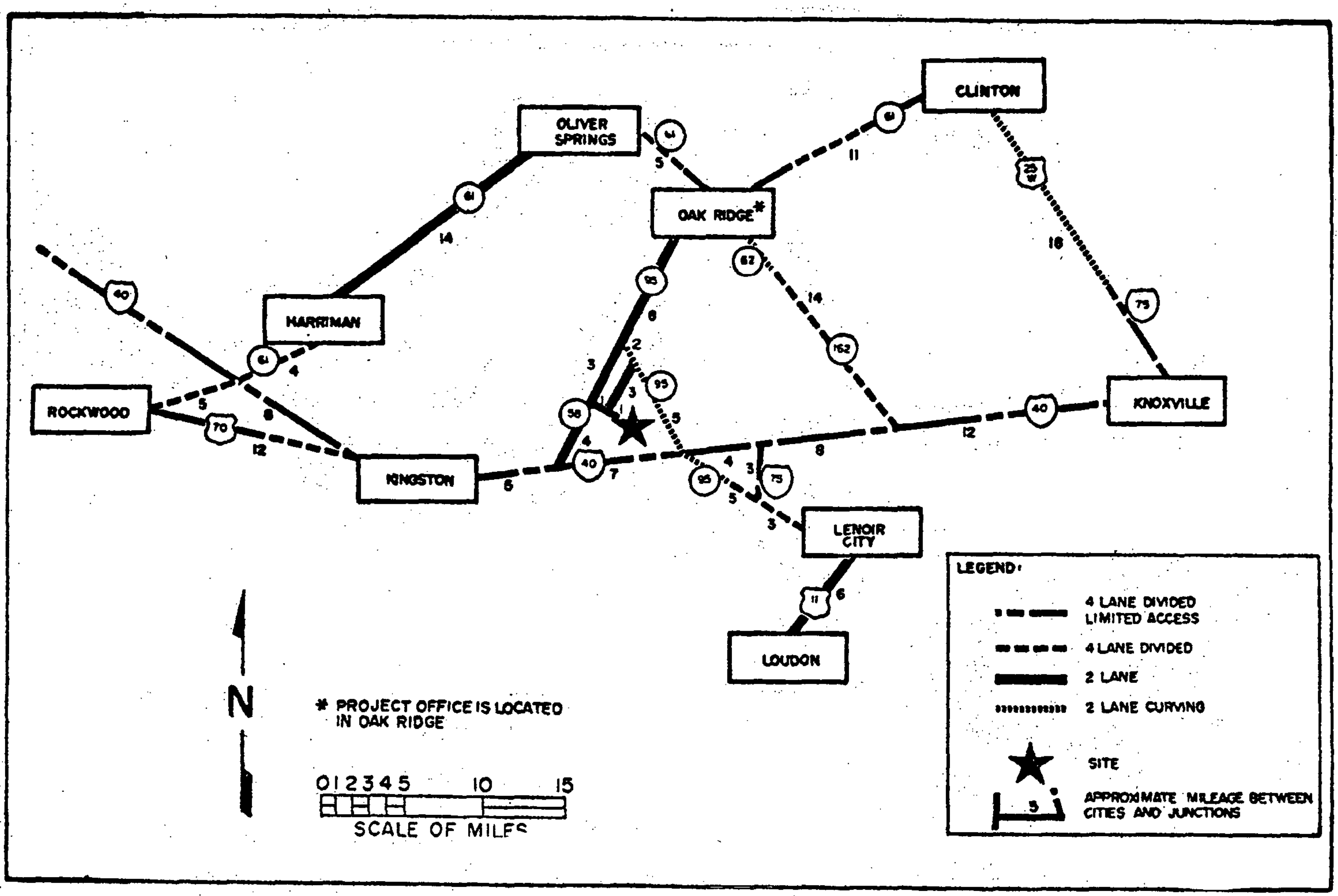


Fig. 4.2 Road Mileage Distances to Site (Source: ER Fig. 8.1.2)

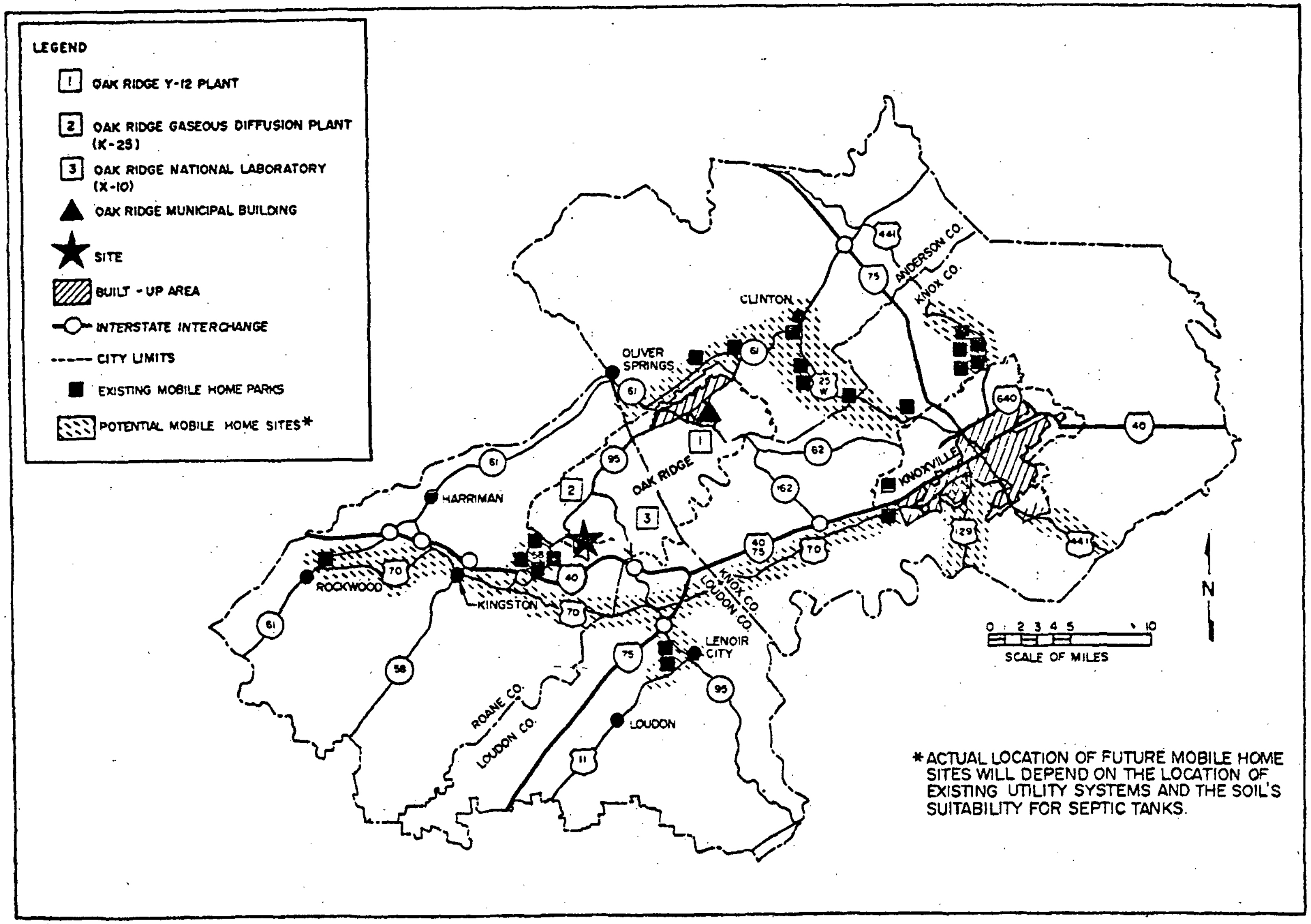


FIGURE 4.3 Existing and Potential Mobile Home Sites (Source: ER Fig. 8.1.5)

TABLE 4.4 Capacity and Enrollment of Area Schools by System and Grade: 1975-6 School Year

System	K	1	2	3	4	5	6	7	8	9	10	11	12	Total	Excess Capacity
Anderson															
Capacity	371	354	354	354	354	354	354	550	550	550	333	333	333	5,144	
Enrollment	292	343	306	324	298	345	355	597	600	471	373	403	349	5,056	1%
Clinton															
Capacity	100	210	140	140	140	140	140	--	--	--	--	--	--	1,010	
Enrollment	101	136	95	102	117	120	121	--	--	--	--	--	--	792	27%
Oak Ridge															
Capacity	443	436	386	393	369	369	475	652	652	652	550	550	550	6,477	
Enrollment	386	373	349	378	334	382	459	527	509	554	501	574	503	5,829	11%
Roane															
Capacity	510	610	565	540	560	590	640	535	440	585	575	555	515	7,220	
Enrollment	440	565	524	500	510	538	595	571	560	551	507	490	425	6,776	6%
Harriman															
Capacity	156	237	235	212	264	223	281	254	220	287	186	224	191	2,975	
Enrollment	119	181	179	162	205	170	214	194	168	219	142	171	146	2,270	30%
Knox															
Capacity	1,032	932	932	932	956	1,070	1,145	1,116	1,116	769	769	769	769	12,307	
Enrollment	912	1,194	1,045	1,155	1,052	1,117	1,178	1,225	1,194	1,052	1,051	965	781	13,921	-12%
Loudon															
Capacity	256	321	283	283	271	181	291	291	291	158	158	158	158	3,100	
Enrollment	250	257	257	257	260	177	261	261	261	138	138	138	138	2,793	11%
Lenoir City															
Capacity	140	140	140	140	140	150	150	150	150	250	250	250	250	2,300	
Enrollment	89	118	97	118	112	115	138	111	140	275	221	223	176	1,933	19%
Area															
Capacity	2,977	3,153	2,975	2,932	2,990	3,029	3,470	3,494	3,399	3,209	2,775	2,790	2,715	40,533	
Enrollment	2,589	3,167	2,852	2,996	2,888	2,964	3,321	3,486	3,432	3,260	2,933	2,964	2,518	39,370	1%

(a) Source: ER, Table 8.1-19.

TABLE 4.5 Projected School Enrollments During 1981

System	Capacity	Enrollment	Excess Capacity (%)
Anderson	5,144	4,684	9
Clinton	1,010	734	37
Oak Ridge	6,477	5,401	20
Roane	7,758	6,204	25
Harriman	2,975	2,078	13
Knox	14,134	15,734	-10
Loudon	3,100	2,709	14
Lenoir City	2,300	1,874	22
Area	43,898	39,418	9

(a) Source: ER, Table 2-2.7.

State. In this past year the school systems of Knox, Roane and Loudon counties and the cities of Clinton and Oak Ridge all filed such waivers with the State.

Table 4.5 provides estimated school enrollments and capacities for the peak construction year, 1981, based on data supplied by the applicant. These data show Roane County adding capacity for 538 students and Knox for 1,827 students by that time and the other school systems simply maintaining current facilities. The data also show decreases in enrollments for all of the school systems (except Knox) as a result of projected declining birth rates. If Knox is eliminated from consideration, these data indicate a 7% decrease in school enrollment for the rest of the area between 1976 and 1981 (from 25,449 to 23,684). In the staff's judgment, it is unreasonable to postulate that in the short time span of 5 years a changing birth rate factor will negate increased in-migration for all of the aforementioned large construction activities in the area and still cause a net 7% reduction in school enrollment. It should also be noted that the data show Roane County adding capacity for 538 students while facing an enrollment decline of 572 students.

Waste Water

Table 4.6 provides the applicant's data on current (1975) capacity and consumption for waste water systems in the CRBRP construction impact area. In the staff's judgment, treatment plant capacities need to be 2 to 3 times the average daily use in order to account for system fluctuations. Using this standard, only Oliver Springs and First Knox Utility District clearly have excess treatment capacities. This conclusion is further substantiated by the data from the State of Tennessee reproduced in Table 4.7. The staff notes that many utility districts in the vicinity of the CRBRP will require expansion in the next few years. Growth in this vicinity will be strongly influenced by and, in turn, will influence waste water treatment capabilities since the soil conditions in the area generally are not very good for septic tanks (ER Appendix C). New housing will probably concentrate in areas currently served by municipal systems, or on the fringe of such areas where new collection systems can be installed.

Municipal Water Supply

In a survey of water supply capacities and demands conducted by the applicant, it was determined that the following systems were either constructing additions now or had plans for future additions to capacity: Oak Ridge (supplied by ERDA), Clinton, Oliver Springs, Anderson County, Rockwood, Cumberland Utility District (Harriman/Oliver Springs), First Knox Utility District and Lenoir City. Thus, the staff concludes that many existing municipal water supply systems in the project impact area are undertaking capacity expansions because they are presently inadequate to handle expected future growth.

TABLE 4.6 Wastewater Systems: Type, Treatment Capacity and Usage of Wastewater Treatment in Area by Municipality[(a)]

Utility District	Treatment Type	Treatment (Pumping) Capacity (gpd)	Average Daily Flow (gpd)	Ratio Capacity/ Average
Anderson County				
Clinton	Primary and Secondary	1,200,000	750,000	1.60
Oak Ridge	Primary and Secondary	4,500,000	3,900,000	1.15
Oliver Springs	Primary and Secondary	1,000,000	150,000	6.67
First	Primary and Secondary	30,000	13,000	1.43
Roane County				
Kingston	Primary	1,500,000	750,000	2.00
Harriman	Primary	1,500,000	1,200,000	1.25
Rockwood	Primary and Secondary	1,500,000	900,000	1.67
Knox County				
First	Primary and Secondary	1,500,000[(b)]	450,000	3.33
West Knox	Primary, Secondary and Tertiary	100,000[(b)]	(c)	
Loudon County				
Loudon	Primary and Secondary	1,000,000	400,000	2.5
Lenoir City	Primary and Secondary	2,000,000	800,000	2.5

(a) Source: Er, Table 8.1-21.
(b) The First Utility District of Knox County and the West Knox Utility District have part of their sewage treated by the City of Knoxville.
(c) Not available.

TABLE 4.7 Adequacy of Waste Water Treatment Systems[(a)]

Utility District	Collection System	Treatment Plant
Anderson County		
Oak Ridge	Needs expansion by 1980	Presently inadequate
Oliver Springs	Needs expansion now	Presently adequate
Clinton	Needs expansion by 1980	Needs expansion by 1980
Knox County		
Hallsdale-Powell	Needs expansion now	Needs upgrading
Knox County	Needs expansion by 1977	Presently adequate
First Knox	Needs expansion now	Needs expansion and upgrading by 1979
West Knoxville	Needs expansion now	Presently inadequate
Loudon County		
Lenoir City	Adequate through 1980	Adequate through 1980
Roane County		
Kingston	Presently adequate	Needs expansion now
Harriman	Presently adequate	Needs expansion now

(a) Data from State of Tennessee, Department of Public Health

Other Social Impacts

There are many nonquantifiable social costs associated with large construction projects. These include inflated rents, inconvenience associated with traffic delays, public congestion in local businesses, public services and recreation areas. Such impacts occur because of the market's lack of response to the temporary demand for goods and services. These social costs affect all people, not only those employed with the project but also those people who receive little or no benefits from the plant construction. The staff considers these costs to the local society to be relevant in terms of the CRBRP construction.

4.5.4 Economic Effects

Private Sector

The economic impact of construction of the CRBRP on the surrounding area would be felt in both the private and public sectors. In general, the economic impact on the private sector would be beneficial. Direct project construction payroll is estimated by the staff to have a present value of $291.8 million through the year 1983 (Table 4.8). The tabulation shows that the payroll generated by induced (secondary) employment would add another $50.9 million through 1983 for a total present value of $342.7 million. The staff estimates that about 40% of the total would be spent in the local economy, while the remaining 60% would be divided between savings and purchases of good or services from outside the region. The 40% figure implies an income multiplier of 0.67, which is consistent with the employment multiplier used by the staff. If the 40% value is realized, this would be equivalent to a flow of $137 million in the local economy, which would be of direct benefit to the private sector.

Public Sector

The economic impact on the public sector would depend upon the balance between tax revenues generated by the project and the need for increased public spending to provide tax supported services to the primary and secondary work force. Table 4.9 lists some of the sources of tax revenue from the CRBRP as compared to the tax revenue situation of a comparable project financed by the private sector. The major differences are in the property and sales taxes and in the two federal in-lieu-of-tax payments.

A private project would pay property taxes to the taxing jurisdiction wherein it is located at the same rate as other real property in the jurisdiction. The portion of local property taxes paid by industry varies among localities, but it averages about 40% when a large enough sample is used. The remaining 60% comes mostly from residential property.

In addition, an industrial project would be subject to sales and use taxes on materials delivered to the construction site for incorporation in the finished plant. Whereas a public project would not be subject to either of these taxes, these two taxes would represent the majority of public revenues attributable to a private project. On the other hand, ERDA has the statutory authority to make in-lieu of (real property) tax payments to affected jurisdictions and has expressed to NRC its intent to exercise this authority in the case of the CRBRP (see Appendix F).

Another source of federal funds is public law 81-874. These funds are earmarked for support of schools in areas where federal projects reduce the tax base. The amount of payment per pupil is based upon the category of the pupil (lives on federal land/parent employed on federal land, lives off federal land/parent employed on federal land, lives on federal land/parent employed off federal land). CRBRP-connected students would probably be in a category which provides an entitlement of 45% of the average local contribution rate to education. This is usually considerably less than total educational costs because of state contribution to education. In Tennessee local receipts accounted for only 41.8% of revenues in 1973-1974 (Research, 1975).

In-moving direct and induced workers will cause increased public sector spending. In the public sector, it is very difficult to allocate a cost for services to a unit served (for example, a family) because most public sector service costs are of an "overhead" type. Direct charges usually are not made for service rendered (for example, no fee is charged for hourly use of the library, etc.). However, one indicator of public sector service cost is dollars of general fund expenditure per person served. Values of this index for all of the counties and several of the cities in the study area are listed in Table 4.10. These data do not include retirement of debt used to finance capital facilities construction, special levies, or non-voter approved bonds.

The staff did not attempt to make a complete balancing of public sector revenues and expenses of the project. Budgets from several local governmental entities were examined to determine the

Table 4.8 Direct and Induced Payroll Effects[a]

Year	Direct[b] Payroll	Induced[c] Payroll	Total Payroll
1975	$ 9,600,000	$ 1,300,000	$ 10,900,000
1976	13,700,000	2,000,000	15,700,000
1977	18,000,000	2,800,000	20,800,000
1978	27,300,000	4,700,000	31,500,000
1979	42,200,000	7,000,000	49,200,000
1980	55,500,000	9,100,000	64,600,000
1981	62,800,000	10,500,000	73,300,000
1982	40,700,000	8,400,000	49,100,000
1983	22,000,000	5,600,000	27,600,000
Construction Subtotal	$291,800,000	$50,900,000	$342,700,000
1984	9,500,000	2,100,000	11,600,000
1985	8,300,000	1,400,000	9,700,000
1986	7,500,000	1,400,000	8,900,000
1987	6,700,000	1,400,000	8,100,000
1988	6,600,000	1,400,000	8,000,000
Demonstration Period Subtotal	$ 38,600,000	$ 7,700,000	$ 46,300,000
Grand Total	$330,400,000	$58,600,000	$389,000,000

(a) An 8% escalation rate and 8% discount rate applied to 1975 dollars.
(b) From Table 8.2-2 ER.
(c) Derived from induced employment (see Table 4.1) by applying a factor of $7,000/man-yr.

Table 4.9 Tax Revenues Generated Directly or Indirectly From the CRBRP Compared to a Hypothetical Private Project

	Private Project	CRBRP
Property Tax	Yes	No
Sales & Use Taxes		
On materials consumed in construction	Yes	Yes
On materials that become a part of the building	Yes	No
Taxes generated by payroll spending		
Property Taxes	Yes	Yes
Sales Taxes	Yes	Yes
Miscellaneous (gas, liquor, cigarettes, etc.)	Yes	Yes
ERDA in-lieu of tax payments	No	Yes
PL 81-874 aid to schools	No	Yes

Table 4.10 Local Government Costs in the Study Area

Unit of Government	General Fund Expense per Capita
Anderson County	$ 191
Knox County	170
Loudon County	110
Roane County	151
Clinton	1258
Harriman	1073
Kingston	221
Knoxville	948
Lenoir City	1413
Loudon City	564
Oak Ridge	340

*Data for the counties are for 1967 and come from U.S. census data. The values for the cities are for 1974 and come from the State of Tennessee.

relative importance of various revenue sources and the relative magnitudes of expenditure categories. It was concluded that real property tax was the single most important revenue source, particularly in the counties, and that schools represented the major expenditure category. For example, in Knox County, property taxes supplied $7.7 million of the total $11.7 million general fund revenues in 1976 (66%). On the expenditure side, school operation, pupil transportation, school bonds, and City of Knoxville payments (mostly schools) made up $61.1 million of the total county expenditures of $99.6 million in 1976 (61%).

Since real property tax provides a major source of financing for government provided general services, it is significant that this source of revenue will be absent for the CRBRP Project (See Table 4.9). If the current level of governmental services is to be maintained, this lost revenue will need to be provided from other sources. If it is not provided by in-lieu-of-tax payments, then it must be collected from the public at large in the form of increased tax rates.

In this regard, it is significant to note that the CRBRP will have a construction cost of close to $1.4 billion, so it is the potential tax revenue from property of this value which is foregone. The staff recognizes that property tax from a facility of this value would constitute a windfall to any but a very large taxing district and permit either extension of services provided, or reduction of tax rates, or a combination of these choices. To provide the most stable maintenance of the status quo in the area, an in-lieu-of-tax payment would need to be of a level that would not perturb existing tax rates and not alter the existing unit level of governmental services.

4.5.5 Aesthetic

The plant would be located in a fairly isolated place and would be visible to the public from only a few vantage points. These points are mainly from the Gallaher Bridge (about 1-1/2 miles away), and a few scattered residences on the opposite bank of the river.

The most noticeable visual feature would be the domed reactor containment building, about 170 feet tall. The outer surface would be insulated and covered with a surfacing material harmonizing with other building finishes.

In the opinion of the staff, the CRBRP would not form an objectionable visual intrusion on the landscape.

4.5.6 Dust and Noise

Dust would be controlled by water sprinkling on construction areas and on roads (ER, p. 4.1-11), in addition to road paving and revegetation (Section 4.2.1). Blasting noise would be minimized by using small multiple blasts (ER, p. 4.1-3). Noise would also result from operating heavy equipment. At 0.5 mile from the site, truck and rock drill noise up to 64 dBA would exceed the 55 dBA threshold, as a day-long average, for outdoor annoyance (EPA, 1974). At 1 mile the threshold would be exceeded only by the rock drill at 58 dBA, during excavation and finishing. Noise would be muffled by surrounding forest. The staff's opinion is that dust and noise and other potentially adverse effects from blasting and heavy equipment would have minor adverse effects and they would be experienced only by the few residents immediately south of the river.

4.6 MEASURES AND CONTROLS TO LIMIT ADVERSE EFFECTS DURING CONSTRUCTION

4.6.1 Applicant's Commitments

The following summarizes commitments made by the applicant to limit adverse effects during construction.

4.6.1.1 From the ER, Sections 4 and 6.1.1.2.1; Buhl, September 24, 1976

1) Open burning would conform to State and Federal air pollution requirements.

2) Ash and other inorganic waste would be buried about 3 feet. The graded surface would be seeded with appropriate vegetation to prevent soil erosion.

3) Blasting would be restricted to small multiple charges over a 4-month period.

4) Depth of the borrow pit would not exceed 25 feet and the sides, a 2 to 1 slope (horizontal to vertical). Encroachment upon the Hensley Cemetery and the Indian Mound would be avoided. Reclamation would consist of grading, returning topsoil and seeding native grasses and forbs.

5) In constructing the barge-unloading facility, river siltation would be controlled by doing major construction elements in sequence.

6) Disposal of construction chemicals would be in accordance with applicable regulations. Control of waste oil would be supervised. Treatment would be given solid and liquid wastes from shop, machinery repair, and cleanup areas.

7) Garbage from the plant and transmission line construction would not be burned. It would be discarded by a licensed contractor in regulated disposal facilities.

8) Treated sanitary wastewater discharged to the river would meet standards of the Tennessee Department of Public Health. Chemical toilets would be used in remote areas, with approved disposal of wastes.

9) General erosion control would consist of leveling rutted areas, maintaining contours where possible, leaving tree stands where possible in the plant construction area, constructing drainage ditches at the base of stockpiles and excavation slopes, riprapping major diversion channels where erosive velocities are indicated, holding up drainage water in settling basins before discharge to the river, developing a storm drainage system for site access roads and spoil laydown areas, landscaping as soon as construction schedules permit, providing burlap protection to seeding on slopes, and planting trees or other appropriate vegetation.

10) Truck traffic would be confined offsite to established routes and, onsite, to paved roads under strict control by a security force.

11) Dust would be controlled by sprinkling roads and construction areas.

12) Existing roads and other accesses are expected to meet construction and maintenance needs for the new transmission lines (ER, Fig 3.9-2). Construction access roads would be restored to equal or better than original condition.

13) Chemicals would not be used in clearing land, although maintenance of right-of-way may involve localized applications of herbicides.

14) During transmission line construction, areas of high erosion potential would be given protection by limiting the use of heavy equipment and attempting to schedule activity during favorable dry weather. Grading would be done when necessary followed by discing, fertilizing, and seeding as quickly as practicable.

15) Additional erosion control during transmission line construction (see 12) would consist of backfilling around tower bases immediately after erection, and grading the right-of-way where necessary, followed by fertilizing and reseeding as quickly as practicable.

16) Stream disturbance at transmission line crossings would be controlled by restricting construction vehicles to bridges and/or stream banks.

17) Relocation of the transmission line route would be considered in the event that current onsite archaeological studies reveal resources of value in the present routing. State and Federal agencies would be consulted as to National Register eligibility of any historic values identified (ER, Sec 3.9.6).

18) Construction would not be done in marshland; monument areas; scenic, recreational and historic areas; and national forests.

19) A fire prevention and control plan would be developed and applied.

20) Siltation impacts would be reduced by dredging and constructing behind temporary dams all such structures as intake channels that require disturbing the soil-water interface.

4.6.1.2 From ER Am I, Part II

1) Prior to construction, the construction plant manager would be provided with locations of critical ecological elements. On-the-ground inspections of species and community locations would be made semi-annually.

2) Construction of the intake, discharge, and barge facilities would be scheduled so as to mitigate environmental impacts.

4.6.2 Staff Evaluation

Based on its review of the anticipated construction activities and the expected environmental effects therefrom, the staff concludes that the measures and controls committed to by the applicant, as summarized above, are adequate to ensure that adverse environmental effects will be at the minimum practicable level with the following additional precautions:

a. The applicant should set aside an appropriate buffer zone upslope of cover type vegetation 32 and 33 on the north edge of the site (ER, Sec. 2.7.1.3.4) to ensure their preservation and protection during the construction period.

b. Water discharged from settling basins shall meet the effluent limitations which are promulgated by EPA in the National Pollutant Discharge Elimination System Permit (see draft in Appendix H).

c. Work schedules staggered with those of other plants probably would be needed to avoid unreasonable congestion on State Road 58 in Roane County.

d. Installation and removal of the cofferdams for the intake and the barge unloading facilities should be conducted during the August to March period unless there is evidence showing that those activities at other times would not adversely affect fish spawning.

e. Local costs for additional public services needed by construction workers and other project personnel and their families may exceed the local benefits from the project. These costs and benefits should be assessed periodically by the applicant to determine the need for offsetting in-lieu-of-tax payments. The results of these analyses should be made available to the State and affected local government entities and negotiations should be conducted with them to agree upon financial assistance and/or other suitable measures to mitigate adverse impacts of the projects.

5. ENVIRONMENTAL IMPACTS OF PLANT OPERATION

5.1 LAND USE

Use of the site for the CRBRP would be consistent with the present industrial zoning for the site and adjacent land on the Oak Ridge reservation. Dedication of the land as a site for the plant represents an improved use of the land, which is presently forested.

Results of the University of Tennessee onsite archaeological investigations will be made available to the public (Section 2.3). Indian artifacts on the site are south of the proposed plant and would not be disturbed. Family members would continue to have access to the Hensley Cemetery which is also south of the plant location. The staff's opinion is that plant operation would have essentially no impact upon other archaeological and cultural values since they are at sufficient distances away. The State archaeologist's opinion is that the applicant has given adequate consideration to archaeological resources. The State Historic Preservation Officer concurs that no properties of historic interest remain in the area (Appendix C).

The plant would have an insignificant adverse visual impact upon the area. Structures would be partially visible from Gallaher Bridge and scattered residences south of the river. Building finishes would harmonize with each other. Ridges and hills would provide a natural screening. The impact of the cooling tower plumes is discussed in Section 5.3.3.

Cooling tower fogging and icing are expected to have insignificant effects upon local transportation routes (Section 5.3.3). Cooling tower noise at the 2200 ft minimum exclusion distance would be about 55 dBA (ER, Sec 5.1.8.4), about equal to the 55 dBA threshold, as a day-long average, for outdoor annoyance (EPA, 1974). There would be no noise problem in the surrounding areas from operation of the plant.

5.2 WATER USE

Plant operation would result in the consumptive use of 8 cfs of river water, about 0.2% of the annual average river flow rate. During the infrequent periods of no flow (the most severe was 29 days, 10 years ago) the consumptive use would represent well under 0.1% of the capacity of the Watts Bar Reservoir, for a 29-day no-flow period. The staff's opinion is that river water consumption by the plant would represent a small, justifiable diversion with negligible effect on downstream uses including the ORGDP intake at CRM 14.4.

The applicant states that, should the need arise for any regulation of Melton Hill Dam that would result in long periods of zero release, the operations (of CRBRP) would be coordinated to meet flow requirements at the CRBRP site (Van Nort, 29 Mar. 1976, Encl. 5, p. 3). No specific requirement is presently contemplated by the staff in view of the insignificant impacts expected from thermal and chemical discharges (Sections 5.3.2 and 5.4). The need for such requirements would be considered again at the operating license review stage and, if found necessary, appropriate limits on discharges will be included in the Technical Specifications for plant operation.

As discussed in Section 3.7, sanitary sewage discharges would meet all applicable standards and would have no significant effect on the river's water quality. Chemicals released by the plant would be diluted to near ambient concentrations within 100 feet of the discharge point. Thus, the use of the river for public water supplies would not be affected. (Section 5.4.1).

The staff's opinion is that groundwater supplies would not be affected either. Supplies on the south side of the river would not be influenced by plant operation, since groundwater flow is toward the river from both sides. There would be no wells and, therefore, no consumptive use on the site. Liquid and solid waste would not be discharged to onsite land (Sections 3.6 and 3.7), except for a small amount of cooling tower drift (Section 5.3.3), resulting in no measurable effect on groundwater.

Plant operation would have no effect on fishing and navigational use of the river. Only 1% of the commercial catch from Watts Bar Reservoir was taken within 10 miles of the site in 1972. About one sport fishing party per day was observed during the base line monitoring (Section 2.7.2). The main channel is near the opposite shore and would not be influenced by the plant (Figure 3.13).

5.3 HEAT DISSIPATION SYSTEM

5.3.1 Water Intake

5.3.1.1 Impingement

The intake system would consist of two perforated pipes placed about 2 ft above the river bottom. Each pipe, 3 ft in diameter and 18 ft long, would be capable of handling the entire plant water requirement. Passage of debris and aquatic biota past the pipes will be facilitated by aligning the pipes with river flow. Several aspects of the system should help reduce fish impingement and entrapment: 1) low intake velocities (0.3 fps through the perforations when both pipes are operating or 0.5 fps when only one pipe is operating) that would be relatively uniform due to internal sleeving of pipes; 2) clear escape pathways in all directions except directly into the perforations (about 3/8 in. dia.); 3) low approach velocities (0.12 fps at 3/4 in. distance); and 4) elimination of need for trash racks or vertical traveling screens (ER, Sec 3.4 and 10.2).

The ability of fish to maintain their position in water currents varies with species, size, water temperature, and dissolved oxygen. There are three types of swimming speeds: 1) cruising speed - maintained for hours, 2) sustained speed - maintained for minutes, and 3) darting speed - single effort, not sustained. Fish normally use their cruising speed for long-distance movement such as migration, sustained speed for locomotion through difficult areas, and darting speed for feeding or escape. Figure 5.1 shows relative swimming speeds of some fish species found in Clinch River (Bell, 1973). For most freshwater fishes, the darting speed is about ten times the body length per second (Gray, 1957). A few species have sustained speeds almost equally fast. Smallmouth bass fry *(Micropterus dolomieui)* 20-25 mm (0.065-0.08 ft) long, acclimated between 5 and 30°C, have sustained speeds ranging from 0.16 to 1.02 fps depending on water temperature (Larimore and Duever, 1968). Striped bass *(Morone saxatilus)* approximately 25-40 mm (0.08-0.13 ft) long can maintain themselves in currents of 1 fps (Kerr, 1953). Based on the swimming speeds of white crappie *(Pomoxis annularis)* and channel catfish *(Ictalurus punctatus)* a maximum approach velocity of 0.75 fps has been recommended for some power plants (Moyer and Raney, 1969). To avoid significant loss of organisms through impingement or entrainment, approach velocities at the water intake generally should not exceed 0.5 fps (Jensen, 1974).

At the plant only organisms that cannot withstand the intake current and that would not pass through 9.5 mm perforations are expected to be impinged on the intake pipe. Such susceptible organisms would consist mainly of fish larvae and weakened or stressed juvenile and adult fish.

The paucity of data on the swimming speeds for the relatively large number of fish species in the vicinity prohibits a quantitative assessment of impingement losses. An estimate was made using the following conservative assumptions:

- Susceptible larvae and juveniles uniformly distributed throughout the water column,
- All fishes remain in the river throughout their periods of susceptibility,
- An average low river flow of 4300 cfs for spring and early summer months, which would tend to concentrate susceptible fishes to maximum densities,
- Maximum intake pumping rate of 22.3 cfs (10,000 gpm),
- Impingement mortalities of 100%, and
- All susceptible fishes impinged and none entrained.

Impingement losses are estimated to be 0.5% of the susceptible fish passing the perforated pipes, based upon the plant water intake as a percentage of the river flow at the plant. The hydrodynamics of the perforated pipes and the low approach velocities should reduce further the impingement losses. The staff concludes that impingement would not be a problem at the CRBRP.

Since there would be no trash racks and conventional intake traveling screens, trash rack debris and screen washings are not a consideration. The applicant stated that the perforated pipes would be fitted with a back flush cleaning system; back flushing would be done as required. The applicant plans a model study to determine best methods to prevent interception of large pieces of debris. If need for a deflection device such as a protective dolphin is indicated, the study would consider movement of bottom sediment caused by river flow past the deflection device (ER, Am I, Part II, C15).

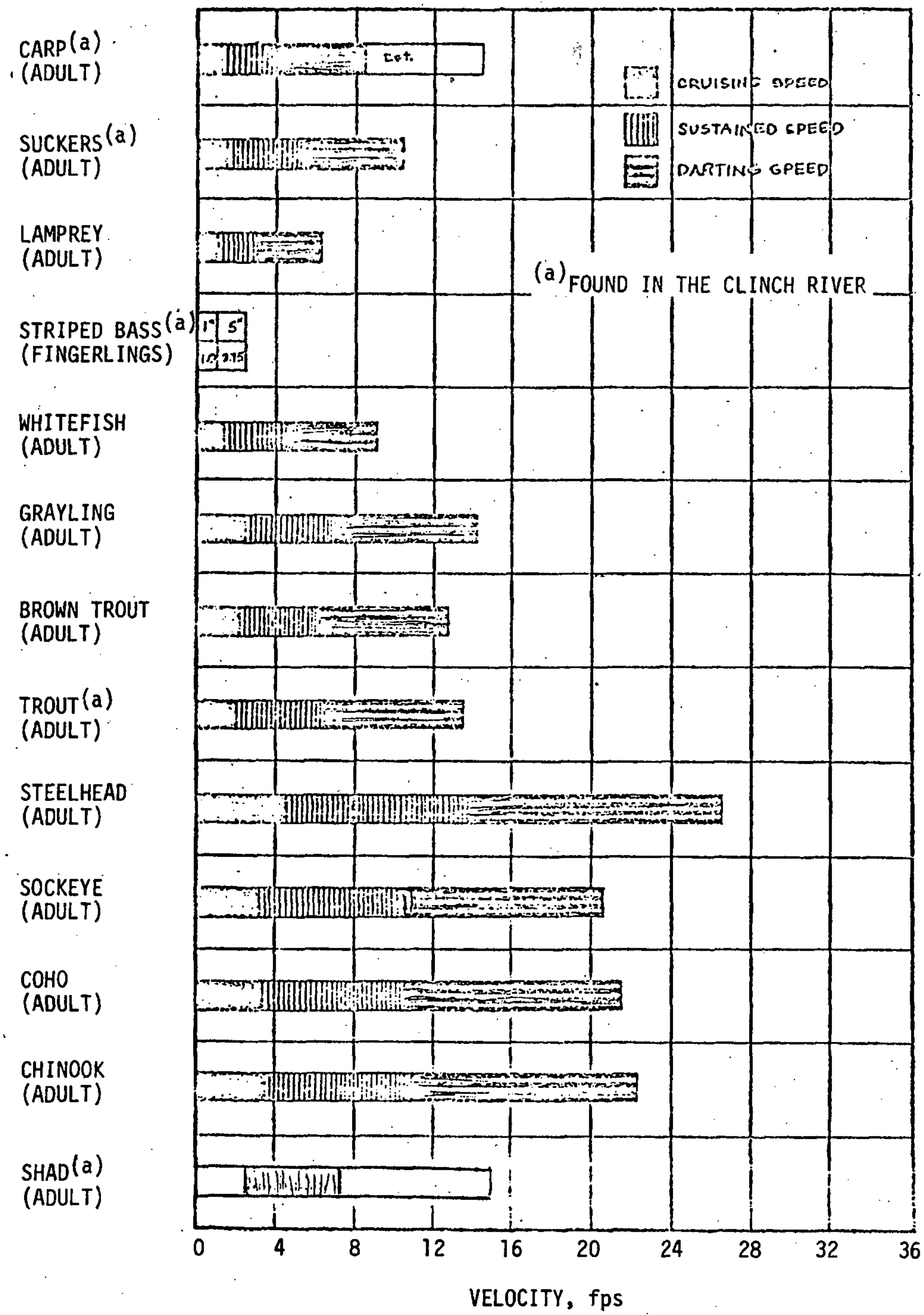


FIGURE 5.1 Fish Swimming Speeds (Bell, 1973)

A potential problem with the intake system is the clogging of intakes by the Asiatic clam (*Corbicula*). Dead spaces and areas of very low velocities within the perforated pipes may cause *Corbicula* larvae to settle out, become attached, and clog the pipes. Partial obstruction of the pipes and perforations would tend to increase approach and intake velocities and the potential for greater impingement and entrainment losses. Secondly, there would be an impact associated with the cleaning of the pipes. The applicant is investigating several design features to preclude any potential problem: 1) chlorination of lead-in pipes, 2) use of anti-fouling paint on the pipes, and 3) scrubbing the intake pipes either in place or reconditioning them out of water. Normal intake pipe maintenance would include back flushing, in-place scrubbing by scuba diver, and removal of sections for major repair. During the first year of operation at least one routine inspection of the water intake would be made by scuba divers (timed for *Corbicula* infestations). One or more sections of the pipe would be removed and inspected (ER, Am I, Part II, C17 through C19). The staff concludes that the applicant's maintenance plans are adequate to prevent any significantly adverse effects. Technical specifications, developed at the plant operating license stage, would include monitoring to identify any problem at the intake requiring correction.

Entrapment results from the creation of areas within an intake structure where fish may congregate and be denied free passage to other parts of the river. Since the proposed perforated pipe intake design does not require intake forebays or other design features that could entrap fish, entrapment is not expected by the staff.

5.3.1.2 Entrainment

Phytoplankton, zooplankton, drift invertebrates, ichthyoplankton (fish eggs and larvae), and other organisms incapable of avoiding the intake velocities and yet small enough to pass through the 9.5 mm (3/8 in.) pipe perforations would be subject to passage through the plant cooling system (entrainment). Entrained organisms would be exposed to a sudden maximum temperature rise of about 16.7°C (30°F) across the condensers. In addition, they would experience the physical and chemical stresses of pumping and passing through the cooling tower before return to the river. Since most entrained organisms would be killed, the staff assumes 100% mortality for all entrained organisms.

The applicant estimated entrainment mortalities based on the maximum intake pumping rate of 22.3 cfs (10,000 gpm) as a percentage (<0.5%) of the average monthly summer discharge from Melton Hill Dam of 4800 cfs and the average winter discharge of 5100 cfs and concluded that entrainment losses would not be significant. The staff made an independent analysis using average and low-flow conditions at the plant. Based on average monthly releases from Melton Hill Dam for the past 10 years, average flow is about 4800 cfs and low flow 1000 cfs unless Melton Hill Dam should be shut down. The special condition (29 days of extended zero discharge) is not anticipated in the future, but if it should occur, the applicant stated that Melton Hill Dam releases would be coordinated to meet flow requirements at the CRBRP site (ER, Sec 2.5.1.3 and Am I, Part II, C10).

The entrained phytoplankton, zooplankton, drift invertebrates and ichthyoplankton all would suffer about the same rate of mortality. Based on the fraction of total river flow withdrawn by the plant, at a river flow of 4800 cfs, the average loss would be 0.46% of the entrainable organisms; under 1000 cfs low flow conditions, the maximum loss would be 2.2% (for assumptions, see Table 5.1).

Phytoplankton net weight biomass losses per day based on mean chlorophyll a concentration of 3.6 mg/m^3 and a maximum pumping rate of 22.3 cfs would be 33.0 kg/day or 73 lb/day; whereas, under minimum pumping rate of 3.7 cfs (40% load factor) the minimum operating losses would be 5.4 kg/day or 12.0 lb/day. For the zooplankton organisms the maximum biomass losses would be 435 g/day or 0.96 lb/day based on biomass densities of 639 $\mu g/\ell$; whereas, the minimum losses would be 72.0 g/day or 0.16 lb/day. Since biomass estimates have not been made for ichthyoplankton, the number of eggs and larvae lost per day were calculated based on maximum density found (0.48/m^3) from March through August 1974. The maximum and minimum losses would be 26,000/day and 4500/day, respectively. Note that out of the 310 ichthyoplankters collected, 95% were unidentified fish eggs, of which a large number may have been spawn of coarse fish whose loss would not affect seriously the presently utilized fishery resources of the area, and 5% were larvae (13 clupeidae and 1 percidae).

Table 5.1 summarizes the estimated entrainment losses and underlying assumptions. Organisms killed in the cooling tower system and returned to the river may become part of the food web. That is especially true for phytoplankton because the same amount of primary produced organic carbon that passes through the plant should still be retained within the food web for the ecosystem. The model used to predict entrainment losses assumed uniform distribution of entrainable organisms, which usually is not the case in aquatic ecosystems. Plankton often tend to occur in patches and many larval fishes tend to school. Since the minimum depth of the perforated pipes from the water surface would be 8 ft, the potential is good for not drawing water from the photic zone where concentrations of entrainable organisms may be highest. Daily ichthyoplankton losses reflect only the season of availability, usually March through August, and are not average daily losses throughout the year. If the fecundity rates of the individual fish species and their seasonality are placed in perspective, average daily numbers lost probably would be very low when compared to the total available in the ecosystem.

In summary, entrainment losses would be small both as to numbers, 2.2% or less of the organisms passing by the plant, and as to biomass, as shown in Table 5.1. The staff concludes entrainment losses would have an insignificant impact on the aquatic ecosystem in the vicinity of the plant.

TABLE 5.1 Summary of Estimated Entrainment Losses

Organisms	Ave. Loss (%)	Max. Loss (%)	Max. Loss (Wt. or No.)	Min. Loss (Wt. or No.)
Phytoplankton	0.46	2.2	33.0 kg/day (73 lb/day)	5.4 kg/day (12 lb/day)
Zooplankton	0.46	2.2	435 g/day (0.96 lb/day)	72.0 g/day (0.16 lb/day)
Drift Invertebrates	0.46	2.2	-	-
Ichthyoplankton	0.46	2.2	26,000/day	4500/day

Assumptions:

1) Organisms susceptible to entrainment are uniformly distributed throughout the water column.

2) Average river flow of 4800 cfs with low-river flow of 1000 cfs,

3) Maximum pumping rate of 22.3 cfs with minimum rate of 3.7 cfs,

4) 100% entrainment mortalities,

5) All susceptible organisms are entrained and none impinged.

6) Percent losses are based on maximum pumping rate of 22.3 cfs with average and low river flow conditions.

7) Weight or number losses are based on maximum and minimum pumping rates.

5.3.2 Water Discharge

5.3.2.1 Thermal Plume Characteristics

To predict river temperature rise induced by plant blowdown discharge, a 1:12 physical model was constructed. Since periods of no flow due to zero release from Melton Hill Dam would result in the greatest potential thermal impact (Sec 2.5), the induced temperatures in the near field of a near-stagnant ambient condition were measured in the model. Four cases were analyzed: two typical cases (winter and summer) and worst cases (winter and summer). Conditions are given in Table 5.2.

TABLE 5.2 Conditions for Physical Model Cases

Cases	Ambient River: Water Temp (F°)	Ambient River: Flow Rate (cfs)	Ambient River: Velocity (fps)	Ambient River: Pool Elevation[a] (ft MSL)	Plant Discharge: Atmospheric Wet Bulb (°F)	Plant Discharge: Blowdown Temp (°F)	Plant Discharge: Blowdown Flow[b] (gpm)	Plant Discharge: Blowdown Flow[b] (cfs)	Jet, Initial: Temp Differential at Jet (F°)	Jet, Initial: Jet Velocity (fps)	Jet, Initial: Distance to Surface Jet Diameter
Winter, Typical (Jan/Feb/Mar)	43.9[c]	5338[d]	1.39	736	43.3[e]	74.9[c]	2500	5.57	31.0	15.96	7.5
Summer, Typical (July/Aug/Sep)	65.7[c]	4777[d]	0.63	741	73.2[e]	89.3[c]	3240	7.22	23.6	20.68	15.0
Winter, Worst[i] (Jan)	33[f]	0	0	735	56.2[g]	79.8[h]	2810	6.26	46.8	17.93	6.0
Summer, Worst[j] (June)	78[f]	0	0	739	74.4[g]	89.6[h]	3280	7.31	11.6	20.94	12.0

(a) ER Table 2.5-5.
(b) ER Figure 10.3A-2.
(c) ER Table 10.3A-1.
(d) ER Table 2.5-3.
(e) ER Table 3.4-3
(f) ER Clinch River (m 21.6) Data, 6/62-9/72.
(g) Bull Run Steam Plant Data, 1/70-12/73.
(h) ER Figure 10.3A-2. Account taken of cooling effect of makeup flow.
(i) Assumes minimum river temp and maximum wet bulb air temp.
(j) Assumes maximum river temp and maximum wet bulb air temp.

Estimated river surface areas that would be encompassed by the isotherms are given in Table 5.3. Table 5.4 gives maximum temperatures at the surface and mid-depth induced by each of the four cases. Table 5.5 gives the estimated percent of river cross-section that would be occupied by the 5°F and 2°F plant isotherms (ER, Am I, Part II, D8).

TABLE 5.3 Estimated Areas Inside Surface Isotherms[a]

Mixing Conditions	Area (acres) Isotherms (F°) 0.7	1.0	1.2	1.5	2.3
Typical Cases					
Winter		0.05	0.01	0.01	
Summer	0.07	0.02	<0.01		
Hypothetical Extreme Cases					
Winter		3.92[b]			0.06
Summer					

(a) As determined from the Iowa Institute physical model study (see ER Table 10.3A-5).
(b) Estimated based on extrapolation of model plume boundaries to achieve closure of isotherm (see ER Figure 10.3A-10).

TABLE 5.4 Predicted Maximum Temperatures

Case	Surface Temperature Increase °F	Surface Temperature °F	Mid-depth Temperature Increase °F	Mid-depth Temperature °F
Winter				
Typical[a]	1.9	45.8	2.9	46.8
Worst[a]	4.8	37.8	5.8	38.8
Summer				
Typical[a]	1.3	67.0	1.9	67.6
Worst[a]	0.8	78.8	1.0	79.0

(a) See Table 5.2 for river water temperature and flow rate, and temperature differential at outfall jet.

TABLE 5.5 Estimated Part of River Cross-section Occupied by 5°F and 2°F Isotherms

Case	5°F Isotherm	2°F Isotherm
Winter		
Typical[a]	negligible	less than 8%
Worst[a]	less than 8%	no more than 30%
Summer		
Typical[a]	negligible	less than 6%
Worst[a]	negligible	negligible

(a) See Table 5.2 for river water temperature and flow rate, and temperature differential at outfall jet.

Based upon physical modeling the thermal change produced by the discharge would be small. All cases suggest that the submerged plant jet would mix rapidly. Beyond a short distance, the heated area would extend from the river bottom to the surface. Vertical mixing would progress so quickly that a temperature rise of more than 2°F at the surface would occur at a maximum of 250 ft from the discharge pipe under hypothetical winter worst conditions. Model results also show that the

2°F isotherm would encompass no more than 30% of the river's cross-sectional area. In every model case the area enclosed at the water surface by the 2°F isotherm did not exceed 0.1 acre. The acreage also would not be exceeded under design capability operation with discharge temperatures a few degrees above ambient. Figures 5.2 and 5.3 represent the thermal plumes for typical winter and summer conditions. The small sizes of the plumes are evident (ER, Am I, Part II, D8d).

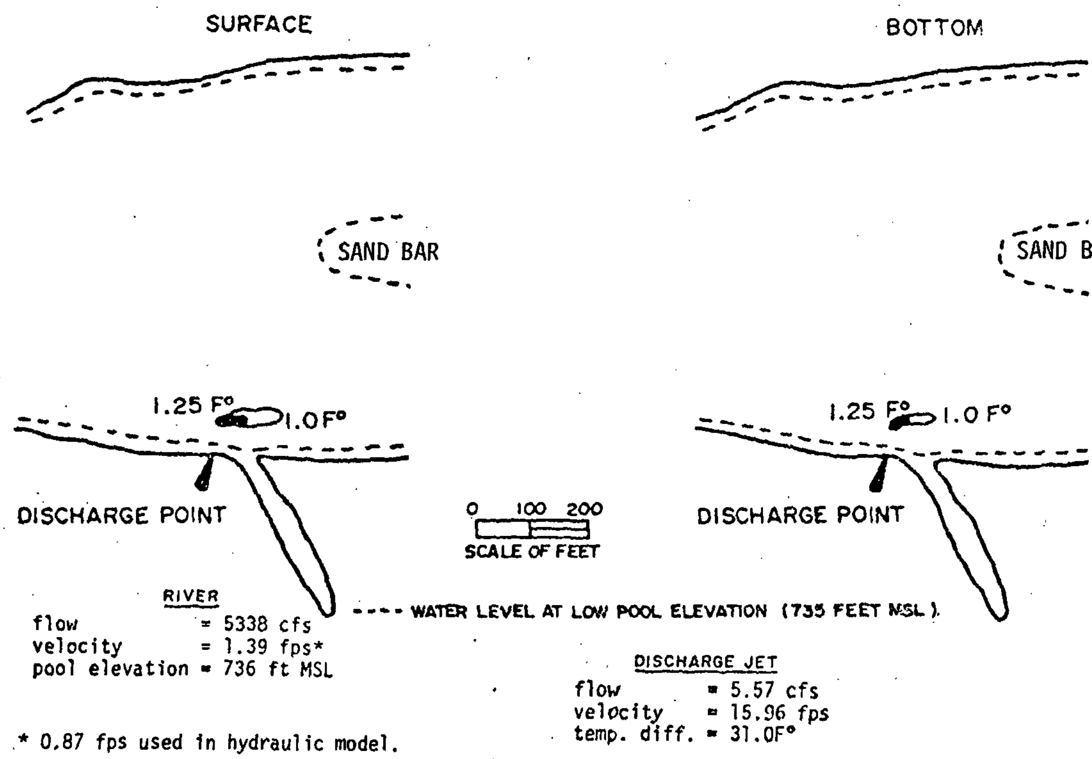


FIGURE 5.2 Thermal Plumes, Winter Typical
(ER, Am I, Part II, D8, p A1-197)

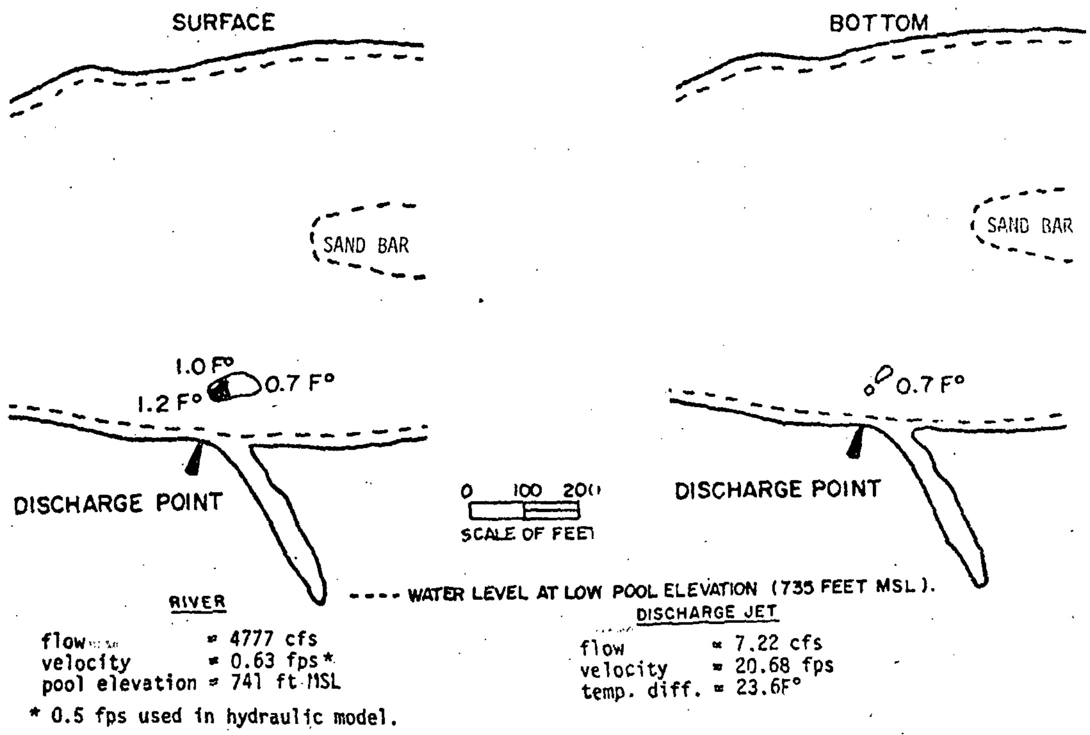


FIGURE 5.3 Thermal Plumes, Summer Typical
(ER, Am I, Part II, D8, p A1-198)

The staff performed an independent analysis of the submerged thermal plume using a three-dimensional model (Bacas, 1971). Three cases were modeled for the purposes of cross-checking the applicant's predictions, namely: summer typical, winter typical, and winter worst. Winter worst would produce greater change than summer worst (Table 5.5). The data used in the physical model (Table 5.2) were used in preparing the model input data for the three cases. As illustrated in Figure 5.4, the mathematical model results show excellent agreement with the data developed from the physical model study, for the summer and winter typical conditions. The comparisons for the winter worst conditions show poor agreement between mathematical and physical model results; the mathematical model predicts a more rapid dilution. The gradual dilution predicted by the physical model probably is the result of thermal buildup in the flume. Thermal buildup problems commonly occur in flume experiments using relatively small cross-flow velocities, because of the finite size of the basin and the time required for the thermal field to reach the steady state. Consequently the staff believes that the physical model results for the winter worst conditions are very conservative in estimating the rate of dilution. Table 5.6 presents the temperature differentials for the plume centerline and the associated volumes predicted by the staff's mathematical models.

Based upon the small size of the thermal plume (less than 200 ft) and the more than 1.5-mi distance between intake and discharge, the staff's opinion is that recirculation would not likely occur even under extended periods of no flow or reverse flow. Recirculation with the plume from the Kingston plant, 9 miles distant, would be even less likely.

Thermal limitations have been proposed on the CRBRP diffuser discharge as follows: "The receiving water shall not exceed (1) a maximum water temperature change of 3°C (5.4°F) relative to an upstream control point, (2) a maximum temperature of 30.5°C (86.9°F), and (3) a maximum rate of change of 2°C (3.6°C) per hour outside of a mixing zone which shall not exceed the dimensions of a circle with a maximum diameter of 30.5 meters (200 ft)" (Appendix H, page 3); blowdown "discharge temperature shall not exceed the lowest temperature of the recirculating cooling water prior to the addition of makeup" (Appendix H, page 18). Based on the results of its hydrothermal analysis, the staff's opinion is that the thermal discharge will comply with these requirements.

5.3.2.2 Thermal Plume Effects

There is little evidence that the plant's thermal discharge would have a measurable effect on river biota. Even if the very unrealistic assumption of 100% mortality is made for organisms passing through the 2.5°C surface isotherm, less than 8% of the biota passing through the plume during worst case winter conditions would be lost, and less than 1% for worst case summer conditions. Exposure to temperature increases greater than 2.5°C would have a duration of less than 60 seconds.

Phytoplankton would sustain little damage if temperatures do not exceed 34°C (93°F) (Patrick, 1969). Zooplankton can survive ΔT as high as 20°C (36°F) (Davies, 1974). A temperature increase of 7.2°C (13°F) produced no harmful effects upon crustaceans and diptera larvae (Markowski, 1959). Stonefly, caddisfly and mayfly larvae acclimated to 10°C (50°F) showed 96 hr median tolerance limits ranging from 21-30°C (70-86°F) (Nebeker, 1968). Temperatures above 30°C (86°F) are not suitable for many benthic organisms (Jensen, et al., 1969). (Benthic macroinvertebrates could potentially be affected to a greater degree than other organisms because of their extended exposure to the thermal plume.) However, the 25.6°C (78°F) maximum river temperature recorded in the plant vicinity plus a ΔT of 2.5°C (4.5°F) gives a potential maximum temperature of 28.1°C (82.6°F), below temperatures reported harmful for most organisms.

Ichthyoplankton generally are more sensitive to temperature differences than most other planktonic organisms. Fish egg temperature tolerances are generally lower than those for fry or adults (Levin, et al., 1970). Most fish in the plant vicinity have demersal or adhesive eggs normally not distributed in the water column. Ichthyoplankton presence in the river is seasonal (usually April through August) and consequently would not be subject to winter thermal regimes.

Fish are able to detect and avoid temperature gradients in both vertical and horizontal planes and generally will avoid lethal temperatures (Alabaster, 1969). Freshwater fish can detect temperature differences of less than 1°C (Levin, et al., 1970). At Lake Monona, WI, fish avoided a power plant thermal discharge area when temperatures reached 35°C (98°F); however, several species of fish maintained themselves at selected temperatures within the mixing zone (Neill, 1970). The majority of 70 Lake Michigan fish collected from a discharge plume had body temperatures lower than that of the discharge water (Spigarelli, et al., 1974). The investigators concluded that the fish were regulating their movements between the warm and cool areas around the heated effluent or just recently had moved into the heated water area. Most of the fish found in the Clinch River are warm water species. The recommended provisional maximum temperatures for various species of warm water fishes, including some found near the plant, are given in Table 5.7.

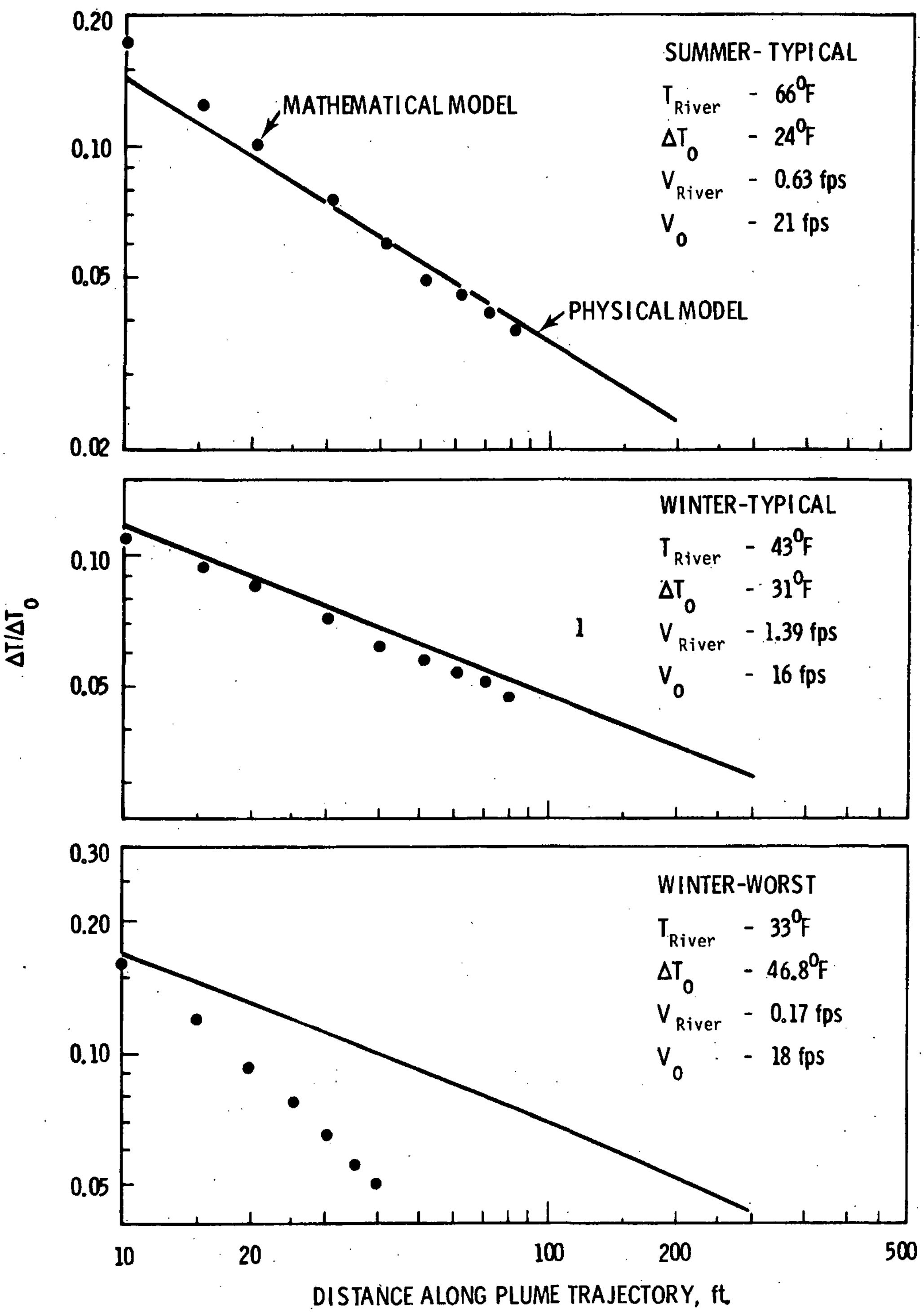


FIGURE 5.4 Comparison of Physical and Mathematical Model Studies

TABLE 5.6 Plume Predictions

Vertical Distance ft	Summer Typical ΔT °F	Summer Typical Cumulative Plume Volume ft^3	Winter Typical ΔT °F	Winter Typical Cumulative Plume Volume ft^3	Winter Worst ΔT °F	Winter Worst Cumulative Plume Volume ft^3
4.00	24.0	<1.0	31.0	<1.0	46.8	<1.0
4.01	7.3	7.8	6.2	1.3	14.0	7.6
4.03	5.4	20.7	4.6	32.8	10.5	19.2
4.05	4.5	34.7	4.2	50.6	9.1	30.9
4.07	4.1	47.7	3.7	71.3	8.5	38.3
4.10	3.7	63.2	3.4	107.1	7.5	56.1
4.30	2.6	191	2.6	275	5.3	159.0
4.50	2.2	312	2.3	425	4.4	298
4.70			2.2	471	4.0	375
5.00	1.8	630	2.0	775	3.5	575
6.00			1.7	1400	2.8	1080
7.00	1.3	1790	1.6	1570	2.5	1630
8.00			1.4	2500*	2.3	2100*
9.0	1.1	2910				
12.0	1.0	4570				
14.0	.9	5640*				

*Volume of plume when it reaches water surface.

TABLE 5.7 Provisional Maximum Temperatures Recommended as Compatible with the Well-Being of Various Fish and Their Associated Biota (FWPCA, 1968)

Maximum Temperatures (°F)	Well-Being Parameter	Fish Species
93	Growth	catfish, gar, white bass, buffalo, carpsucker, gizzard shad
90	Growth	largemouth bass, drum, bluegill, crappie
84	Growth	perch, walleye, sauger
80	Spawning, Egg Development	catfish, buffalo, gizzard shad
75	Spawning Egg Development	largemouth bass, white bass
48	Spawning, Egg Development	walleye, sauger

Table 5.8 lists the estimated effects of increasing water temperatures on the fish community of the Tennessee River (Bush et al., 1972). The Clinch River empties into the Tennessee River about 15 miles below the plant. With prolonged exposure to 32°C (89.6°F), the temperature that seems to be critical for most of the fish species, 51% of the fish species would be expected to be lost from the system. The maximum temperature predicted would be 32.5°C (90.5°F) at the point of discharge under extreme conditions (no river flow and highest water temperature and atmospheric conditions). Temperatures lethal to fish potentially could be reached at the effluent discharge point and in the extremely small area around it, but fish would need to remain in the near vicinity of the effluent discharge for an extended period of time before they would suffer mortalities from the elevated temperatures. Their ability to maintain themselves in that area for long periods is questionable because of the high current velocity (15 fps) of the plant discharge. Although fish are attracted to the discharges of thermal power plants, creating productive sites for sports fishing, the small increase in temperature over a very limited area is not expected to enhance sport fishing near the CRBRP.

TABLE 5.8 Estimated Effects of Increasing Water Temperature on the Fish Community of the Tennessee River[a] (Bush et al., 1972)

°C	°F	Species Within Preferred Temperature Range %	Species in Suboptimal Temperature Conditions[b] %	Species Expected to be Lost from the System %	Species Expected to be Lost from the System
12	53.6	100	0	0	
14	57.2	99	1	0	
16	60.8	99	1	0	
18	64.4	97	3	0	
20	68.0	96	4	0	
22	71.6	72	28	0	
24	75.2	61	39	0	
26	78.8	51	48	1	Brook trout
28	82.4	21	78	1	
30	86.0	15	81	4	Shovelnose sturgeon, brown trout
32	89.6	6	43	51	Skipjack herring, rainbow trout, blue sucker, smallmouth buffalofish, largemouth buffalofish, highfin carpsucker, carpsucker, spotted sucker, hogsucker, silver redhorse, shorthead redhorse, river redhorse, black redhorse, golden redhorse, white sucker, longnose dace, white bass, walleye, sauger, log perch, gilt darter, dusky darter, speck darter, greenside darter, Tennessee snubnose darter, Johnny darter, goldstripe darter, banded darter, redline darter, spottail darter, Cumberland fantail darter
34	93.2	1	30	69	Stoneroller, golden shiner, bluntnose minnow, river chub, blotched chub, spotfin chub, bigeye chub, common shiner, popeye shiner, mimic shiner, Tennessee shiner, silver shiner
36	96.8	0	12	88	Muskellunge, blue catfish, channel catfish, flathead catfish, brown bullhead, stonecat, smallmouth bass, black crappie, white crappie, warmouth, longear sunfish, orangespotted sunfish, redear sunfish
38	100.4	0	1	99	Gizzard shad, threadfin shad, carp, largemouth bass, spotted bass, rockbass, bluegill
40	104.0	0	0	100	White streaked killifish

(a) Based on preferred and lethal temperature data for adult and juvenile fish. Where specific data for a species were unavailable, data from closely related species were used.
(b) The temperature range above the preferred temperature and below the lethal temperature, a range in which most species of fish are considered stressed, with adverse effects on activity, growth and survival.

In summary, the staff judges the impacts from the thermal discharge upon the aquatic biota to be insignificant. The highest isotherm predicted with definable boundaries, 2.5°C (4.5°F), can occur only during the winter season under no river flow conditions and would encompass <8% of the river's cross-sectional area and <0.01 surface acre of water. Due to the small size of the plume, small rise in temperatures, small quantity of water discharged (∿5 cfs) and short exposure time, the impacts from the thermal discharge would not produce a significant change on the aquatic ecosystem.

5.3.2.3 Cold Shock

Cold shock is the thermal stress resulting from a rapid decrease in temperature that can occur immediately after plant shutdown. The most adverse result of cold shock would occur during the winter, when ΔTs are at their highest. Because the small area within the 2.5°C isotherm would not be able to support large numbers of fish, fish loss is unlikely to result from interruption of heated effluent.

5.3.2.4 Scouring

The effluent discharge was described in Section 3.4.3. Physical modeling of the discharge demonstrated that the plant would produce a localized scour hole. Under the four cases analyzed the area of the scour hole would be as follows: winter no flow, 7.2 m^2; winter average flow, 8.4 m^2; summer no flow, 6.4 m^2; and summer average flow 10 m^2. The scour hole would produce a permanent loss of habitat to the benthic macroinvertebrates. However, the staff concludes that the impact would not be significant due to the small area affected.

5.3.3 Atmospheric Heat Transfer

The visible plume from the cooling tower possibly could extend up to 6 miles from the site about 6% of time during plant operation. However, a large majority of the plumes probably would extend no more than 1.5 miles (ER, Am I, Part II, A2). The 684 MWt (0.61 x 1121 MWt) waste heat from the cooling tower would be comparable to the waste heat from the ORGDP (K-25) cooling towers (500 to 1500 MWt). Hanna (1974a) calculated that the visible plume from the K-31 and K-33 mechanical draft towers also could extend up to 6 miles. However, plumes of that length would occur with a natural cloud deck and not be very noticeable. At the K-25 location, the length of the visible plume is typically 100 to 200 meters (Hanna, 1974b). A typical plume rise range of 200 to 400 meters should occur for the various atmospheric stability classes (ER, App to Sec 10.1). Cloud development has been initiated by the K-25 cooling towers about 10% of the time (Hanna, 1974b). On one occasion, light snowfall extending many kilometers downwind of the towers was reported (Culkowski, 1962).

Major plume sources in the area of the plant include three mechanical draft cooling towers at K-25 2.5 miles from the site, and smoke plumes from the Kingston and Bull Run steam plants 9 and 15 miles from the site, respectively. Additionally, very small plume sources are located at X-10 and Y-12, on the reservation. The only interaction of plumes from those sources and the plant cooling tower plume would be from the K-25 towers. Only with a constant wind from the northern sector coupled with stable atmosphere could the K-25 plume reach lengths interacting with the plume at the site (ER, Am I, Part II, A1). Other sources are either very small (X-10 and Y-12) or at such great distance and height (Kingston and Bull Run) above the plant plume as to have negligible interaction.

The model for calculating plume length frequency employs a Gaussian equation for dispersion of water vapor and considers plume rises for various stability classes (Briggs, 1970 and 1974). Site meteorological data were used except for humidity data from Bull Run, northwest of the site. The model gives conservative results, specific for the CRBRP cooling tower.

The applicant estimated that fogging and possible icing conditions would occur about 11% of the time or approximately 40 days/yr (ER, Am I, Part II, A4). Based on this estimate, fogging conditions could occur at distances of 4.5 miles NE from the site for very short periods of time. Since natural fogging probably would exist already, the applicant's estimates are unrealistically high. Calculations of fogging for the K-25 towers predict that about 100 extra hours of fog per year would occur at distances of 100 to 200 meters from the towers when naturally occurring rain or fog is absent (Hanna, 1974a). No extra fog is predicted under the above conditions at distances greater than 2 km.

Fogging from the plant tower possibly could have some small effect on local transportation routes. Based on data supplied by the applicant (ER, Am I, Part II, A4), the staff concluded that the potential for fogging would exist 3.6 hr/yr and 2.4 hr/yr along Interstate 40 at Caney Creek and Gallaher Bridge, respectively. Additionally, the potential for fogging due to the plant tower will exist 2.4 hr/yr at ORNL. Monitoring fog and ice impact of tower operation would be a part of the technical specifications at the operating license stage.

Drift deposition was modeled using a diffusion type equation that includes the spatial rate of change in droplet concentration as a function of their radii, size changes due to evaporation or condensation, chemical concentrations, and atmospheric conditions (Roffman, et al., 1973). Plume height calculations used in drift calculations accounted for moisture in the plume and possible condensation (Hanna, 1972). Data collected at the site along with humidity data from Bull Run were used for input.

Drift from the cooling tower would have a composition similar to that of the circulating water. Based upon onsite meteorological data, a conservative drift rate of 0.05%, and a concentration of 375 mg/ℓ of total dissolved solids in the circulating water, worst-case average deposition would be about 52 lb/acre/mo, or 620 lb/acre/yr, 0.3 mile to the northeast. Estimates of the mineral content of litter-fall range from approximately 500 lb/acre/yr for cedar glade areas to 1200 lb/acre/yr for white pine plantations (ER, Am I, Part II, B1). Thus the deposition from drift would add about the same amount of minerals normally returned to the soil surface each year in cedar glade areas and about half the minerals normally cycled in a white pine plantation through litter-fall. No account was taken of mineral runoff and leaching in the soil profile. Both processes would substantially reduce the mineral quantities accumulated in the soil from drift. Drift from the K-25 towers has been extensively investigated (Lee, et al., 1973, Shofner, et al., 1973, and Hanna, 1974a). Although the K-25 area towers have a rather large drift rate (0.08 to 0.12%) as compared to that anticipated for the CRBRP tower (0.005 to 0.008%) and somewhat near the same cooling capacity, measured effects of K-25 cooling tower drift can be used to estimate CRBRP drift effects on vegetation. Growth of tobacco beyond 600 m downwind from the tower base was almost unaffected, based upon measuring leaf sizes of this comparatively sensitive plant (Jallouk, et al., 1974). The staff concludes that drift deposition from the CRBRP tower would have no important effect on vegetation or fauna.

There would be no measurable increase in rainfall or icing due to plant drift, based upon none observed from K-25 using standard collection devices.

The staff's opinion is that the impacts from operating the mechanical draft towers would be regarded primarily as minor aesthetic and nuisance factors rather than health or safety problems.

5.4 OTHER NONRADIOLOGICAL EFFLUENTS

5.4.1 Impacts of Chemical Effluents

The chemicals that will be discharged in waste water to the river were discussed in Section 3.6. Table 3.5 cites maximum and average ambient concentrations of chemicals from neutralized plant waste and sanitary waste, mass discharge, and maximum concentrations in the river under no-flow conditions. Under 30-day no river flow and maximum ambient chemical concentrations, all chemicals would be diluted to near ambient concentrations at a distance of 100 ft from the discharge point. Iron would increase by less than 20 μg/ℓ above ambient within the 100-ft radius; other chemicals would be much less. The staff's recent analysis takes into account the use of a second cooling tower and smaller cooling water needs (Section 3.3 and 3.4). Under the current plant design and a condition of no river flow and maximum ambient concentrations, discharged chemicals would be in concentrations below those reported as toxic to aquatic organisms and below concentrations found in 95% of U.S. waters supporting a good mixed fish fauna (McKee & Wolf, 1963 and Becker & Thatcher, 1973). The staff concludes that discharged chemicals would have no adverse effect on aquatic biota.

The biocide system was described in Section 3.6. Neither free available chlorine nor combined available chlorine would be discharged for more than 2 hr/day. The maximum release of total residual chlorine would not exceed 0.5 mg/ℓ and the average would not exceed 0.2 mg/ℓ during the 2-hr period (Appendix H, p. 2). A total chlorine residual of 0.2 mg/ℓ for 2 hours or less per day is considered acceptable for warm water fish species in the vicinity of power plant discharges (Brungs, 1973). Because of evaporative qualities of cooling towers, reducing agents found in circulating water and intermittent discharges involving small areas, the staff concludes that the total residual chlorine concentrations would meet all Federal and State regulations and would not have significant effects upon aquatic biota.

5.4.2 Sanitary and Other Waste

The applicant's sanitary and other waste systems were described in Section 3.7. Based on a review of the proposed systems, the staff concludes that impacts from the sanitary and other waste effluents would have an insignificant effect upon aquatic biota. The systems are designed to meet the criteria of the Tennessee Water Quality Control Board. The treated effluents discharged would meet all applicable Federal and State regulations.

Plant chemicals would not be discharged on land, except in cooling tower drift (Section 5.3.3). Sewage sludge would be trucked for approved disposal offsite. Gaseous pollutants from emergency diesel generators and the diesel fire pump would be well within SO_2, NO_x, and particulate limits. Tennessee standards for nonprocess pollutants are based upon a plant's heat input to one or more stacks. Based upon CRBRP's 1.9 million Btu/hr release, the allowable emissions are more than three times expected plant emissions (Section 3.7.2: SO_2, 0.8 lb/hr (maximum 2-hr average) and particulates, 0.6 lb/hr (TN Dept of Public Health). NO_x standards apply only for heat outputs of 250 million Btu/hr and greater. Standards have not been set for nonprocess CO emission. The staff's conclusion is that no adverse environmental effects would result from operation of the diesel generators and the fire pump.

5.5 TRANSMISSION LINES

Insignificantly adverse visual impacts would result from the 3 miles of new lines on expansions of existing rights-of-way. The lines would be visible only from short distances along nearby highways serving the industrial area.

The applicant plans to control vegetation growth by mechanical cutting every 4 or 5 years at the 1-ft level and by limited use of Tordon 10K pellets, hand applied to occasional stumps (ER Am I, Part II, B2). Each year TVA's herbicide use practices are submitted to the Federal Working Group on Pest Management for official approval. Protective vegetation would be maintained along stream banks. After emergency maintenance, rutting would be repaired and disturbed drainage restored (ER Am I, Part II, G9).

The staff expects no adverse impacts from the hand application of Tordon 10K herbicide. Immediately after cutting brush, quail and other species preferring open areas would be favored. As the vegetation grows up, songbirds and game birds would be favored. Towards the end of the 4- to 5-yr maintenance cycle, the tall brush would discourage the species preferring open areas. There would be minimal impact on the 46 acres of presently unforested land, since the corridors would be maintained as an open shrubby area.

In the staff's opinion, the planned erosion control practices at stream banks and following emergency maintenance (Section 3.8) would minimize adverse impacts.

Ozone (O_3) can form in the air as a result of corona discharge around high-voltage transmission lines, particularly during wet weather. Ozone also occurs naturally, produced mainly by ultraviolet radiation and lightning discharges. Ozone is a major component of photochemical "smog". Ground-level ozone concentrations in areas distant from urban pollution generally range between 10 and 50 ppb (parts per billion) (Darley, 1966; Treshaw, 1970). The Environmental Protection Agency established the national primary air quality standard for oxidants as 80 ppb by volume (maximum arithmetic mean) for a 1-hr concentration not to be exceeded more than once per year (40 CFR 52). Ozone is known to be injurious to vegetation and animals (including humans) when concentrations exceed 50 ppb for prolonged periods (Stern). To date, however, there is no clear evidence that damage has occurred in the vicinity of high-voltage transmission lines. Analysis at two 500-kV transmission lines on a particular day in April 1972 indicated O_3 concentrations of 210 ppb at the edge of the right-of-way and 230 ppb at the center. "Background" concentration was given as 20 ppb. Two months later, measurements at the same site, a depression about 350 yards across, indicated a "background" ozone concentration of 12 ppb, with 22 ppb at the edge of the right-of-way and 25 ppb at the center. The authors attributed the high concentrations during April to a moderate temperature inversion (ORNL-4848, 1972). Corona effects and ozone production are known to increase in wet weather, which often prevails at the CRBRP site; however the staff anticipates no significant impact from operation of the 161 kV lines.

Transmission line operation creates potential for adverse effects from audible noise, corona, radio and television interference, and electrostatic induction. However, experience with 161 kV lines on the TVA system shows that the effects are minimal (ER, Sec 5.6). The staff expects no adverse impacts having any significant consequence.

5.6 COMMUNITY IMPACTS

The socioeconomic impacts during the operational phase will arise mainly from absorption of the operating work force into the existing community. The applicant estimates a plant operations force of about 180 during the demonstration period and a project office force tapering from 145 to 60. In the staff's judgment, a higher fraction of these workers will be in-movers than for the construction labor force because of the specialized nature of the work. However, the staff also notes that many of these workers will have moved into the area during the construction period in order to begin training; hence, their initial arrival in the community would be a construction phase impact.

Another distinction between construction phase and demonstration phase effects is the probable distribution of the in-movers. Based on the experience of Oak Ridge-ERDA operations, a substantial number of professional employees elect to live in permanent housing in the cities of Knoxville and Oak Ridge. In the opinion of the staff, this pattern would also be true for the demonstration phase workers.

In order to determine the combined socioeconomic effect of the operational phase without regard to the fraction of in-movers or place of residence, the staff constructed the following hypothesis:

Single adult workers	120
Married adult workers	360
Subtotal - Adult work force	480
Spouses	360
School aged children	290
Nonschool aged dependents	70
Total new population	1200

The adult work force of 480 derives from an average of 275 primary workers and 205 service workers (using a multiplier of 0.75). This value is in the range used by the applicant for 1984 (593) and for 1988 (425) in ER Tables 8.2-1 and 8.2-3.

The permanent population attributable to the project thus is estimated to be 1200 people, including 480 wage earners. The staff estimates that the new permanent population would require the facilities and services listed in Table 5.9. New services would not be provided in fractional quantities as tabulated. Communities generally wait until services are strained and then correct in quantum jumps, possible over-correcting for a time.

TABLE 5.9 Community Services Required by Permanent Employment (Direct & Induced) Resulting from CRBRP Operation

Service or Facility	Factor	Required by Population of 1200 Persons
School teachers	1/20 students	14 teachers
Other school staff	1/60 students	5 other school staff
Hospital beds	1/475 persons	2.5 hospital beds
Parks and playgrounds	1 acre/100 persons	12 acres
Library	1/25,000 persons	0.05 library
Fire stations	1/15,000 persons	0.08 fire stations
City employees	1/75 persons	16 city employees
Water treatment plant	60 gpd/person	72,000 gpd capacity
Sewage treatment plant	60 gpd/person	72,000 gpd capacity

The payroll effect of this population is estimated by the staff to be $46.3 million during the five-year demonstration period (Table 4.8), of which about $20 million would flow to the local economy. For the remaining plant life, the sum of the direct and induced payroll effect would be about $5.3 million/yr, with about $2.2 million flowing to the local economy. (All dollars are present value.)

5.6.1 Taxes

The project would not contribute directly to the tax base of the local area through the payment of property (plant and land) taxes. That leaves three possible revenue sources by which the project would help meet the increased public spending load in the local area as a result of operation of the project: direct and indirect taxes from payroll and spending, ERDA in-lieu-of-tax payments, and PL 81-874 payments to schools.

Taxes from Payroll Spending

The major source of tax revenue generated by the project would be the Tennessee State sales tax which is levied at a rate of 4.5% on designated items. Local communities can add to that collection an additional 1.5% maximum, which is returned to counties and often used for school systems support. For example, throughout Roane County, a 1% levy is assessed (except for Harriman, which uses a 1.5% rate), producing $775,000 in 1974, 9.26% of total county revenues (Budget, 1974). Similarly, in 1974, Loudon County collected $275,000, 6.4% of total revenues (Budget, 1975).

The staff's estimate of the present value of the total state sales tax generated from payroll spending by the direct and secondary workers associated with operation of the plant between 1984 and 1988 would be about $875,000. If the maximum rate of 1.5% is applied, the present value of the local sales tax could be about $290,000. The state sales tax value is derived from the present value of the total payroll in 1983 through 1988 (Table 4.8) by assuming 42% of payroll spent on taxable items and a tax rate of 4.5%. The value is consistent with the allowance by the Internal Revenue Service of a $155/yr deduction for Tennessee sales tax for a family of 3 with an annual income of $10,500.

There would be other sources of tax revenues as a result of the CRBRP payroll. Gas taxes, hotel and motel privilege tax, cigarette taxes, and liquor taxes are examples. The work force also would make some contribution to the real estate tax base either directly as property owners, or indirectly through the payment of rent. The effect of real estate taxes would depend on how much low tax base land is converted to high tax base land by construction of homes or apartments. The total value of such taxes is difficult to estimate because of the uncertainty of property assessment in the future.

In-Lieu-of-Tax Payments

The Supreme Court decision in the case of McCulloch versus Maryland (1819) firmly established the immunity of the Federal Government from taxation by the States. In practice, however, the Congress has recognized that the creation of a federal project on land formerly taxable by local government can create an inequity by reducing local tax base and federal agencies often have made some financial compensation in cases such as that of CRBRP. The Atomic Energy Act of 1954 and the Atomic Energy Community Act of 1955 establish the conditions for ERDA in-lieu-of-tax payments. The Tennessee Valley Authority Act of May 18, 1933, establishes a system of payments to states and localities affected by TVA projects.

In the case of the CRBRP, ERDA has authorization to make in-lieu-of-tax payments to Roane County, Anderson County, and the City of Oak Ridge. (See Appendix F.) TVA, although an applicant, is immune from in-lieu-of-tax payments for the CRBRP by virtue of the fact that TVA is not currently an owner of the project. This situation could change during the post-demonstration period if TVA took over the plant.

PL 81-874 Payments

Using an estimate of about 42% of school operating funds coming from local sources, an average per pupil cost of $1 thousand/yr, and a PL 81-874 rate of 45% of local contribution, each project-connected pupil could result in about $190/yr for his school district. If 55-60% of the 290 school aged children hypothesized above from both direct and indirect employment were eligible for PL 81-874 support, the total revenue generated during the demonstration phase would be about $32,000/yr.

5.7 RADIOLOGICAL IMPACTS

5.7.1 Radiological Impact on Biota Other Than Man

5.7.1.1 Exposure Pathways

The pathways by which biota other than man may receive radiation doses in the vicinity of nuclear power plants are shown in Figure 5.5. Two comprehensive reports explain radioactivity in the environment and these pathways (NAS-NRC, 1971; Carner, 1971). Depending on the pathway being considered, terrestrial and aquatic organisms receive either approximately the same radiation doses as man or somewhat greater doses. Although no guidelines have been established to set acceptable limits for radiation exposure to species other than man, the limits established for humans generally are agreed to be conservative for other species (Auerbach, 1971).

5.7.1.2 Radioactivity in the Environment

The staff estimated the quantities and species of radionuclides expected to be discharged annually by the CRBRP in liquid and gaseous effluents. The estimates are given in Tables 3.3 and 3.4, respectively. Their basis is discussed in Section 3.5. For the determination of doses to biota other than man, specific calculations were made primarily for the liquid effluents. The liquid effluent quantitites, when diluted in the plant's discharge, would produce an average gross activity concentration, excluding tritium, of 4.8×10^{-4} pCi/mℓ in the plant discharge area. Under the same conditions, the tritium concentration would be 10 pCi/mℓ. Additional discussion concerning liquid dilution is presented in Section 5.7.2.

Doses to terrestrial animals such as rabbits or deer due to the gaseous effluents are quite similar to those calculated for man. For this reason, both the gaseous effluent concentrations at locations of interest and the dose calculations for gaseous effluents are discussed in detail in Section 5.7.2.

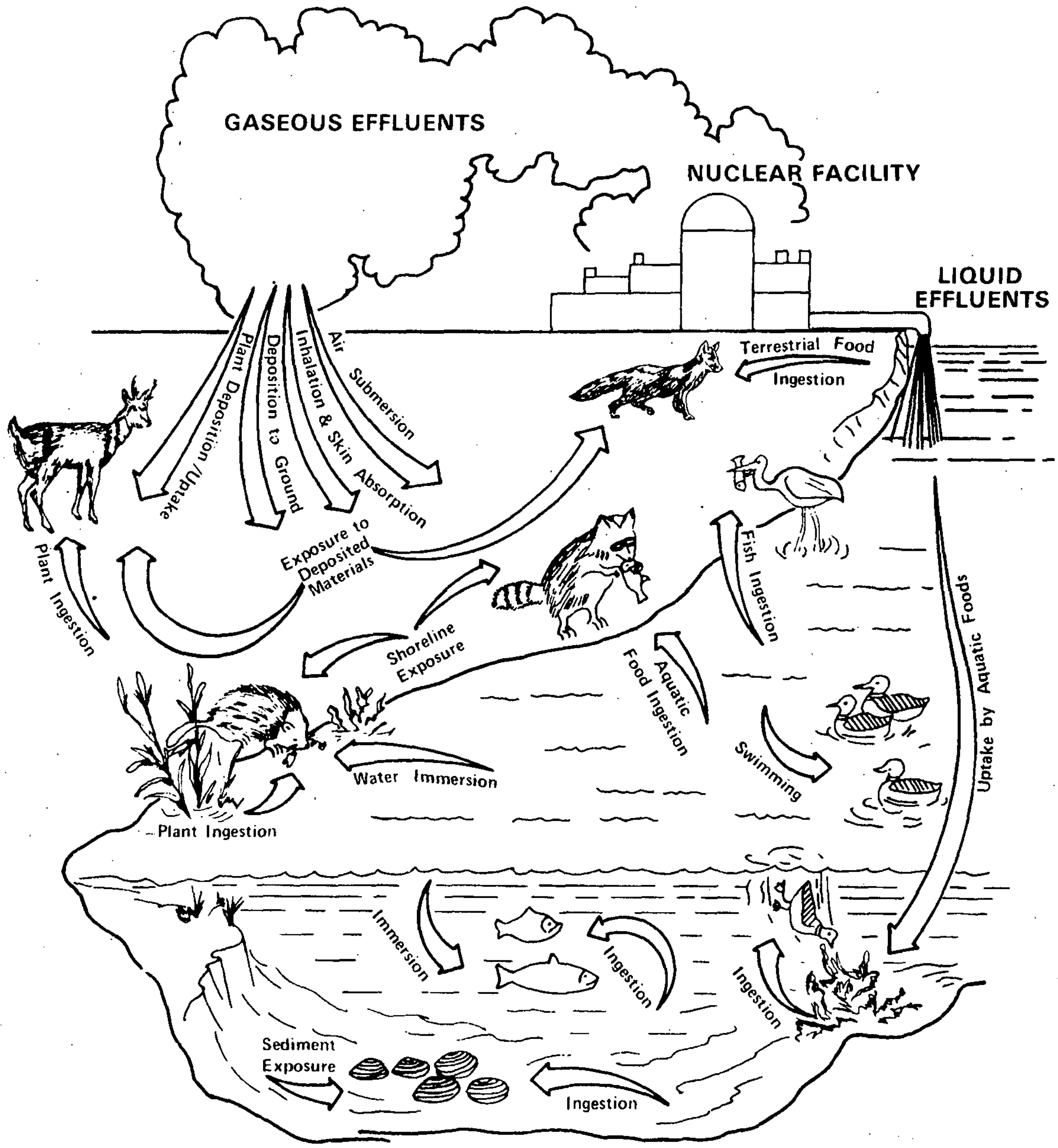


FIGURE 5.5 Exposure Pathways to Biota Other than Man

5.7.1.3 Dose Rate Estimates

The annual radiation doses to both aquatic and terrestrial biota were estimated on the assumption of constant concentrations of radionuclides at a given point in both water and air. Radiation dose has both internal and external components (Figure 5.5). External components originate from immersion in radioactive air and water and from exposure to radioactive sources on surfaces, in distant volumes of air and water and in equipment. Internal exposures result from ingesting and breathing radioactivity.

Doses would be delivered to aquatic organisms living in the water containing radionuclides discharged from the power plant, principally as a consequence of physiological mechanisms concentrating a number of elements that can be present in the aqueous environment. The extent to which elements would be concentrated in fish, invertebrates, and aquatic plants upon uptake or ingestion has been estimated. Values of relative biological accumulation factors (ratio of concentration of nuclide in organisms to that in the aqueous environment) of a number of waterborne elements for several organisms are provided in Table 5.10.

TABLE 5.10 Freshwater Bioaccumulation Factors[a]

	pCi/kg Organism Per pCi/liter water		
Elements	Fish	Invertebrates	Plants
C	4550	9100	4550
Na	100	200	500
P	100000	20000	500000
Sc	2	1000	10000
Cr	200	2000	4000
Mn	400	90000	10000
Fe	100	3200	1000
Co	50	200	200
Ni	100	100	50
Zn	2000	10000	20000
Rb	2000	1000	1000
Sr	30	100	500
Y	25	1000	5000
Zr	3	7	1000
Nb	30000	100	800
Mo	10	10	1000
Tc	15	5	40
Ru	10	300	2000
Rh	10	300	200
Ag	2	770	200
Sn	3000	1000	100
Sb	1	10	1500
Te	400	150	100
I	15	5	40
Cs	2000	100	500
Ba	4	200	500
La	25	1000	5000
Ce	1	1000	4000
Pr	25	1000	5000
Nd	25	1000	5000
Pm	25	1000	5000
Sm	25	1000	5000
Cu	25	1000	5000
Gd	25	1000	5000
W	1200	10	1200
Np	10	400	300
Pu	4	100	350
Am	25	1000	5000
Cm	25	1000	5000

(a) From Report UCRL-50564, Rev. 1

Doses to aquatic plants and fish living in the discharge region due to water uptake and ingestion (internal exposure) were calculated to be 4.1 and 2.1 mrads/year respectively for the plant's operation. The discharge region concentrations were those given in Section 5.7.1.2 and the staff assumed that the organisms would spend all of the year in water at maximum concentrations. All calculated doses are based on standard models (ICRP-II, WASH-1258). The doses are quite conservative since the mobile life forms are highly unlikely to spend a significant portion of their life span in the maximum activity concentration of the discharge region. Both radioactive decay and additional dilution would reduce the dose at other points in the river.

External doses to terrestrial animals other than man are determined on the basis of gaseous effluent concentrations and direct radiation contributions at the locations where such animals in the environs of the station would receive approximately the same external radiation doses as those calculated for man. For example, a deer living at the site boundary in the WSW direction would receive a whole body dose of 0.37 mrad/year due to immersion in CRBRP gaseous effluents.

An estimate can be made for the ingestion dose to a terrestrial animal, such as a duck, which is assumed to consume only aquatic vegetation growing in the water in the discharge region. The duck ingestion dose was calculated to be about 6.4 mrads/year, which represents an upper limit estimate since equilibrium was assumed to exist between the aquatic organisms and all radionuclides in water. A nonequilibrium condition for a radionuclide in an actual exposure situation would result in a smaller bioaccumulation and therefore a smaller dose from internal exposure.

The literature relating to radiation effects on organisms is extensive, but very few studies have been conducted on the effects of continuous low-level exposure to radiation from ingested radionuclides on natural aquatic or terrestrial populations. The most recent and pertinent studies point out that, while the existence of extremely radiosensitive biota is possible and while increased radiosensitivity in organisms may result from environmental interactions, no biota have yet been discovered that show a sensitivity to radiation exposures as low as those anticipated in the area surrounding the Clinch River plant. In summary, evidence to date indicates that no other living organisms are very much more radiosensitive than man (NAS-NRC, 1972). Therefore, no detectable radiological impact is expected in aquatic biota or terrestrial mammals as a result of the quantity of radionuclides to be released into the river and into the air by the plant.

5.7.2 Radiological Impact on Man

5.7.2.1 Exposure Pathways

Routine operation of the plant would result in the release of small quantities of fission and activation products to the environment. This evaluation provides dose estimates which can serve as a basis for a determination that releases to unrestricted areas are as low as practicable in accordance with 10 CFR Part 50 and within the limits specified in 10 CFR Part 20. The staff estimated the probable radionuclide releases from the plant based upon an evaluation of the radwaste system (Section 3.5).

Estimations were made of radiation doses to man at and beyond the site boundary via the most significant pathways among those diagrammed in Figure 5.6. The calculations are based on conservative assumptions regarding the dilutions of radionuclides in the liquid discharge and effluent gases, and the use by man of the plant surroundings. In general, radiation doses calculated by the staff are intended to apply to an adult whose ingestion rates and usage of the plant environs are above average. Where age dependent variables resulting in a significantly higher dose to a teen, child or infant apply, they are used. Specific persons would receive higher or lower doses, depending upon their ages, living habits, food preferences, and recreational activities.

Based on experience at operating light water reactors and the staff's preliminary judgment that the magnitude of occupational radiation exposures at liquid metal breeder reactors should not be substantially different from those experienced at light water reactors, an estimate was made of the occupational radiation exposures expected to result from plant operation (Section 5.7.2.5).

5.7.2.2 Liquid Effluents

Expected radionuclide releases in the liquid effluent were calculated for the plant and are listed in Table 3.3. In the immediate vicinity of the plant discharge, the gross activity concentration, exclusive of tritium, is estimated to be 4.8×10^{-4} pCi/mℓ. Under the same conditions the tritium concentration would be 10 pCi/mℓ.

The nearest potable water intake on the Clinch River is 1.6 miles downstream of the plant site for the Oak Ridge Gaseous Diffusion Plant. The dose to an individual who receives half of his water from that intake was evaluated (Table 5.11). The dose to a hypothetical individual who receives his drinking water from the plant discharge region was estimated to be 1 mrem/yr. There are no irrigation water intakes on the Clinch River downstream of the plant, however, some cattle receive part of their drinking water from the river. The potential doses to man from ingesting beef and milk from such cattle were therefore evaluated.

Other pathways of relative importance involve recreational use of the river in the vicinity of the discharge zone. Potential individual doses from consuming fish or invertebrates caught in the immediate discharge area were also evaluated using the biological accumulation factors listed

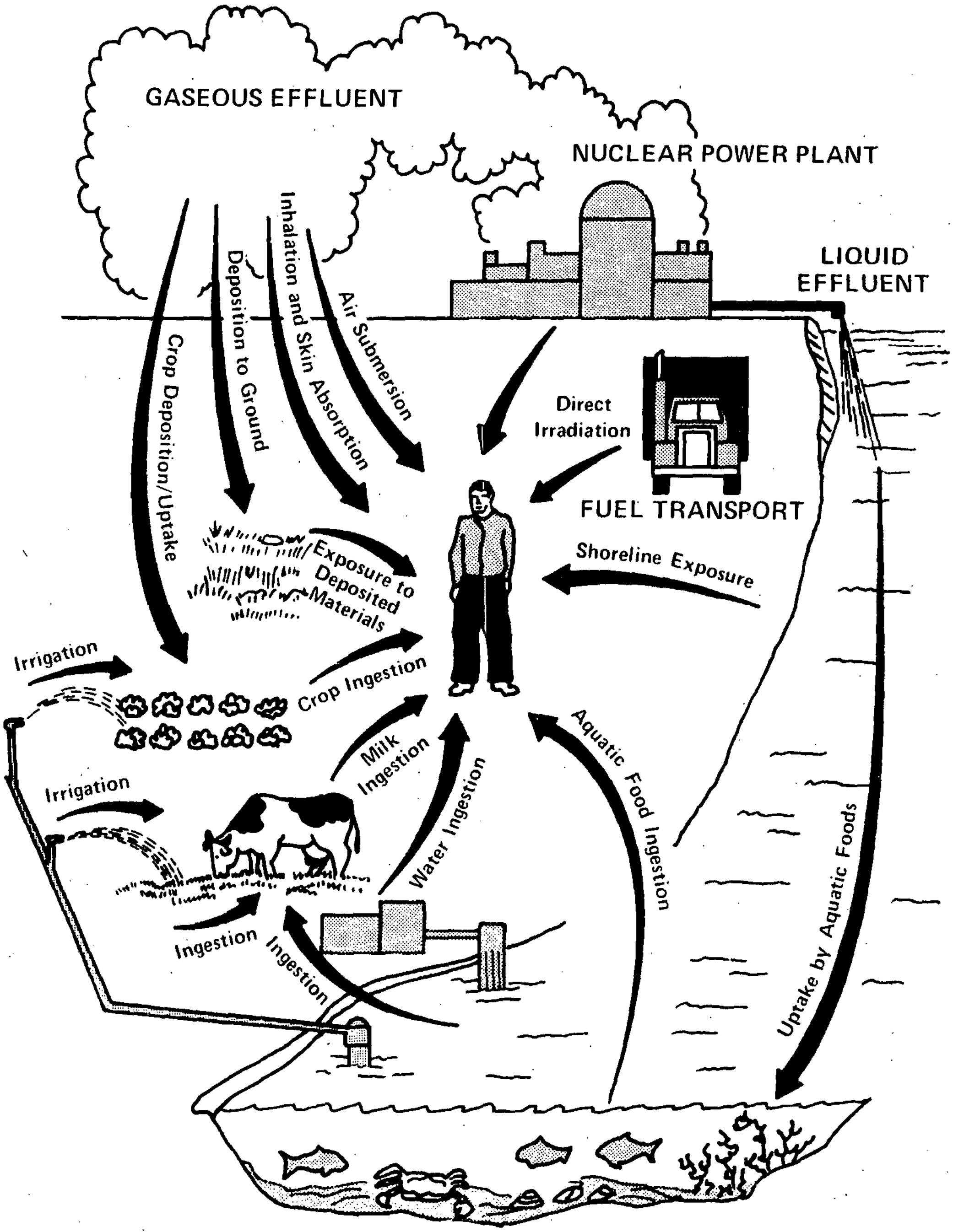


FIGURE 5.6 Pathways of Radiation to Man

in Table 5.10 and standard models (ICRP-II, Reg. Guide 1.109). Humans are not expected to consume Clinch River invertebrates. However, if someone did consume 5 kg/yr of invertebrates caught in the discharge region, his dose rate would be 2.5×10^{-2} mrem/yr. Potential individual doses from swimming, boating, and shoreline recreation in the discharge region were also evaluated. Table 5.11 summarizes the potential individual doses from liquid effluents. The radionuclides primarily responsible for the quoted doses are tritium, cesium, strontium, cobalt and tellurium. In all cases, the plutonium radioisotopes would contribute less than 1% to the quoted doses.

5.7.2.3 Gaseous Effluents

Radioactive effluents released to the atmosphere from the plant would result in small radiation doses to the public. Staff estimates of the probable gaseous releases listed in Table 3.4 were used to evaluate potential doses. All dose calculations were performed using annual average site meteorological conditions and assuming that releases would occur at a constant rate. Doses resulting from near-ground releases of radioactive gases were calculated by considering immersion in the gases, inhalation of the gases, and ingestion of food from pathways exposed to the gases (Slade, 1968; Reg. Guide 1.109). Two food pathways to man would involve the ingestion by dairy and beef cattle of tritium absorbed by grass in grazing areas. The doses to an infant from ingesting milk and an adult from ingesting beef from cattle grazing at the site boundary were calculated using recognized models (Reg. Guide 1.109). The following assumptions were used: the cattle grazed 12 mo/yr, an infant's milk consumption is 330 ℓ/yr, and an adult's meat consumption is 110 kg/yr.

Another food pathway to man would involve the consumption of vegetables absorbing tritium released into the atmosphere by the plant. The dose to an adult consuming 410 kg/yr of vegetables grown at the site boundary was calculated. All doses due to gaseous effluents are summarized in Table 5.12.

TABLE 5.11 Annual Individual Doses from Liquid Effluents

		Dose, mrem/yr			
Location	Pathway	Total Body	GI Tract	Thyroid	Bone
Coolant discharge region	Fish ingestion (21 kg/yr)	5.5×10^{-2}	5.6×10^{-2}	6.3×10^{-2}	3.8×10^{-2}
	Beef ingestion (110 kg/yr)	1.5×10^{-1}	1.5×10^{-1}	1.5×10^{-1}	1.1×10^{-4}
	Swimming (100 hrs/yr)	2.7×10^{-4}			
	Boating (100 hrs/yr)	1.4×10^{-4}			
	Shoreline activities (500 hrs/yr)	3.8×10^{-3}			
	Milk[a] ingestion (330 ℓ/yr)	9.9×10^{-1}	9.9×10^{-1}	1.0	2.5×10^{-3}
Oak Ridge Gas Diffusion Plant Intake	Water ingestion (370 kg/yr)	1.3×10^{-2}	1.3×10^{-2}	1.4×10^{-2}	1.2×10^{-4}

[a] These dose rates are for an infant.

TABLE 5.12 Annual Individual Doses due to Gaseous Effluents at Site Boundary[(a)]

Pathway	Dose, mrem/yr Total Body	Skin	Thyroid
Plume	3.7×10^{-1}	2.3	3.7×10^{-1}
Inhalation	1.1×10^{-2}	1.1×10^{-2}	1.1×10^{-2}
Vegetable, meat, and milk food chains	4.4×10^{-2}	4.4×10^{-2}	4.4×10^{-2}

(a) (0.4 miles SSW), $X/Q = 1.1 \times 10^{-4}$ sec/m^3.

5.7.2.4 Direct Radiation from the Facility

Normal reactor power plant operations result in some human exposure to direct radiation (i.e., radiation from contained sources). A principal source of human exposure to direct radiation that would result from operation of the Clinch River plant would be the sodium-24 produced by neutron activation of the liquid metal coolant.

The plant design includes specific shielding of the reactor, holdup tanks, filters, demineralizers and other areas where radioactive materials may flow or be stored, primarily for the protection of plant personnel. Direct radiation from those sources is therefore not expected to be significant at the site boundary. Confirming measurements would be required as part of the applicant's environmental monitoring program after plant startup.

5.7.2.5 Occupational Radiation Exposure

Based on a review of the applicant's Safety Analysis Report, the staff determined that individual occupational doses can be maintained within the limits of 10 CFR Part 20. The radiation dose limits in 10 CFR Part 20 are based on thorough consideration of the biological risk of exposure to ionizing radiation. In the PSAR, the applicant estimated a total occupational radiation dose of about 300 man-rems, using projected occupancies and anticipated operations involving personnel in radiation areas, and projected design radiation levels at CRBRP. This is considered a reasonable estimate of expected occupational radiation exposure for those activities considered under the conditions assumed. Since there are several factors that cannot be predicted at this time (including frequency and magnitude of maintenance), a conservative occupational radiation exposure of 1000 man-rem is used for this impact statement.

5.7.2.6 Transportation of Radioactive Materials

The transportation of fresh fuel to a reactor, of spent fuel from the reactor to a fuel reprocessing plant, and of solid radioactive wastes from the reactor to burial grounds is discussed generically for light-water reactors in AEC's WASH-1238 report entitled, "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants." While much of the information in the report is applicable to the transportation requirements of the Clinch River Breeder Reactor Plant, there will be differences in environmental impact due to the much smaller rating of the CRBRP (439 MWe maximum vs 1100 MWe for a typical LWR), its use of plutonium-uranium mixed oxide fuel, and the relatively high number of shipments during its demonstration period. The staff has therefore analyzed the transportation effects in its consideration of the CRBRP fuel cycle (see Appendix D of this statement).

As shown in Table 7 of Appendix D, the cumulative radiation dose to transport workers and the general population along the assumed 750 miles of transportation routes is estimated to be 17 man-rem annually during the 5-year demonstration period; it would be less during the equilibrium period of operation.

5.7.2.7 Fuel Cycle Impacts

Environmental impacts from the fuel cycle facilities supporting the CRBRP and from the transportation of materials between such facilities have been considered by the staff and the results are presented in Appendix D. Table 2 of Appendix D shows the various effluents and their sources. As indicated in Table 3, the highest individual total-body dose expected is 10 millirem/year (probably to a transport worker). As shown in Table 4, the annual dose to the U.S. population would be on the order of 16 man-rem.

5.7.2.8 Summary of Population Annual Radiation Doses

The cumulative dose (man-rem) due to gaseous effluents to all individuals living within a 50-mi radius of the plant was calculated using a projected population of 987,000 persons in the year 2010 (Section 2.2).

The cumulative dose (man-rem) resulting from drinking water taken from Clinch River and its tributaries was estimated. The staff assumed that 28,000 people received their drinking water from Clinch River intakes where the discharge would be fully diluted by a factor of 670 over the unmixed plant discharge.

The cumulative dose (man-rem) resulting from the consumption of fish caught downstream of the plant was estimated. The staff assumed that 4.5×10^4 kg of fish would be caught downstream of the plant where the discharge would be fully diluted by a factor of 670 over the unmixed plant discharge. The staff assumed also that the entire fish catch would be consumed by the population within the 50-mi radius.

The cumulative dose (man-rem) received from recreation by the total population was estimated by assuming that 25% of the 50-mi population would engage in 8 hr/yr each of shoreline activities, boating, and swimming (50 hr/yr for teens, 9 hr/yr for children) in the river where full dilution had taken place.

The cumulative dose (man-rem) received by the 50-mi population from ingestion of milk and beef was estimated by assuming that 1% of the milk and beef cattle would drink their water from the river where full dilution had taken place. The staff also assumed that all of the milk and beef produced from those cattle would be consumed by the 50-mi population.

The U.S. population dose associated with the export of food crops produced within the 50-mile region and atmospheric and hydrospheric transport of the more mobile effluent species such as noble gases and tritium have been considered. Beyond 50 miles, and until the gaseous effluent reaches the northeastern corner of the U.S., it is assumed that all the noble gases and tritium are dispersed uniformly. Decay in transit was also considered. Beyond this point, noble gases having a half-life greater than one year (e.g., Kr-85) were assumed to completely mix in the world troposhere. Tritium was assumed to mix uniformly in the world hydrosphere.

Beyond 50 miles, it was assumed that all the liquid effluent nuclides except tritium have deposited on the sediments so they make no further contribution to population exposures. The tritium was assumed to mix uniformly in the world hydrosphere.

Beyond 50 miles, the only liquid pathway which could add a potentially significant amount of population dose to U.S. population is the drinking water pathway. It was assumed that 1% of the U.S. population receives their drinking water from the Tennessee and Mississippi Rivers downstream of the Clinch River.

The estimated dose to the 50-mi population and the U.S. population from all sources, including natural background, gaseous effluents, consumption of fish, recreation, transportation, and occupational exposure, are presented in Table 5.13. Also shown in the table for completeness of information is annual population dose expected from the CRBRP supporting fuel-cycle facilities.

5.7.3 Evaluation of Radiological Impact

The average annual total-body dose to an individual living, playing, and working at the site boundary and eating fish, beef, and milk exposed to plant effluents by various pathways would be 1.6 mrem/yr. This value, which is less than 2% of the natural background exposure of 0.1 rem/yr (Oakley, 1972), is below the normal variation in background dose, and represents no radiological impact. The average dose to other individuals in the 50-mi population would be significantly less than 1.6 mrem/yr.

Using conservative assumptions, a total dose of about 0.29 man-rem/yr would be received by the estimated 2010 population of 987,000 living in unrestricted areas within a 50-mi radius of the plant. By comparison, an annual total of about 9.9×10^4 man-rem is delivered to the same population as a result of the average natural background dose rate of about 0.1 rem/yr. Also, the 1000 man-rem estimated as occupational onsite exposure is about 1% of this annual total background dose.

TABLE 5.13 Summary of Annual Whole Body Doses to the Population in the Year 2010

Category	Population Dose (man-rem/yr) Population within 50 miles	U.S. Population
Natural Environmental Radioactivity	9.9×10^4	2.8×10^7 (d)
Nuclear Plant Operation		
Plant work force	(c)	1.0×10^3
General public		
Gaseous	1.7×10^{-1}	2.1×10^{-1}
Fish ingestion	8.4×10^{-4}	8.4×10^{-4}
Recreation (fishing, swimming, boating)	3.1×10^{-4}	3.1×10^{-4}
Water ingestion	1.0×10^{-1}	2.0×10^{-1}
Beef ingestion	8.0×10^{-3}	1.2×10^{-2}
Milk ingestion	1.4×10^{-2}	1.8×10^{-2}
Transportation of nuclear fuel and radioactive waste[a]	-	1.7×10
Supporting Fuel Cycle Facilities[b]	-	1.6×10

[a] Most of this dose would be received outside of the 50-mi radius since it accrues mainly to transport workers and the balance to persons who live along the entire shipping routes (see Appendix D, p. D-13).

[b] This dose would probably be received entirely outside the 50-mi radius of the site.

[c] A large portion of the 1.0×10^3 man-rem to the U.S. population would be received by the population within 50 miles.

[d] Based upon year 2010 projected population from "Population Estimates and Projections," Series II, U.S. Department of Commerce, Bureau of the Census, Series P-25, No. 541 (Feb. 1975).

Most of the 17 man-rem annual dose from transport of radioactive materials to and from the plant and probably all of the 16 man-rem annual dose from supporting fuel cycle facilities would be received outside the 50-mile radius of the plant. Using conservative assumptions, a total dose of about 34 man-rem/yr would be received by the estimated 2010 population of 280,000,000 living within the United States. By comparison, an annual total of about 28,000,000 man-rem is delivered to the same population as a result of the average natural background dose rate of about 0.1 rem/yr.

6. ENVIRONMENTAL MEASUREMENT AND MONITORING PROGRAMS

6.1 PREOPERATIONAL

6.1.1 Hydrological

This subject is included in Section 6.1.5, Physical and Chemical.

6.1.2 Radiological

The applicant proposed an offsite preoperational radiological monitoring program identifying background levels of radiation and radioactivity in the plant environs. The program would permit the applicant to train personnel and evaluate procedures, equipment and techniques, as indicated in Regulatory Guide 4.1. A description of the applicant's proposed program, to be started two years before plant operation, is summarized in Table 6.1 with sampling locations shown in Figures 6.1 and 6.2. More detailed information is in the ER Sec 6.2. The staff considers the proposed program adequate.

Table 6.1 Radiological Environmental Monitoring Program

Sample Type	Number of Samples and Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
• Airborne particulates	• 4 samples offsite in sectors of highest wind frequency	• Continuous sampler operation with weekly sample collection	• Weekly-gross beta, gross alpha • Monthly composite-gamma scan, Pu, U
	• 9 samples within 10 miles in sectors of highest wind frequency		
	• 2 control samples		
• Airborne Radioiodine	• Same as airborne particulate locations	• Same as airborne particulates	• I-131
• Heavy particulate fallout	• Same as airborne particulate locations	• Continuous sampler operation	• Monthly composite-gross beta, gross alpha
• Rainwater	• Same as airborne particulate locations	• Continuous sampler operation	• Monthly composite-gross beta, gamma scan, Sr-89, 90, H-3
• Airborne moisture	• 4 samples at local airborne particulate locations	• Continuous sampler operation	• Biweekly composite- H-3
	• 1 control sample		

Table 6.1 Radiological Environmental Monitoring Program (Continued)

Sample Type	Number of Samples and Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
• Soil	• Same as airborne particulate locations	• Quarterly	• Gross beta • Gross alpha • Gamma scan • Pu • U
• Direct radiation	• Same as airborne particulate locations	• Quarterly	• Thermoluminescent dosimeters
• Vegetation	• Same as airborne particulate	• Quarterly	• Gross beta • Heavy metal total alpha • Gamma scan • Sr-89, 90 • Pu
• Pasturage grass	• Nearby dairy farms	• Monthly	• Same as vegetation analyses
• Beef		• Based on trigger levels in pasture grass	
• Milk	• Nearby milk animals	• Monthly	• Gamma scan • Sr-89, 90 • I-131
		• Weekly during pasture months	• I-131
• Groundwater	• Nearby wells	• Monthly	• Gross beta • Gross alpha • Gamma scan • H-3
• Food crops	• Nearby farms	• Annually	• Gross beta • Heavy metal total alpha • Gamma scan • Sr-89, 90 • Pu
• Surface water	• All potable water intakes within 10 miles downstream	• Automatic sequential sampling, collected monthly	• Gross beta • Gross alpha • Gamma scan • H-3 • Pu
	• Samples at Clinch River miles 14.4, 15.4, 18.6, 24.0	• Same as above	• Gross beta • Gross alpha • Gamma scan • H-3 • Sr-89, 90 • Pu and U (one downstream sample and one upstream sample)

Table 6.1 Radiological Environmental Monitoring Program (Continued)

Sample Type	Number of Samples and Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
• Fish	• Upstream and downstream of Melton Hill Dam	• Quarterly	• Recreational-gross beta • gross alpha • gamma scan • Commercial same as recreational plus Sr-89, 90 and PU
• Periphyton	• Samples at Clinch River miles 14.4, 15.4, 17.9, 24.0	• Monthly	• Quarterly composite- • Gross beta • Gross alpha • Gamma scan • Sr-89, 90
• Sediment	• Same as periphyton locations	• Quarterly	• Same as commercial fish analysis
• Asiatic clams	• Same as periphyton locations	• Quarterly	• Shell-Sr-89, 90, Pu • Edible portion-gross beta gross alpha gross scan

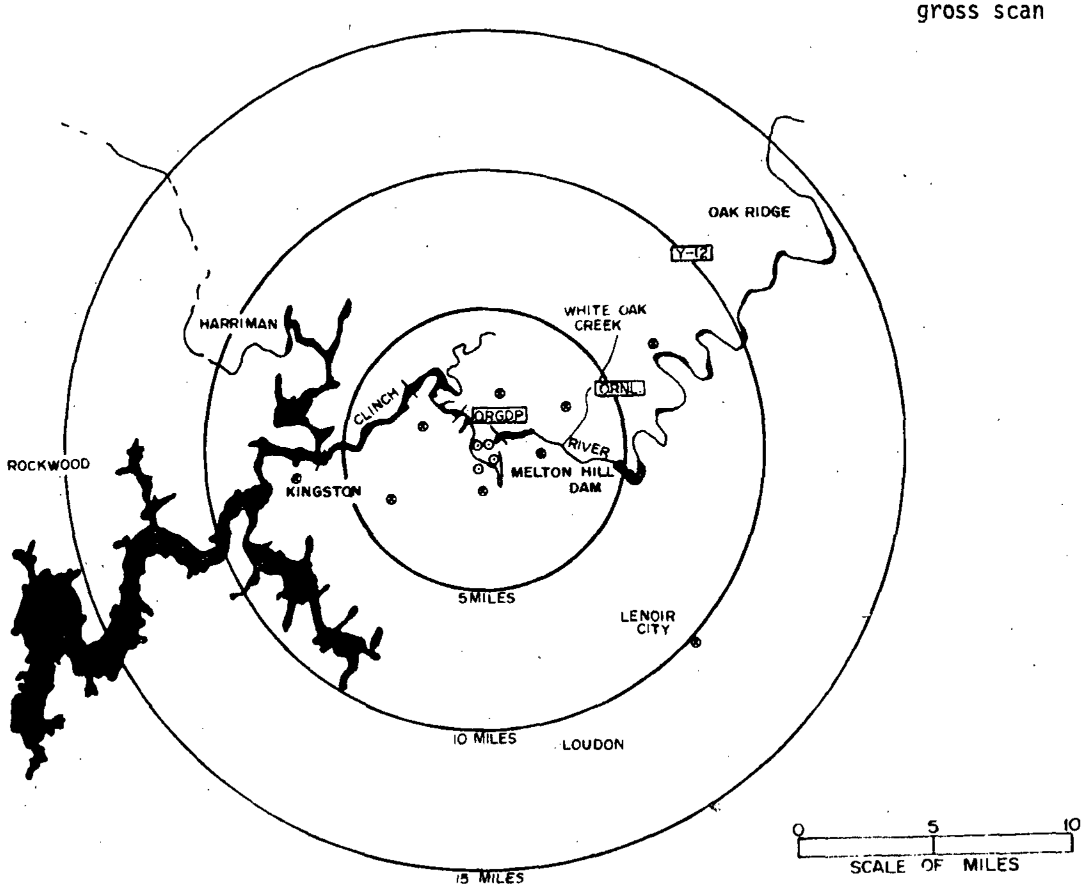


FIGURE 6.1 Atmospheric and Terrestrial Monitoring Network for CRBRP

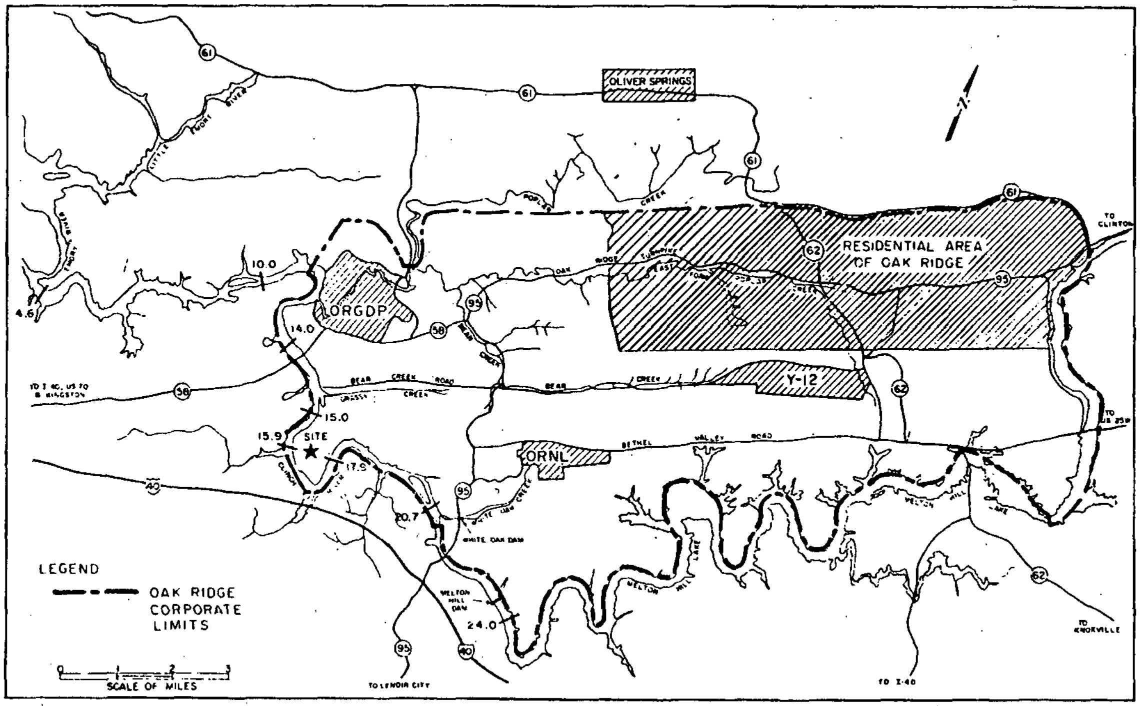


FIGURE 6.2 Reservoir Monitoring Network for CRBRP (ER, Fig. 6.2-2)

6.1.3 Meteorological

Since April 1973 a temporary 200 ft instrumented tower has been in operation 0.4 mile SW of the reactor site. The data acquisition equipment is located in a mobile trailer unit at the base of the tower. Although the terrain is generally irregular and wooded, the tower is located in a reasonably representative and exposed area.

The present measurement system consists of the following sensors (ER, p 2.6-21):

Wind Sensors - Climet Model 011-1 wind speed sensor and Climet Model 012-11 wind direction sensor are presently located at the 33, 75 and 200 ft levels of the tower. Operating range of the wind speed sensor is 0.6 to 100 mph, with an accuracy of 1% of true value or 0.15 mi/hr, whichever is greater. The direction sensor operates through a range of 0-540° with an accuracy of ±3°.

Dry Bulb Temperature - Aspirated Aerodet Model R-22.3-100 platinum resistance temperature sensor is presently located at the 33, 75 and 200 ft tower levels. The sensor range is -10°F to 100°F with an accuracy of ±0.06°F.

Temperature Difference - Between the tower levels of 33, 75 and 200 ft, delta temperature values are determined from the separate dry bulb temperature sensors. In view of radiation and recording device errors common to both temperature sensors, the delta temperature system has an accuracy of at least ±0.12°F.

Dew Point - An EG&G Model 440 dew point hygrometer records dew point temperatures in the range of 0° to 100°F. The accuracy of this sensor is ±0.7°F.

Rainfall and solar radiation values are not recorded at the site.

Data from this system are recorded by a digital system interfaced with a NOVA 1200 Minicomputer and peripheral equipment. Wind direction and speed values are additionally recorded by an analog system. A calibration program for the sensors is in effect along with an adequate data reliability program.

The onsite program, in terms of sensor accuracy, calibration intervals, and recovery rate, meets standards required in Regulatory Guide 1.23.

To provide relative concentrations (X/Q) and deposition (D/Q) values for the site, the staff used the joint frequency distributions of wind speed and direction by atmospheric stability class collected onsite between June 1974 and May 1975. Wind speed and direction were measured at 75 feet, while atmospheric stability was derived from the vertical temperature difference between 200 and 75 feet. Data recovery was 96%. Using the wind-height power law relationship (Smith, 1968), the 75-foot wind speeds were amended to reflect 33-foot winds.

In evaluating these atmospheric transport and diffusion characteristics, the staff used a "Straight-Line Trajectory Model," as described in Regulatory Guide 1.111- Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors. Continuous releases only were evaluated and all releases were assumed ground level. The calculations also included an estimate of maximum increase in calculated relative concentration and deposition due to recirculation and stagnation of airflow not considered in the straightline trajectory model. If non-continuous releases are identified, the staff will evaluate them in a manner similar to evaluation for compliance of light water reactors to Appendix I of 10 CFR Part 50.

Due to poor data recovery, Project Management Corporation has not been able to provide one full year of joint frequency wind and stability data as recommended by Regulatory Guide 1.23, i.e. wind speed and direction measured at 33 feet, vertical temperature difference measured with the lower sensor at 33 feet, and data recovery of at least 90%. However, Project Management Corporation has provided data collected concurrently over a 1 1/2 month period based on 1) 75-foot winds, 200-75 foot vertical temperature difference, and 2) 33-foot winds, 200-33 foot vertical temperature difference. Both data sets produce comparable annual average X/Q values when the 75-foot winds of the first data set are amended to reflect 33-foot winds. PMC will continue to provide concurrent data so that this comparison may continue.

6.1.4 Ecological

6.1.4.1 Aquatic

The baseline program began in March 1974 with the main purpose of identifying biological communities, their spawning habits and the presence of rare and endangered species. Sampling transects and locations according to biological type are shown in Figure 6.3 (ER, Fig 6.1-1 through -9). Sampling schedule is given in Table 6.2 (ER, Tab 6.1-1), and methods and frequencies in Table 6.3 (ER, Tab 6.1-2).

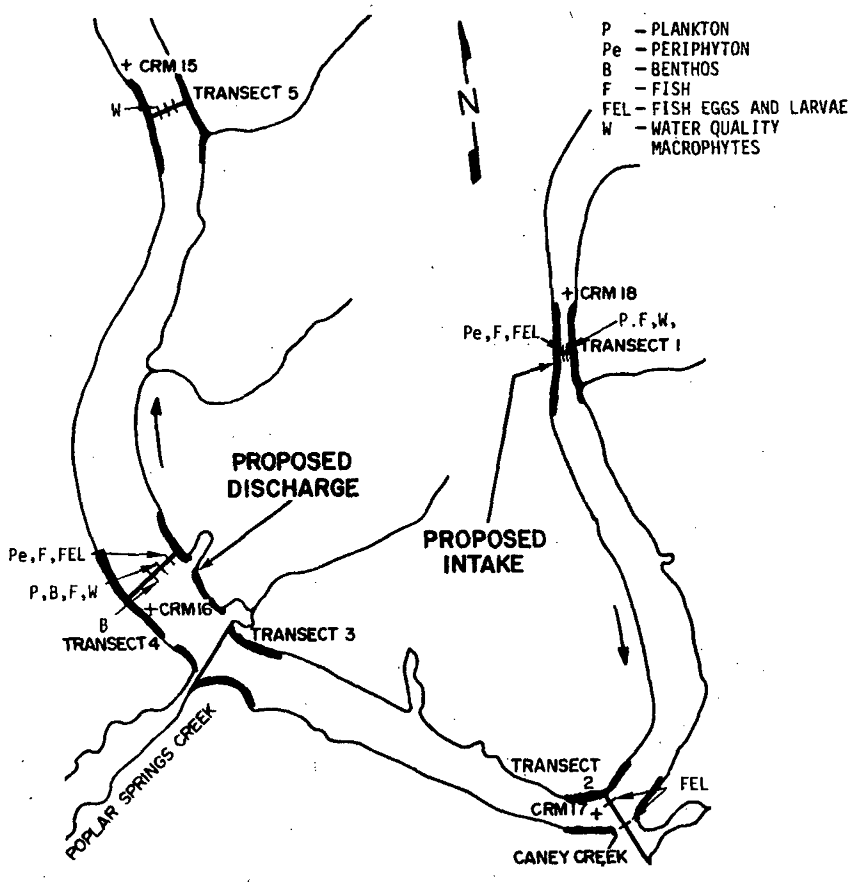


FIGURE 6.3 River Sampling Transects for Baseline Monitoring

TABLE 6.2 Aquatic Baseline Sampling Schedule[a]
(ER, Table 6.1-1)

	J	F	M	A	M	J	J	A	S	O	N	D
Biological Parameters												
Bacteria	X		X		X	X	X	X	X		X	
Phytoplankton	X		X		X	X	X	X	X		X	
Zooplankton (tows)	X		X		X	X	X[b]	X	X		X	
Zooplankton (pumping)	X		X		X	X	X[b]	X	X		X	
Periphyton	X			X			X			X		
Benthos (dredging)	X		X		X	X	X	X	X		X	
Benthos (artificial substrate)	X		X		X	X	X	X[c]	X		X	
Macrophytes			X		X		X					
Fish Populations	X		X		X	X	X	X	X		X	
Fish Eggs and Larvae			X[d]	X[d]	X[d]	X[d]	X[d]	X[d]				
Fish Stomach Contents	X		X		X	X		X	X		X	
Physical and Chemical Parameters												
Field Measurements	X		X		X	X	X	X	X		X	
Routine Lab. Analyses	X		X		X	X	X	X	X		X	
Additional Analyses	Once at the beginning of the study and once after six months.											
Sediment Analyses												
Particle Size and Organic Content	X		X		X		X		X			
Heavy Metal Content	Once at the beginning of the study.											
Total Phosphate Content	Once at the beginning of the study.											

(a) ER Table 6.1-1.
(b) A decision would be made at this point, after completion of four field trips, whether to continue sampling using towing or pumping.
(c) Continued use of artificial substrates after August would depend on results collected to that date.
(d) Biweekly.

Table 6.3 Biological Sampling Methods for the Aquatic Baseline Survey (ER, Table 6.1-2)

Parameter	Sampling Frequency	Sampling Method	Analyses	Sampling Location
BIOLOGICAL				
Bacteria				
Standard plate count Total coliform count Fecal coliform count Fecal strep. count	Once each month in Jan., March, May-Sept. and Nov.	surface collection (one foot below surface) using sterilized glass containers	(1) concentration expressed as colonies/100 ml (2) analyses according to "Standard Methods"*	Figure 6.1-2
Phytoplankton	Once each month during Jan., March, May-Sept. and Nov.	(1) Van Dorn bottle (2) surface collection	(1) identification to the specific level, when practical (2) number/liter (3) species diversity (4) percent composition--major groups (5) biomass (chlorophyll a method including measurement of chlorophyll b, c and pheophytin a content ratio)	Figure 6.1-2
Zooplankton tows	Once each month during Jan., March, May-Sept. and Nov.	(1) vertical tows (2) 0.5 meter diameter, 0.76μ mesh plankton net with TSK outside and inside flow meters	(1) identification to the specific level, when practical (2) number/liter (3) species diversity (4) composite biomass (volume by displacement or measurement of cells depending on abundance)	Figure 6.1-2
Zooplankton pumping	Once each month during Jan., March, May-Sept. and Nov.	(1) submersible pump (2) filtered through a 0.76μ mesh plankton net (3) surface, mid and bottom collections	(1) identification to the specific level, when practical (2) number/liter (3) species diversity (4) composite biomass (volume by displacement or measurement of cells depending on abundance)	Figure 6.1-2
Periphyton	Once each month during Jan., April, July and Oct.	(1) plexiglass slides on floating racks (2) 2-4 week exposure period	(1) identification to the specific level, when practical, of species of all groups of algae (2) species diversity (3) autotrophic index	Figure 6.1-3
Benthos dredging	Once each month during Jan., March, May-Sept. and Nov.	Ponar dredge	(1) identification to the specific level, when practical (2) number/m² and number/liter (3) size ranges of larger mollusks (4) species diversity (5) composite biomass (blotted wet weight and ash free dry weight)	Figure 6.1-4
Benthos artificial substrate	Once each month during Jan., March, May-Sept. and Nov.	(1) hardboard, multi-plate sampler suspended 1 to 2 feet above bottom (2) continued use beyond August will depend on data collected to date	(1) identification to the specific level, when practical (2) number/m² (3) species diversity (4) composite biomass (blotted wet weight and ash free dry weight)	Figure 6.1-5
Macrophytes	Once each month during March, May and July	(1) collection by hand (2) quantitative sampling within quadrates if substantial growth encountered	(1) identification to the specific level, when practical (2) composite biomass (blotted wet weight and ash free dry weight) (3) construction of vegetation map if substantial growth encountered	Figure 6.1-6
Fish populations	Once each month during Jan., March, May-Sept. and Nov.	(1) electroshocking (2) gill nets (3) scale collection of 7 most abundant species	(1) species composition (2) relative species abundance (3) percentage game, rough and forage fish (4) species diversity (5) length and weight determinations (6) condition factor of 7 most abundant species (7) length by age-growth curves of 7 most abundant species	Figure 6.1-7
Fish eggs and larvae	Once every two weeks during March through August	(1) stationary bottom 1,000μ ichthyoplankton net with TSK inside and outside flow meters (2) pumping using submersible pump 1 to 2 feet from bottom	(1) density (number/m³) (2) stage of development (3) species identification, when practical	Figure 6.1-8
Fish stomach contents	Once each month during Jan., March, May, June, Aug., Sept. and Nov.	collection of stomachs from each of the 7 most abundant fish species	(1) identification of food items to the most specific taxon practical (2) number and percent abundance of food items (3) percent fulness of stomach (4) net weight of stomach contents	Figure 6.1-7

Preconstruction-construction monitoring was initiated in March 1975. It would emphasize limnological studies. Limnological studies would involve 2-month exposures of artificial substrates in triplicate to identify species and relative densities of benthic organisms. Ponar grab samples would be used for biomass and species diversity determinations of the benthos. Ponar grabs also would be used to classify substrate type. Plankton communities would be monitored indirectly by employing the in situ ^{14}C uptake method, giving an evaluation of primary productivity in the system. The limnological study for the construction phase is summarized in Table 6.4 (ER, Table 6.1-4).

The applicant states that fish are able to avoid areas of excessive siltation and turbidity. Neither chemical nor thermal impacts are anticipated from construction activities; therefore, fish monitoring is not planned during construction (ER, Sec 6.1.1.2.2 and Am I, Part II, C20 and C21).

In general, the staff finds the overall baseline and construction monitoring adequate. The staff would require the applicant to conduct a detailed monitoring program, to start 2 years before plant operation, including the following: location of sampling transects, frequency of sampling, sampling methodologies and analyses to be used. The proposed monitoring program should be submitted to NRC at least 6 months prior to its initiation.

6.1.4.2 Terrestrial

Threatened or unique species and/or communities discovered during baseline operations have been mapped for future reference.

Monitoring during preconstruction-construction calls for identifying "critical ecological elements" by means of the baseline study as defined in Table 6.5 (ER, Table 6.1-5). The applicant plans to provide the plant construction manager maps and photographs showing the locations of critical elements so that they may be avoided during construction. Semi-annual inspections of species and community locations are planned. In addition, spring, summer, and fall-winter inventories of waterfowl and shorebirds would be made (ER, Am I, Part II, B8).

The staff finds the preconstruction-construction monitoring acceptable provided that results from the terrestrial ecology baseline study are used to define the "critical ecological elements" and that contractor activities are monitored to assure that sufficient protection is provided for critical terrestrial resources (Section 4.6.1).

6.1.5 Chemical and Physical

During the baseline program (March 1974 through May 1975), sampling was done at three transects in the river (Figure 6.3). Measurements were scheduled (Table 6.2) for parameters identified in Table 6.6 (ER, Table 6.1-2).

In March 1975, TVA began the preconstruction-construction effects monitoring program which was based primarily on a continuation of many features of the baseline program. This program was reviewed and revised in January 1976 to reflect a more comprehensive site specific construction effects monitoring program. Under the revised program, TVA plans to collect physical/chemical data by sampling at CRM 17.9, upstream from the site, CRM 15.4 and CRM 14.4, both downstream from the site (Fig. 6.4) (ER Fig. 6.1-11). Samples for general water quality surveys will be collected once during January, then monthly during the period March through October, and these will be analyzed for temperature, dissolved oxygen, pH, conductivity, alkalinity, nitrogen (organic, ammonia, and nitrate-plus-nitrite), phosphorus (total and filterable), chemical oxygen demand, total organic carbon, solids (suspended and dissolved), turbidity, and color (true and apparent). Measurements for temperature, dissolved oxygen, pH, and conductivity will reflect a complete vertical profile rather than data at specified depths. Additional samples will be collected at CRM 17.9 and CRM 14.4 during the months of January, April, July, and October for the determination of biochemical oxygen demand, fecal coliform (surface samples only), sulfate, silica, chloride, cadmium, copper, chromium, lead, mercury, nickel, zinc, iron (total and filterable), sodium, potassium, calcium, magnesium, hardness, and manganese (total and filterable). Samples for suspended solids and turbidity analysis will also be collected in sloughs and creeks that drain the construction area on a monthly prescheduled basis and during periods of heavy rainfall (0.3 inches per hour or 1.0 inches or more during 24 hours). The construction effects monitoring will be further complemented by the effluent monitoring program required for the NPDES permit (ER, Sec. 6.1.1.2.1 Am 6). The construction effects monitoring program will be subject to periodic review by the TVA technical staff and will be revised as needed on detection of adverse impacts and/or major changes in the stages of construction activities.

TABLE 6.4 Construction Effects Limnological Monitoring (ER Table 6.1-4)

Station (CRM)	Artificial Substrate for Benthos - Triplicate Barbecue Baskets (Two Months Exposure): Baskets In	Baskets Out	Dredge Samples - 10 Samples Per Substrate by Ponar for Benthos and Sediment Analysis for Particle Size Determination (Months Sampled)	Primary Productivity (in situ C^{14} Uptake) Duplicate Samples Each Depth (Months Sampled - March through October) (Depths Sampled)	Submarine Photometer (% Light Penetration)
14.4	March	May	March, May, July, September	Surface, 1, 3 and 5, if possible	Frequency and depth are the same as primary productivity monitoring
	May July September	July September November			
15.4	Same as CRM 14.4		Same as CRM 14.4	Same as CRM 14.4	Same as CRM 14.4
17.9	Same as CRM 14.4		Same as CRM 14.4	Same as CRM 14.4	Same as CRM 14.4
19.0	Same as CRM 14.4		Same as CRM 14.4	None	None

TABLE 6.5 Terrestrial Baseline Monitoring Summary (ER Table 6.1-5)

Parameters	Sampling Frequency	Sampling Method	Sampling Location	Statistics and Analyses
Floristic Survey	Monthly surveys (March through September)	General floristic survey.	Entire site	Presence or absence of species in various habitat types.
Vegetative Ground Cover	Three surveys (Spring, summer and fall)	Point-centered circular 0.01 acre quadrants.	Twelve communities	Identification of ground cover and shrubs. Calculations to determine relative frequency, density and importance values.
Woody Vegetation	One survey (Summer)	Nested circular plots (0.1, 0.05 and 0.01 acre) for trees, saplings and woody understory, respectively.	Twelve communities	Identification of overstory species. Calculations to determine relative density, basal area and frequency. Also determine importance value, site index, productivity, merchantable timber by species, size class and quality.
Mammal Survey	Five times per year (March, May, August, October, and December)	Live trapping and snap trapping of small mammals. Direct observation and secondary signs such as dens, scats and tracks.	5 grids and 6 transects	Species identification, vigor, sex, weight, species fluctuation and habitat preference. Calculations to determine relative population estimates or trap night indices.
Avifauna Survey	Quarterly (to include major seasons and migratory periods)	Direct observations, calls and songs while conducting walking surveys during migratory periods and systematic observations on permanent transects.	Eleven communities and edge areas	Species seasonal utilization, annual fluctuations, relative abundance and species diversity of residents.
Herpetofauna Survey	Two surveys (late spring and mid-summer)	Direct observations	General search of entire site	Species identification and relative abundance.

TABLE 6.8 Sampling Methods for the Aquatic Baseline Survey Physical and Chemical (ER, Table 6.1-2)

Parameter	Sampling Frequency	Sampling Method	Analyses
PHYSICAL AND CHEMICAL			
A. Field measurements - Temperature (profile) - Dissolved oxygen (profile) - Water velocity and current direction (profile) - pH (surface, mid, bottom) - Specific conductivity (surface, mid, bottom) - Light penetration (profile) - Water depth	Once each month in Jan., March, May-Sept. and Nov.	(1) temperature, pH, DO and conductivity measured by Hydrolab unit and additional electronic recording units (2) light penetration measured by submarine photometer (3) velocity measured by Gurley and Savonius meters; current direction by internal compass (4) water depth measured by recording Fathometer	(1) temp. in degrees centigrade (2) pH in pH units (3) dissolved oxygen in mg/l (4) conductivity in umho (5) light penetration in foot-candles and percent transmittance; determination of 1% light incidence (6) water depth in meters (7) water velocity in feet per second (fps)
B. Routine Laboratory Analyses Total alkalinity ($CaCO_3$) Hardness ($CaCO_3$) Turbidity Color (true) BOD COD TOC (total organic carbon) Chloride Chlorine residual (field method) Sulfate Sodium Potassium Solids Dissolved Settleables Suspended Volatile Fixed (by difference) Total Volatile Fixed (by difference) Nitrogen NO_2 NO_3 NH_3 Phosphate Total - PO_4 Ortho - PO_4	Once each month in Jan., March, May-Sept. and Nov.	"Standard Methods"*	(1) concentration expressed in parts per million (2) turbidity in Jackson turbidity units (3) color in color units (4) "Standard Methods"* used in all analyses except for sodium and potassium in which case "Methods for Chemical Analysis"** is used
C. Additional Analyses Chlorine demand Fluoride Nitrogen gas Silicate Calcium Magnesium Molybdenum Selenium Tin Aluminum Manganese Zinc Copper Mercury Silver Arsenic Cadmium Chronium Lead Nickel Cobalt Iron (total) Organic compounds Cyanide Detergents-surfactants (MBAS) Oil and grease (solvent extraction) Phthalate esters Pesticides Organochlorines (insecticide) Atrazine (herbicide) 2-4-D (herbicide)	Once at the beginning of the study and once again after six months. Those chemicals which exceed federal or state maximal standards will be added to the routine laboratory analysis group.	"Standard Methods"*	Analyses will be done using "Standard Methods"* except for: (a) mercury, molybdenum and nickel in which case "Methods for Chemical Analysis"** is used (b) nitrogen gas in which case the Van Slyke method+ is used (c) selenium in which case "Proposed Tentative Method"++ is used

TABLE 6.8 (Concluded)

Parameter	Sampling Frequency	Sampling Method	Analyses
SEDIMENT			
Particle size and total volatile (organic) solid content	Once each month during Jan., March, May, July and Sept.	collection by dredge	(1) particle size determination as in "Shore Protection"∇ (2) total volatile solid content by combustion according to "Standard Methods"*
Total Phosphate Content Heavy Metal Content	Once at the beginning of the study	collection by dredge	acidification, then procedure as in "Standard Methods"* for metal analysis
Molybdenum Selenium Tin Aluminum Manganese Zinc Copper Mercury Silver Arsenic Cadmium Chromium Lead Nickel Cobalt Iron (total)			

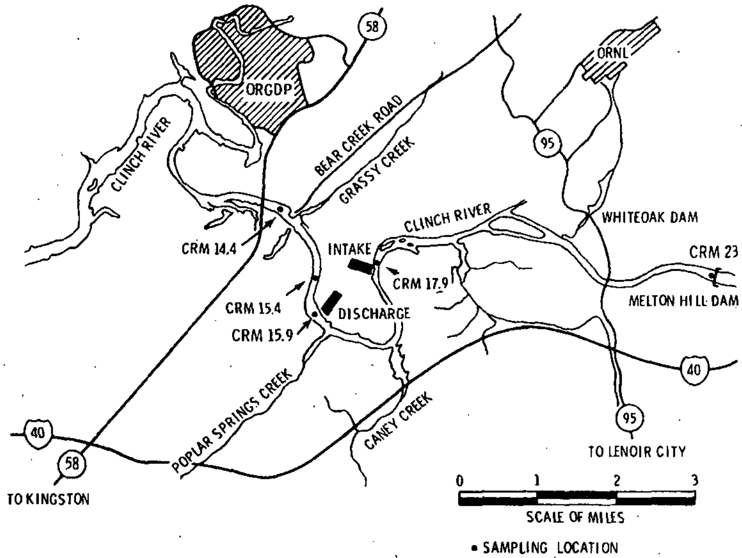


FIGURE 6.4 Sampling Locations for Physical-Chemical Monitoring, Preconstruction-Construction

The preconstruction-construction effects monitoring program is separate from the preoperational monitoring program. The latter will be designed and implemented two years prior to the scheduled fuel loading and will be based on details of the final plant design and environmental data available at that time.

The staff's opinion is that the preconstruction-construction program is adequate. The staff would require the applicant to submit a monitoring schedule supporting the aquatic ecology program outlined in Section 6.1.4.1 two years before plant operation.

6.1.6 Socioeconomic

The socioeconomic impacts of construction and operation discussed in Chapters 4 and 5 could be appreciable if not addressed with appropriate community planning. Growth policies of the potentially affected areas need to be established and activities undertaken to manage growth. Such actions might include enactment of ordinances relating to zoning, expansion of municipal/county capital facilities, or working with state/federal agencies on jointly sponsored projects such as highway safety and road improvement. The most desirable way to carry out this planning activity is with some type of information feedback system that tells how many new workers are moving into the area, where they are locating, what type of residential accommodations they are using, and their family makeup. With this information, combined with background data on normal growth in the area and capacity utilization of current facilities and staff, the affected units of government can make enlightened plans to accommodate or control growth effects related to the construction and operation of the CRBRP and other projects.

To assist the affected communities, the staff recommends that the applicant be required to conduct surveys of its construction work force, as described in Section 6.1.6.1, and submit appropriate reports (Section 6.1.6.2).

6.1.6.1 Primary Work Force Surveys

On a periodic basis the applicant shall determine certain demographic-sociological data on the primary work force. The primary work force is taken to mean construction labor, onsite construction managemnet, and onsite (Oak Ridge vicinity) ERDA, TVA, and PMC staff working essentially full time on the project. The data shall be recorded quarterly during the construction period and annually for the first three years of operation.

The desirable data would be family composition, place of residence, type of housing, length of time at current address, previous address, length of time at previous address, number and grades of school age dependents, and occupation. If the applicant feels that these specific data would be difficult to obtain or that the frequency of recording and reporting the data is inappropriate, the staff recommends that an alternative program providing essentially the same type of information on a timely basis be submitted to the staff for review.

6.1.6.2 Reporting

The staff recommends that the reports of each survey be submitted to the NRC staff and the major authorities in the affected areas within 3 months after the conclusion of each recorded period.

6.2 OPERATIONAL

6.2.1 Hydrological

Preoperational programs would be reviewed for application to the operational phase. A brief monitoring effort may be adequate to establish the dimensions of the thermal plume. According to the modeling results (Section 5.3.2.1), a number of close-in sampling stations would be needed. The work would be a part of the physical and chemical monitoring (Section 6.2.5).

6.2.2 Radiological

The preoperational program would be reviewed by the staff prior to operation.

6.2.3 Meteorological

The program basically would be a continuation of the preoperational effort. The essential elements are included in Section 6.1.3.

6.2.4 Ecological

An operational aquatic monitoring program is described in Section 6.2.5.4 and 6.2.5.5 of the ER, but a detailed program subject to staff approval may be required at the operating license stage.

The applicant outlined a tentative terrestrial program for assessing the impacts of increased relative humidity, icing, and cooling tower drift (ER, Sec 6.2.5.1, 6.2.5.2 and 6.2.5.3). If icing occurs, aerial photography would be used to establish the extent of accumulation and damage; subsequently, plots would be established in the area and periodically evaluated. No firm commitment was made as to relative humidity and drift; however, an operational program may be required, subject to staff approval, at the operation licensing stage.

6.2.5 Chemical and Physical

Waste streams originating within the plant will be monitored in accordance with the operational NPDES permit. Receiving water quality monitoring programs will be implemented as necessary to correspond with the requirements of the NPDES permit and the results of the preoperational monitoring program (ER 6.2.2 Am 6).

6.2.6 Socioeconomic

The program conducted during construction should be continued during the demonstration period at a level to be specified at the operating license stage.

6.3 RELATED PROGRAMS AND STUDIES

Air quality measurements in the vicinity of the site are the responsibility of the Tennessee Department of Public Health, Division of Air Pollution Control. The department makes quarterly reports of ambient air quality data taken at Oak Ridge, Clinton, Harriman, and other stations throughout the state (AIR). Emissions to the atmosphere in the region of the site are subject to existing State regulations.

The Atmospheric Turbulence and Diffusion Laboratory of the National Oceanic and Atmospheric Administration, located in Oak Ridge, has done extensive research into air quality problems of eastern Tennessee. Information regarding their research efforts is available from the Laboratory (Hanna, et al, 1970; Hanna, 1972; Hanna, 1974; Culkowski, 1970; Culkowski, et al, 1974).

The Oak Ridge National Laboratory has in progress several types of ecological, water and radiological programs in the general area of the CRBRP site. The ORNL annual progress reports and annual ERDA environmental monitoring reports contain the findings. The TVA Water Quality and Ecology Branch routinely measures water quality throughout the Tennessee Valley and makes the results available to the public.

7. ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS

7.1 PLANT ACCIDENTS INVOLVING RADIOACTIVE MATERIALS

A potential impact from the operation of the CRBRP is that associated with accidents which might occur during the plant's lifetime. Therefore, the applicant has submitted a Preliminary Safety Analysis Report which provides a preliminary analysis and evaluation of the design and performance of structures, systems and components of the CRBRP, including assessments of postulated accidents. The objective of the staff's safety evaluation is to determine whether the risks from normal operations, from transient conditions anticipated during the life of the plant, and from postulated accidents are acceptable. The staff, in order to perform its environmental assessment of possible accidents, has used the information provided in the PSAR, the ER, other LMFBR-related source material, and its own experience and expertise in LMFBRs and LWRs.

The Commission's regulations require that an applicant design, manufacture and operate the plant to minimize the likelihood of postulated accidents. To this end, a quality assurance program is used to establish the necessary high integrity and reliability of the reactor system and other plant systems and components that would prevent or control accidents.

Protection systems that place and hold the plant in a safe condition are provided should incidents or malfunctions occur and cause deviations from acceptable operating conditions. Notwithstanding this, the conservative postulate is made that serious accidents could occur, and engineered safety features are installed to protect the public by mitigating the consequences of highly unlikely accidents. These measures are intended to assure that the design features of the CRBRP, including those stemming from the inherent characteristics of an LMFBR, are such that the plant is not likely to experience damaging faults and, if accidents should occur, their consequences will be safely controlled. For example, the primary coolant is sodium which becomes highly radioactive and, in addition, will burn readily in air. Consequently, the equipment containing this coolant is housed in inerted, well-shielded cells, with the intention that if a leak occurs, any resulting sodium fire will be limited by the low oxygen level, and the sodium and combustion products will be contained in the cells.

The procedures employed in the design and review of the CRBRP are comparable to those employed for LWRs. For example, the rigorous design codes and standards applied to LWRs are applied to the CRBRP; in some circumstances additional standards are employed such as, for example, on components which experience higher service temperatures. Design criteria appropriate to the CRBRP have been developed which are analogous to and based on the General Design Criteria for water-cooled nuclear power plants.

Because of measures such as these, occurrences that may be anticipated during the plant life are not expected to exceed specified acceptable limits or result in substantial releases of radioactivity. Similarly, design basis accidents have been established and their consequences are required to be safely mitigated.

In the staff's safety review, conservative assumptions are used in the calculation of doses from the various design basis accidents. For the staff's site safety evaluation, extremely conservative assumptions are used for the purpose of comparing calculated doses resulting from a hypothetical release of fission products from the core to the siting guidelines given in Part 100 of the Commission's regulations.

Realistically computed doses that would be received by the population from these postulated accidents would be significantly less than those conservatively calculated potential doses to be presented in the Safety Evaluation. The Commission issued guidance to applicants on September 1, 1971, requiring the consideration in environmental reports of a spectrum of accidents with assumptions as realistic as the state of knowledge permits. This guidance has since been supplemented in the case of LWRs, including a specification of the events to be considered and the assumptions to be used in assessing their consequences. The applicant's implementation of this guidance in the CRBRP is contained in the ER (Section 7 and Appendix B). The staff's detailed analysis of the consequences of severe accidents is to be presented in the SER. Only a summary of these analyses and the major conclusions are given in this report.

7.1.1 Classification of accidents

The applicant's environmental report has been evaluated, using accident assumptions and guidance similar to those issued for LWRs. Nine classes of postulated accidents and occurrences with consequences ranging in severity from trivial to very serious were identified by the Commission. In general, accidents in the high potential consequence end of the spectrum have a low occurrence rate and those on the low potential consequence end have a higher occurrence rate. Table 7.1 lists the nine general classes as outlined in the guidance of September 1, 1971 together with analogous events in the CRBRP. The staff's selection of postulated accidents for the CRBRP was based on a review of the applicant's submittals and the staff's independent analyses and evaluations.

The accident categories (Classes 1-9) in Table 7.1 were organized so as to enable an assessment of the consequence of the most severe type of accident within any one class. Specific examples of events in each category have been selected by the staff, and their consequences are shown in Table 7.2.

The events in Classes 1 and 2 represent occurrences which are anticipated during plant operations; and their consequences, which are very small, are considered within the framework of routine effluents from the plant. Except for a limited number of fuel failures, the events in Classes 3 through 5 are not anticipated during the plant lifetime. Accidents in Classes 6 and 7 and small accidents in Class 8 are of similar or lower probability than accidents in Classes 3 through 5 but are still possible. The probability of occurrence of large Class 8 accidents is very small. To support this conclusion, the applicant has provided substantial analyses of postulated accidents, including failure mode and effect analyses of both the reactor shutdown and decay heat removal systems, as well as a number of other analyses relating to the probability of potential accidents that might involve large releases of radioactivity. The applicant has committed to continue to pursue an extensive design review and research and development program to assure that the likelihood of accidents is made low, as the design progresses.

The postulated occurrences in Class 9 involve sequences of successive failures that are considered to be less likely than those required to be considered in the design bases of protection systems and engineered safety features. Their consequences could be severe. However, as with LWRs, the probability of their occurrence is to be made acceptably low. This is accomplished by means of multiple physical barriers, quality assurance for design, manufacture and operation, continued surveillance and testing, and conservative design.

In establishing the boundary between accident sequences that are to be within the design basis envelope (classes 1-8), and hence for which engineered safety features are provided, and accidents that may reasonably be assigned to that residuum for which no further protective features are normally necessary (class 9), the NRC staff in the past has used the safety objective that the risk to the public from all reactor accidents should be very small compared to most other risks of life, such as disease or natural catastrophe. The staff believes this safety objective is met by requiring a design basis accident envelope that extends to very unlikely postulated accidents, with the objective that there be no greater than one chance in one million per year for potential consequences greater than 10 CFR 100 guidelines for an individual plant.

In the case of CRBRP, the staff has concluded that the design should assure the capability to minimize the risks associated with core meltdown events to an extent comparable to LWR designs. To ensure that the probability of core melt and disruptive accidents is low, emphasis is being placed on the prevention of conditions which could lead to such accidents. To help ensure that this is accomplished, the staff is emphasizing and requiring the achievement of an adequate degree of diversity, redundancy and reliability in key safety features and aspects of the design. Examples of such measures include the following accident prevention requirements:

1. At least two independent, diverse, and functionally redundant shutdown systems.

2. At least two independent, diverse, and functionally redundant decay heat removal systems.

3. Means to detect fuel subassembly faults, to cope with these faults, and to protect against progressive subassembly fault propagation.

4. Initial and continuing assurance of a high degree of integrity of the heat transport system.

5. Protection of the containment system from the effects of sodium releases in the equipment cells, particularly those cells containing the main heat transport system equipment.

TABLE 7.1

CLASSIFICATION OF POSTULATED ACCIDENTS AND OCCURRENCES

NO. OF CLASS	DESCRIPTION	EXAMPLES (9/1/71 LWR GUIDANCE)	CRBRP EXAMPLES-GENERAL
1	Trivial Incidents	Small spills Small leaks outside containment	Single seal failures, minor sodium leaks
2	Misc. Small Releases Outside Containment	Spills Leaks and pipe breaks	IHTS valve, seal leaks, condensate storage tank valve leak Turbine Trip/Steam venting
3	Radwaste System Failures	Equipment failure Serious malfunction or human error	RAPS/CAPS valve leaks RAPS surge tank failure cover gas diversion to CAPS Liquid Tank leaks
4	Events that release radioactivity into the primary system	Fuel failures during normal operation. Transients outside expected range of variables	Loss of hydraulic hold-down Sudden core radial movement Maloperation of Reactor Plant Controller
5	Events that release radioactivity into the secondary system	Class 4 & Heat Exchanger Leak	Class 4 & Heat Exchanger Leak*
6	Refueling accidents inside containment	Drop fuel element Drop heavy object onto fuel Mechanical malfunction or loss of cooling in transfer tube	Inadvertent floor valve opening Leak in CCP in EVTM Drop of fuel element Crane impact on head
7	Accidents to spent fuel outside containment	Drop fuel element Drop heavy object onto fuel Drop shielding cask--loss of cooling to cask Transportation incident on site	Shipping cask drop EVST/FHC system leaks Loss of forced cooling to EVST
8	Accident initiation events considered in design-basis evaluation in the Safety Analysis Report	Reactivity transient Rupture of primary piping Flow decrease-Steamline break	S-G leaks Steamline break Primary Na storage tank failures Cold trap leaks Rupture of primary piping

TABLE 7.1 (Continued)

CLASSIFICATION OF POSTULATED ACCIDENTS AND OCCURRENCES

NO. OF CLASS	DESCRIPTION	EXAMPLES (9/1/71 LWR GUIDANCE)	CRBRP EXAMPLES-GENERAL
9	Hypothetical sequences of failures more severe than Class 8	Successive failures of multiple barriers normally provided and maintained	Successive failures of multiple barriers normally provided and maintained**

*The CRBRP has a closed cycle secondary heat transport system which separates the primary coolant from the power conversion system. Class 4 failures and coincident heat exchanger leaks therefore do not result in a significant release to the environment.

**Class 9 accidents are not included in the design basis of the plant protection system and engineered safety features. However, the staff has determined that the plant should include capabilities to reduce the risks associated with a spectrum of events in this category (see Sec. 7.1.1).

IHTS = Intermediate Heat Transfer System
RAPS = Radioactive argon processing system (purifies contaminated core gas)
CAPS = Cell atmosphere processing system
EVST = Ex-vessel storage tank (in spent fuel)
FHC = Fuel handling cell
SG = Steam generator
EVTM = Ex-vessel transfer machine (for fuel handling)

TABLE 7.2

SUMMARY OF RADIOLOGICAL CONSEQUENCES OF POSTULATED ACCIDENTS[1/]

CLASS	EVENT	ESTIMATED DOSE AT SITE BOUNDARY (REM) IN 2 HR.	ESTIMATED DOSE TO POPULATION IN 50 MILE RADIUS (MAN-REM) (DURATION OF ACCIDENT)
1.0	Trivial Incidents	2/	2/
2.0	Small releases outside containment	2/	2/
3.0			
3.1	Failure of liquid waste storage tank	0.001	< 0.04
3.2	Rupture of RAPS surge and delay tank[3/]	0.2	32
4.0	Events that release radioactivity into the primary system[4/]	< 0.001	< 0.04
5.0	Events that release radioactivity into secondary system	< 0.001 (thyroid)	0.08
6.0	Refueling accidents inside containment		
6.1	Inadvertent floor valve opening reactor port plug removed[5/]	< 0.001	< 0.04
6.2	Drop of fuel assembly in loaded position[6/]	< 0.001	< 0.04
7.0	Accidents to spent fuel outside containment		
7.1	Loss of Forced Cooling to EVTM[7/]	0.012 (thyroid)	1.3
7.2	EVST pipe rupture @ pump suction[8/]	0.5 (whole body) 0.4 (thyroid)	19 14
7.3	Shipping cask drop	0.007 (thyroid)	2.6
8.0	Accident initiation events considered in design basis evaluation in the SAR	0.007 (thyroid)	2.6
8.1	Steam-Generator tube rupture	< 0.001	< 0.04
8.2	Steam line break	< 0.001	< 0.04
8.3	Large primary system rupture (does not result in core disruption)	0.005 (whole body) 0.002 (thyroid) 0.020 (bone)	0.6 (whole body) 0.4 (thyroid) 4 (bone)
8.4	Sodium cold trap fire[9/]	0.003 (bone)	25
8.5	Site suitability source term[10/]	0.1 (whole body) 1.0 (thyroid) 1.2 (bone) 0.2 (lung)	28 183 279 37
9.0	Hypothetical sequence of failures more severe than class 8[11/]	0.17 (whole body) 0.6 (thyroid) 0.35 (bone) 0.4 (lung)	5.4×10^4 1.0×10^7 6.3×10^6 1.6×10^7

TABLE 7.2 (Cont'd)

Footnotes to Table 7.2

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

2/ These releases are expected to be in accordance with Appendix I for routine effluents, (i.e., 3 mrem per year to the whole body from liquid effluents and 5 mrem per year to the whole body from gaseous effluents).

3/ The RAPS surge and delay tank is conservatively assumed to fail instantaneously. This accident was selected to bound the failures that might occur in the systems processing the CRBRP cover gas. It is assumed that the cell housing the tank will leak at 100 v/o per day. During the Commission's safety evaluation, the staff will assure that the plant criteria are consistent with that assumption.

4/ Assumed fuel failures; the primary system is effectively isolated from the steam generators by the intermediate heat transport system. Consequently, releases are generally insignificant.

5/ After 30 days shutdown, a reactor port plug is assumed to be inadvertently opened or not properly closed and 100% of the reactor cover gas is released directly to the environment. Cover gas activity is based on operation with 0.5% failed fuel.

6/ Event is assumed to occur 87 hours after shutdown and the noble gas and iodine gap activity of two fuel assemblies is assumed to leak directly to the environment at a rate of 8.6×10^{-5} % per day. The gap activity is assumed to be 1% of the total fuel assembly inventory.

7/ Event is assumed to occur 87 hours after shutdown. Noble gas and iodine activity equal to 3% (gap activity plus partial melt) of the total fuel assembly inventory is assumed to leak directly to the environment at a rate of 0.02% per day.

8/ Failure is assumed to lead to combustion in a de-inerted cell which releases an aerosol (70 pounds of sodium) directly to the environment. Radioactive concentrations in the aerosol are based on end of life (30 year) coolant activity based on operation with 0.5% failed fuel.

9/ An aerosol containing 30 pounds of sodium is assumed to be generated from combustion in the cell. The iodines and volatile solid fission products concentrations in the aerosol are assumed to be a factor of three higher than in the sodium pool. All of the aerosol is assumed to be airborne in containment where it leaks to the environment at a rate of 0.032% per day.

10/ The source term inside containment is assumed to consist of 100% of the noble gases, 25% of the halogens, 1% of the solid fission product inventory and 1% of the core plutonium inventory. This source term is judged to be suitably conservative for purposes of site evaluation, in accordance with the requirements of 10 CFR 100. The RCB is assumed to leak at a rate of 0.032% per day. The X/Q value used was determined from onsite meteorological data at the 50% probability level. Plutonium dose factors were taken from Regulatory Guide 1.109.

11/ This category generally applies to accidents which have a lower probability of occurrence than design basis accidents. The applicant and the staff have independently examined a spectrum of possible events leading to core disruption (see Section 7.1.3). Both have analyzed a range of consequences that might be associated with such events. The staff concluded that subsequent release of radioactive materials could be that resulting from long-term melt through (no large initial source) as well as from energetic disassembly of the core (large initial source). The event analyzed herein is one which involves a very large initial release. Specifically, an accident is postulated which results in a core release of 100% of the noble gases and volatiles, 10% of the solid fission product inventory and 10% of the plutonium inventory. In this scenario, the volatiles, including halogens, are reduced to 10% of the core inventory and the solid fission products and fuel are reduced to 1% of the core inventory during passage out of the reactor vessel and into the outer containment building. Containment leakage is taken as proportional to the square root of the pressure for 24 hours, at which time containment integrity is assumed to be lost and all airborne material released to the environment. No air cleanup systems are assumed to operate during this period, but aerosol depletion due to fallout is assumed to occur. Consistent with the scenario, plutonium dose factors for a 0.5 μ particle size are used during the 2 hour exposure following the accident, but dose factors for 5.0 μ particle size are used for the release after containment failure at 24 hours. These particle sizes are derived from the HAARM-2 fallout calculations. Note that the cited site boundary doses are for the first two hours after core disruption. It is presumed that protective measures could be taken on behalf of individuals at that location prior to the release that was assumed to occur 24 hours after core disruption.

These requirements were communicated to the applicant in a letter dated May 6, 1976. This letter is reproduced in its entirety as Appendix I. The staff is of the opinion that these requirements can be met. A number of illustrations of the features reinforcing the staff's opinion that the above five accident prevention requirements can be met are given in the following paragraphs.*

The applicant must provide a design such that the probability of accidents leading to severe core damage or substantial releases of radioactivity is very remote. To illustrate, it is expected that once or twice during the plant lifetime all offsite power will be lost. When this occurs, power to main heat transport system pumps is lost, resulting in a loss of normal coolant flow in the core. The reactor is shutdown but decay heat is generated and must be removed if damage to the fuel is to be prevented. Because of the importance of effective decay heat removal, the CRBRP design will include redundant and diverse Residual Heat Removal Systems (RHRS) for dissipation of reactor decay heat. The RHRS consist of redundant Steam Generator Auxiliary Heat Removal Systems (SGAHRS) and a diverse Direct Heat Removal System (DHRS). The SGAHRS performs its functions using two subsystems - short and long term heat removal subsystems. Each of these subsystems provides redundant decay heat removal paths. For example, for short term decay heat removal, redundant Auxiliary Feedwater Systems (AFWS) with diverse motive power will be provided. Even if a failure were to occur in one component of the AFWS, sufficient decay heat removal capability will still be available. To further assure that the probability of AFWS failure is extremely low, diversity of design and selection of high quality components are also provided. For example, one AFWS train includes a 100% capacity steam driven pump and is powered by batteries; the other includes two 50% capacity electric pumps and is powered by diesel generators. Furthermore, for both short and long term decay heat removal, a diverse system (DHRS) will be required to be available for use in decay heat removal on an emergency basis, if needed.

Another illustration of plant features designed to reduce the probability of accidents leading to severe core damage is the dual shutdown system. Two distinct shutdown systems are provided, namely, the primary system which is spring assisted and the secondary system which is hydraulically assisted. In order to reduce the probability of common-mode failures, the two systems are designed to provide diversity in their latching mechanisms, couplings, number of absorber pins, enrichment of absorber material, and many other features. The two systems are redundant in that either system alone is designed to be capable of shutting down the reactor during extreme conditions, such as the Safe Shutdown Earthquake (SSE) (extremely unlikely fault). No electrical or other external power is required for a scram of any control rod. The staff considers it feasible, by use of the dual system, to reduce the probability of scram failure to a level consistent with the requirement of excluding CDAs from the design basis. The current dual system, which is under review, appears to have the potential to comply with the requirement.

The heat transport system is another feature in which the applicant has designed for a high level of integrity and for continued assurance of this integrity throughout the operating history of the plant. The specifications include stringent non-destructive examination requirements. The material is characterized by high fracture toughness and corresponding large critical flaw size, a negligible growth rate of postulated defects, and the probability of through-wall growth rather than the elongation of defects. The system has low stored energy and is monitored by sensitive leak detection instruments. The staff has concluded that double-ended rupture of the CRBRP primary cold leg piping (an event that could potentially lead to a CDA unless otherwise mitigated) should not be considered a design basis event. This conclusion is conditioned on an acceptable preservice/inservice inspection program, a material surveillance program, continued research and development verifying material degradation processes, and verification of leak detection system performance. The staff considers it feasible to implement programs to satisfy these requirements.

A final illustration concerns the manner in which the containment system will be protected from the effects of sodium releases in the equipment cells, particularly those cells containing the main heat transport system equipment. Dispersed releases of sodium into these cells could, under extremely adverse conditions, result in the cell design pressure being exceeded. However, the staff will require that the inner cell system and outer reactor containment building have the capability to accommodate a wide spectrum of sodium spray and pool fires coupled with sodium-concrete reactions in the event that part of the cell liner should fail. The staff considers it feasible to implement design provisions to satisfy these requirements, such as by increasing the cell structural capability, providing controlled venting of the cell, and decreasing the cell

---

*Radiological health and safety hearings will not be held before mid to late 1977. Those hearings will include a detailed assessment of the ability of the CRBRP design structures and engineered safety features to perform their identified functions. Where the design, structure or ESF is found deficient, appropriate modifications to the design will be required. The staff believes that the state of technological experience pertinent to LMFBRs is such as to provide sufficient assurance such modifications, if necessary, can be made.

oxygen content. To provide a greater degree of accommodation against accidental releases of sodium, the applicant has recently committed to increasing the cell design pressure from 10 psig to 30 psig, and the staff is currently evaluating the safety adequacy of the applicant's proposal.

In addition to the measures to prevent core melt and disruptive accidents, the staff has concluded that there should be a low likelihood that even such low probability accidents could result in early containment system failure. Based on evaluations of the CRBR under such accident conditions, the staff concluded that the containment system should be protected from a core energetic accident,* core meltdown events and accidental release of sodium.

The staff concludes that feasible courses of action are available that can be implemented to reduce the probabilities of core disruptive accidents to an acceptably low level. As contained in the May 6, 1976 guidance letter (see Appendix I), the staff is aware of design provisions which could be utilized to provide the required containment system protection.

7.1.2 Comparison of probabilities of Class 9 events: LWRs vs. CRBRP

The staff has considered the information available at this time and conducted assessments of very unlikely accidents and events involving multiple successive failures, particularly those which may result in core melting or severe core damage (see Table 7.3).

A comparison of selected accident sequences with the results of similar sequences analyzed in the Reactor Safety Study (WASH-1400) provides an additional basis for gaining perspective on risks of very severe accidents in CRBRP.

For example, the loss of all offsite power for an extended period of time ($\geq$ 30 minutes) is an event which, for both LWRs and the CRBRP, requires proper functioning of decay heat removal systems. A probability of occurrence of $\approx 4 \times 10^{-2}$ per reactor year was assigned for the extended loss of offsite power in WASH-1400 (cf. Figure I 4-11). In the case of PWRs, the WASH-1400 assessment for failure of the decay heat removal systems following this event, due to a coincident failure of the Auxiliary Feedwater System (AFWS), is $\approx 1 \times 10^{-4}$. Thus, the probability of a core melt due to this accident sequence was assessed to be approximately 4×10^{-6} per year. This scenario also results in core melt in the CRBRP assuming coincident failure of the DHRS. The probability of the CRBRP losing offsite power for over 30 minutes would also be about 4×10^{-2} per year. Since CRBRP AFWS system has design bases and employs components similar to those in PWRs, it is reasonable to expect that it can be designed and operated in such a manner that the probability of its failure can be made at least comparable to that in a PWR. In this case, the probability of a core melt in the CRBRP by this sequence would also be in the range of 4×10^{-6} per year. However, as noted previously, the CRBRP design, unlike a PWR design, will have a diverse decay heat removal system (i.e., DHRS). The staff concludes that the inclusion of such a system in the CRBRP further reduces the probability of a core melt by such a sequence (i.e., failure of decay heat removal).

The other general type of failure associated with a loss of offsite power is failure of the reactor shutdown system.** This event is not predicted to lead to core melt in current generation PWRs but could do so for the CRBRP and has the potential to cause core disruptive accidents. However, if the unavailability of the CRBRP shutdown system given loss of offsite power is sufficiently low, this scenario would not contribute significantly to the overall probability of core disruptive accidents associated with loss of offsite power. If a shutdown system were designed, constructed, and operated in such a manner that the unavailability of the shutdown system is in the range of 10^{-5} to 10^{-6} per demand, this scenario would contribute only 1% to 10% to the total probability of core disruption given loss of offsite power. The assessments that have been made of LWR shutdown systems indicate that they have system unavailabilities in this range. Thus, it appears that the CRBRP should be able to attain an unavailability in this range. Therefore, the likelihood of a core melt resulting from loss of offsite power coupled with additional failures would be comparable to that of LWRs.

---

*The applicant has appealed within the regulatory process the staff specification of 1200 MJ (1 MJ = 1 megawatt-second), and has proposed that the specification be changed to 661 MJ. Although this appeal is still under consideration, and it may be some time before consideration is completed, the staff believes that either value could be implemented in the design, and that the basic modes of implementation would be essentially the same in either case. Since the appeal process has not been completed and the staff specification currently remains at 1200 MJ, the further accident evaluations are based on the 1200 MJ energy release.

**As used herein, shutdown system failure means lack of significant negative reactivity insertion by the control rods on demand.

TABLE 7.3

GENERAL CLASSES OF EVENTS POTENTIALLY LEADING TO CORE MELTING OR DISRUPTION

	Initiating Event	Coincident Failures or Conditions
A.	Reactivity Transients	(1) No Reactor Trip (RT), no Pump Trip (PT), ramp terminated at trip point, or
		(2) No RT, PT, ramp terminated, or
		(3) No RT, PT, ramp continues beyond trip point, or
		(4) No RT, no PT, ramp continues
B.	Loss of Heat Sink Transients	(1) No PT, no RT, or
		(2) PT, no RT, or
		(3) PT, RT (complete loss of sink only), or
		(4) Loss of one loop, no RT
C.	Other Unlikely Faults	
	. Large Gas Bubble (leads to limited duration reactivity insertion and channel voiding)	
	. Moderator in the Coolant (leads to limited duration reactivity insertion)	
	. Assembly Failure and Propagation, no RT	
	. Primary System Rupture (1) PT, no RT, or	
	(2) No PT, RT, or	
	(3) No PT, no RT	
	. Larger than Design Basis External Event (tornado, earthquakes, etc.)	

NOTES ON TABLE 7.3

1. Reactivity transients include both anticipated and unanticipated transients - from inadvertent rod withdrawal at normal speed to hypothesized multiple failures of the rod controller system. Core melting does not result with those reactivity addition rates unless coincident failures of the shutdown systems occur. The consequence is an increasing fuel temperature which, depending on the conditions, may result in fuel failure or hot channel boiling in times ranging from seconds (rapid transient - ten's of cents per second or more) to minutes or more. Core disruption does not result unless other coincident failures occur.
2. The coincident conditions relate to the type of failure of the reactor protection system that might be postulated. For example, no RT, no PT might be attributed to a failure of the sensing devices or multiple electronic failures. PT, no RT might result from a mechanical failure of both reactor shutdown systems.
3. Loss of heat sink transients include such events as a pump failure where of the order of 15 - 20 minutes is available before reactor shutdown is required as well as events such as a loss of offsite power where reactor shutdown is required on the order of 8 - 10 seconds. The loss of offsite power/failure-to-scram event has been considered in depth in contemporary fast reactor safety evaluations, in part because of the demands for prompt shutdown action and in part because the consequences of this type of event may be more severe than other core melt accident scenarios.

While the PWR can accommodate many reactor transients combined with failure of the reactor shutdown system without core melting, the same is not true of the CRBRP. Partially due to this factor, the CRBRP includes two reactor shutdown systems. Multiple and diverse sensing and logic systems, in conjunction with two separate and diverse reactivity control rod systems, are included. The applicant has proposed an extensive reliability engineering and development program to identify and eliminate potential weaknesses in the design and to assure that shutdown system action will occur when needed. The applicant argues that these provisions provide a substantially greater probability (than in LWRs) that the reactor shutdown system action will function properly in the event of loss of offsite power or other transient requiring control rod insertion. The staff has concluded that it is feasible to achieve the required redundancy, diversity and reliability in the CRBRP shutdown system.

7.1.3 Consequences of Class 9 Accidents

From among the spectrum of events beyond the design bases, the staff has examined various sequences that lead to core melting and disruption. These evaluations have led to a delineation of the sequences, forces, loadings, structural behaviors, activity releases, etc., associated with such events in the CRBR design. The staff concluded that some of the accidents analyzed could lead to energetic disassembly of the core and the production of vaporized fuel, and that these characteristics must be considered in the design evaluation to ensure that the consequences of Class 9 accidents in the CRBR were made comparable to Class 9 accidents in LWRs. Since WASH-1400 indicates that most LWR core melt accidents do not lead to early containment failure, the staff determined that the CRBR containment should be protected from accident energetics and large releases of vaporized fuel, and should also be protected from early failure due to the other manifestations of core melt; the staff specified a time of at least 24 hours to maintain containment system integrity.

The staff's study has led to the following grouping of core disruptive accidents, in the order of increasing severity of consequences:

I. Primary system remains intact; no major release of radioactive materials.

II. Primary system initially intact but ultimately fails due to ineffective long term decay heat removal (of the order of hours or more):

The steel liners in the reactor cavity could fail either through penetration of the core debris or due to excessive steam pressure (from water released in heated concrete structures). The reactor cavity atmosphere would be pressurized (from reaction products and/or sodium vapor) beyond its design value. Ultimately, the sodium boils off. Outer containment fails due to overpressurization and/or structural thermal degradation. Core debris may continue to penetrate into concrete. Fission products are volatilized and released. Consequences may exceed 10 CFR 100 guideline values.

III. Primary system seals fail due to excessive mechanical and/or thermal loads. Some sodium fuel vapor and fission products are expelled into the head access area. Longer term consequences as in II above.

IV. Primary system fails due to excessive mechanical loads. Outlet piping (three loops) fails and sodium is expelled into the reactor guard vessel. Substantial quantities of fuel, sodium or sodium vapor and fission products are released to the outer containment. Initial failure of the containment due to these effects is possible. Longer term consequences as in II above.

The above accident grouping is consistent with a spectrum of calculations performed by the staff for scenarios which included reactivity insertions from a few cents to a few dollars per second, step reactivity insertions, loss of coolant flow, loss of heat sink, and fuel failure propagation. The steps involved in core disruption were analyzed including direct hydrodynamic disassembly, such as may arise from reactivity additions caused by loss of coolant flow, recriticality resulting from material reentry and meltdown instabilities, and thermal interactions of fuel and other materials with the coolant. The applicant has proposed to incorporate a number of features specifically designed to minimize the probability of failure of the reactor cavity and containment (such as through controlled venting of water vapor as may be formed behind the cell liners). The applicant has also proposed a system for controlled venting of the reactor containment atmosphere through filters as a means of reducing the likelihood of a large uncontrolled release of radioactivity. These systems are currently under review by the staff.

Further perspective on the magnitude of the consequences of a large release of radioactive material can be gained from the Reactor Safety Study. For the equilibrium core of a 1000 MWe LWR and the largest release fractions assumed therein, no early (< 1 year) fatalities and only about 1% and 5% of the latent cancer fatalities are attributable to plutonium and strontium isotopes, respectively (i.e., the rest are attributable to other fission products). A comparison of the equilibrium CRBRP core to that assumed in WASH-1400 shows that the inventory of significant fission products is about three-fold lower in the CRBRP and the plutonium inventory is not significantly different. In the event described in Table 7.2, the assumed release to the environment involved approximately 0.3% of the core inventory of plutonium, which compares with the maximum value of 0.4% estimated in WASH-1400. Although sufficient information is not available to reach firm conclusions on the release fractions potentially associated with the spectrum of possible core disruptive accidents, the release fractions for all isotopes except strontium and plutonium cannot be more than a factor of two higher since the assumed fractions in WASH-1400 were between 0.4 and 0.9. Since plutonium and strontium were such relatively small contributors to the consequences, even if their release fractions were ten-fold higher, the overall consequences from a CRBRP accident would not be substantially different from those predicted by the Reactor Safety Study for LWRs. The above argument, of course, does not account for the sodium which might be released from the CRBRP. We believe that the release of massive quantities of chemically toxic sodium, coincident with a core melting event, would not result in significantly greater consequences than those already estimated in the Reactor Safety Study. The consequences of the event described in Table 7.2 did include the contribution of radioactive sodium which was found to be minor. Further work will be required and is planned to confirm this assessment. This work includes sodium fire and material interaction studies by the applicant and confirmatory studies by the NRC.

7.1.4 Accidents: Conclusions

The design information and evaluations available at this time have been reviewed. Based on this review, our conclusion is that the accident risks can be made acceptably low with the incorporation of the features and requirements in the design as discussed above. The staff's safety evaluation will provide the basis for determining what plant features and R&D programs are acceptable in this regard. The staff believes it is within the state-of-the-art to design, construct and operate the CRBRP in such a manner that the consequences of accidents will not be significantly different from those already assessed for LWRs. Should our further reviews indicate that residual risks are not sufficiently low or that substantial modifications to the plant are required to meet our safety requirements, the staff will require such changes as deemed necessary.

7.2 TRANSPORTATION ACCIDENTS INVOLVING RADIOACTIVE MATERIAL

A recent survey (NUREG-0073) indicates that about 2.5 million packages of radioactive material are transported within the United States each year. About 1300 of these packages are casks containing spent fuel. Of the more than 32,000 reports of transportation incidents involving hazardous materials that were submitted to the Department of Transportation during 1971-1975, 144 incidents involved radioactive materials and 36 involved release of contents or excessive radiation levels (Grella, 1976). In most cases, releases involved minor contamination. No deaths or significant injuries due to radiation or radioactivity were experienced. This record is a continuation of the excellent safety record observed in transportation of radioactive materials during the previous 25 years.

The probability of an accident occurring in transportation of hazardous materials by truck is small--about 1.7 accidents per million vehicle miles--and decreases with increased severity of the accident to about one extra severe accident (one in which the package containment may be breached) per 50 billion vehicle miles, and one extremely severe accident per 10 million-million vehicle miles (WASH-1238). Based on an assumed shipping distance of 750 miles, a shipment to or from the CRBRP might be involved in an accident once in about 800 shipments. Assuming the average number of 96 shipments per year estimated for the CRBRP in Appendix D, an accident might occur once in about 8 years. The frequency of an extra severe transportation accident associated with the CRBRP for these same assumptions would be once in about a million years. Effectively, no releases of radioactive material from transportation accidents would be expected for the lifetime of the plant.

Primary reliance for safety in the transport of radioactive material is placed on the packaging (WASH-1238; 10 CFR Part 71). Both the package design and the quality assurance exercised in its manufacture, use and maintenance must comply with the requirements of 10 CFR Part 71. The regulatory standards established by the Atomic Energy Commission, predecessor of the Nuclear Regulatory Commission, the Department of Transportation and the various agreement states provide that packaging of radioactive materials shall prevent the loss or dispersal of the radioactive contents, retain shielding efficiency, assure nuclear criticality safety, and provide adequate heat dissipation under normal conditions of transport and under specified accident damage test conditions (WASH-1238). Thus, a breach in the containment of a package involved in an accident is unlikely to occur.

Even though a radioactive release due to a transportation accident is unlikely to occur, such an event could happen. The consequences of such an event should be no worse than those analyzed for accidents to current shipments of spent LWR fuel (WASH-1238) and proposed shipments of spent MOX fuel (NUREG-0002).

The CRBRP irradiated fuel assemblies would be producing large amounts of heat and penetrating radiation after removal from the reactor core. They would be stored at the plant for about 360 days to permit these emanations to subside before being shipped in casks to a reprocessing facility. The cask primary coolant being considered is phenyldiphenyl eutectic, although helium is a possible alternative (WASH-1535, p, 4.5-18). The spent fuel cask is assumed to be designed to carry cooled assemblies and to be built to current standards with current technology. The CRBRP fuel would probably be irradiated to greater exposures than typical LWR fuel--100,000 megawatt-days thermal burnup for CRBRP fuel vs about 40,000 megawatt-days thermal burnup for LWR fuel. Comparison of calculated activities of particular nuclides for LWR and MOX fuels cooled about 150 days (EPA-520/3-75-023, Table 6) to CRBRP fuel cooled for 360 days (ORNL-4678) indicates that the activities do not differ by more than a factor of 3 for these fuels. The results of WASH-1238 would not be much changed by this factor of 3 because the releases in question are so small to begin with; hence, the analyses and conclusions of WASH-1238 are applicable to accidents involving spent CRBRP fuel. The spent fuel casks designed to transport spent CRBRP fuel will be subject to the same regulations in 10 CFR Part 71 that govern spent fuel casks designed to transport spent LWR or MOX fuel. An assumption that a severe accident would not cause a greater release of radioactive material from a CRBRP cask than from an LWR or MOX cask thus appears reasonable. The environmental impact of an accidental release from an LWR cask is judged to be small in WASH-1238. Similarly, the environmental impact of an accident to a CRBRP cask is also judged to be small.

Unirradiated fuel transportation accident risks are not considered to be significant because of measures taken to prevent nuclear criticality and releases of radioactivity in such accidents. The CRBRP unirradiated fuel assemblies would be shipped in special containers approved by NRC. These packages would incorporate additional neutron and gamma shielding for the high burnup plutonium likely to be associated with the CRBRP fuel. The consequences of accidents to shipments of unirradiated LWR and MOX fuel are discussed in WASH-1238 and NUREG-0002 respectively. Accidents to shipments of unirradiated CRBRP fuel are expected to have similarly small consequences because of design similarities.

The CRBRP is expected to produce low radioactivity wastes in the forms of concentrated liquids, compactible solids, non-compactible solids, metallic sodium, and sodium bearing components. The basic approach to management of these radioactive wastes is to render them all into solid forms for shipment to disposal centers. Of these wastes, shipments of non-compactible solids and metallic sodium would contain the greatest radioactivities, about 34 Ci and 25 Ci, respectively (See Appendix D, Table 5). The average package contents would be about 0.5 Ci and 1.7 Ci, respectively.

These packages would most likely be Type A packages, which are not required to be designed to withstand accidents, because the most restrictive isotopes in the wastes are categorized in Transport Group III (see 10 CFR Part 71). For an isotope in this group, if the contents are greater than 3 Ci, a Type B package, which is designed to withstand accidents, would be required by NRC regulations. An exception has to be made for the presence of Sr-90, which is in Transport Group II; for isotopes in this group, contents of 0.05 Ci or more are required to be shipped in a Type B package.

Assuming the wastes are shipped in Type A packages, the package contents are so limited that the expected environmental impact of an accident is such that no more than 10^{-6} of the package contents would be taken into the body of an individual within the vicinity of the accident. If such an intake occurred, the expected radiological dose would not exceed internationally accepted limits, assuming a 50-year life expectancy after the intake. A severe accident would be expected to destroy the shielding effectiveness of the package, but in such a case the package contents are so limited that the external radiation dose at 10 feet from the unshielded contents would not exceed 1 rem/hour.

If the wastes are shipped in a Type B package, the environmental impact of an accident is not expected to involve a radiological dose unless the accident is extremely severe. In such an event the solid, non-combustible, unreactive form of the contents and the hardiness of the package would serve to limit the radioactive release so that the environmental impact is small.

Metallic sodium wastes present as much of a chemical hazard as a radiological hazard in transportation, primarily because of metallic sodium's high chemical affinity for water and air. Accordingly, these wastes must be treated before they are transported and they must be packaged in airtight containers (49 CFR § 173.206). The environmental impact of an accident is expected to involve a small radiological dose.

Considering the low probability of a shipment of radioactive material being involved in an accident, the requirements for package design and quality assurance, the nature and form of the radioactive material, and the controls exercised over the shipment during transport, the staff concludes that the risk of radiation injury from transportation accidents involving radioactive material from CRBRP would be very low.

7.3 SAFEGUARDS CONSIDERATIONS

Safeguards are defined as those measures employed to prevent the theft or diversion of special nuclear materials and the sabotage of nuclear facilities. Special nuclear material (SNM) is defined as plutonium, uranium-233, or uranium enriched in the 235 isotope. This section addresses the potential environmental impacts of the CRBRP resulting from (1) possible acts of sabotage directed at the CRBRP itself or spent fuel discharged from the CRBRP, (2) possible thefts of SNM from the CRBRP, its associated fuel cycle facilities or transportation links and (3) the measures which are necessary to minimize the risk of successful acts of theft or sabotage.

Preliminary to the analysis of potential environment impacts a brief discussion is in order of the nature and characteristics, to the extent that they are known, of the threat to nuclear facilities. For purposes of the safeguards evaluation in this environmental impact statement, a discussion of the threat to a facility or SNM can be separated into (1) the likelihood that an act of sabotage or theft might be attempted at nuclear facilities and (2) the resources that would be utilized in such an attempt.

The possibility that such acts would be directed at a nuclear facility can be examined in the following manner. The commercial nuclear power industry in the U.S. is in a period of substantial growth which will result in large numbers of operating reactors. In addition, serious consideration is being given to the widespread commercial use of mixed oxide fuels (MOX) and of breeder reactors. The effect of these developments is to increase the number of opportunities, at least, for possible attempts at sabotage or theft. This fact, together with an apparent increase in terrorist violence in recent years, has caused additional public and Federal attention to be focused on nuclear material and facilities safeguards. The response by NRC has been to assume that acts of sabotage and theft might be attempted (although there is no conclusive evidence to support this assumption) and to require that safeguards capabilities be provided at licensed facilities.

This leads us then to consideration of (2) above which asks what level of resources should be assumed in conjunction with the postulated threat. Studies have been performed to examine historical data relating to terrorist activity.* While very little of these data are applicable to nuclear facilities, it is apparent that the only known acts of violence directed toward nuclear facilities were characterized by levels of resources (training, knowledge, violence, etc.) insufficient to cause danger to the public health and safety. To supplement these data the NRC maintains working liasions with other Federal agencies to obtain any information which might become available on individuals or groups who could pose a threat to nuclear facilities. To date, the NRC has no indication of any threat to domestic nuclear facilities that would endanger the public health and safety.

---

*See for example:

(1) "Will Terrorists Go Nuclear?" by Brian Jenkins, presented at the California Seminar on Arms Control and Foreign Policy; October 1975.
(2) MITRE Corp., The Threat to Licensed Nuclear Facilities, MTR-7022 (McLean, Va., September 1975).
(3) P. A. Karber, H. C. Greisman, R. W. Mengel, G. S. Newman, E. J. Novotny, and A. G. Whitle, Analysis of the Terrorist Threat to the Commercial Nuclear Industry, "Draft working paper summary of findings," BDM/W-75-176-TR (Vienna, Va.: The BDM Corp., September 1975).
(4) P. A. Karber, H. C. Greisman, R. W. Mengel, G. S. Newman, E. J. Novotny, and A. G. Whitle, Analysis of the Terrorist Threat to the Commercial Nuclear Industry. "Draft working paper C, supporting appendices," BDM/W-75-176-TR (Vienna, Va.: The BDM Corp., September 1975).
(5) R. W. Mengel, Analysis of Group Size, BDM/W-75-247-TR (Vienna, Va.: The BDM Corp., December 1975).

Even though historical evidence and current "intelligence" fail to reveal any substantive threat to nuclear facilities, the NRC recognizes the possibility that persons with resources sufficient to be of concern might attempt to sabotage a facility or steal SNM. Therefore the NRC will require that the CRBRP be protected against such potentialities.

Current NRC regulations for physical protection do not state explicitly the threat level for which protection must be provided. Instead, certain specific provisions such as fences, barriers around vital equipment, access controls, onsite armed guard force, etc., are required. Threat levels have been implicitly considered in the development of the NRC guidelines for some time (e.g., Regulatory Guide 5.43, Regulatory Guide 1.17 and ANSI N18.17, "Industrial Security for Nuclear Power Plants").

NRC is presently considering amendments to its regulations which might include specified threat levels. The threat levels would act as a performance objective for the design of physical security systems by licensees and as a basis for evaluation by the NRC. In addition, the NRC is continuing its assessment of the "threat" and future regulations could reflect changes in the proposed design threat levels. In any event the CRBRP will be required to meet all applicable regulations as well as any additional requirements that the NRC staff determines are necessary to provide an adequate level of protection.

7.3.1 Current Safeguards Program Elements

The CRBRP safeguards system will include measures to deter, prevent and respond to the unauthorized possession or use of significant quantities of special nuclear materials through theft or diversion and to sabotage of nuclear materials and facilities. These measures will provide multiple opportunities to interrupt adversary action sequences, including all of the following features: (1) obvious physical security and employee awareness/motivation measures that serve to deter adversaries; (2) the capability to detect any attempt to breach physical security barriers; (3) an effective internal material control program; (4) arrangements for external assistance; and (5) contingency plans for recovery of nuclear materials.

The following functional elements are utilized by the NRC to assure effective implementation of a safeguards program:

(1) consideration of the nature and dimensions of the threat in the development of regulatory requirements;

(2) imposition on the applicant of safeguards requirements directed toward countering the threat;

(3) licensing activities, including review of safeguards procedures proposed by the applicant, as required by regulations;

(4) inspection of safeguards implementation to ensure adequacy;

(5) enforcement of requirements through administrative, civil, or criminal penalties;

(6) administrative and technical support for response and recovery;

(7) confirmatory research related to the development and testing of methods, techniques, and equipment necessary to the effective implementation of safeguards;

(8) continuous program review in the light of industrial/technical or social/political changes to assure that any needed changes are made in these elements.

Title 10 of the Code of Federal Regulations (10 CFR 70) provides that, with certain limited exceptions, no person may receive title to, own, acquire, deliver, receive, possess, use, transport, import, or export special nuclear material without a license. NRC publishes specific safeguards requirements for materials and plant protection in 10 CFR Parts 70 and 73 and carries out the following activities to assure effective compliance with the requirements: (1) prelicensing evaluation of proposed nuclear activities, including safeguards procedures; (2) issuance of licenses to authorize approved activities subject to specific safeguards requirements; and (3) inspection and enforcement to assure that applicable safeguards requirements are met by implementation of approved procedures. In addition, the establishment of a reasonable state of preparedness for coping with emergency situations, particularly those involving radiological hazards, is also required.

7.3.1.1 Safeguards Licensing Activities

The safeguards prelicensing review addresses information submitted by the applicant to the NRC for approval - including the applicant's technical qualifications; a description of the process, equipment, and facilities to be used; the material control and accounting program, including measurement performance capability; and a physical security plan. Details of the material control and accounting program and the physical security plan are withheld from public disclosure as provided in 10 CFR Part 2.

The prelicensing review includes consideration of other regulatory aspects of the CRBRP design and operation. Account is taken of the interrelated effects of safety requirements and the inherent features of the facility that contribute to the protection afforded by the safeguards system. For example, the requirements that SNM be safely contained during normal operation, operational accidents, and natural phenomena, such as earthquakes and tornadoes, also provide significant physical protection. Similarly, the requirements for shielding and safe shutdown in the event of maloperation, and special personnel access control during such emergencies, in themselves enhance safeguards.

The applicant will be required to confine possession and use of SNM to the purposes and locations authorized in the license and may transfer nuclear materials only to an authorized recipient. The applicant will also be required to comply with the detailed accountability and physical protection requirements (fixed-site and in-transit) incorporated into the license pursuant to the regulations. The current types of safeguards requirements for special nuclear materials at fixed sites and in transit are summarized in Appendix E.

7.3.1.2 Inspection and Enforcement

The applicant will be required to afford the NRC the opportunity, at all reasonable times, to inspect SNM and the premises and facilities where SNM is used, produced, or stored, and to review the procedures for, and observe, the offsite movement of SNM. In addition the applicant will be required to make available for inspection any relevant records and to perform, or to permit the NRC to perform, any tests deemed necessary for the administration of the NRC regulations.

Following each safeguards inspection, a letter setting forth the inspection findings will be prepared and sent to the applicant. Where items of noncompliance or deficiencies are found, the applicant will be directed to take prompt corrective action and to inform the NRC of the results. In addition, the NRC can take one or more of the following steps: assess a civil penalty; suspend a license; revoke a license; or modify a license.

7.3.2 CRBR Site

Two potentially significant risks have been identified in safeguarding the CRBR site; (1) acts of sabotage directed at the plant itself, and (2) theft or diversion from the plant of special nuclear material (SNM) contained in the fuel. The applicant provides information in his Preliminary Safety Analysis Report regarding the provisions which will be incorporated in the physical security plan and in the plant design to provide protection against such acts. The staff, in its safety evaluation, reviews these safeguards measures and imposes additional requirements as necessary to establish compliance with the applicable regulations of the Commission. Such compliance provides reasonable assurance that there will be no significant increase in the overall risk to the public from acts of sabotage, theft or diversion at the reactor site.

7.3.2.1 Sabotage

Acts of sabotage at a reactor site are of concern because they could lead to a threat to the health and safety of the public and result in substantial environmental harm. If sufficient damage were done to selected combinations of plant systems, radioactive materials could be released to the environment, resulting in significant offsite consequences. Acts of sabotage could involve system failures or damage that would be accommodated within the envelope of design basis accidents (DBAs) for which the CRBR is being designed. The radiological consequences of Class 1-8 accidents discussed in Section 7.1 would be applicable even if the accidents were the result of deliberate actions. More extensive acts of sabotage could be postulated which could lead, for example, to substantial core damage and release of large quantities of radioactive materials. These acts, while possible, are highly improbable in the judgement of the staff. The bases for this conclusion are enumerated below.

Nuclear power reactors are designed to meet rigorous safety standards, including protection against natural phenomena and the consequences of postulated accidents. The CRBR design embodies this concept of defense in depth which provides considerable inherent protection against sabotage.

For example, multiple barriers are provided against the release of fission products and backup safety systems are required to be redundant, separate, and in protected areas of the plant. The staff finds that these features, when combined with an appropriate safeguards program, provide adequate protection against the occurrence or effects of sabotage.

The need to provide effective safeguards at nuclear power reactors and requirements for physical protection measures is recognized in the Commission's regulations. 10 CFR 50.34(c) requires that each application for an operating license include a physical security plan demonstrating compliance with 10 CFR Part 73. 10 CFR Part 73, specifically § 73.40, § 73.50, § 73.60 and proposed § 73.55,* delineates the need for, and the elements of, physical protection programs at applicable facilities.

Section 73.55 is a proposed amendment to Part 73 which will provide further deterence to acts of sabotage at nuclear power reactors, including the CRBRP. A general performance requirement may be included which is intended to aid in the implementation of the rule and more explicitly indicate the level of protection required. The threat level which may be specified therein is (1) an external threat of several well trained persons armed with pistols, shotguns, or rifles (including semi-automatic weapons), who may be assisted by an insider (employee or unescorted person); or (2) an internal threat of an insider. The use of this performance statement also provides flexibility in implementing the following generally required elements of a physical security program for protection against sabotage:

- <u>Personnel (employee) screening</u>: Licensees must establish and implement procedures for determining the acceptability of candidates for nuclear plant employment.
- <u>Physical Security Organization</u>: Licensees must maintain a physical security force, including qualified armed guards, to protect the facility against industrial sabotage.
- <u>Physical Barriers</u>: Licensees must maintain alarmed physical barriers around the facility and its vital areas. The barrier at the perimeter of the protected area is required to be illuminated and to have an isolation zone adjacent to it.
- <u>Access Requirements</u>: Licensees are required to control all points of personnel and vehicle access into the protected area. All personnel, vehicles, and hand carried packages are required to be searched for devices which could be used for industrial sabotage. A numbered picture badge identification system would be used for all individuals who are authorized access to protected areas without escort. Access to vital areas would be limited to authorized individuals who require such access to perform their duties.
- <u>Detection Aids</u>: Licensees are required to provide a hardened central alarm station where all alarms annunciate, with the capability of continuous communication with individual guards, and with the capability to summon assistance from offsite law enforcement authorities.
- <u>Response Requirement</u>: Licensees are required to establish and document liason with local law enforcement authorities. In selecting the size of the onsite guard force the licensee will take into account the probable size and response time of the local law enforcement authorities.

It is also worth noting that the task of providing physical protection against sabotage at the CRBR site is no different than for current generation LWRs. In both cases, large inventories of radioactive materials are present in the reactor core and in spent fuel stored at the site and therefore represent potential targets of sabotage. Consequently, the technology and systems design concepts which have been developed and found to be effective for current reactors can, in large part, be translated to the CRBRP. The requirements contained in proposed § 73.55 represent the staff's judgement at this time of what constitutes an appropriate level of protection against sabotage. The applicant will be required in the course of the licensing process to demonstrate that an equivalent level of protection is provided at the CRBRP.

*All references to the proposed § 73.55 refer to the as-modified version following the public comment period.

Of course, the NRC recognizes the dynamic nature of safeguards concerns and has therefore established an agressive program designed to judge the effectiveness of present safeguards arrangements and to evaluate the merits of and need for new concepts in the future treatment of safeguards. The results of these studies will be factored into the licensing review of the CRBRP, as appropriate.

In summary, the staff has evaluated the potential environmental impacts associated with acts of sabotage directed at the CRBR plant and has concluded that they are minimal. The basis for this conclusion rests on the absence at this time of any evidence which would indicate a significant threat to nuclear facilities, the protective features of the plant associated with its safety design bases which provide inherent resistance to acts of sabotage, and the additional margin of protection afforded by an effective safeguards system.

7.3.2.2 Theft or Diversion of SNM

In addition to protecting the CRBRP against sabotage, the safeguards program will also provide additional measures to protect against the theft or diversion of SNM. Special nuclear materials, most significantly plutonium, are involved in the operation of the CRBRP. The possible theft or diversion of these materials from the plant and their subsequent use in the fabrication of nuclear explosive devices or dispersal devices to create radiological incidents represents a potential environmental impact of the CRBRP. However, the overall safeguards program, by virtue of physical security and material control measures, is designed to provide a high degree of protection against theft or diversion.

Unirradiated fuel assemblies containing SNM will be stored at the CRBRP for a period of time before insertion into the reactor core. During this time the fuel assemblies will be located in the fuel storage facilities except for periods of fuel transfer or inspection in the fuel handling cell. The storage facility for both new and spent fuel will consist of a 26-ft square by 50-ft deep concrete vault. The fuel will be stored in a vessel within the vault, which is filled with sodium, and the top of the vessel will be provided with a cover plate and a 20-inch thick steel shield. The movement of fuel at the CRBRP will require the use of highly sophisticated handling equipment.

The safeguards measures that must be provided at the reactor site for protection of unirradiated fuel when outside its storage facility would be overlaid on the safeguards system for protecting the reactor against acts of sabotage and would be consistent with the safeguards levels of other facilities possessing significant quantities of SNM. The safeguards measures that will be applied to unirradiated fuel while located in its storage facility will take into account the inherent protection provided by this location.

In summary, the staff concludes that the potential environmental impacts due to theft or diversion of SNM from the CRBR site are minimal. The unirradiated fuel will be stored on site in a highly tenable configuration (in a sodium filled vessel within a vault) and will be further protected when outside the storage vessel by an onsite physical security system commensurate with the possession of a significant quantity of SNM.

7.3.3 Fuel Cycle Safeguards Impacts

Fuel cycle activities in support of the CRBRP are expected to be carried out in conjunction with the commercial fuel cycle(s) in use during the plant's operating life and with ERDA LMFBR demonstration programs. At the present time the supplier of the fuel for the CRBRP has not been established nor has it been determined where the spent fuel will be processed. The safeguards-related environmental impact of other fuel cycle activities stemming from the operation of the CRBRP will be dependent upon the exact nature of the activities and their relationship to the CRBRP fuel cycle. Although a detailed assessment of this impact is precluded by the present and future uncertainties associated with the supporting fuel cycle activities, it should be recognized that the safeguards policies and techniques utilized to protect strategic special nuclear materials (SSNM)* in one facility or shipment are applicable to protection of the same kind of nuclear materials in other facilities or shipments. The safeguards measures being studied for application to existing nuclear facilities and to new fuel cycles will be directly applicable or readily adapted to the CRBRP fuel cycle activities. This section provides a general discussion of the anticipated effects of CRBRP operation on fuel cycle safeguards.

---

*Strategic special nuclear material is defined as plutonium, uranium-233, or uranium enriched to greater than 20% in the isotope 235.

7.3.3.1 CRBRP Fuel Cycle Activities

The nature of the safeguards problem is closely related to the characteristics of the nuclear materials present in a fuel cycle and of the forms and locations in which they appear. Plutonium and the radioactive fission products resulting from reactor operation are the materials of primary concern in considering the safeguards implications of the CRBRP.

Figure 1 of Appendix D in this environmental statement presents a simplified schematic diagram of the CRBRP fuel cycle. The initial core loading of the reactor would consist of approximately 6.5 metric tons (MT) of uranium and plutonium. Fuel would be in the form of sintered mixed-oxide pellets of PuO_2 and UO_2 encapsulated in stainless steel tubing (rods). The PuO_2 makes up approximately 20% of the fuel and provides the fissile material for power generation. The UO_2 would contain either depleted or normal uranium concentration. Plutonium enrichment would be 18.7 weight percent in the inner core zone and 27.1 weight percent in the outer zone of the first core. In future cores, the plutonium enrichment would be 22 weight percent in the inner core zone and 32 weight percent in the outer zones. With equilibrium loading, the reactor core would contain 1.7 MT of plutonium and 4.8 MT of uranium. An additional 21.7 MT of depleted uranium would be committed in the radial and axial blankets. Average isotopic composition of the plutonium metal in the core and blanket would be approximately 71% Pu-239, 19% Pu-240, 7% Pu-241 and 2% Pu-242.

After its period of use in a reactor, the irradiated fuel becomes poisoned with fission products and must be replaced with fresh fuel. An estimated 2,300 fuel assemblies and 850 radial blanket assemblies would be committed during the 30-year life of the CRBRP. The total requirements of the plant during its life could be as high as 20 MT of plutonium and 210 MT of uranium.

Spent fuel elements would be transported in massive shielded casks (following a cooling period at the plant site) to a reprocessing plant where the fission products would be separated, solidified, and transported to high-level waste storage. The recovered plutonium would be transported to storage (or directly to the fuel fabrication facility for recycle) as PuO_2. Unused uranium would be separated as uranyl nitrate and, after conversion to uranium oxide or uranium hexafluoride, would be transported to storage or recycled directly to the fuel fabrication facility.

7.3.3.2 Related LWR Fuel Cycle Activities

The CRBRP fuel may be supplied by existing plutonium fuel facilities or by future facilities that would come into existence as a result of a favorable decision on wide-scale plutonium recycle.

With regard to existing licensed plutonium fuel facilities, the NRC has determined that the safeguards framework of existing and proposed regulations discussed in its statement of November 14, 1975* is adequate to enable the Commission to carry out its responsibilities to protect the public health and safety and the common defense and security. While experience and continuing study may indicate areas where revisions to the Commission's regulations applicable to these facilities should be made, the production of CRBRP mixed oxide fuel in conjunction with these existing activities should not involve substantially different safeguards issues or costs.

7.3.3.3 ERDA Demonstration Programs

The Energy Reorganization Act transferred the licensing and inspection operations for privately-owned nuclear facilities from the regulatory arm of AEC to the NRC. Responsibility for promulgation of safeguards requirements and inspection of AEC-owned nuclear facilities was transferred from the AEC to ERDA (except for new demonstration nuclear reactors and facilities for the receipt and storage of high-level radioactive waste, which are subject to NRC licensing and inspection). ERDA is charged to develop and to demonstrate the effectiveness of safeguards for new fuel cycles. NRC is to conduct confirmatory research and to determine whether the safeguards plan submitted to NRC by ERDA for facilities subject to NRC licensing, and plans submitted by private facilities, satisfy NRC criteria.

Facilities operated by ERDA in the course of the development and demonstration program for the LMFBR and its fuel cycle are another possible alternative source of fuel fabrication and reprocessing operations in support of the CRBRP. The safeguards measures being formulated for use at these facilities are themselves part of the LMFBR program. The ERDA safeguards program includes the development of a capability to make improved threat predictions and system effectiveness evaluations, and the design and demonstration of balanced, flexible safeguards systems for application to future fuel cycles.

While the regulatory responsibilities of NRC and the developmental responsibilities of ERDA must be clearly separated, the activities of the two agencies toward improved safeguards will be

*40 FR 53056, Mixed Oxide Fuel; Scope, Procedures and Schedule for Generic Environmental Impact Statement and Criteria for Interim Licensing Actions.

coordinated. In view of the safeguards development programs which will be underway at the ERDA LMFBR demonstration facilities, it is expected that the CRBRP activities will not give rise to substantially different safeguards issues at these facilities.

7.3.4 CRBRP Nuclear Material in Transit

7.3.4.1 Shipments of Unirradiated Fuel Assemblies, Radioactive Wastes, and Irradiated Fuel Assemblies

7.3.4.1.1 Unirradiated (Fresh) Fuel Assemblies

During annual refueling, approximately one-third of core fuel assemblies would be replaced. New fuel assemblies would be shipped to the site in NRC-approved shipping containers. Each container holds one fuel assembly and is approximately 3.5 feet wide by 4 feet high by 19 feet long. Two containers would be shipped on a single truck. The total weight of the two fuel assemblies (not including containers) would be approximately 900 pounds. The loaded weight of each container would be on the order of 2,000 pounds. During the first five years of plant operation (pre-equilibrium mode) there would be an average of 51 truck shipments of two fuel assemblies per truck each year to the CRBRP.

The plutonium enrichment of the fresh fuel varies from 18.7 to 32.0 weight percent. The total weight of heavy metal in each fuel assembly would be approximately 33 kg, with the plutonium content ranging from 6 kg to 10 kg per assembly (12 kg to 20 kg per shipment).

7.3.4.1.2 Radioactive Wastes

Each year the CRBRP would ship approximately 220,000 pounds of radioactive waste having a combined activity of 4.5×10^4 curies. All packaged radioactive waste would be shipped to a licensed burial site for disposal. As yet, the location of this site has not been determined.

7.3.4.1.3 Irradiated (Spent) Fuel Assemblies

Irradiated fuel assemblies would be transported and protected in a cask approximately 8 feet in diameter by 21 feet in length. Irradiated fuel assemblies would be inserted in a removable canister inserted in the cask. The canister capacity is nine fuel assemblies. The approximate weight of the cask is 77 tons; it is designed for transportation on a 100-ton capacity railroad flatcar. The cask and car combination is designed in accordance with NRC and DOT regulations. It is provided with crash protection and passive cooling capability. The actual number of fuel assemblies per cask shipped will be determined on the basis of economic considerations and a heat load limit of 27 kW per cask.

It is estimated that the number of spent fuel assemblies removed from the reactor would require eight shipments per year during equilibrium cycle and 26 shipments per year during the pre-equilibrium cycle mode of operation.

7.3.4.2 Theft or Diversion of CRBRP Nuclear Material in Transit

7.3.4.2.1 Unirradiated Fuel Assemblies

Based on the considerations listed below, the transport process might be <u>perceived</u> as the most attractive and vulnerable segment in the entire fuel cycle.

- The fuel could be SSNM grade material.
- The material, already packaged, would be safe to handle, transfer, transport and store.
- A single shipment could contain a strategic quantity.
- Material on the open road could appear to be less defensible than material behind barriers or in vaults at a fuel site.

The mixed oxide fuel assemblies consisting of depleted uranium combined with 18.7 to 32 weight percent plutonium must be considered a potential target for theft or diversion. Published reports* have stated that such material could be used directly as a fissile explosive. In addition, the dissolution and separation of the PuO_2 from the mixture is not considered to require rare or unique skills.

*See for example: M. Willrich and T. B. Taylor, Nuclear Theft: Risks and Safeguards, Ballinger Pub. Co., Cambridge, Mass., 1974.

Consequently, the physical security measures employed to protect the fresh fuel assemblies in transit must be selected and implemented with the greatest care. Many alternatives are being examined and compared for effectiveness. It is expected that the development and use of new protection techniques in conjunction with the general NRC safeguards program will be a continuous process.

Proposed safeguards measures for in transit security that are being considered include:

- Use of specially designed vehicles with penetration resistant cargo compartments and immobilization capability. (Safe Secure Trailers provided by ERDA's Division of Military Application will be used according to ER Amendment 6, p. 3.8-1.)
- Use of convoys with massive defensive forces and equipment.
- Transport by air from secure base to secure base.
- Combinations of above elements.

Given the relatively small number of yearly shipments (51 the first five years, less if combined into convoys), it would be possible to amass and apply resources to counter any conceivable threat. There are no known technical, logistic or societal impediments to producing a transit protection system that would be essentially undefeatable.

7.3.4.2.2 Radioactive Wastes

Because of the low concentration of plutonium and uranium in the waste and the relatively low radioactivity per unit weight, waste is not considered to be either attractive or useful to terrorists.

7.3.4.2.3 Irradiated Fuel Assemblies

Irradiated fuel is not considered to be an attractive target for theft by malevolent groups. The extreme radioactivity, requiring the use of massive gamma and neutron shields in the shipping container, prohibits removal of the fuel from the container without special equipment and procedures. In addition, the contained plutonium cannot be easily separated from the fission products.

7.3.4.2.4 Consequences of Theft

A complete review of the safeguards problem must include consideration of the potential consequences of safeguards failures. A successful theft could lead to the use of explosives or radiological weapons. These potential consequences are discussed below:

There is considerable debate as to the ease or difficulty of amateurs fabricating a nuclear explosive device, with a wide range of authoritative opinion on the subject. There appears to be general agreement that, given the availability of the requisite nuclear material, the construction of an illicit explosive device requires a certain level and range of skills and resources. Disagreement arises with respect to the way the level of required skills and resources is characterized. It must be recognized that successful nuclear weapons fabrication depends on many factors: type, form and quality of nuclear material,* availability of essential accessary equipment, capability for handling hazardous components including radioactive materials and explosives, knowledge of the technical features of a nuclear device and many others. There is essentially no likelihood that a terrorist group could fabricate a modern efficient bomb such as those in military inventories. There is, however, a low but credible probability that such a group could assemble a device which would produce significant fission yield. This probability must be minimized by the safeguards program.

The assembly of a workable weapon is complex and laden with many obstacles, any one of which could prevent the accomplishment of the adversary's first goal--the availability of a workable explosive device. Depending on the design approach and materials to be used, sophisticated knowledge and skills may be required. They could include precision machining, chemical processing, foundry skills, electromechanical devices, electronics, and high-explosives handling. Such

---

*Fabrication of a nuclear device from stolen fresh fuel rods or spent fuel is exceedingly more difficult than use of stolen mixed-oxide powder from a fabrication facility or reprocessing plant. The discussion here concerns the degree of difficulty encountered with the oxide powder form. This is the most susceptible form in which plutonium in the CRBR fuel cycle will occur. The probability of successfully stealing, reprocessing and fabricating a nuclear device from a fresh fuel rod or spent fuel rod is increasingly low.

knowledge and skills are not rare, but gathering together those who possess them, in a clandestine project, with the common motivation to build and detonate a nuclear weapon for unlawful purposes, would be difficult.

The designer of a nuclear explosive faces several dilemmas. The simpler and less sophisticated the design, the larger the size and weight of the device and the greater the requirements for nuclear materials and high explosives. If the design is unsophisticated, it is more likely to be heavy and to require a team of people or special equipment to assemble and transport it. If the available amount of nuclear material is small, the design must be sophisticated, requiring additional skills and more time for fabrication.

The risks in fabricating a crude nuclear explosive device are both numerous and significant. The very nature of the activities in such a project, the kinds and numbers of people required, and the materials involved all combine to enlarge the total size of the aggressor group, stretch the time and activity required for completion, and thereby facilitate detection of the enterprise.

Further, the manufacture of nuclear weapons involves use of extremely hazardous materials, and there is a substantial chance that amateurs would suffer accidents from criticality, from chemical reactions, or from the mishandling of high explosives. In the history of making nuclear weapons such accidents have occurred under highly controlled conditions, and their probability would be enhanced by the conditions to be expected in an amateur project. While the accidents that have occurred have had no adverse impact on society, they have had serious effects upon the individuals involved. Assembly and delivery pose opportunities for lethal radiation exposures, premature nuclear detonation or, more likely, premature explosion of a large quantity of conventional high explosives.

Experts are divided as to the true difficulty that might stem from such considerations as those mentioned above, and as to what might be the requirements if a determined and skillful group were to undertake the simplest possible means of creating a crude but effective nuclear explosive. Accordingly, three opinions are quoted below in an attempt to present a range of views:

1. <u>Willrich and Taylor (1974)</u>

   As a result of extensive reviews of publications that are available to the general public and that relate to the technology of nuclear explosives, unclassified conversations with many experts in nuclear physics and engineering, and a considerable amount of thought on the subject, we conclude:

   Under conceivable circumstances, a few persons, possibly even one person working alone, who possessed about ten kilograms of plutonium oxide and a substantial amount of chemical high explosive could, within several weeks, design and build a crude fission bomb. By a "crude fission bomb" we mean one that would have an excellent chance of exploding, and would probably explode with the power of at least 10 tons of chemical high explosive. This could be done using materials and equipment that could be purchased at a hardware store and from commercial suppliers of scientific equipment for student laboratories.

   The key persons or person would have to be reasonably inventive and adept at using laboratory equipment and tools of about the same complexity as those used by students in chemistry and physics laboratories and machine shops. They or he would have to be able to understand some of the essential concepts and procedures that are described in widely distributed technical publications concerning nuclear explosives, nuclear reactor technology and chemical explosives, and would have to know where to find these publications. Whoever was principally involved would also have to be willing to take moderate risks of serious injury or death.

   Statements similar to those made above about a plutonium oxide bomb could also be made about fission bombs made with high-enriched uranium or uranium-233. However, the ways these materials might be assembled in a fission bomb could differ in certain important respects.

2. <u>J. Carson Mark</u> (as quoted in Schmidt and Bodansky, 1975):

   If one thinks of a small group wanting to build a bomb, and if one supposes that their primary requirement is that it give a "nuclear yield" (as to say, for example, "the yield must be at least so much; but it is all right if it should turn out to be a few times larger") then I think that such a device could be designed and built by a group of something like six well-educated people, having competence in as many different fields. As a possible listing of these, one could consider: a chemist or chemical engineer; a nuclear or theoretical physicist; someone able to formulate and carry out complicated calculations, probably requiring the use of a digital computer, on neutronic and hydrodynamic problems; a person familiar with explosives; similarly for electronics; and a mechanically-skilled individual. Among the above (possibly the chemist or the physicist) should be one able to attend to the practical problems of health physics which would arise. Clearly, depending on the breadth of experience and competence of the particular individuals involved, the fields of specialization and even the number of persons could be varied, so long as areas such as those indicated were covered.

3. M. Levenson and E. Zebroski (1975)

> Perhaps a more skeptical view of this possibility [of producing a crude nuclear weapon] would be by analogy to the ability of a reasonably well-informed technical person to sketch up a workable concept for a small jet propelled airplane, or a medium sized computer. Given access to manufactured modules for most of the critical parts, construction of such a project by a small dedicated group of artisans is conceivable. However, if the project must literally start from the raw materials in inconvenient chemical and physical form, and with very substantial hazards associated with handling and processing the materials, one obtains a rather different view of the probability of the "garage operation weapon."

Analysis indicates less difference among the foregoing views than initially appears. Willrich and Taylor, starting with the assumption that the aggressor had acquired approximately 10 kilograms of plutonium oxide, state that he could fabricate a crude nuclear device. Levenson and Zebroski, assuming that the aggressor must chemically process and refine his plutonium from some much less readily usable substance, highlight the difficulties inherent in obtaining such readily usable materials as 10 kilograms of plutonium oxide. J. Carson Mark, in listing six different skills required, does not deny that those skills could be gathered together in a group of less than six persons.

Considering the sequence of goals that must be attained by an adversary, the probability of a successful explosion of an illicit weapon in the multi-kiloton range is low. That the nuclear material would also have derived from a theft at CRBRP makes the overall probability increasingly low. Nevertheless, the potential consequences arising from any nuclear explosive are so serious as to warrant the utmost vigilance, however low the probabilities may be. With time, simple "recipes" for crude nuclear explosives that might just work could pass into the public domain from the minds of experienced weapon makers. Thus, it is essential that nuclear materials be safeguarded so as to prevent unauthorized access to or acquisition of any significant quantities of nuclear materials that could be employed in the fabrication of a nuclear explosive.

Conclusions which may be drawn from the foregoing include the following:

Any assessment of the likelihood of the fabrication of an illicit crude nuclear explosive device must acknowledge that there are people who have the requisite knowledge and experience.

While it is highly unlikely that those motivated to use an illicit nuclear weapon would have the skills and experience to build one, or that those with the skills would be inclined to use them in this manner, one cannot preclude the possibility that a person or group with both the motivation and skills would attempt to steal nuclear material, fabricate an explosive device, and, subsequently use or threaten to use it.

To assess the ease or difficulty of constructing a nuclear explosive is a difficult task. Successful construction would require a combination of technical competence, intelligence, application, and resources sufficient to work through and understand the construction and operation of the device. This assemblage of skills and resources is possible, but certainly not easy.

The complications referred to in the foregoing analyses--for example, the necessity to acquire significant quantities of a heavily guarded material, and the need for a wide range of skills and the large associated hazards--all tend to deter an aggressor from attempting such a difficult task. The true challenge of safeguards is to further complicate that already formidable task.

The physical effects of a nuclear blast can be determined from the published literature. A summary of these physical effects is given by Willrich and Taylor. The damage radii for various effects of nuclear explosions as functions of yield are shown in Table 7.5 of this section.

Examples are given by Willrich and Taylor to illustrate the effects of nuclear explosions in a football stadium, a residential area, or a basement parking lot. While the examples given are speculative and are based on an assumption of complete success by the adversary, they do illustrate the extremely severe consequences of a nuclear explosion.

Clearly, if a workable illicit device of even modest yield were cleverly placed and detonated, thousands of people could be killed and millions of dollars worth of property could be destroyed. For reasons stated earlier, the probability that any of these events would actually take place, while not specifically quantifiable, is considered to be extremely low. It should be further noted that the adversary who has succeeded in fabricating a workable weapon, despite the obstacles cited above, faces further serious obstacles if his goal is to cause a high number of casualties and great damage. The selection of appropriate emplacement areas is finite; the safeguards response capability, alerted by the theft or diversion, would have brought its search and detection techniques to bear; and law enforcement agencies would be watchful for suspicious actions, especially in congested urban areas, at public gatherings, at key governmental facilities, and in areas of technological vulnerability.

<u>Dispersal Weapons</u>

The treatment of the consequences of radiological (dispersal) weapons is more speculative than that for nuclear explosions because of the greater extent of uncertainty involved. Detailed discussions of the subject of dispersal of plutonium are contained in WASH-1327 (GESMO draft) and WASH-1535. In summary, it can be said that the possibility exists that plutonium could be dispersed into buildings or the atmosphere (as could most any chemical, radiological or biological agent).

Although the potential consequences could be significant, they would not approach the severity of a nuclear explosive. The use of radiological weapons does not appear to be consistent with the observed behavior of terrorists or extortionists.*

7.3.4.3 Sabotage of CRBRP Nuclear Material in Transit

Shipments of certain nuclear materials to and from the CRBRP must be considered as possible targets for acts of sabotage which could result in radiological hazards outside of the plant boundary. Of the three categories of nuclear material transported to and from the site (fresh fuel, spent fuel, and waste) only fresh fuel (unirradiated) assemblies and spent (irradiated) fuel assemblies are likely to be considered as attractive targets for acts of sabotage (See Section 7.3.4.2.2 regarding the unattractiveness of radioactive waste).

7.3.4.3.1 Unirradiated Fuel Assemblies

The possible consequences of acts of sabotage directed at shipments of fresh fuel assemblies do not constitute a significant radiological hazard. There is substantial probability that no material would be released in an attack. Although the inner and outer containers may be ruptured, it is likely that the fuel cladding would remain intact following a credible sabotage attack. Should any material escape to the environment, it would likely produce only localized contamination in view of the high density ceramic form of the fresh fuel.

Safeguards measures which will be applied to guard shipments of fresh fuel assemblies against theft (cf. Appendix E and Section 7.3.4.2.1) will also provide assurance that the shipments will be protected from attack by saboteurs. This protection further decreases the likelihood of an act of sabotage causing a radiological hazard involving unirradiated fuel.

7.3.4.3.2 Irradiated Fuel Assemblies

Acts of sabotage directed toward shipping casks containing irradiated fuel might be attempted with the intent of creating a radiological incident. The design features that enable the shipping

---
*Willrich and Taylor.

TABLE 7.5

DAMAGE RADII FOR VARIOUS EFFECTS OF NUCLEAR EXPLOSIONS AS FUNCTIONS OF YIELD[a]

Yield (high explosive equivalent)	Radius for Indicated Effect (Meters)						
	500-rem Prompt Gamma Radiation	500-rem Neutrons	Fallout (500-rem Total Dose)[b]	Severe Blast Damage (10 psi)	Moderate Blast Damage (3 psi)	Crater Radius (surface burst)	Crater Radius (underground burst)
1 ton	45	120	30-100	33	65	3.4	6.7
10 tons	100	230	100-300	71	140	6.8	13.3
100 tons	300	450	300-1,000	150	300	13.6	26.5
1 kiloton	680	730	1,000-3,000	330	650	27	53
10 kilotons	1,150	1,050	3,000-10,000	710	1,400	54	104
100 kilotons	1,600	1,450	10,000-30,000	1,500	3,000	108	208
1 megaton	2,400	2,000	30,000-100,000	3,250	6,500	216	416

[a]M. Willrich and T. B. Taylor, Nuclear Theft: Risks and Safeguards, Ballinger Pub. Co., Cambridge, Mass., 1974.

[b]Assuming 1-hr exposure to fallout region, for yields less than 1 kiloton, increasing to 12 hr for 1 megaton.

cask to withstand severe transportation accidents (e.g., multiplicity of heavy steel shells, a thick, dense gamma shield, a liquid jacket, and sacrificial impact absorbers) also enable the casks to withstand attack by small arms fire and explosives. It would require extraordinary skills and uncommon materials to breach the inner vessel.

Historically, spent fuel shipments have not been protected in a manner similar to the protection of shipments of unirradiated SSNM. The high radiation levels and the undesirable fission product inventory of the spent fuel make it a highly unattractive target for theft. In addition, the package design features are relied upon as providing adequate protection against saboteurs. In the course of the continuing appraisal of safeguards adequacy in response to perceived changes in the nature of the threat, the possibility exists that spent fuel shipments may be the subject of upgraded safeguards measures.

During the past 25 years several thousand packages of irradiated fuel have been transported within the United States; to NRC's knowledge there has never been a criminal act or sabotage attack directed toward release of or diversion of any shipment of spent fuel. This past experience provides basis for the belief that the future probability of criminal acts or sabotage of a spent fuel shipment is very small. It is the staff's opinion that, for quick, lethal action, a saboteur is more likely to choose any one of a large number of other, much more readily available types of hazardous shipments -- such as explosives and chemical agents -- to accomplish his purpose. The dispersion of the radioactive material contained in spent fuel shipping casks using the scenarios discussed above is inefficient, costly, dangerous to the criminal or saboteur, requires a high degree of technical and scientific knowledge, is uncertain in its consequences, and because of the delayed action of radioactive effects, is less than feasible for an immediate threat to life.

7.3.5 Safeguards Costs

7.3.5.1 Costs of Safeguards at CRBRP

The capital and operating costs associated with the safeguards measures necessary to protect the CRBRP against acts of industrial sabotage and theft of SNM will not significantly impact upon the cost-benefit balance. The staff has estimated that the incremental capital and annual operating costs for providing an adequate safeguards program at the CRBRP should not exceed $1.5 million and $1 million, respectively. A breakdown of safeguards costs for CRBRP is shown in Table 7.6. These costs are over and above those items required in the construction and operation of the plant which would normally be provided for the routine operation, safety, and conventional security of such a facility.

TABLE 7.6

COST OF THE CRBRP PHYSICAL SECURITY SYSTEM

Item	Initial Investment	Annual Operating Cost
Perimeter Control	$ 354,000	$ 56,000
Perimeter Access Area	$ 152,000	$ 20,000
Alarm Stations	$ 523,000	$ 102,000
Access Points	$ 224,000	$ 44,000
Guard Equipment	$ 47,000	$ 14,000
Guards	-	$ 751,000
Total	$1,302,000	$ 987,000

In developing the guard force cost, it was assumed that six uniform guards and one supervisor would be on site during normal periods of operation. Four additional guards were assumed to be required for protection against theft when new fuel shipments arrived onsite. In both of the above situations additional armed, trained security personnel may be required. During these periods of time the fuel assemblies would be outside the normal fuel storage facility and therefore accessible. For purposes of this cost analysis it was assumed the additional protection would be required for a total of one month per year. If new fuel were outside and accessible more frequently than the one month per year, the cost would be proportional to the cost associated with providing the four additional guards.

7.3.5.2 Fuel Cycle Safeguards Cost

The use of existing plutonium fuel facilities for the production of CRBRP fuel should not give rise to significant additional fixed-site safeguards costs (cf. Section 7.3.3.2).

7.3.5.3 Costs of Transport Security for Fresh Fuel Assemblies

While a cost/benefit analysis assessing the impact of incremental changes can be made for a specific transport system, comparison of one system to another is best performed on a total transport cost basis.

Three systems were selected for cost discussion; two that are under consideration for use in the future and one of the systems now in use.

The following costs (in 1975 dollars) were estimated for the year 1990 and based on shipment of 102 fuel assemblies per year.

System Number	System Description	Protection Afforded
1	Safe, Secure Trailer 3 escort vehicles 10 guards and drivers	Maximum
2	Cargo aircraft from secure terminal to secure terminal, 3 guards or pilots, no escorts	Maximum
3	Armored road vehicle with 2 guards and drivers, no escort vehicles (current option)	Medium

Single Carrier Shipments

System	Per Shipment Unit Cost	No. of Shipments	Annual Cost
1	$12,200	51	$620,000
2	$34,000	26	$890,000
3	$ 8,800	51	$450,000

The costs for System 1 could be reduced approximately 20% by use of convoy shipments.

7.3.6 Conclusions

Analysis of the potential environmental impacts associated with the safeguards at CRBRP and its related fuel cycle activities and transportation links indicate that they would be negligible. The inherent design characteristics of the CRBRP which incorporate the concepts of defense in depth and multiple barriers against the release of fission products, combined with a safeguards program that conforms to applicable regulations will provide a prudent level of protection at the CRBRP. The staff concludes that this capability constitutes an appropriate protective margin in the absence at this time of any specific threat to nuclear reactors. The safeguards related environmental impact of fuel cycle activities stemming from the operation of the CRBRP will be substantially dependent upon the exact nature of the activities and their relationship to existing fuel cycles. Safeguards policies and techniques for protecting SNM though are generally applicable to all fuel cycle facilities; consequently, existing safeguards and those under development will be directly applicable or readily adaptable to the CRBRP fuel cycle activities. The production of CRBRP fuel therefore, whether in existing or planned facilities, should not necessitate any changes in the fixed site safeguards. Similarly, for the transportation links within the fuel cycle, there are no known technical, logistic, or societal impediments to producing a system with a very high protective capability. The relatively small number of shipments required for CRBRP operation will make it possible to concentrate safeguards resources to counter any conceivable threats.

In summary, the staff concludes that provisions can and will be incorporated in the CRBRP and its related fuel cycle activities, as necessary, against the occurrence or effects of theft or sabotage such that there would be no significant increase in risk to the environment or the public due to such acts.

8. NEED FOR THE PROPOSED FACILITY

8.1 HISTORICAL BACKGROUND OF THE LMFBR PROGRAM

The major incentive for development of breeder reactors is the potential for vastly improved utilization of uranium fuel resources and, thus, extension of that natural fuel resource over a considerably longer period of time (ER, p. 1.1-1). One breeder concept, the liquid metal fast breeder reactor (LMFBR), has been studied since the early 1950s. In a 1962 report to the President (USAEC, 1962), the AEC recommended intensive development and, eventually, demonstration of the breeder concept. In the mid-1960s, greater emphasis was given to the LMFBR program and several industrial groups, in cooperation with utilities, conducted studies of demonstration concepts.

These efforts continued to the point where the AEC was authorized on July 11, 1969 to conduct the project definition phase (PDP) of an LMFBR demonstration project. The PDP was the first step of a two-phase approach and was intended to lead to a "definitive contractual arrangement for the design, supporting R&D, construction and operation of a specific plant" (USAEC, 1969). Three reactor manufacturers, Atomics International (now a division of North American Rockwell Corporation), General Electric Company and the Westinghouse Electric Corporation, participated in the PDP under cooperatively funded contracts with the AEC and about 90 utilities. While the program was underway, the AEC was authorized on June 2, 1972, to enter into a cooperative arrangement with industry for the development, design, construction and operation of an LMFBR demonstration plant.

In April 1971, the AEC established advisory committees (Senior Utility Steering Committee and Senior Utility Technical Advisory Panel) consisting of management and engineering executives from the electric utility industry, as well as senior AEC representatives, to review and evaluate plans for the LMFBR Demonstration Plant Program. Their deliberations (which are recorded in WASH-1201) and their determinations ultimately led to the AEC's selection of the CE/TVA proposal and the Clinch River Breeder Reactor Plant.

Although the decision to proceed with an LMFBR demonstration project preceded NEPA, in 1972 the AEC issued an environmental statement identifying the project objectives and providing information on options and alternatives regarding the plant (WASH-1509). In 1973, the AEC initiated preparation of an environmental statement on the overall LMFBR Program (WASH-1535). The draft statement was issued in March 1974, and a proposed final environmental statement (PFES) was issued in January 1975. The PFES was prepared by the AEC to comply with the decision of the U.S. Court of Appeals, District of Columbia Circuit, in Scientists Institute for Public Information, Inc., vs. Atomic Energy Commission et al., 481 F. 2d 1079 (June 12, 1973). The Court held that the AEC was required by the National Environmental Policy Act of 1969 (NEPA) to issue a statement on the environmental impact of the LMFBR Program as a whole, including ramifications of commercial deployment and alternative courses of action.

Since the formation of the NRC and ERDA in January 1975, further actions on the NEPA review of the LMFBR Program have been the responsibility of ERDA. A public hearing on the PFES was held on May 27-28, 1975, and on June 30, 1975 the ERDA Administrator issued his findings which included the statement that the PFES amply demonstrates the need to continue research, development and demonstration of the LMFBR concept. He also indicated a need for examination of alternative methods of conducting the program "to be sure that:

(a) the research, development and demonstration activities are properly directed to resolve the remaining technical, environmental, and economic issues in a definitive and timely way;

(b) these issues are resolved before a final decision concerning the acceptability of commercial deployment is made; and

(c) test and demonstration facilities that are needed in the LMFBR program are conservatively designed to protect the health and safety of the public and to provide useful information for subsequent environmental, economic, and technical assessments."

The PFES has been supplemented and amended to provide the results of the reviews called for by the Administrator. The resulting documentation constitutes ERDA's Final Environmental Statement on the LMFBR Program (ERDA-1535), which was issued in December 1975. Based upon the supplementary information in the Program FES, the Administrator issued additional findings on December 31, 1975, which included, in part, the following assessments that are pertinent to understanding the current status of the LMFBR Program:

- "I find that the FES is not, and cannot be at this stage of LMFBR technology development, a dispositive assessment of the impacts of widespread commercial deployment of that technology. Nevertheless, I find that the FES does provide sufficient information on the foreseeable impacts of such deployment and on the programmatic alternatives available to resolve the major areas of uncertainty affecting such deployment, so that I now am in a position to determine the structure and pace of a research, development, and demonstration program to provide a more dispositive assessment of those impacts and to resolve those areas of uncertainty in a timely manner.

- "The FES shows that the major areas of uncertainty lie in plant operation, fuel cycle performance, reactor safety, safeguards, health effects, waste management, and uranium resource availability. I find that the availability of sufficient information to resolve these areas of uncertainty is crucial before ERDA can render a meaningful decision on the commercialization of that technology, i.e., the environmental acceptability, technical feasibility and economic competitiveness of LMFBR technology for widespread commercial deployment.

- "ERDA has programs in place in each of these areas. The LMFBR Program has focused on plant operation through the development of experience in LMFBR demonstration plants, on fuel cycle performance through its base program of fuel cycle development, and on reactor safety which is an integral part of both the plant demonstration program and the base program. The other areas of uncertainty - safeguards, health effects, waste management and uranium resource availability - are not unique to the LMFBR, and are being addressed generically by other programs which have schedules not susceptible to significant acceleration. Measured against the schedules for these programs, the FES evaluates eight options for structuring the necessary research, development and demonstration program for LMFBR technology. These options are structured to reflect changes in the timing and number of prototype reactor plants and various component test facilities, and the consequent changes necessary in the supporting base program, thus reflecting a wide range of program strategies.

- "On balance, I find that the issue of plant operation in a utility environment is best addressed by the program plan entitled 'reference plan.' This plan contemplates construction and operation of the CRBR, a Prototype Large Breeder Reactor (PLBR), and a Commercial Breeder Reactor (CBR-1) on a schedule which calls for operation for three years of a Nuclear Regulatory Commission-licensed CRBR and completion of the design, procurement, component fabrication and testing phases for, and issuance by the Nuclear Regulatory Commission of, a construction permit for the PLBR prior to a commitment to construct the CBR-1. In my judgment, this schedule should provide sufficient experience in design, procurement, component fabrication and testing, licensing and plant construction and operation from CRBR and PLBR taken together to enable ERDA to predict with confidence the successful construction and operation of the CBR-1. This schedule will be periodically re-examined to assure that the experience derived from operation of the CRBR and the pre-operation of the PLBR is sufficient before ERDA commits itself to construction of the CBR-1. Moreover, a separate NEPA review of each of these plants will be undertaken on a site-specific basis to assure that they are environmentally acceptable and are conservatively designed to protect the health and safety of the public and to provide useful information for subsequent environmental, economic, and technical assessments.

- "The base program consists of necessary supporting efforts which proceed relatively independently of the plant demonstration program. These efforts concurrently focus on the design of advanced fuels and fuel reprocessing system. Key to this effort is the design, construction and operation of an LMFBR fuel reprocessing hot pilot plant. The FES indicates that completion of the design work for this plant and its equipment would provide an adequate basis upon which to predict with confidence whether a safe, reliable, and economical LMFBR fuel cycle will be developed.

- "The FES also addresses major uncertainties in the areas of reactor safety, safeguards, waste management, health effects, and uranium resource availability. In reviewing the programs in each of these areas, I find that the controlling item currently appears to be the construction of and testing in a large scale safety test facility. While the results of these tests are not required to assure the safety of early demonstration plants, they are required to provide realistic design conservatism for commercial plants.

- "On the basis of the material set forth in the FES, I find that if the reference plan and its supporting programmatic efforts are vigorously pursued, sufficient information would be available as early as 1986 to resolve the major uncertainties affecting widespread LMFBR technology deployment and therefore to permit an ERDA decision on commercialization of that technology. It should be emphasized that availability of the necessary decisional data by 1986 requires the successful and timely completion of a large number of interrelated and parallel efforts. Delay in any of the aforementioned controlling elements will result in a delay of the decision date. It should be emphasized also that following an ERDA decision on commercialization the utility industry and the public would have to determine the extent, if any, LMFBR technology would be commercially deployed.

- "In conclusion," stated the ERDA Administrator's findings, "it must be emphasized that at this stage of LMFBR technology development we do not have all the answers necessary to determine the environmental acceptability, technical feasibility and economic competitiveness of LMFBR technology for widespread commercial deployment. It is to find these answers that ERDA is continuing the research, development, and demonstration program. As the LMFBR Program and its supporting programs continue to evolve and new information is generated, ERDA may decide to reorient the structure or pace of the LMFBR Program or even terminate it altogether. In any event, at least one additional programmatic environmental statement will be prepared and considered prior to any future ERDA decision on the commercialization of LMFBR technology. The current planning schedule calls for the preparation and consideration of such a programmatic statement in 1986."

The above discussion provides the context in which the need for the CRBR is reviewed in the following sections. Further information about the LMFBR Program is found in the Program FES (ERDA-1535).

8.2 ROLE OF THE DEMONSTRATION PLANT

As indicated above in the ERDA Administrator's findings and in the Program FES (ERDA-1535), the licensing of the CRBRP for research, development and demonstration purposes would not consitute a commitment of resources to future widespread commercial use of breeder reactors. But the CRBRP would be one of the key sources of the information which will be considered by ERDA prior to a decision on commercialization of LMFBR technology. Various programmatic alternatives, including options which postulated omitting the CRBRP, were rejected by the Administrator who stated that "in my judgment, the CRBRP offers the most timely and cost-effective construction, licensing and operating experience essential to the successful completion of the LMFBR Program" (Findings, Dec. 31, 1975).

Specifically, the CRBRP is expected to play a major role in meeting the following objectives:

(1) Demonstrate that the necessary technology is available to scale up and successfully construct and operate commercial-sized LMFBRs,

(2) Provide a technical basis for extending the technology to future commercial plants where improvements in fuel life, plant capacity and thermal efficiency will be made for economic reasons,

(3) Develop operating data on the environmental impact of the LMFBR before large numbers of commercialized LMFBRs are constructed,

(4) Provide a demonstration of the nuclear parameters necessary for commercial development,

(5) Demonstrate the minimal impact from disposal of radioactive waste materials,

(6) Demonstrate the equipment on a large scale, and

(7) Demonstrate the breeder concept in an industrial environment. (ER, p. 1.3-2)

The staff believes the above objectives are within the broader objectives specified in the LMFBR Program FES (ERDA-1535). In order to determine whether or not the CRBR demonstration plant can meet its objectives, the staff has evaluated (in Sect. 8.3) the ability of the CRBRP to meet the programmatic objectives.

The role of the CRBRP is further described as follows in Section 3.5.1 of the PFES:

> "The demonstration plant is the first point at which utility companies become deeply involved in the demonstration of the LMFBR concept. Each involved utility evaluates the technology in terms of its own needs and methods of operation, factoring its requirements into the program. At the same time, the utility develops its capability to maintain and operate power plants of this type. This plant also constitutes a step increase in the involvement of industrial suppliers because it now entails a utility-related power plant designed to demonstrate commercial application rather than a government-owned facility. Thus, there is a commercial overtone to the relationship because of the expectation that the utility will be making future purchases from reactor manufacturers. At this point, therefore, development of the industrial base broadens and industry is expected to develop sufficient breadth so that the utilities will eventually have a number of vendors and reliable components from which to choose.
>
> "The construction and operation of an LMFBR demonstration plant will provide practical experience on the functioning of essential plant components. More importantly, however, it will provide data and experience on operation of a large-scale power plant system and the interaction of that system with its associated supporting facilities and with the local environment. A firmer grasp will be obtained on the range of costs and other factors of interest to energy development and use. Construction and operation will also play an essential role in determining the safety, reliability, economics, and environmental impact in the context of the utilization of the LMFBR on electric power systems. Without such data and experience from an operating plant, one can only speculate as to what its performance might be. With such data and experience, the validity of the LMFBR as the Nation's prime candidate for assuring an abundance of energy may be demonstrated."

Current plans for the CRBRP are for a five-year demonstration period, which would include the three years of operating experience considered desirable by the ERDA Administrator prior to a commitment to build the CBR-1. After the initial period of start-up and testing, the demonstration plant would be operated in a manner similar to the commercial LMFBR plants. Except for research and development requirements that are part of the planned program, every effort would be made to sustain high plant availability.

At the conclusion of the five-year demonstration period, TVA may exercise its option to buy the plant and the applicant anticipates that the CRBRP would continue to be operated in a manner similar to a commercial power plant. The continued output of operational and maintenance data would be available for use in the design and operation of subsequent commercial components and systems and it is likely that the facility would also be used for specific experimental and operational tests (ER, Am 1, Part III, Q5).

The CRBRP would be operated as an integral part of the TVA electrical grid and the electricity generated by the plant would be purchased by TVA at the highest incremental cost TVA would otherwise have incurred in producing or acquiring such energy. However, the availability of the electricity and of the plant's generating capacity is of secondary importance to the primary objectives of the project. Electricity generated by the CRBRP would constitute less than 1% of the total TVA system generation during the period of its operation. The 350 MWe of capacity provided by the plant would also be a small percentage of the system capability, as indicated by comparison to the scheduled additions of 18,394 MWe from June 30, 1974 to the end of 1982 (NUREG-75/039).

8.3 THE ABILITY OF CRBRP TO MEET ITS OBJECTIVES

The staff has considered the likelihood that the CRBRP will meet its demonstration objectives within the program to develop the LMFBR concept. These objectives are stated in the Program PFES (WASH-1535, p. 3.5-2) as follows:

(1) to demonstrate the technical performance, reliability, maintainability, safety, environmental acceptability, and economic feasibility of an LMFBR central station electric power plant in a utility environment, and

(2) to confirm the value of this concept for conserving important non-renewable natural resources.

In this review, the need, objectives, structure and timing of both the LMFBR program and a demonstration scale facility are regarded as established by the ERDA Administrator's findings (see section 8.1). It is clear from the context of the Administrator's findings that the demonstration plant is regarded as part of a larger program to achieve the objectives; the CRBR project alone will not completely achieve them but its function is to be a major contributor to the informational needs of the program. The staff has therefore considered whether or not the information obtained from the CRBRP is likely to be useful to the Administrator when he makes his decision on commercialization of the LMFBR. The ability of the CRBRP to meet its objectives is discussed in this section, and the likelihood that various alternatives would better meet the objectives is discussed in section 8.4.

Technical Performance - In evaluating the potential of the CRBRP as a contributor to the ability to predict the technical performance of commercial LMFBRs, the experience from demonstration reactors in foreign countries should be considered. Three such demonstration plants have been constructed and in only one of them has the demonstration itself yet been an apparently complete success for a sustained period of up to a year. This successful demonstration occurred in France where the Phenix reactor achieved an availability factor of 76% in its second year of operation. The PFR reactor in Great Britain and the BN-350 in the Soviet Union have not yet achieved full power operation because of faults in the steam cycle system. However, each of these countries has been sufficiently encouraged to proceed with development of the LMFBR to the 1000 MWe scale. This is certainly a reflection of the view that the difficulties encountered in the demonstration reactors would be correctible. Thus, even though a high level of technical performance was not yet achieved in the demonstration plant, acceptable performance could be predicted with some assurance for the next larger size.

These cases are mentioned to indicate that the mere fact of a low initial plant performance record, although serving to stimulate criticism of the specific project, does not appear to be cause for abandonment of a program. Similarly, a good initial performance record, although encouraging, may not be sufficient to justify the Administrator's proceeding with commercialization of the concept unless the other elements of the LMFBR program are also promising.

In order to provide a direct continuous demonstration of rated power (975 MWt), the entire heat removal, energy conversion and electrical generation system must function as designed, not just the reactor. If full-rated core power could not be handled by the available energy conversion and heat rejection system, it might still be feasible to demonstrate full sodium temperature operation, as the British and Soviet reactors have done. Such a demonstration has some value but it is not satisfactory as a full-power demonstration of an integrated energy conversion system. If the CRBRP does not achieve full power and a favorable use factor, its value as a technical performance demonstration will depend to a large extent on the nature of the problems and deficiencies, whether they are correctible for the demonstration plant, and whether they can clearly be avoided in future plants.

The staff believes that sufficient attention to technical performance has been given during design of the CRBRP so that there is a reasonable probability of achieving full-rated core and electrical power on a continuous basis. (It is expected that the quality assurance programs adopted by the CRBRP will increase the chances of avoiding some of the PFR problems.) If these performance goals should not be achieved, there is a strong probability that enough will be learned about the deficiencies to permit them to be corrected on future designs. Steam-generator performance is recognized as a potential problem in achieving a demonstration of full power. The high speed (3600 rpm) superheated steam turbine proposed for the CRBRP is commonly used in fossil fuel plants, but it is somewhat new to nuclear power plant application and might also be a potential problem. The three-year demonstration period would be expected to provide a reasonable interval to identify and correct all but very serious deficiencies, if any should develop. The less satisfactory goal of achieving only the full-rated temperature (995°F at sodium outlet), is almost certain to be achieved, since reactors in this country have already achieved close to this temperature (EBR-II at 883°F, for example) and reactors abroad have achieved even higher sodium temperatures (Phenix at 1040°F). In part, this evidence has led the staff to conclude that the CRBR is likely to achieve its rated technical performance. There is, of course, a higher probability that it will achieve at least a partial technical success that will be of significant technical value.

Reliability - In a general sense, there have already been significant demonstrations of LMFBR reliability. This fact should be recognized as a basis for confidence that the CRBRP can achieve its reliability objective rather than an indication that demonstration of this objective is unnecessary because it has already been achieved elsewhere.

The outstanding demonstration is the Phenix reactor, as already noted above. In this country, the smaller EBR-II has recently achieved annual use factors as high as 65%, a remarkable figure in view of the fact that it is being operated primarily as an irradiation facility. The UK PFR and the Soviet BN 350 have achieved reliable reactor operation, although steam cycle problems have forced them to operate at reduced power. Fuel element reliability and performance will be studied in the FFTF.

If the CRBRP could demonstrate no more than reliable fuel performance, its cost would hardly be justified, since there is little doubt that fuel performance can be demonstrated elsewhere. The staff therefore interprets the reliability objective as a requirement for demonstration of the integrated behavior of the total reactor system complex, including the heat transport and steam generator systems, the turbine-generator, and the fuel handling and auxiliary systems. Attainment of a high availability factor for CRBRP during the first few years of operation will not be possible due to the testing sequences which will probably be imposed on the plant. However, the potential availability factor for the plant can be ascertained during the early years by making allowance for the time spent in these test programs.

The staff also notes that the potential for two-loop operation could have an impact on achievable plant factors, and hence on reliability as a power plant. The extent to which two-loop operation can be sustained in the event repairs on the third loop are required, and the extent to which maintenance can be performed on part of the system while the balance is operating, will be investigated and determined during the operating phase. However, in its general review of the plant, the staff found that only limited consideration has been given to demonstrations of these areas of reliability in the design and proposed operational scheme of the plant; for example, two-loop operation has not been analyzed in the PSAR. The staff concluded that the CRBRP has a high potential for providing reliability information that will be relevant to the LMFBR program, particularly if the program continues in the direction of loop type reactors and if appropriate safety analyses for restricted operation are completed. It may be difficult to apply some of the reliability information from CRBRP to future LMFBRs of the pool type (if any are proposed), since, as noted in section 8.4, the pool type would probably lead to different concepts in fuel handling, inert gas seals, intermediate heat exchanger design, pumps, etc.

Maintainability - The maintainability aspects of the CRBRP, like reliability, will have to be divided into those which are related to first-of-a-kind test programs and those which are related to more routine operations in order to provide useful projections for commercial plants. When this division is made, the staff believes that the maintainability records of CRBRP would indeed be valuable input for the decision on commercialization, again provided the loop concept is followed. Maintenance of equipment within the primary and intermediate systems of pool type reactors require considerably different techniques, and the CRBRP experience would be of minimal benefit if that direction of commercialization is taken. Equipment beyond the IHX is, of course, not fundamentally different in the two systems. The information to be obtained in the area of maintainability includes the economic cost of maintenance, the enforced reduction in plant operating factor, and the personnel hazards involved. Definitive measures of these problems can only be obtained through an actual demonstration under realistic operating circumstances.

Safety - The objective of demonstrating the safety of LMFBRs will not be achieved merely by safe operation of the CRBRP. Although a satisfactory record of performance based on (1) reliable operation of systems and components important to normal safe operation, and (2) the effectiveness of measures to control off-normal events should they occur* would be encouraging, it would not provide a direct indication of the total safety of larger LMFBRs. Much of the safety program relevant to the larger reactors is being carried out in separate studies. These are being done in reactor test facilities and in out-of-pile tests. There are, however, several safety areas where the CRBRP would make a significant contribution.

The first of these is demonstration of safe operation of an integrated system. Although all of the components of the CRBRP would be of a quality that can be regarded as safe individually, the demonstration of their performance in the total system would provide additional confidence that they will all continue to work together in a satisfactory manner and, consequently, that similar larger scale systems can also be made to work.

Another area has to do with those few individual features of the reactor whose safety effectiveness has not been established in advance. (Back-up devices or procedures are provided where

*This refers to safety levels 1 and 2 of the defense in depth concept, which is a basic aspect of nuclear reactor safety philosophy. This is more fully described on p. 7-1 and again on p. 11-25. CRBRP operation is not expected to provide information on safety level 3, which encompasses the control and mitigation of highly unlikely accidents.

these safety aspects have not been established.) An example is the use of natural convection circulation for decay heat removal. No credit has been given for natural circulation in the CRBRP because of the lack of an adequate demonstration of this process on the geometry and scale of the CRBRP reactor system. Emergency forced circulation devices are provided instead. The CRBRP is capable of providing a demonstration of the phenomenon on a scale that will be useful in the evaluation of this important safety characteristic for larger LMFBRs.

Still another area in which the CRBR will provide a unique demonstration of a safety feature is in the core clamping and support design. There has been no way of demonstrating on an engineering mockup the full combination of thermal and hydraulic effects that influence the expansion and bowing behavior of the fuel elements and assemblies in an actual reactor. Elaborate calculations of this type of behavior have been done to supplement the engineering test program, but the actual behavior of the reactor is required for final validation of the engineering predictions. The additional effects of irradiation on fuel assembly behavior, through irradiation swelling and constrained creep, will also be demonstrated. These effects are essential to calculations of power coefficient and transient behavior, and are thus safety related. Experience with the CRBRP will permit a demonstration of these phenomena on a scale that will be applicable to commercial plants. Thus, the CRBRP can make a significant contribution to knowledge of the safety of LMFBRs by significantly narrowing the uncertainties in component and system behavior that now exist.

Environmental Acceptability - The ability of the CRBRP to demonstrate environmental acceptability of LMFBRs will depend in large measure on the scalability of impacts resulting from its construction and operation. The various LMFBR concepts are not expected to have substantially different radioactive effluent generation from one another; the staff therefore believes that the demonstration results provided by the CRBRP will be applicable, with minor modifications, to any of the future LMFBRs now proposed. All LMFBRs would have an inert cover-gas system in conjunction with the sodium coolant, and all concepts would include systems to clean up the radioactive contamination in this cover-gas. Moreover, the conditions encountered by these systems in containment control or release are not substantially different among the various designs.

All LMFBRs will have to restrict and control the release of tritium. As has been demonstrated, much of the tritium is retained in the system cold traps. The quantities of tritium produced are somewhat design dependent, but they are not so different among the various designs that the demonstration provided by CRBRP would be inapplicable if another design concept were adopted.

The other considerations of environmental impacts of the CRBRP, which are discussed in Chapters 4 and 5, have been reviewed by the staff and no items have been found which could not be scaled to larger LMFBRs, or modified slightly to accommodate different LMFBR concepts. The staff therefore finds that the CRBRP would provide a useful demonstration of the environmental impact of liquid metal fast breeder reactor technology. Fuel cycle and waste disposal aspects of LMFBR technology are the subject of separate studies which will include the environmental impact of the balance of the cycle. The entire impact of the LMFBR program will be estimated by ERDA using all available sources of information. The CRBRP is capable of making a significant contribution to this study.

Economic Feasibility - The economic projections for an LMFBR utility plant will be guided by a detailed cost accounting of capital and operating expenses for the CRBRP, after proper corrections for non-repetitive, non-prototypic costs associated with the first-of-a-kind nature of the plant. The project is undertaking a very comprehensive cost-reporting system to provide the information for such an evaluation (Buhl, Nov. 18, 1976, Encl. 2). The costs reported for the CRBRP will also be adjusted for possible improvements as the scale of plant is increased, in order to provide information relevant to commercial LMFBRs. Such adjustments are determined subjectively and are partly based on other experiences with small scale plants that have later been extrapolated to larger sizes. Although this process of cost extrapolation is not as precise as one would like, the cost data from the CRBRP would provide a better basis than currently exists for such estimates.

The Utility Environment - Since commercial LMFBR plants would be operated by the electric utility organizations that provide and maintain the conventional systems of electical energy generation and distribution, it is important that the demonstration plant be compatible with the needs and operational modes of the utility industry. One of the purposes of the CRBRP is to achieve and demonstrate such compatibility in an actual utility environment, which will provide a basis for future decisions regarding the commercialization and application of this concept. The conditions important to a utility environment would be created, as proposed, by operating the plant as a power supplier to the TVA transmission grid and by using electric utility personnel to operate and maintain the plant. Personnel from the Commonwealth Edison Company, TVA and other utility organizations are participating in the design work so that their experience and judgment is factored into the day-to-day decisions which affect the operation and maintainability of the plant. Since TVA will operate and maintain the plant, its personnel undoubtedly will play a major role in developing procedures for this purpose.

Under the conditions described above, the staff concludes that an appropriate utility environment would be provided for achievement of the demonstration plant objectives.

Conserving Non-renewable Natural Resources - The staff recognizes that the CRBRP is not designed to achieve a specific breeding ratio as a primary goal, but the objective of demonstrating the conservation of non-renewable natural resources is tied to the breeding capabilities of the LMFBR. If a significant number of breeder reactors with doubling times on the order of 10 years can be brought on line, the plutonium so created can provide a source of energy whose rate of expansion is as great as 7% per year. Even with less favorable doubling times, however, significant reductions in mined uranium are possible through the breeding and use of plutonium fuel. It has been estimated, for example, that under a 3-1/2% annual growth rate the introduction of breeders with a doubling time as long as 25 years would save several hundred thousand tons per year of uranium production by the year 2010 (Nuclear Eng. Int'l., July 1975).

Development of fuels and materials for improving the breeding ratio is being conducted primarily under the LMFBR base technology effort.

The staff believes that the contribution of CRBR to demonstrating the breeding aspects of LMFBR technology will consist primarily of a verification of preoperational calculations of breeding rates in different regions of the core and blankets. Because of the limitations of experimental accuracy, it is difficult to determine these values in critical experiments, while pure calculations of breeding ratio suffer from incompletely known cross-sections. Thus, the actual operation of the CRBRP for sustained periods, followed by analysis of the accumulated breeding products, is the most reliable way to verify the breeding behavior calculated for the first few years of operation. These determinations can produce corrections to the calculated breeding ratio, and the corrections in turn can be judiciously applied to the design of other (commercial) breeder reactors where the breeding ratio of the equilibrium cores is most relevant. In order for the process to be most valid, the neutron energy spectrum and the general configuration and composition of the demonstration reactor core must be similar to that of the commercial breeder core to follow. In the CRBR there is a similarity in the disposition of blankets to what is expected in commercial reactors, but there is a major difference in the core volume, and in the details of core composition, since future commercial reactors are expected to operate with advanced fuels with superior breeding ratios. Nevertheless, the neutron energy spectrum of the CRBR has the general character of the fast reactors to follow and is much more similar to the spectrum expected in commercial reactors than previous U.S. fast reactors have been. The CRBR breeding measurements would therefore provide useful and relevant data for evaluation of the extent of breeding in larger commercial reactors and the consequent conservation of important non-renewable natural resources.

Timing - The desired schedule for CRBRP, PLBR, and CBR-1, as deduced by the staff from the Administrator's findings (see Section 8.1), and from the license application (App. April 7, 1975) is shown approximately in Figure 8.1. The staff notes that this schedule provides an orderly progression in design from CRBRP through the commercial phase, with the design of each reactor following the design of its predecessor without waiting for operating experience. The staff believes that this is an advantageous procedure for deriving benefits from each step for application to later steps, and that the CRBRP fits appropriately into this orderly progression.

As indicated in Figure 8.1, the ERDA Administrator's decision on commercialization of the LMFBR is scheduled to be made in 1986, after three years of operating experience with CRBRP. This would require a CRBRP criticality date in 1983. Since the earliest date for CRBRP criticality in the license application is October 1983, there is room for only two months slippage beyond the earliest anticipated schedule while still meeting the 1983 date. However, the staff notes that slippage has already occurred in the front end of the schedule to the extent that a limited work authorization permitting site preparation is not expected until June 1, 1977 (Buhl, Dec. 29, 1976, Fig. 1), and even this date would be in jeopardy if the environmental hearings consumed more time. The staff believes that a realistic allowance for the environmental hearing time would move the estimated date for an LWA decision to no earlier than July 1977.

The staff notes that with the possible July 1977 start of site preparation, and with the currently allocated time periods for site preparation, construction and preoperational testing (78 months) critical operation would not begin before the early part of 1984 (see Figure 9.4 for additional schedule information). If this schedule is held, the Administrator's subsequent decision regarding commercialization would not be possible in 1986 unless he determined that less than three years of operating experience for CRBRP is sufficient. If the operating experience is clear and definite, some conclusions about engineering design, reliability, maintainability, safety, and environmental and economic acceptability of the CRBRP should be possible by 1986, even without the full three years of operation in the current plan. The Administrator also pointed out that experience in the design, component testing, and the construction permit review phase of PLBR is expected to be available at that time, and also preliminary design experience with CBR-1.

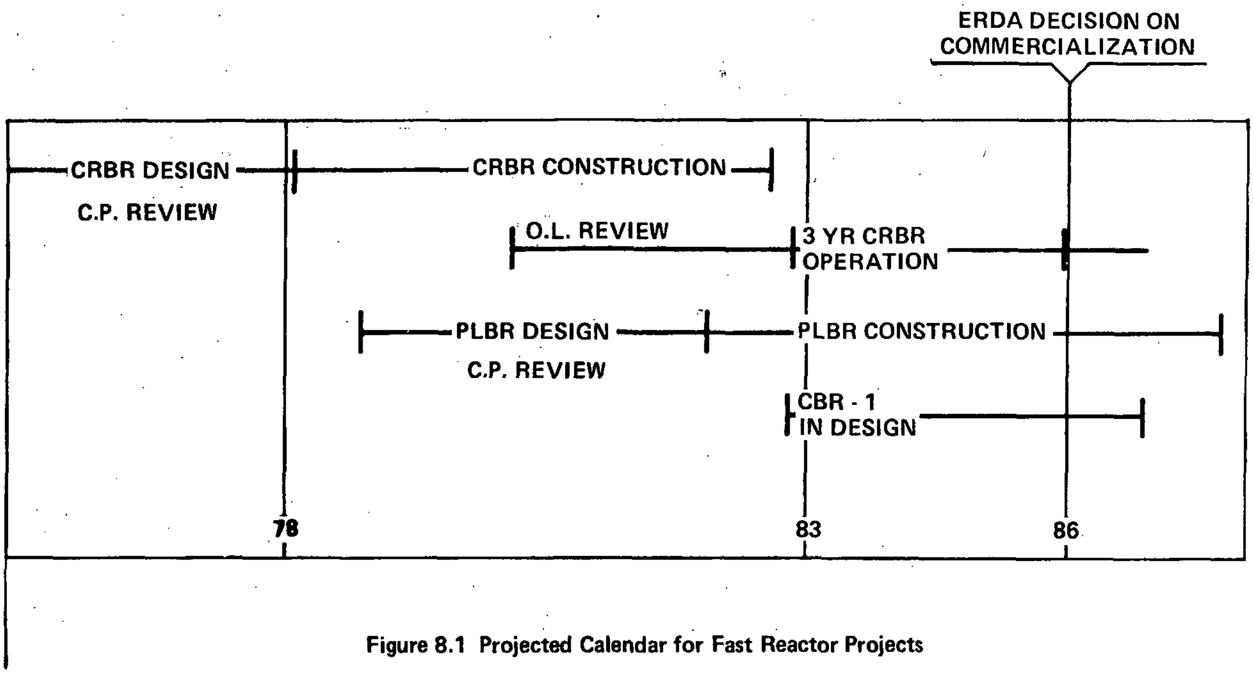


Figure 8.1 Projected Calendar for Fast Reactor Projects

The staff recognizes the uncertainties in predicting the precise time of a milestone so far in the future. The staff also recognizes that if a greater commitment of effort and resources is made in the latter part of the schedule to make up for slippage in the early part, it is still possible to meet the 1983 criticality date.

The staff has also examined whether, in light of construction delays in the FFTF project, the projected schedule for CRBR construction should be considered achievable. The U.S. General Accounting Office (GAO) has evaluated the status of the FFTF program (Comptroller General, November 15, 1976), including an examination of the schedule slippage. The GAO report lists the principal factors responsible for the slippage as

- Difficulties in establishing the necessary disciplined engineering approach
- Underestimation of technical complexity in certain areas of design
- Difficulties in obtaining qualified personnel
- Unexpected rework in design and fabrication

The GAO has also noted in the same report that ERDA officials are aware of the problems of undertaking construction and design simultaneously in FFTF, and that they plan to avoid this situation on CRBR. The GAO notes that, based on information supplied by ERDA, all conceptual and preliminary design and 70% of final design is scheduled to be completed prior to the start of CRBR construction. The GAO concluded that if these design schedules are met, the Clinch River Project should be able to avoid many of the problems FFTF experienced. The staff is in general agreement with these observations and conclusions.

The staff has stated its intent to resolve all major safety issues related to CRBRP prior to the construction permit decision. The applicant is aware of the staff's intent and is developing the technical information to support the licensing review. The staff believes that such an approach should reduce the likelihood of the design engineering difficulties encountered in the FFTF. The staff therefore concludes that the schedule slippages in FFTF need not be duplicated in CRBR, and that construction and preoperational testing are achievable within the projected time allowances.

The staff also concludes that the CRBRP is capable of making substantial contributions to the informational needs of the LMFBR program in a timely manner, and that delays which have already occurred in the schedule will not necessarily delay the Administrator's proposed decision date on commercialization of the LMFBR concept.

8.4 TECHNICAL ALTERNATIVES TO THE CRBRP

The staff has examined whether certain demonstration facility alternatives might offer substantial benefits. The list of alternatives was chosen by the staff as a result of review of fast reactor literature, including ERDA-1535, and the numerous comments and suggestions that it received. The staff regards the following alternatives as the most significant for consideration:

(1) Pool type reactors,

(2) Advanced fuels, such as carbide, nitride, metallic or advanced oxide fuel,

(3) A different size plant,

(4) FFTF role expanded to include demonstration,

(5) Base-loading as a performance goal,

(6) Foreign purchase of a demonstration plant design or technology

8.4.1 Pool Type Reactors

The two generic types of LMFBRs that are being developed at various locations in the world are designated as the loop and the pool (or pot) types. Schematic diagrams of the loop and pool types are shown in Figure 8.2, taken from WASH-1201, p. 209. The discussion in WASH-1201 is cited as the justification for the choice of the loop concept for CRBRP (WASH-1535, Vol. I, p. 3.5-4).

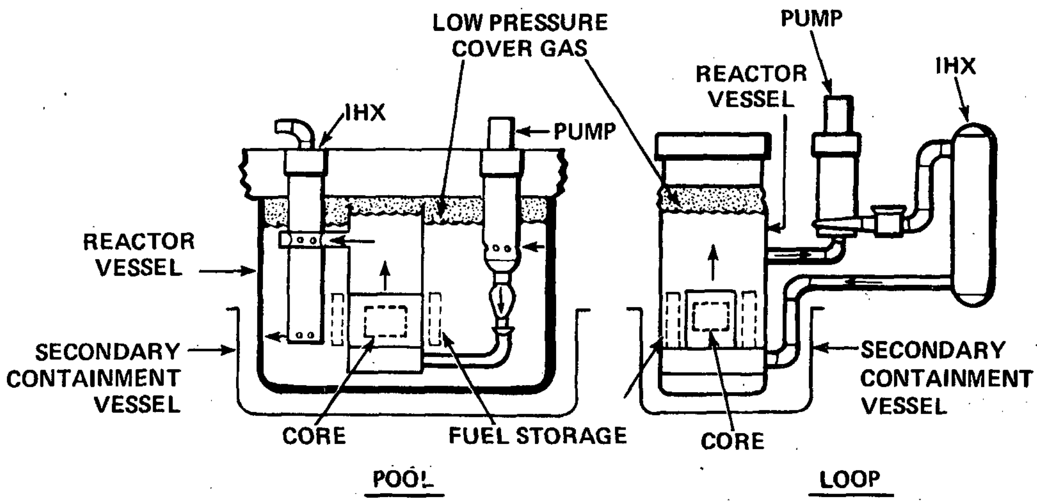


Figure 8.2 Pool and Loop Concepts

Both the loop and pool types are regarded as viable candidates for commercial U.S. LMFBRs (WASH-1535, Vol. I, p. 3.3-4).

In the loop system, the reactor core is contained within a relatively small reactor vessel. The primary sodium coolant is pumped through the vessel and into piping that leads to intermediate heat exchangers (IHX) located in vaults external to the vessel: FERMI, SEFOR, BN-350 (USSR), Rapsodie (France), and Dounreay Fast Reactor (UK) have employed the loop concept. The German demonstration plant SNR-300 and the larger SNR-2, the FFTF in the U.S., and the Japanese MONJU, are loop systems.

In the pool system, the reactor container, and all of the main primary heat transfer equipment, including pumps and IHX's, are contained within a relatively large tank which is filled with sodium. Non-radioactive secondary sodium flows out of the IHX to externally located steam generators, as in the loop system. EBR-II, PFR (UK), and Phenix (France) are operating as pool systems; Super-Phenix, CFR and BN-600 are being designed as pool systems. These are included in the summary of world-wide fast breeder plants presented in Table 8.1. A more complete tabulation is given in WASH-1354.

It is clear that there is no world consensus as to which type of LMFBR is the best choice. Safety, operational and maintenance advantages are claimed for each system design (Comptroller General, May 6, 1976).

Pool type reactors are alleged to have certain inherent safety advantages as a result of the large volume of primary sodium. One cited advantage is a greater ability of the primary system to absorb thermal transients and decay heat without forced circulation. Since the pressurized parts of the system are surrounded by sodium, it is virtually impossible for a sodium leak to uncover the core (decay heat could cause fuel melting if the core were uncovered). On the other hand, loop type reactors offer the possibility of separate inspection and maintainability of the individual units and easier accessibility for maintenance of the (external) fuel handling mechanisms. A pool type reactor requires additional engineering attention over and above development of the components to provide for repair and replacement within the primary sodium tank.

The staff's review of these two concepts has led to the conclusion that the choice of a pool design would not provide any substantial advantage. However, one of the program goals is to keep both options open at this time, and it is true that the initial choice of loop or pool tends to influence a great amount of the detailed design and engineering in the balance of the plant. This was brought out in a paper by Schramm (EURFNR-1258) and is substantiated by surveying the current and past LMFBR designs. Loop types generally have external fuel handling mechanisms based on up to three eccentric rotating plugs in the reactor head; they also tend to use hot-leg primary pumps with higher velocity of the primary sodium in the IHX. The pool types use internal sweep arms for fuel handling (space and weight restrictions prevent the triple rotating plug design), primary pumps are in the cold leg circuit, and the primary pressure drop in the IHX is kept low. Thus, it appears that a change from a loop design in the demonstration phase to a commercial pool design, if that is later determined to be preferable, would require substantial new engineering and development. Nevertheless, the staff notes that such a changeover would not be impossible. Soviet designers are undertaking just such a changeover between their BN-350 and BN-600 reactors. Because of the U.S. plan of developing detailed base technology prior to the demonstration, as contrasted to the European approach of developing each plant with less emphasis on a base technology program, it may be more difficult for the U.S. to make a comparable change. However, the U.S. is not entirely without pool type experience, the smaller EBR-II having been designed this way. The staff, therefore, also concludes that the loop choice for the CRBR has not irrevocably committed the U.S. program in that direction.

8.4.2 Advanced Fuels

It has been suggested that alternative fuels (carbide, nitride, metallic, or an advanced version of an oxide), might ultimately be preferable to the oxide fuels for which the major backlog of experience exists up until now. Such major modifications in fuel concept may be required to develop an efficient breeder with short doubling time. As a result, some doubt has been expressed whether relevant experience can be obtained from construction and operation of oxide breeders (Roisman, Sept. 17, 1976). However, the advanced fuels are not expected to be available in time for initial use in the demonstration plant; therefore, they are not viable alternatives for consideration during the early years of the demonstration.

The staff has concluded that, other than development of the fuel itself, including its diameter, spacing, and optimum sodium velocity, little would be substantially changed throughout the system to introduce one of the new fuels. Thus, experience gained on pumps, valves, piping, heat exchangers, instruments, control systems and other auxiliary equipment would remain relevant.

Experience gained with the CRBR will therefore be relevant to the evaluation and development of future reactors, even in the event of a change in fuel. The CRBRP follows a program in which the first U.S. demonstration reactor emphasizes the commercial goals of reliability and maintainability, but also proposes to incorporate the ability to utilize advanced fuels in the future.

Table 8.1

WORLD-WIDE FAST BREEDER REACTOR PLANTS

Name	Country	Power Megawatts thermal	Power Megawatts electric	Pool or Loop	Initial Operation
Decommissioned					
Clementine	USA	0.025	--	Loop	1946
Experimental Breeder Reactor-1	USA	1	.02	Loop	1951
BR-1/BR-2	USSR	0.1	--	Loop	1956
LAMPRE	USA	1	--	Loop	1961
Fermi	USA	200	60.9	Loop	1963
SEFOR	USA	20	--	Loop	1969
Operable					
BR-5/BR-10[a]	USSR	5/10[a]	--	Loop	1959[a]
Dounreay Fast Reactor	UK	72	14	Loop	1959
Experimental Breeder Reactor-II	USA	62.5	18.5	Pool	1963
Rapsodie	France	20/40[b]	--	Loop	1966[b]
BOR-60	USSR	60	12	Loop	1969
BN-350	USSR	1000	150[c]	Loop	1972
Phenix	France	567	250	Pool	1973
Prototype Fast Reactor	UK	600	250	Pool	1974
Under Constr.					
Joyo	Japan	100[d]	--	Loop	1976
BN-600	USSR	1470	600	Pool	1978
Fast Flux Test Facility	USA	400	--	Loop	1979
Planned					
KNK-II[e]	W. Germany	58	20	Loop	1976[e]
Prova Elementi di Combustibile	Italy	140	--	Modified Pool	1978
SNR-300	W. Germany[f]	770	312	Loop	1980
Super-Phenix	France[g]	2900	1200	Pool	1982
Monju	Japan	714	300	Loop	1983
Clinch River Breeder Reactor	USA	975	350	Loop	1983
Commercial Fast Reactor	UK	3230	1320	Pool	1984-5
SNR-2	W. Germany[g]	5000	1200-2000	Loop	1985-6
Prototype Large Breeder Reactor	USA	2500	1000	Not Decided	1988

[a] Initially operated at 5 megawatt thermal as BR-5; upgraded to BR-10 (10 megawatt thermal) in 1973.

[b] Initially operated at 20 megawatt thermal; power increased to 40 megawatt thermal in 1970 with "Fortissimo" core.

[c] Also produces the equivalent of 200 megawatt electric as process steam for desalination.

[d] To be operated initially at 50 megawatt thermal.

[e] Operated 1971 through 1974 as a thermal reactor, KNK-I.

[f] In cooperation with Belgium and the Netherlands.

[g] Tripartite effort of French, German and Italian electric utilities.

8.4.3 A Different Size Plant

The two major factors that appear to govern the size of the demonstration plant are:

1. Extrapolation of component sizes. Both the extrapolations from previous reactors to CRBR and the future extrapolations from the CRBR to commercial sizes must be considered.

2. Timing. If the informational needs are to be met on the projected schedule, choices must be made within the schedule rather than await a lengthy development period.

Secondary considerations, such as the ability to provide useful data in a utility grid, probabilities of cost overruns, and prospect of later design changes also affect (and are affected by) the choice of plant size.

A survey has been made of the principal components whose size might affect the demonstration plant size.* Table 8.2 presents some of the results of this survey with ERDA's recommendations for the sizes of demonstration plant components. It shows that the overall CRBRP rating of 975 MWt is about the same factor of increase over FFTF as commercial plants are expected to be increased over CRBR, i.e., factors of about 2.5 in each case.

The staff notes from the table that perceptions of target operating temperatures are lower now than at the time WASH-1201 was prepared in 1972. The temperatures of the IHX and the steam generators appear to have reached a steady level in FFTF and state-of-the-art designs, with little or no increase required for demonstration or commercial designs. On the other hand, considerable size extrapolation, and hence possibly development, is required for primary pumps and heat exchangers.

The applicant's choice of plant size appears reasonable because of the following points:

1. A substantially smaller size would not provide a suitable intermediate range for the development of pumps and valves. The subsequent extrapolation to commercial sizes would be too great a step for confident predictions. Therefore, any possible savings in time associated with a smaller sized demonstration plant would be more than offset by a reduction in assistance to the commercialization decision. Furthermore, the staff does not believe that there would be any substantial savings in time by building a smaller size plant within the range of interest.

2. Any substantially larger size would require extrapolations from present sizes that would entail increased risks of delay in the demonstration program and hence delays in obtaining information to be utilized in the commercialization decision. If sufficient time were available for development of a somewhat larger plant, the staff believes that such a demonstration could facilitate extrapolation to commercial sizes. However, it should be noted that the 350 MWe size chosen for CRBR is already larger than PFR and Phenix (250 MWe).

A direct step from the present state-of-the-art to full commercial sizes is regarded as involving substantially greater risk than the CRBRP. While ERDA's balancing of objectives and risks may be arguable, it is clear that a major shift in the size of the demonstration plant would have uncertain benefits and could involve substantial delays.

8.4.4 FFTF Role Expanded

The FFTF is being built to fulfill the needs of the LMFBR program for an irradiation and fuel testing facility. It is similar in design to CRBRP but with a lower power level by a factor of about 2.5. As a test facility, the full power output of FFTF (400 MWt) is to be dissipated to the atmosphere through air dump heat exchangers. It had been anticipated that the irradiation test program would require reactor shutdowns that would be incompatible with a program of sustained steam-electric power generation. The EBR-II experience has shown, however, that in many typical irradiation tests, it is advantageous to maintain, as far as possible, a constant power level throughout. This pattern of irradiation operation has been found in the case of EBR-II to be compatible with steam and electricity generation, as indicated by the high plant factors recently achieved.

---

*See WASH-1201, p. 213, for a summary discussion. It is the staff's belief that the survey results are in substantial agreement with the results of the earlier Project Demonstration Phase, in which extrapolation was an important study area.

Table 8.2

LMFBR SODIUM COMPONENTS

	State-of-Art	FFTF	Demonstration Plants	Target Plants**
Intermediate Heat Exchangers (IHX)				
MWt/IHX	43 - 143	133	314 - 625	800 - 1300
Design Temperature (°F)	600 - 900	1050	1050 - 1100	1000 - 1150**
Shell Diameter (in.)	- 69	82	84 - 105*	-
Shell Length (ft.)	- 31	35	36 - 57*	-
Configuration		Sine wave tube; removable bundle	"L" shell fixed tube sheets; and straight tube bundle*	"L" shell fixed tube sheets; Sine wave tube*
Steam Generators				
Capacity (MWt)	5 - 143	N.A.	Once-thru Modular 75 - Recirculating Single, 315	Once-thru Modular, 78-280
Steam Pressure (psi)	605 - 1250		1450 - 2500	2500
Steam Temperature (°F)	780 - 840		900 - 950	900 - 1000
Tubing	Single Wall Double Wall		Single wall	Single wall
Materials	Croloy and SS		Croloy Incoloy 800	Croloy Incoloy 800
Primary Pump				
Capacity (GPM)	2,500 - 13,000	14,500	25,180 - 57,800	62,800 - 150,200
HEAD-TDH (ft)	160 - 310	503	405 - 517	237 - 432
NPSH Available (ft)	35 - 17	40	60 - 243	89 - 30
Design Temp. (°F)	800 - 1000	1050	800 - 1000	770 - 1140***
Shaft Length (ft.)	10 - 18	24	17 - 28	
Check Valves				
Size (in.)	14 - 16	16	22 - 24	38*
Temp. (°F)	550 - 1000	830	800	800*
Press. (psi)	100 - 150	225	200 - 225	200*

*Selections Incomplete

**Operating Parameters

***Based upon 1969 1000 MWe studies and 1971 modifications in (W) Steam Generator Development Concept

Full three-loop steam operation at FFTF would require an extensive piping network that could not be accommodated within the presently available space at FFTF without interfering with completion of the irradiation test facility and significant rework of the construction. However, a steam-electric generation system fed from one of the three primary sodium loops of FFTF might provide an early demonstration of this phase of the LMFBR cycle without undue interference from either space or programmatic restrictions, and without requiring construction of a separate demonstration plant. Such a demonstration would be smaller in scale than any single loop of CRBRP by the 2.5 factor; extrapolations to commercial size steam-electric systems from an FFTF loop without the intermediate experience of CRBRP would therefore entail the greater risk of such a large step. Furthermore, schedule conflicts between the needs of the irradiation/fuel-test program and the power demonstration program might easily arise. For these reasons, the staff is unable to conclude that expanding the role of FFTF would provide a satisfactory alternative to CRBRP.

8.4.5 Base Loading As a Performance Goal

Emphasis has been placed on the use of CRBRP as a load-following plant (PSAR, Appendix B). Assuming that the principal application for larger LMFBRs will be as base-loaded power plants, the incorporation of design features in the CRBRP to enhance load following capability appears unnecessary. Designing and constructing CRBRP as a base-load plant may expedite some aspects of the project, focus efforts on the more relevant aspects of a demonstration plant, and be more directly related to the objective of the commercialization decision. It is the staff opinion that operation of the CRBRP during the demonstration period should focus on the base load aspects of operation and that CRBRP evaluations should be oriented to assure that its load capabilities are relevant to the larger, follow-on, LMFBRs.

8.4.6 Foreign Purchases of a Demonstration Plant Design or Technology

Another possible time and cost saving alternative would be the purchase from a foreign developer of the required design and technology to build a demonstration reactor. Parameters of the known U.S. and foreign LMFBR designs have been tabulated (WASH-1354). Although the overall pace of national programs is hard to compare, it is apparent that British and French LMFBR programs are ahead of the U.S. program in at least one respect; that is, they have operational demonstration plants and either have under construction or have designed plants whose proposed output is comparable to current commercial light water reactors. The purchase of such a program from abroad entails serious risks and uncertainties, however.

A recent report on the possibilities of accelerating the breeder program by using foreign technology has been prepared by the GAO (Comptroller General, May 6, 1976). The GAO cites several impediments to such a course, including the commerciality of the program, the impact of the Freedom of Information Act, the tighter time frames imposed in foreign programs, potential licensing problems, certain inherent difficulties in exchanging information, lack of travel funds, and national pride. In addition, development of an excessive reliance on foreign technology may be contrary to the U.S. goals of energy independence. The GAO also expresses the belief that foreign countries would probably not be willing to make public the licensing information on technical data, development and design that is required under U.S. licensing procedures. The GAO report brings out the differences between the nationalized utilities and somewhat nationalized industries of foreign countries and the more disperse competitive picture in the U.S. This organizational structure may, to some extent, shape the choice of parameters for each nation's breeder program.

The staff has sufficient knowledge of the Phenix reactor to predict that some design changes would be necessary for licensing in the United States; for example, the staff notes the lack of a diverse and redundant shutdown system and the lack of a gas-tight containment in Phenix. These impediments could be overcome; in fact, current French designs of LMFBRs include improved shutdown systems. Insofar as licensing is concerned, the staff does not expect that licensing of a foreign designed LMFBR demonstration plant would be achievable in any shorter time than a U.S. designed plant. The same general view would apply to larger LMFBR plants.

Exchanges of technical information may be of more value than purchases of major facilities. The previous discussions have highlighted at least one area where such exchanges may be of more than background benefit; this is in the area of pool technology. Since the U.S. is not currently pursuing this technology and yet wishes to keep the option open for future consideration, and since the technology is different from loop technology in many respects, information exchanges with those nations that have chosen the complementary course may prove useful to both sides should they decide to switch. The Germans have cited this as a reason for their joint participation in Super Phenix (Comptroller General, May 6, 1976, p. 83). Such information exchanges are not without difficulties, as the GAO has pointed out in connection with a proposed exchange with the Soviet Union involving steam generator test facilities. Nevertheless, the staff concludes that the pursuit of a U.S. demonstration program, supplemented by exchanges of information with foreign programs, would seem to be a much more reliable way of meeting the identified U.S. objectives than a major purchase of foreign design and technology.

8.5 SUMMARY AND CONCLUSION

The overall objective of the LMFBR program is to "establish a broad technical and engineering base sufficient to permit industrial involvement required for a commercial breeder industry." ERDA identified the CRBRP as an important element in attaining this objective (ERDA-1535, Section I.B.1). The ERDA Administrator's Findings of December 31, 1975 support this statement and specifically reject those options involving rapid acceleration of the program because of the "lack of any demonstration plant or large plant experience...". Similarly, delays or omission of the CRBRP from the program are stated to be unacceptable (ERDA-1535). The staff believes that the CRBRP is capable of making substantial contributions to meeting the needs of the LMFBR program and it is therefore likely to meet its objectives under the program (see Sect. 8.3). Furthermore, the staff concludes that no substantially better technical alternatives are available to achieve the objectives of the demonstration plant in a timely manner (Sect. 8.4). Delays which have already occurred in the schedule will not necessarily delay the ERDA Administrator's proposed decision date on commercialization of the LMFBR concept beyond 1986.

9. ALTERNATIVES

9.1 ENERGY SOURCES

Alternative energy sources are discussed and analyzed in the Final Environmental Statement on the LMFBR Program (ERDA-1535). They are not considered in this statement because none were considered to be capable of fulfilling the general objectives and specific purposes of the CRBRP as an LMFBR demonstration plant (Chapter 8).

9.2 SITES

In the staff's draft statement, only sites within the TVA service area were considered as alternatives to the proposed Clinch River site. In this final statement, certain alternative sites outside the TVA service region have been considered in response to comments from the Natural Resources Defense Council (see p. A-61) and considerations in the Commission's order of August 27, 1976 (see Sec. 9.2.6).

9.2.1 Background

During the LMFBR Demonstration Plant Project Definition Phase which ended in 1971, several sites were proposed to the AEC by reactor manufacturers and utilities. These included a General Public Utilities site near Scottsville, Pennsylvania; an ESADA (Empire State Atomic Development Associates) site in New York next to the St. Lawrence River; a site on the Hanford reservation near Richland, Washington; and a site at Savannah River, South Carolina. All of these locations were considered likely to be acceptable (WASH-1201, p. 36). As part of this program, backup sites were considered so as to minimize potential delays in meeting the program objectives due to non-LMFBR related matters. The Scottsville, New York and Hanford sites were reviewed in a preliminary manner by the AEC Regulatory staff. The Scottsville site was found generally acceptable but some issues developed with regard to the New York site, principally with regard to seismicity of the region. The Hanford site was not reviewed in detail. Formal findings of site suitability were not made for any site.

The site selection process under the program then underwent a major modification as part of the AEC's change from the approach of first considering vendor design/site combinations to an approach of considering possible owner-operators of the demonstration reactor, each with its own complement of candidate sites. In the subsequent implementation of plans for the demonstration plant, the AEC invited proposals from utilities or groups of utilities who were willing to become the owner-operator of the plant. The proposals received identified only one of the previously proposed locations - the ESADA site in New York. The group of utilities which had participated in the earlier reviews of the Hanford site declined to submit a proposal, apparently because of resource limitations. A group of utilities in the northeast suggested a site on the New England Power Company system near Rowe, Massachusetts (WASH-1201, p. 459). Commonwealth Edison Company (CE) and the Tennessee Valley Authority (TVA) jointly proposed the location of TVA's John Sevier Plant near Rogersville, Tennessee, where steam from the reactor could be used to drive existing turbines at the plant (WASH-1201, p. 404). An alternative in the CE/TVA proposal was to locate the demonstration plant on a new site on the Clinch River at Oak Ridge, Tennessee. The CE/TVA proposal was ultimately accepted by the AEC with the understanding that the demonstration plant would be constructed on a suitable site within the TVA power service area (WASH-1201, p. 415).

9.2.2 TVA Site Selection Criteria

The AEC's program office recognized that the considerations applying to LWR site selection should also apply to fast breeder site selection (WASH-1201, p. 36). It had therefore been determined that any potential site must not require unusual design features or special licensing considerations and should permit the construction of a plant that would conform with applicable environmental standards. In recognition of the developmental nature of the LMFBR concept, however, an important factor in selecting the site was to assure that the demonstration plant would not have an adverse effect on TVA's ability to provide an adequate supply of electricity to the region it serves. The siting criteria used by TVA are summarized (ER, p. 9.2-3) as follows:

1. The demonstration plant size will be in the 300 to 500 MWe range;
2. The site must meet physical and environmental requirements;
3. A hook-on plant is preferable to a new plant provided adequate incentives exist;
4. Concerning the hook-on criteria:
   a. The project should not adversely affect TVA's power system operation or system reliability and should permit the use of existing boilers during periods when the LMFBR nuclear steam supply system (NSSS) is not available for operation; and
   b. Steam conditions and unit sizes of existing steam plant should closely match requirements of the LMFBR demonstration plant;
5. Concerning new site criteria:
   a. The site should be available immediately; and
   b. The site should be one which is not expected to be used for a commercial generating plant in the near future.

The NRC staff considers the above siting criteria to be reasonable for coarse screening of proposed sites within the TVA service region, with the exception of criterion 5b. Although TVA did not wish to commit a site which was usable for large nuclear units, such a site would likely be suitable for the demonstration plant. For this reason, the staff has considered several of these sites in its review.

9.2.3 Alternative Sites for the Hook-On Option

The applicant reviewed all TVA plants that would be operational on a schedule consistent with the demonstration plant to determine their suitability for operation of existing turbines with steam from the LMFBR. These plants and the initial factors used in evaluating them are shown in Table 9.1 (ER, Tab 9.2-1). Sites in the western portion of the TVA system, downstream from Tennessee River Mile 240 and the Cumberland River west of Nashville, were eliminated due to the proximity of the New Madrid faulted zone in which major seismic activity occurred in 1812. For this reason, the Allen, Shawnee and Johnsonville Steam Plant locations were not considered further.

TABLE 9.1 TVA Steam Plant Characteristics for Demonstration Plant Siting Adaptability[a]

Plant	Units	Unit Nameplate Capacity-MWe	Throttle Steam Pressure 16/in^2 gage	Throttle/ Reheat Steam Temp. °F	Meets Size Criteria	Acceptable Seismology	Candidate Site
Allen	3	330.00	2400	1050	Yes	No	
Browns Ferry[b]	3	1152.00	950	540	No	--	
Bull Run	1	950.00	3500	1000/1000	No	--	
Colbert	1&2	200.00	1800	1050/1050	Yes	Yes	
	2-4	223.25	1800	1050/1050	Yes	Yes	Yes
	5	550.00	2400	1050/1000	No	--	Yes
Cumberland	1&2	1300.00	3500	1000/1000	No	--	
Gallatin	1&2	300.00	2000	1050/1050	Yes	Yes	Yes
	3&4	327.60	2000	1050/1050	Yes	Yes	Yes
John Sevier	1	223.25	1800	1050/1050	Yes	Yes	Yes
	2-4	200.00	1800	1050/1050	Yes	Yes	Yes
Johnsonville	1-4	125.00	1450	1000	Yes	No	
	5-6	147.00	1450	1000	Yes	No	
	7-10	172.80	2000	1050/1000	Yes	No	
Kingston	1-4	175.00	1800	1000/1000	Yes	Yes	
	5-9	200.00	1800	1050/1050	Yes	Yes	Yes
Paradise	1-2	704.00	2400	1050/1000	No	--	Yes
	3	1150.20	3500	1000/1000	No	--	
Sequoyah[b]	1-2	1220.58	765	515	No	--	
Shawnee	1-10	175.00	1800	1000/1000	Yes	No	
Watts Bar	1-4	60.00	850	900	No	--	
Watts Bar Nuclear Plant	1-2	1269.90			No	--	
Widows Creek	1-4	140.63	1450	1000	Yes	Yes	Yes
	5-6	140.63	1800	1000/1000	No	--	
	7	575.01	2400	1050/1000	No	--	
	8	550.00	2400	1050/1000	No	--	
X-14 & X-15[b]	1-2	1332.00			No	--	

(a) ER, Table 9.2-1
(b) Nuclear Plants

As indicated in the right-hand column of the table, certain generating units at five of the plants appear to be suitable hook-on candidates. However, Colbert, Gallatin and Kingston all were operating and are expected to operate at capacity factors greater than 60%.

Due to the relatively high utilization of these plants in meeting system load, TVA believed it prudent to exclude them from further consideration provided Widows Creek units 1-4 or John Sevier units 1-4, which had capacity factors of 50.8% and 54.8%, respectively, were suitable for use with the demonstration plant. The NRC staff concurs with this judgment since the average capacity factor of the demonstration plant is unlikely to exceed 55% during the initial 5-year demonstration period (ER, Am I, p A1-73). The extent to which a plant with a normally higher capacity factor is not utilized would represent an economic penalty to the TVA system.

Units 3 and 4 at the John Sevier coal-fired power plant near Rogersville, Tennessee, were initially selected to accommodate the hook-on arrangement. Adequate space was available adjacent to these units for the reactor and other components of the nuclear steam supply system (NSSS). These units have normal steam conditions of 1800 psig at 1050°F, with 1050°F reheated steam; whereas the steam from the nuclear system would be delivered at about 900°F, which would result in a 36 MWe reduction in plant capacity. Reheating the steam would be necessary to keep the moisture level in the last stage of the turbines below about 9%. Sodium reheat capability was thought to involve significantly increased system complexity and technological extrapolation as compared to non-reheat systems. A separate oil-fired reheater was therefore considered as a means of providing the reheated steam, but this would also increase the complexity of the project and involve added capital and operating costs.

The normal steam conditions of 1450 psig - 1000°F at Widows Creek unit 1-4 are better matched to design objectives of the NSSS and no reheat cycle would be required. Steam from the NSSS would have a higher moisture content which would accelerate the turbine blade erosion somewhat, but not enough to make the arrangement infeasible. Reducing the steam temperature to 900°F would also reduce the plant capacity by 27 MWe. Vacant land near the existing units is sufficient for addition of the NSSS. However, the staff found during a site visit that a 1000-ft smoke stack was being erected between these units and the river. In view of the accident potential of a toppled stack of this size, a reevaluation of the location and design of a breeder reactor on this site, or possibly relocation of the stack, would be necessary if this alternative were chosen for the demonstration plant.

The staff considers the applicant's screening process to be reasonable and agrees with its selection of the John Sevier and Widows Creek sites for the add-on alternatives. These are considered further in Section 9.2.5.

9.2.4 Alternative New Sites in the TVA Service Area

Eleven new sites, including Clinch River, were studied by the applicant for the demonstration plant (ER Sec. 9.2.4 and ER, App. A). Their locations are shown in Figure 9.1. These sites were evaluated by the applicant on the basis of population, seismology, geology, transportation access, nearness to transmission lines, hydrology, and ecology. The principal factors are summarized in Table 9.2.

The applicant's reasons for elimination of certain sites were as follows:

Spring Creek, Caney Creek, Buck Hollow, and Lee Valley	-	have less favorable geologic characteristics than Clinch River.
Murphy Hill	-	has potential for future commercial power production.
Blythe Ferry	-	would require construction of 19 miles of new railroad line and 6 bridges.
Taylor Bend	-	would block access to the tip of the peninsula, where extensive development is planned, and require purchase of an unneeded additional 1550 acres.
Phipps Bend	-	has potential for future commercial power production.
Hartsville	-	is being developed for commercial power production.
Rieves Bend	-	availability of adequate cooling water is questionable.

The staff's review of the 11 new sites indicates that the Spring Creek, Rieves Bend and Hartsville sites are all located in the Central Stable Region tectonic province which has

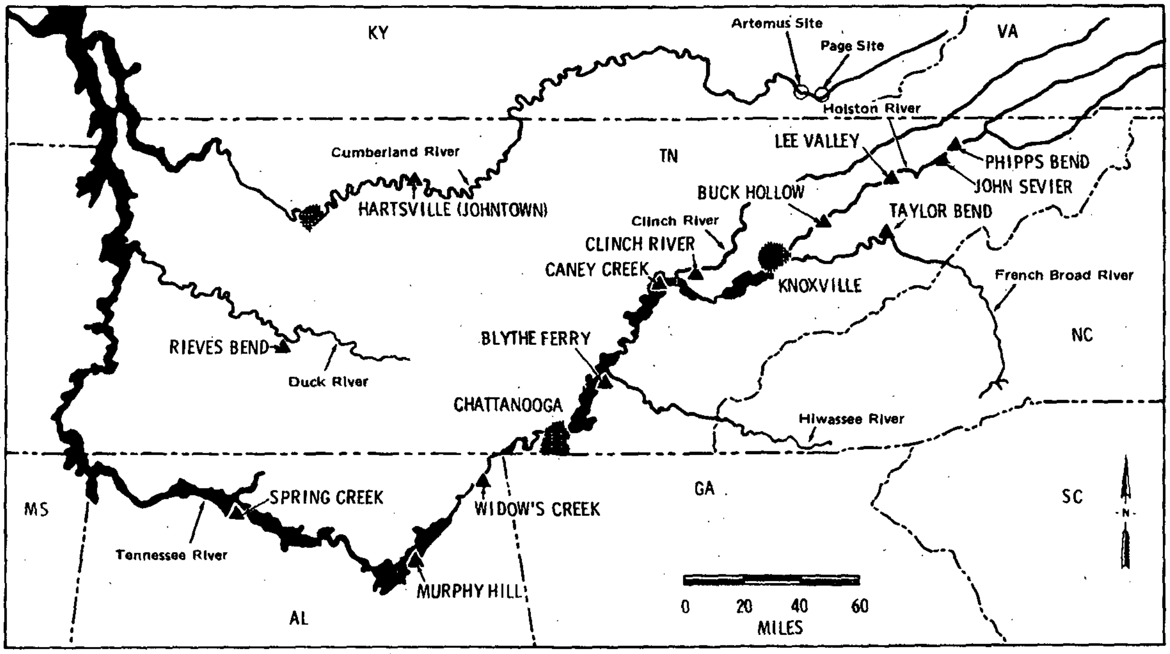


FIGURE 9.1 General Location - Alternative Sites

experienced a maximum seismic intensity of VII-VIII, whereas all the other new sites (and the John Sevier and Widows Creek hook-on sites) are in the southern part of the Valley and Ridge tectonic province which includes a maximum intensity of VIII. There is no known evidence of active faults in this region; consequently, the presence of faults near some of the sites is unlikely to be an important factor. However, a major potential problem is the presence of extensive karstic features (solution features) associated with the limestone foundation rock which is common to many of these sites. The discovery of sink holes at Spring Creek indicates such potential foundation problems and is good cause for its elimination from further consideration. Extensive karstic features are not present at the Clinch River, John Sevier or Phipps Bend sites, but detailed review would be required to make a final assessment of the other sites.

From the limited information available on the Caney Creek, Buck Hollow and Lee Valley sites, the staff has not concluded that these sites have less desirable geological characteristics than the Clinch River site, as indicated by the applicant. However, they are generally similar in atmospheric dispersion and other characteristics to the Clinch River and Phipps Bend sites, which are discussed further in Section 9.2.5, and do not offer any significant advantages over the proposed site. The faults near these sites are unlikely to be an important factor in their acceptability since there is no known evidence of active faults in this region. But, the presence of such faults is an uncertainty which must be extensively investigated before a site suitability determination can be made. In view of this uncertainty and the probability that the timing requirements of this project could not be met, the staff considers the Caney Creek, Buck Hollow and Lee Valley sites to be less desirable alternatives for the demonstration plant.

TABLE 9.2 Site Data for Candidate New Sites

NO.	SITE	RIV MI	GR EL	POSS FL EL	CONDENSER COOLING	ACCESS FACILITIES HWY	RAIL	BARGE	FOUNDATION CONDITIONS	DIST FROM POPULATED AREAS	TRANS LINES 161 KV
1.	TENN RIVER Spring Creek (Wheeler Res)	283L	580	573	Auxiliary Cooling Req'd	7±mi (Ala20)	7±mi (SOU)	Yes	Not investigated not suitable	18±mi to Athens Ala (pop 14,000±) 19±mi to Decatur Ala (pop 37,800±)	1-3 mi SW
2.	Murphy Hill (Guntersville Res)	370L	618	618	Auxiliary Cooling Req'd	16±mi (US431)	27±mi (L&N)	Yes	Core drilling indicates top of rock 21 to 61 ft below general site grade	11±mi to Guntersville Ala (pop 6,500±) 15±mi to Scottsboro Ala (pop 9,300±)	1-Just across reservoir. Proposed line and substation 3 mi S
3.	Blythe Ferry (Chickamauga Res)	499L	730	725	Auxiliary Cooling Req'd	0.3±mi Tenn 80	22±mi (SOU)	Yes	Seismic determinations indicate top of rock at favorable depth below plant grade	6±mi to Dayton Tenn. (pop 4,400±)	1-6 mi SE
4.	Caney Creek (Watts Bar Res)	562R	820	775	Auxiliary Cooling Req'd	1.5±mi (US70 & 27)	6±mi (L&N)	Yes	Not investigated	4.5±mi to Rockwood Tenn (pop 5,300±) 5.5 mi to Kingston Tenn (pop 4,200±)	1±mi NW 1-4 mi SE across reservoir
5.	CLINCH RIVER Clinch River (Watts Bar Res)	16R	800	785	Auxiliary Cooling Req'd	2±mi (Oak Ridge Turnpike)	2±mi Spur of SOU	Yes	Core drilling indicates lime stone and silt stone underlies site Geologists believe adequate foundation is available	8±mi to Kingston Tenn (pop 4,200±) 10 mi to Oak Ridge Tenn (pop 28,000±)	1-passes through site 1±mi N
6.	FR. BROAD RIVER Taylor Bend (Douglas Res)	64R	1055	1016	Auxiliary Cooling Req'd	2±mi (US 25E)	4±mi (SOU)	No	Currently under investigation	7±mi to Newport Tenn (pop 7,300±) 12±mi to Morristown Tenn (pop 20,300±)	1-6±mi N 2-9±mi N
7.	HOLSTON RIVER Buck Hollow	39L	1050	950	Auxiliary Cooling Req'd	4±mi (US 11E)	4±mi (SOU)	No	Currently under investigation	5±mi to Jefferson City (pop 5,100±)	1-passes through site 1-2±mi S
8.	Lee Valley (Cherokee Res)	88L	1120	1089	Auxiliary Cooling Req'd	2±mi (Tn 66A)	6±mi (SOU)	No	Geologists say site is underlain by limestone and shale	10±mi to Rogersville Tenn (pop 4,000±) 11±mi to Morristown Tenn (pop 20,300±)	3-passes just north of the site
9.	Phipps Bend	122R	1195	1152	Auxiliary Cooling Req'd	2±mi (US 11 W)	1.5±mi (SOU)	No	Currently under investigation	11.5±mi to Rogersville Tenn (pop 4,000±) 16±mi to Kingston Tenn (pop 32,000±)	2-9±mi SW
10.	CUMBERLAND RIVER Johntown (Old Hickory Res)	285R	536	514	Auxiliary Cooling Req'd	1±mi (Tn 25)	5.5±mi (L&N)	Yes	Extensive core drilling indicates satisfactory foundation available	8±mi to Harrisville Tenn (pop 2,200±) 18±mi to Carthage Tenn (pop 2,500±)	2-5±mi S
11.	DUCK RIVER Rieves Bend (Proposed Columbia Res)	146L	700	644	Auxiliary Cooling Req'd	3±mi (Tn 50)	4±mi (L&N)	No	Core drilling indicates satisfactory foundation available	5±mi to Columbia Tenn (pop 21,500±)	1-10±mi S

The lack of an assured supply of cooling water at the Rieves Bend site is adequate reason for its rejection, and the same deficiency applies to Buck Hollow which is discussed above. Both the Blythe Ferry and Taylor Bend sites would be more costly or less desirable to develop than Clinch River for the reasons given by the applicant. The staff therefore agrees that the Buck Hollow, Rieves Bend, Blythe Ferry and Taylor Bend sites should be eliminated from consideration.

Site preparation activities for a 4-unit nuclear power plant at the Hartsville site have been authorized by the NRC since the Draft Environment Statement on the CRBRP was issued. Sufficient space is probably available at the Hartsville site for the demonstration plant as well; however, constructing the demonstration plant there during the same time period would increase the socio-economic impacts on the small communities in the area by 50 percent (2800 persons at peak construction of CRBRP added to 5300 for Hartsville). The staff concluded that this situation should be avoided in view of the considerable stress on facilities which is already expected from the Hartsville project (NUREG-75/039).

Murphy Hill and Phipps Bend are also potential sites for commercial nuclear power plants and were therefore rejected by TVA for the LMFBR demonstration plant in accordance with its siting criteria (Sec. 9.2.2). Based on a review of information provided by the applicant and a visit to both sites, the staff concluded that either would be suitable for the demonstration plant. An application for permits to construct two nuclear units at Phipps Bend is under review, but the review has not progressed enough for any licensing decisions to have been made. Both of these sites are therefore presently available as alternatives to the Clinch River site.

The NRC staff has considered several additional nuclear power plant sites in the TVA service area during environmental reviews of other construction permit applications by TVA. Seven alternative power plant sites were identified and evaluated in the staff's FES for the Bellefonte Nuclear Plant (1974) and three alternative sites were evaluated in the staff's FES for the Hartsville Nuclear Plant (NUREG-75/039, 1975). Currently, the staff has under review construction permit applications for the Phipps Bend (DES, NUREG-0098, 1976) and Yellow Creek Nuclear Plants (TVA, ER, 1976). In summary, it is the staff's judgment that previous and current construction permit application reviews of alternative plant sites in the TVA service area by the NRC staff have not identified any sites which would offer substantial environmental advantages relative to the Clinch River site.

9.2.5 Selected Alternative Sites in the TVA Service Area

The selection process described in the foregoing sections resulted in the applicant's eliminating all but three sites: the John Sevier and Widows Creek hook-on sites; and the new site at Clinch River. To this list the staff has added the Phipps Bend and Murphy Hill new sites. A comparison of all five sites is given in Table 9.3. The data reveal numerous differences in site characteristics, but none which indicate that location of the LMFBR demonstration plant at any one of the five sites would not be feasible.

In Table 9.3, slight differences in meteorology are noted; the atmospheric dispersion conditions at these sites along the rivers of eastern Tennessee are so nearly alike that they should be considered comparable. Relative to other regions of the country, there is a greater frequency of stagnant or poor dispersion conditions. This generally results in somewhat more restrictive controls on routine and potential accidental releases. On the other hand, the area is characterized by relatively low populations. For example, as shown in Table 9.3, the populations surrounding the five sites were all below one million out to a distance of 50 miles (an average of about 130 people per square mile). This may be compared to the value of 500 people per square mile currently used by the NRC staff as a criterion that triggers a more extensive review of alternative sites. This is further illustrated in Figure 9.2.

The applicant has made a cost comparison of locating the demonstration plant at John Sevier, Widows Creek and Clinch River (Table 9.4). (Cost estimates were not made for installations at Phipps Bend and Murphy Hill, but neither site has unique characteristics suggesting unusual costs.) The comparison showed that adding the nuclear facility to the Widows Creek plant would be $98.4 million less expensive than construction and five-years' operation of an entirely new plant at the proposed Clinch River site; adding the nuclear facility at John Sevier would be $55.7 million less expensive than the CRBRP. The savings at the two hook-on sites would come mainly in lower site development costs and avoiding the purchase of a turbine-generator and other balance-of-plant facilities.

TABLE 9.3 A Summary of Comparisons Between the John Sevier, Widows Creek, Clinch River, Phipps Bend and Murphy Hill Sites (ER, Table 9.2-3)

	John Sevier[(a)]	Widows Creek[(a)]	Clinch River[(a)]	Phipps Bend[(b)]	Murphy Hill[(b)]
	Based upon a preliminary analysis, each site represents a feasible location to build the plant.				
Foundation Conditions	Good	Several potential problems have been identified. Adequate foundation could be designed.	Similar to TVA's Bull Run Steam Plant. Adequate foundation could be designed.	Adequate	Adequate
Seismology	Seismology is similar for these sites. No active faults in vicinity of any of the sites and no physical evidence of any recent seismic activity at the sites.				
Flooding	Site grade lies below Design Basis Flood (DBF) level elevation which would require special flooding protection.	Site grade lies below DBF level elevation which would require special flooding protection.	Plant grade can be established above DBF level elevation. Best site from this standpoint.	Site grade lies below DBF(c) level elevation which would require special flooding protection.	Site above DBF.
Cooling Water	Adequate based on John Sevier Steam plant operations.	Adequate cooling water available.	Will require supplemental cooling.	Mean daily stream-flow is 3600 cfs.	Mean daily stream-flow is 39,360 cfs.
Meteorology	Slightly better than Clinch River site.	Less desirable than Clinch River.	Slightly less desirable than John Sevier site.	Slightly less desirable than the Clinch River site.	Slightly less desirable than the Clinch River site.
Available Land	All five plant sites can accommodate the facilities and an exclusion area radius of 2,000 ft.				
Access	Highway and rail facilities available. Must tie into facilities at the plant.	Highway, rail and barge facilities available. Tie into facilities may require some rerouting of existing lines plus additional track to the NSSS.	Highway, rail and barge facilities can be added. Two miles of rail track and two miles of improving or building of roads is required.	Good road and railroad access, but river is not navigable.	Would need about 16 miles of new roads and 16 miles of new railroads. Barge access is feasible.
Transmission Facilities	No additional offsite transmission lines required with only some tie-in equipment needed.		Some additional offsite transmission lines required. (Section 3.9) Tie-in to 161-kV line and switchyard needed.	Acceptable access to transmission grid.	Acceptable acccess to transmission grid.
Steam Conditions	Degraded from existing conditions. Considered feasible but will have increased turbine erosion and associated maintenance.	Degraded from existing conditions. Considered feasible but moisture may be a problem.	Set by plant design.	Set by plant design.	Set by plant desigr
Population					
Total population within 50 miles (1970)	694,295	783,760	678,800	700,000	914,000
Total population within 10 miles 1970	18,955	15,105	41,895	18,000	9,600
2010	27,560	24,985	65,089	--	--
Total population within 2 miles	725	359	No significant concentration	No significant concentration	No significant concentration
Land Impact					
Additional land Committed - Acres	None	None	Some (to be determined)	1350 acre total site	1235 acre total site
Land Use Designation	Industrial	Industrial	Industrial	Industrial	Industrial
Proximity to National Monuments or Historic Sites	Andrew Jackson historical site within 25 miles	Russel Cave within 15 miles	Museum of Atomic Energy and ORNL Graphite Reactor within 10 miles	Two National Register properties within 5 miles.	No national properties, but a historic log cabin
Water Impact					
Distance to Nearest Surface Water User	31.4 miles	21.7 miles	1.6 miles	--	--
Potable Water Intake	3.46 MGD	1.19 MGD	2.5 MGD	--	--
Additional Heat Rejection to Reservoir from LMFBR	Essentially none	Essentially none	Small with cooling towers	Small with cooling towers	Small with cooling towers
Air Quality Impact	SO_2 emissions from operation of oil-fired reheater of 1.4 tons/hr. However, operation of LMFBR will decrease SO_2 emission levels when plant would otherwise be required.	Reduces overall system emission levels when LMFBR is in operation. In comparison to John Sevier, these sites have lower emission levels by amount contributed by operation of oil-fired reheater during operation of LMFBR.			

(a) ER, Table 9.2-3
(b) ER, App A
(c) DBF level is currently unresolved.

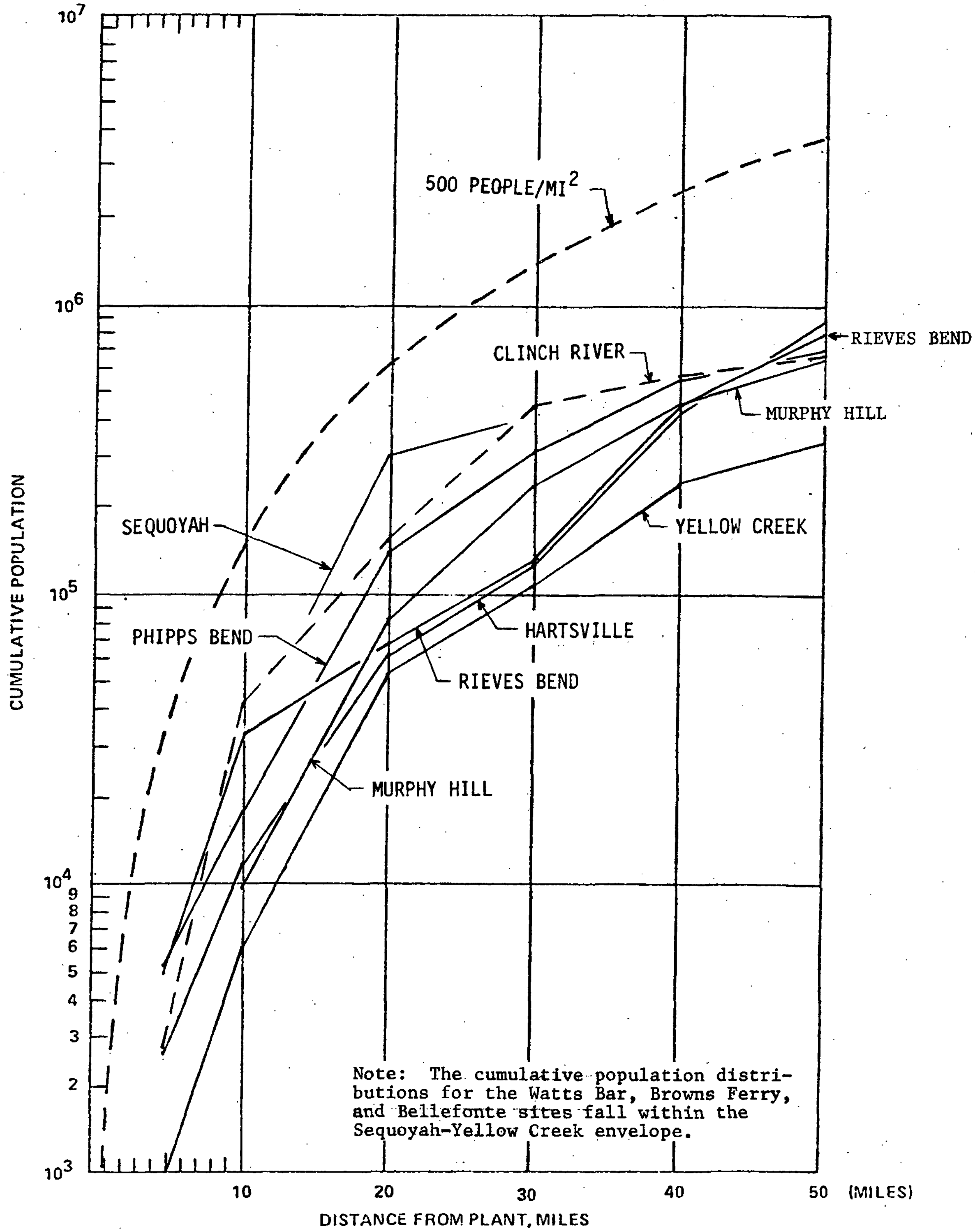


Figure 9.2 Cumulative Population Distribution (1970) at Sites in the TVA Service Area

TABLE 9.4 Summary of Economic Comparison of LMFBR Demonstration Plant Alternatives

	(Millions of Dollars)[a]		
	Clinch River	Widows Creek	John Sevier
A. PLANT COST[b]			
Site Development[c]	18.2	--	--
Nuclear Plant (NSSS)	701.2	701.2	699.2
Turbine Plant	104.6	--	--
Hook-on	--	44.6	50.9
Cooling Facilities	7.4	20.8	18.8
Switchyard	4.3	--	--
Subtotal (1974 $)	835.7	766.6	768.9
B. FIVE-YEAR DEMONSTRATION PERIOD OPERATING COST			
Nuclear Fuel Fabrication[d]	107.3	107.3	101.3
Fuel Oil	--	--	34.0
Non-Fuel O & M	47.3	46.1	45.4
Subtotal	154.6	153.4	90.7
Potential Power Credit	(71.8)	(67.9)	(68.7)
Net Operating Cost (1974 $)	82.8	85.5	112.0
C. OTHER PROJECT COST			
Project Management	47.8	47.8	47.8
Contract Services	8.8	8.8	8.8
Property Insurance	4.8	4.8	4.8
Supporting R&D	336.8	336.8	336.8
Subtotal (1974 $)	398.2	398.2	398.2
D. PROJECT COST			
A + B + C (1974 $)	1316.7	1250.3	1279.1
Escalation Allowance	633.7	601.7	615.6
Total	1950.4	1852.0	1894.7
Differences	Base	(98.4)	(55.7)

(a) Source: Letter to NRC from A. R. Buhl, CRBRP Project Office, Jan. 10, 1977.

(b) Plant cost estimates include normal overhead and appropriate contingencies for each part of the plant estimate, but do not include interest during construction.

(c) Site development costs for John Sevier and Widows Creek are small and included in the hook-on cost estimate.

(d) Nuclear fuel fabrication cost does not include the cost of other fuel cycle materials and services that will be provided by ERDA; the difference in cost indicated is due to the smaller reactor size at John Sevier.

An important economic factor in favor of an entirely new plant is its potential value to TVA, which will have the option to purchase and operate the plant at the conclusion of the initial 5-year period. The CRBRP, with its own turbine-generator, probably can be continued in operation as a power producer, whereas the hook-on plants cannot be assigned a value as capacity since they would not represent an increase in power system capacity; they would actually incur a 27-MWe reduction of the present capacity at Widows Creek, or a 36-MWe reduction at John Sevier, due to the off-design steam conditions which would result from the reactor. This reduction in net capacity and the need to shut down the facility during connection of the nuclear island to the turbine system would result in temporary but significant losses of generating capacity. Moreover, the ages of the existing turbines (about 25 years at John Sevier and about 30 years at Widows Creek), and the degradation of turbine performance resulting from the mismatch in steam conditions in the hook-on arrangement, present uncertainties as to the capability of these machines to meet the reliability objectives of the project.

With respect to the plant design in general, an all-new plant offers a distinct advantage since it could be designed in an integrated fashion to accommodate the LMFBR nuclear steam supply system. Engineering complications associated with design would thereby be minimized. An all-new plant would also provide greater assurance that the facility would be available beyond the demonstration period for extended research and development on the LMFBR concept and advanced fuels.

In view of the above considerations and other potential technical problems with a hook-on arrangement (ER, p. 9.2-32), the applicant chose to construct an entirely new plant. The NRC staff concurs with this decision on the basis that expenditure of the additional funds is necessary to assure a high degree of probability that the demonstration plant will meet its objectives under the LMFBR program.

The applicant's choice of the Clinch River site rather than Phipps Bend, Murphy Hill or any of the other TVA alternative sites, appears to have been influenced by TVA's desire to reserve certain sites for commercial power plants. However, there appear to be no significant environmental benefits to be gained from locating the plant at these alternative sites.

From the safety standpoint, as shown in Table 9.3 and Figure 9.2, none of these sites is substantially different than the Clinch River site with respect to site isolation (population density). There are some differences with respect to available exclusion radius, size of population within a few miles of the plant and nearby industrial facilities. While the Clinch River site is less favorable in these respects, the differences are not so great, in the staff's view, as to warrant a conclusion that relocation to another site within the TVA region should be considered.

9.2.6 Alternative TVA Sites Outside Its Service Area and Alternative ERDA Sites

This discussion is provided in response to NRDC comments (see p. A-61) on the DES which state that alternative sites with more favorable environmental and safety features were not analyzed, specifically the ERDA properties at Hanford, Idaho and Nevada. (Alternative sites within the TVA service area are discussed in Sections 9.2.1 through 9.2.5 and 11.9.3. Co-location with fuel cycle facilities is discussed in Section 11.9.5 and underground sites in Section 11.9.6.) In performing this review, the staff has observed the general principle in the Nuclear Regulatory Commission's Memorandum and Order of August 27, 1976, that "consideration of alternatives need go no further than to establish whether or not substantially better alternatives are likely to be available." The staff has also noted the Commission's judgement that this agency does not need to determine that CRBR is the "best" or "optimal" alternative, but only that the applicant's preferred approach is "reasonable."

The Commission's Order stated also that the programmatic impact statement (ERDA-1535) is dispositive of need for a demonstration-scale facility, including its timing and objectives. The staff has therefore included in its consideration of alternative sites an assessment as to whether a change in the proposed site is likely to permit the timing requirements to be met.

In order to determine if alternative sites with substantially more favorable environmental and safety features are found elsewhere in the United States, the applicants were requested to survey such possibilities for location of the LMFBR demonstration plant on properties in their custody outside the TVA power system. TVA compared TVA-owned sites outside its service area to the Clinch River site and ERDA similarly compared U.S. government-owned sites under its jurisdiction (Buhl, Nov. 18, 1976). In the applicant's screening process, a minimum requirement for site size was 300 acres assuming an exclusion distance of 2000 feet. This criterion was stated to be based on Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations." The staff agrees that this is a reasonable value for the purpose of site screening for the demonstration plant. The sites which are large enough for the plant were then considered with respect to the other site suitability parameters discussed in the guide and potential impacts of the plant on the environment.

TVA has only two sites, Page and Artemus, outside the TVA service area which might be considered (Fig. 9.1). Both were purchased because of their proximity to coal resources. Page, 3.5 miles southeast of Pineville, Kentucky, is unsuitable for the LMFBR demonstration plant site because of its insufficient size, 122 acres. Purchase of additional land would be necessary to provide an adequate exclusion area. The site also has a limited water supply, a potential problem for fish passage at the discharge, no barge access and relatively high transmission line costs. Characteristics of the 553-acre Artemus site, 8 miles northwest of Pineville, are similar to those of the Page site. While the size is adequate, the site is inferior to the proposed site because of the limited amount of water in the Cumberland River (6.2 cfs minimum daily low flow), no barge access and the extensive transmission facilities that would be necessary to integrate the plant into the power system. The resulting higher costs that would be sustained on both counts, and the fact that no significant advantages of the site are evident over the Clinch River site, gave cause to conclude that both Page and Artemus are not suitable alternatives.

From a survey of all ERDA properties, the applicant found that 29 ERDA areas appeared to meet the minimum size requirement of 300 acres. Five mining claim areas were eliminated upon further examination because each of the parcels held by the Government in fee contains less than 300 acres. Twenty-one other areas were rejected for one or more of these reasons: insufficient cooling water, excessive seismic ground motion, interference with projects under the Division of Military Applications weapons program, relatively high population density, insufficient space or undesirability of location in close proximity (1/2 mile) to existing ERDA facilities. Upon examination of the descriptive information regarding the 26 areas, the staff agreed with the applicant's decision to reject them as candidate sites for the demonstration plant.

Specifically, the 800,000-acre Nevada Test Site is not suitable because of the high cost associated with the estimated 0.75 g design requirement for seismic ground motion, lack of surface water and limited groundwater (use for the demonstration plant would conflict with other uses of Nevada's limited supply) and relatively high transmission line costs, as well as conflicts with current site projects covering research, development, and testing nuclear weapons. The site is bordered on three sides by the U.S. Air Force's Nellis Bombing and Gunnery Range, an additional potential conflict. A second Nevada site, the 2500-acre Central Nevada Test Area, about 100 miles north of the above-discussed site, was rejected because it is held in reserve for potential underground nuclear testing, it has a limited water supply (50 to 100 wells about 1000 ft deep very likely would be needed to give water with a 300 to 600 ppm dissolved solids content, and the quality probably would deteriorate as withdrawal proceeded), it has an estimated 0.4g design requirement for seismic ground motion, it would require costly transmission lines, and labor supply is limited. The staff concurs with rejection of both Nevada sites.

The remaining three ERDA properties considered were Hanford, Savannah River, and the Idaho National Engineering Laboratory (INEL). All three are in relatively remote areas and are between 200,000 and 600,000 acres in size. Preliminary analysis indicates that any one of them could readily accommodate the demonstration plant, along with the current wide variety of nuclear energy projects including, at Hanford, the construction of commercial nuclear power plants (WPPSS 1, 2 & 4).

Characteristics of the three alternative ERDA sites are compared in Table 9.5 to those of the Clinch River site. Aside from a higher safe shutdown earthquake design requirement at Idaho, there would probably be no differences in plant design except as necessary to adapt it to terrain and climatic conditions. Nor are there likely to be any substantial differences among the four sites with respect to potential socioeconomic impacts resulting from plant construction and operation. The biological impacts of construction would vary among the sites due to their differences in ecology, but the staff believes these impacts would be no more than minor at any of the sites. Effluents from the plant under normal operating conditions would be so small that the environmental effects would be minimal. Hence, there appears to be no substantial differences among the sites with respect to impacts from construction and normal plant operation.

However, all three of the alternative sites provide the opportunity to use very large exclusion areas and they have lower surrounding population densities. The atmospheric dispersion at the three alternative sites is also superior to that at the Clinch River site. These factors would result in lower calculated doses from an identical release of airborne radioactivity. Therefore, the staff concluded that the three alternative sites do offer the opportunity for reducing the potential impact of accidental radiological releases to the atmosphere. Because of the advantage of the alternative ERDA sites in this regard, the staff also reviewed these sites from the standpoint of their ability to meet the other objectives of the demonstration reactor (Sec. 8.3).

Table 9.5 Comparison of Clinch River Site to Selected Alternative ERDA Sites[a]

	CLINCH RIVER	HANFORD RESERVATION	IDAHO RESERVATION	SAVANNAH RIVER RESERVATION
Location	9 miles SW of Oak Ridge, TN (adjacent to Oak Ridge Reservation)	On the north boundary of Richland, Washington	About 25 miles W of Idaho Falls, Idaho	About 25 miles SE of Augusta, Georgia
Site Size:	1364 acres	360,000 acres	570,000 acres	190,000 acres
Exclusion Boundary	2,200 feet	Potential for >>2,200 ft	Potential for >>2,200 ft	Potential for >>2,200 ft
Population Center Distance	~7 miles (Oak Ridge-28,319)	(Richland-26,290)[b]	~25 miles (Idaho Falls-35,776)	~25 miles (Augusta-59,864)
Population Exclusion Boundary	2200 feet	15 miles	20 miles	10 miles
Population within 50 Miles	700,000	300,000	100,000	450,000
Cooling Water Supply	Clinch River - Adequate	Columbia River - Adequate	Groundwater - adequate	Savannah River - adequate
Flooding Problems	None at proposed location on site	None expected	None expected	None expected
Foundation Conditions	Adequate - limestone and siltstone	Adequate - dense sand and gravel to 100 ft, clay below	Good - surface basalt	Adequate - hard clay marl with limestone nodules
Seismology - probable design basis SSE acceleration	0.25g	0.25g[c]	Uncertain[d]	0.20g[e]
Atmospheric Dispersion	Base	Better than Clinch River	Better than Clinch River	Much better than Clinch River
Land use on site	Wooded	Nuclear-related; environmental research	Nuclear-related; grazing	Nuclear; unoccupied land is environmental research park
Nearby Facilities	Nuclear-gaseous diffusion plant, 3 miles; ORNL 4 miles; small industrial park 1.5 miles; small farms	Nuclear-NPR within 2 miles of possible location in 100 Area; agriculture, LMFBR technology center	Nuclear - LOFT, test reactors	Nuclear - Weapons related activities, H_2S stored; agriculture

Table 9.5 (Continued)

	CLINCH RIVER	HANFORD RESERVATION	IDAHO RESERVATION	SAVANNAH RIVER RESERVATION
Site Access	Road, railroad, and barge	Road, railroad, and barge	Road and railroad only	Road, railroad, and barge
Transmission Facilities	~3.2 miles of new line required	Only minor transmission line construction expected	20 miles or more of new line and substation additions required	Only minor transmission line construction required
Terrestrial Impacts	Minor	Minimal	Minor, 2 endangered species present	Minor, 2 endangered species present
Aquatic Impacts	Minor	Minimal	None	Minor
Labor Supply	Over 50% local	Over 50% local	Over 50% local	Over 50% local
Socioeconomic Impacts	Some adverse impact on local government services	Same as Clinch River	Same as Clinch River	Same as Clinch River
Utility Participation	Yes	Doubtful at this time	Unlikely	Doubtful at this time

(a) Basic sources of information were the applicant's submittal (Buhl, Nov. 18, 1976), this FES, the documents listed below, and the staff's judgment.

(b) Richland borders the Hanford Reservation; for FFTF the distance is 6 miles; for WPPSS, 8 miles; for the 100 Area, about 30 miles.

(c) SER for WPPSS 1 & 4 on the Hanford Reservation. On-going review of the Skagit site (Docket Nos. STN 50-522 & 523) has brought to the staff's attention a possible change in the location and size of the 1872 Central Washington earthquake. The proposed new location would place the earthquake closer to the Hanford site and could impact our previous conclusion regarding the acceleration for seismic design there.

(d) ERDA estimate 0.32g for the LOFT facility near center of the reservation (ANL/RAS 76-22, Vol. 6, Pt. 1, Sept. 1976).

(e) SER for Alvin W. Vogtle Nuclear Plant across the river.

Except for the delay that would ensue from selection of an alternative site, both Savannah River and Hanford appear to be acceptable sites. The INEL site is less certain because of the relatively high rate of seismic activity in the Idaho region and the lack of any licensed power reactor in that region. These conditions imply that the regulatory review of a site at INEL could be more time consuming than at the other sites and it is not unlikely that the demonstration plant would have to be redesigned for a higher level of vibratory ground motion than that required at the Clinch River site. The availability of an appropriate utility to operate (and potentially own) the plant at this site also appears doubtful (Nyland, 1976). In view of these uncertainties, the staff considers a site at INEL to be less desirable for the demonstration plant than the Clinch River site and the other ERDA-owned alternative sites.

Because the Hanford and Savannah River sites have some potential advantage over the Clinch River site, the staff further explored the reasons why neither was selected for the demonstration plant. As indicated in Section 9.2.1, both Hanford and Savannah River were considered likely candidates during the Project Definition Phase which ended in 1971, but neither of them was proposed by utility groups during subsequent negotiations with the AEC. In response to the staff's inquiry, the applicant explained that the utility groups in both areas were not in a position to offer proposals in 1971-72 when the site selection was made and they are not able to accommodate the demonstration plant currently. The reasons given are essentially as follows:

(1) The Northwest utilities determined that the capital investment commitment for a demonstration plant at Hanford (or Idaho) would be substantially more than could be dedicated by the Northwest utilities. Also, these utilities did not have the necessary technical expertise in nuclear plant construction and operation. Since then, the Northwest has become substantially committed to development of commercial nuclear power and has 10 units or more in various stages of planning, construction and operation. However, with all of its technical, financing and managerial talent concentrated on implementation of this program, the Northwest would not be willing to undertake an additional obligation (Nyland, 1976).

(2) For the Savannah River site to be eligible for consideration, the utility companies felt that Duke Power Company, as the closest utility with substantial nuclear experience at that time, would have to be in a position to operate the plant and to provide substantial technical input for the project to be successful. However, Duke Power and the other utilities in the area did not have the manpower to do so at the time because their personnel were already engaged in extensive nuclear construction programs of their own (Lee, 1976). The same situation exists today (Buhl, Nov. 18, 1976, Sec. 2.1.2.2.13).

From the above discussion it is evident that arrangements for utility participation and operation, similar to those at the Clinch River site, would not be possible at Hanford or Savannah River without considerable reordering of priorities among the utilities that would be responsible for operation, and possibly eventual ownership, of the plant. Another factor is the applicant's view that the selected site is preferred in the sense of providing a test of the demonstration nature of the project at a relatively typical power reactor site (in terms of exclusion area distance and population density). The staff agrees that the proposed site is more typical of those generally available across the country and it would therefore provide some benefit in demonstrating the licensability of such sites for LMFBRs. However, the staff does not regard this as significant at this stage of LMFBR development.

Also to be considered in weighing the relative benefits of another site are the necessity of negotiating new contract arrangements, which would be subject to approval by the Congress, and the possible delay associated with such an action. New site-related studies and revisions of the Environmental Report, the Preliminary Safety Analysis Report and this environmental statement would be required. Since it appeared doubtful that these efforts could be accomplished without some impact on the project's ability to meet the timing objectives of the demonstration, the staff requested the applicant to provide estimates of the additional time and costs that would be incurred from such a move.

9.2.6.1 Schedule Impacts

The information provided by the applicant shows that a decision to relocate the proposed plant would cause a substantial delay in its operation (Buhl, Dec. 29, 1976). A reference case characterized as "optimistic on the whole" indicates a total delay of 43 months in the criticality date (Fig. 9.3) and a "bare minimum case," which assumes the most optimistic course of action for each event along the schedule critical path, indicates a 33-month delay from the date of decision. The difference of 10 months less delay in the minimum case is in postulating 7 months

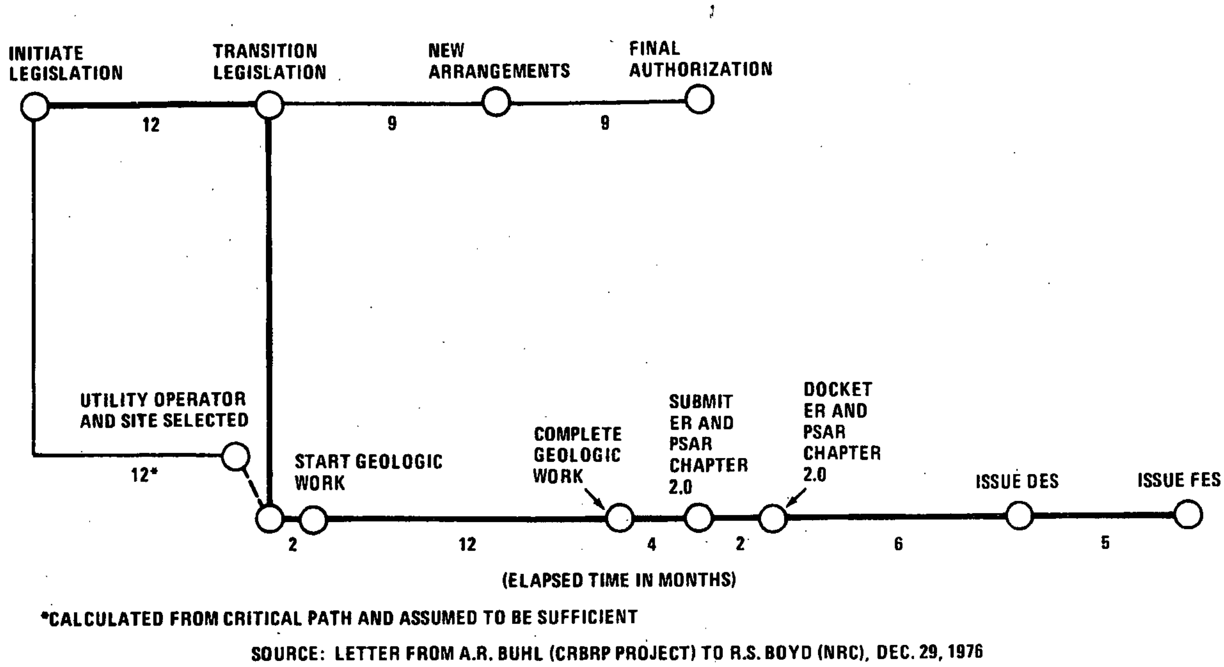


Figure 9.3 Applicant's Critical Path for Reference 43-Month Delay to Develop FES for a New Site

rather than 12 to select another site and obtain transition legislation from the Congress to perform detailed studies at the site and develop new project arrangements, 10 months instead of 14 to complete the geological investigations, and 3 months rather than 4 for completion of the ER and Chapter 2 of the PSAR. Assuming a decision were made immediately by the applicant to select another site, the earliest date for operation would be in 1987 on the 43-month delay schedule or 1986 on the 33-month schedule. In either case, the demonstration plant's goal of providing 3 years of operating data for the ERDA Administrator's planned decision in 1986 regarding commercialization of the LMFBR concept could not be met.

However, in calculating the cost differences due to a change of site, the applicant established October 1, 1977 as Reference Time 0 for the start of its delay schedules on the assumption that the NRC determination and the ERDA decision process would require this time interval before ERDA would accept that a site other than the Clinch River site should be chosen. Therefore, adding the 9-month interval to October 1, 1977 from the January 1, 1977 date which the applicant assumed as the FES issue date, for comparison with its "likely revised schedule" for the plant at the CRBRP site, the 43-month reference delay schedule becomes 52 months and the 33-month minimum delay schedule becomes 42 months. The resulting schedules to completion of the plant are shown in Figure 9.4.

The staff understands the applicant's position to be that an extensive amount of time may be required to revise the utility arrangements in order to use another site, and that no detailed site studies can be undertaken at another site until authorized by the Congress through transition legislation. However, in view of the importance attached to the LMFBR program by the applicant and the Congress, the staff believes it is logical to assume that both entities would give priority to implementing a decision to change sites if that should be necessary. Although the applicant may not make a final decision to adopt a new site for several months, the staff believes it would be feasible for ERDA to pursue a contingency plan under which the preparation of transition legislation and discussions leading to new utility arrangements could be initiated immediately. The staff also believes that means could be found to provide the funds necessary for initiating site exploration prior to enactment of the transition legislation. In view of the substantial amount of information already available on the alternative ERDA sites, the applicant should be able to complete the site studies and the ER and Chapter 2 of the PSAR in a minimal amount of time. On this basis, the staff postulates a schedule which calls for submittal of transition legislation to Congress by April 1, 1977, completion of geological work and other site studies by March 1, 1978, submittal of the ER and PSAR Chapter 2 to NRC by June 1, 1978 and

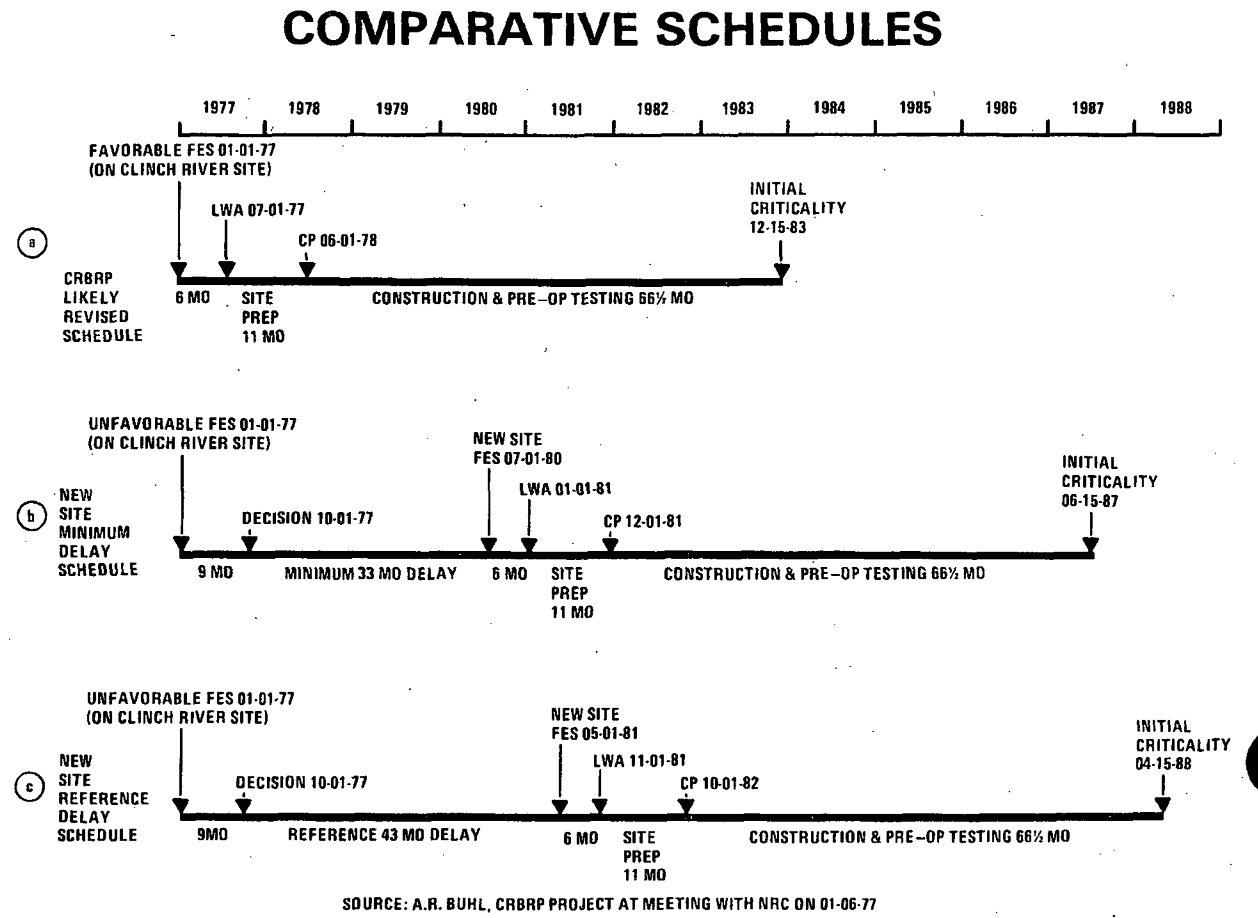


Figure 9.4 Applicant's Projected Schedules for the LMFBR Demonstration Plant Showing (a) a Likely Revised Schedule for the Clinch River Site, and the Effect of Selecting Another Site Following Such a Decision on 10-01-77. A Delay of 33 Months (b) or 43 Months (c) is the Time Required for Enacting Transition Legislation, Gathering Site Data, Submittal of New ER and Completion of FES.

docketing of these documents by August 1, 1978. In view of the minimal changes in plant design which would be involved for a new site, the staff expects that its environmental and site suitability reviews could be accomplished within 8 months rather than 11 months, thus leading to possible completion of a new FES by April 1, 1979. Assuming the same time intervals postulated by the applicant thereafter to completion of the plant, initial criticality would be scheduled for March 15, 1986. This schedule includes a 27-month interval between January 1, 1977 and April 1, 1979 for development of an FES for a new site. The NRC critical path schedule for an FES on a new site and the NRC schedule to criticality, including a 27-month delay, are shown in Figure 9.5.

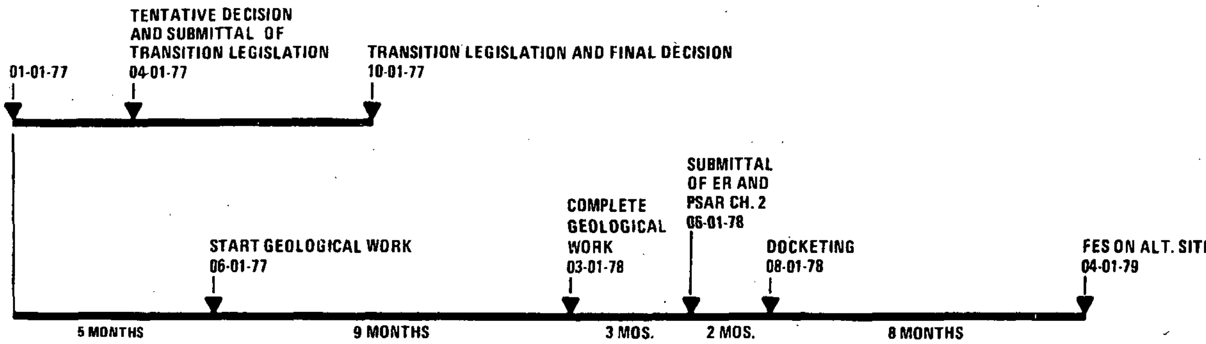


Figure 9.5(a) NRC Critical Path for New FES Assumes that Applicant's Familiarity with the Alternative ERDA Sites Would Permit Completion in Minimum Time Increments; it also Assumes that Gathering Site Data can be Initiated Prior to Passage of Transition Legislation.

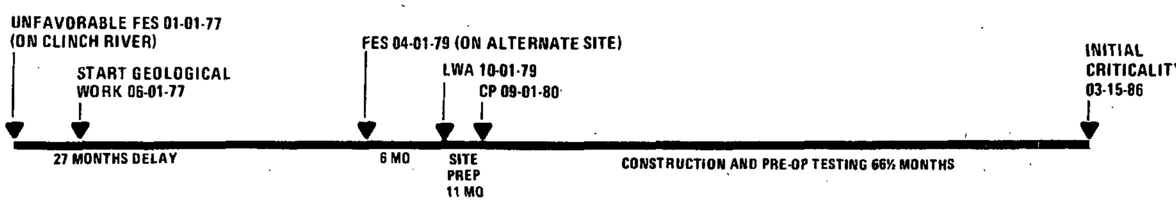


Figure 9.5(b) NRC Alternative Schedule Includes a 27-Month Delay for Completion of a New FES for the LMFBR Demonstration Plant on Another Site (Assuming a Tentative Decision on New Site and Submittal of Transition Legislation to Congress by 4-1-77, also Assuming that Site Data can be Gathered in Parallel with Legislative Action).

9.2.6.2 Cost of Delay

The applicant has estimated the additional costs of a 42-month delay (the 33-month minimum schedule plus the 9 months from January 1 to October 1, 1977) and differences in design at a new site to be $809.6 million at Hanford, $757.9 million at Idaho, $639.6 million at Savannah River and $611.4 million at potential sites on the TVA system. For a 52-month delay schedule, these incremental costs are estimated to be $963 million at Hanford, $911.3 million at Idaho, $793 million at Savannah River and $764.8 million at potential TVA sites. Table 9.6 shows the estimates for the 52-month reference delay case, which the applicant evidently considers the more probable impact of a decision to change proposed sites. The staff understands that the incremental costs in the table are based on 1975 dollars, as in the LMFBR FES (ERDA-1535), but they have been escalated at the rate of 8% per year to the expected years of expenditure for appropriations purposes.

The staff's estimate of the incremental costs for location of the demonstration plant at alternate sites, based on a 27-month delay in schedule from January 1, 1977, are shown in Table 9.7. The main differences in the figures from those of the applicant are due to (1) the length of delay assumed (27 months by the NRC vs 52 months by the applicant), (2) the staff's comparison of the costs on the basis of 1975 present value rather than year of expenditure, (3) exclusion from the staff's estimate of escalation of plant costs and the staff and support stretch-out costs, (4) the manner in which reduced revenue from the sale of power generated by the plant is treated for the alternate sites, (5) the staff's inclusion of the difference in present value of capital costs, and (6) the reduction of LMFBR program benefits due to the delay. The differences in the staff's treatment of these are discussed further below:

TABLE 9.6

APPLICANT ESTIMATES
REFERENCE 52-MONTH DELAY-COST*
IMPACT OF ALTERNATIVE SITES ON CRBRP PROJECT COST

ITEM	HANFORD	IDAHO	SAVANNAH RIVER	POTENTIAL TVA SITES
	($ MILLION)			
Escalation	429.0	429.0	429.0	429.0
Staff and Support Stretch Out	275.6	275.6	275.6	275.6
Equipment Procurement	31.8	31.8	27.8	27.8
Relocate Project Office	2.3	2.1	1.8	-0-
Additional Travel	1.6	1.5	0.3	-0-
Difference in Prevailing Labor Rates	38.0	10.0	(6.0)	-0-
Site Studies - Other than geological	0.7	0.7	0.7	0.7
Site Studies - geological	3.2	3.2	3.2	3.2
Site Work Package	0.4	0.4	0.4	0.4
Seismic	0.3	34.0	0.3	0.3
Foundation Materials and Walls	1.5	2.3	1.5	1.5
Site Adaptation Redesign	25.	25.	25.	25.
Excavation	(10.0)	-0-	(4.0)	-0-
Water Supply Line	0.5	0.8	-0-	-0-
ER Rework	1.0	1.0	1.0	1.0
PSAR Rework	.3	.3	.3	.3
Reduced Revenue from Sale of Power	161.8	93.6	36.1	-0-
TOTAL COST IMPACT-ADD	963.0	911.3	793.0	764.8

This summary of costs is considered to reflect the minimum cost increase to the CRBRP Project from use of the alternate sites shown. It is based upon a reduction in work force and redirection of work activity to a pace that would enable an orderly cost effective schedule of activities such that the Project could proceed to completion upon receipt of an FES 33 months after a decision that forced an alternate site.

*The 52 months delay is based on the applicant's 43-month schedule beginning 9 months after January 1, 1977.

TABLE 9.7

NRC STAFF ESTIMATE OF INCREMENTAL COSTS
FOR LOCATION OF CRBRP AT ALTERNATE SITES
BASED ON 27 MONTH DELAY IN SCHEDULE
FROM JANUARY 1, 1977

(1975 Present Value in Millions of Dollars)

	Hanford Site	Idaho Site	Savannah River Site	Another TVA Site
Escalation (see text)	0	0	0	0
Staff and Support Stretch Out	45.2	45.2	45.2	45.2
Equipment Procurement	23.9	23.9	20.9	20.9
Relocate Project Office	1.7	1.6	1.4	0
Additional Travel	0.9	0.8	0.2	0
Difference in Prevailing Labor Rates	21.5	5.6	(3.4)	0
Site Studies - Non Geological	0.5	0.5	0.5	0.5
Site Studies - Geological	2.4	2.4	2.4	2.4
Site Work Package	0.3	0.3	0.3	0.3
Seismic	0.2	25.5	0.2	0.2
Foundation Materials and Walls	1.0	1.6	1.0	1.0
Site Adaptation Redesign	20.7	20.7	20.7	20.7
Excavation	(6.8)	0	(2.7)	0
Water Supply Line	0.3	0.5	0	0
ER Rework	0.8	0.8	0.8	0.8
PSAR Rework	0.2	0.2	0.2	0.2
Reduced Revenue from Sale of Power	7.3	9.6	4.1	5.6
Difference in Present Value of Capital Cost	(63.9)	(63.9)	(63.9)	(63.9)
Total Cost Impact, Present Value (1975)	56.2	75.3	27.9	33.9

Escalation and Present Value - The cost and benefits of the LMFBR program in the ERDA Final Environmental Statement of December 1975 (ERDA-1535) are given in constant dollars, not allowing for general movements in wages and prices. This is in accordance with Circular No. A-94 of March 27, 1972, from the Office of Management and Budget to the heads of executive departments and establishments. The ERDA FES discounts benefits and costs to 1975 using alternative discount rates of 7.5% and 10% per year. OMB Circular No. A-94 gives a discount rate of 10% to be used for evaluation of Government decisions concerning the initiation, renewal, or expansion of programs or projects. NRC staff, in computing future costs of delay and reduction in benefits due to delay for the LMFBR program, also uses constant (1975) dollars and a discount rate of 10% per year to obtain 1975 present values. The applicant, on the other hand, used an escalation rate of 8% per year and did not discount to obtain present values. From an appropriations standpoint, the total cost of the LMFBR demonstration plant would increase due to escalation during the delay period. Based on the staff's estimate of 27-month delay and the applicant's 8% escalation rate, this additional cost would amount to $195 million (at 5%, the escalation would be $105 million). The corresponding increase in cost due to escalation is estimated by the applicant at $429 million for the 52-month delay ($331 million for the 42-month delay).

Staff and Support Stretch Out - The annual cost of staff and support is summarized in the following table along with the cost for a 27-month delay:

	Annual Cost (Millions $)	27-Month Delay (Millions $)
Project Office	5.6	12.6
Reactor Manufacture	18.1	40.7
Architect Engineering	8.3	18.7
Construction	3.6	8.1
	$35.6	$80.1

It was assumed that the $80.1 million would be spent over the period 1977 thru 1985 and this was discounted from the mid-point of 1981 to a 1975 present value of $45.2 million. The applicant's estimates based on years of expenditure were a total of $275.6 million for the 52-month delay case and $219.8 million for the 42-month delay.

Equipment Procurement - The applicant's estimates of $31.8 million for Hanford and Idaho and $27.8 million for Savannah River appear reasonable. The Hanford and Idaho costs are higher than Savannah River and another TVA site because of increased shipping cost. These costs were assumed to be expended during the 1977-1979 period and were discounted from 1978 to 1975.

All Other Costs - The remaining costs listed by the applicant were assumed to be expended at the mid-point of the years of expenditures, after adjustment for the delay.

Revenue from Sale of Power - The staff recognizes that agreements would have to be concluded with another utility and that this alternate site agreement might be more or less favorable than the current agreement with TVA. However, the staff's estimate of the revenue from sale of power is based on the assumption that the local utility would reduce power in a coal-fired plant in order to take power generated by the LMFBR demonstration plant. The incremental cost of producing this power would essentially be the cost of coal. The costs of coal in the area of the alternative sites were used to estimate the revenue from the sale of power for the alternate sites, based upon the estimate in the ER that the demonstration plant will produce 9.6×10^9 kWhr during the 6-month start-up period and the 5-year demonstration period. The revenue from the sale of power is summarized in the following table assuming a heat rate of 9500 Btu/kWhr for the coal plant.

	Present TVA Site	Another TVA Site	Hanford	Idaho	Savannah R.
Coal Cost, mills/kWhr	8.2	8.2	7.5	6.5	8.8
Revenue, $ million	78.6	78.6	71.8	62.3	84.9
1975 Present Value, $ million*	24.7	19.1	17.4	15.1	20.6
1975 Present Value of Reduced Revenue from the Sale of Power, $ million	base	5.6	7.3	9.6	4.1

*The revenue for the present site was discounted from the period 1984-1/4 thru 1985-1/4 by year to 1975. That is, the revenue produced in 1984 was discounted back to 1975, and the revenue produced in 1985 was discounted back to 1975 and so on. The revenue for alternate sites was treated the same way except the period of power operation was shifted 2-1/4 years to 1986-1/4 thru 1991-3/4.

Difference in Present Value of Capital Cost - In order to put the capital cost of the CRBR on the same basis as the LMFBR program statement, the 1974 dollar estimates of cash flow were converted to 1975 present value in the following manner. The applicant's cash flow estimates for the present schedule, a 33-month delay and 43-month delay were discounted back to 1974. The 1974 present value was adjusted to a 1975 basis by escalating the 1974 present value by about 9.5%--the 1974-75 inflation rate. The 1975 present values are shown in the following table.

	Present Schedule	27-Month Delay	33-Month Delay	43-Month Delay
1975 Present Value, $ million	908.7	844.8*	832.8	806.6
Difference in Present Value of Capital Cost	base	(63.9)	(75.9)	(102.1)

*The 1975 present value for the 27-month delay was obtained by interpolation between the 1975 present value for the present schedule and the 33-month delay schedule.

9.2.6.3 Reduced Benefits of LMFBR Program

The applicant estimated a $6 to 8 billion loss of benefits for a 52-month delay (Buhl, Dec. 29, 1976, p. 31). The staff agrees that a significant delay in the CRBR project could have an effect on the commercial introduction date of the LMFBR concept and has therefore estimated the reduced program benefits on the assumption that a delay in completion of the demonstration plant would result in a similar delay in LMFBR commercialization and that the rate of commercialization is as projected in the program statement (ERDA-1535).

In the Program FES (ERDA-1535), Table III F-10 of Volume 1 outlines 63 cases of computed benefits. For a 1993 LMFBR introduction date, the case with the lowest benefits is Number 59 and the case with the highest benefits is Number 23. The staff has examined these cases and concludes that the reduction in benefits for a 27-month delay would range from $0.3 billion to $5.8 billion. The corresponding reduction for a 42-month delay would range from $0.5 billion to $9 billion and for a 52-month delay, from $0.6 billion to $11 billion.

The above costs or reduced benefits resulting from delays associated with a change in site for the CRBRP assume that current schedules would otherwise be met in order to carry out the demonstration plant and program objectives. If the CRBR were significantly delayed for other reasons, the impact of a change in site would be reduced.

9.2.6.4 Radiological Risk

As noted earlier, the advantage of a remote site is a degree of inherent protection against airborne releases of radioactive materials. However, none of the alternative sites has an important advantage over the Clinch River site from the standpoint of routine releases, since the resultant radiological doses to individuals and to the population at any site would be in conformance with Appendix I of the Commission's regulations. The staff has therefore reviewed the ERDA sites from the standpoint of the relative societal risks of accidental releases. As discussed in Section 7.1, the objective of the staff's safety review is to assure that the risk associated with a spectrum of plant accidents at the Clinch River site would be acceptably low, comparable to those of a light water reactor. Assuming that the demonstration reactor could be located on the alternative ERDA sites at a distance of approximately 8000 meters from the nearest residence, the radiological doses at that residence would be roughly 50 times lower at the alternative ERDA sites than at the Clinch River site based on the conservative dispersion conditions assumed for dose calculations in the staff's safety review. Another measure of the relative differences was obtained by estimating the relative consequences in terms of overall population exposures (as man-rem) out to 50 miles. The radiological doses at the alternative ERDA sites would be roughly a factor of 10 less than at the Clinch River site by this measure. Also, land contamination costs would be lower at the remote sites. Based on the considerations discussed above, the alternative sites would therefore offer a relative advantage with regard to accidental releases of radioactivity.

As indicated in the Commission's regulations on reactor site criteria (10 CFR Part 100, § 100.2(b)), consideration of the safeguards provided - either site isolation or engineered features - should reflect the lack of certainty that only experience can provide. The matter of design and engineered features is being addressed during the safety review. Certain design features have been required by the staff and will be provided by the applicant to achieve the required level of safety. For example, design features are being provided to mitigate the potential consequences of a spectrum of Class 9 accidents, in addition to those safety design features which the staff requires in consideration of more likely events in conformance with the Commission's regulations. The general measures considered necessary to assure that accident risks are acceptably low at the Clinch River site are discussed at some length in the staff letter of May 6, 1976 (see Appendix I). The staff believes it is likely that these measures can be met within the state-of-the-art and that, given these measures, the probability of accidents which would release large quantities of radioactive materials to the environment would be very low. Consequently, the risk from such accidents should be acceptably low at the Clinch River site even though it would be lower at the alternative sites.

The advantages of a remote site cannot be exactly balanced by engineered safety features. However, the NRC must determine that the requirement set forth in 10 CFR Parts 50 and 100 and the requirements set forth in the staff letter of May 6, 1976, would be met before a construction permit would be issued for the plant. Additional design requirements would also be imposed by the staff if they are found necessary at any time during the continuing safety review. These measures are intended to assure that there is a very low probability that large accidental releases would occur. However, there is a possibility that, at some point in the safety review process, it will be judged that the plant design would not meet all of the NRC's requirements regarding comparability. The staff believes the probability that this will occur and would not be correctable by appropriate design or operating limitations at the Clinch River site is low.

The alternative sites may also offer a benefit from the standpoint of materials safeguards because of their relative isolation, existing security measures, and available security resources. Nevertheless, adequate safeguards measures would be required by the Commission's regulations in any event and the additional benefit provided by the alternate sites would be small.

9.2.7 Conclusion

The staff concluded from its evaluation of alternative sites that only the ERDA sites at Hanford, Idaho and Savannah River have sufficient advantages over the proposed demonstration plant site at Clinch River to warrant detailed consideration. These sites are better than the proposed site or any of the other alternative sites because the isolation provided would result in lower radiation doses in the event of an accidental release of radioactivity, in terms of both the nearest receptor and the total number of people exposed. Societal risks, however, are dependent upon both the frequency with which accidents occur and the magnitude of the consequences. The staff safety review is proceeding on the basis that the risks to public health and safety from CRBR accidents must be made comparable to the risks from LWRs. A preliminary determination of requirements to accomplish this is set forth in the staff's May 6, 1976 letter (see Appendix I).

Most, if not all, of the safety features required by the staff at the Clinch River site would also be required at the more remote sites. Assuming that comparability is achieved through design and operating limitations, the reduction in risk would be proportional to the reduced consequences since the probability of accidents at any of the sites would be comparable. An isolated site would reduce the consequences from accidents by at least an order of magnitude. Although such a reduction on a relative basis would seem to tip the balance toward requiring an isolated site, the absolute value of risk must also be considered. By requiring the safety features discussed in Section 7.1, the risk to the public resulting from accidental releases of radioactivity at the Clinch River site is expected to be acceptably low. Therefore, the absolute decrease in risk achieved by locating the plant in a more isolated site must be weighed against the cost of such a change in the project plan.

While the staff does not adopt the applicant's estimates of the cost implications of site relocation, it is clear from our own estimates that the demonstration plant goals and objectives would be significantly impacted. A delay of 2-1/4 years in completion of the project appears to be the minimum result of a change in site location at this time, assuming current schedules would otherwise be met. Consequently, the plant would not begin operation until early 1986 and could not provide sufficient operating data in time for the ERDA Administrator's commercialization decision which is currently scheduled to be made later that year. We estimate that relocation would result in an increase in the cost of the project of $26-74 million on a 1975 present value basis and considerably more on an appropriations basis. Also, a substantial reduction of the program benefits could be attributed to such a delay, judging from the LMFBR program statement (ERDA-1535).

The staff's overall conclusions hinge on a balancing of the reduction in accident risks achievable with a remote location against the resulting costs and inability of the demonstration plant to accomplish its goals on a time frame compatible with the present timing goals of the LMFBR program. On the basis that the accident risks associated with the CRBRP will be made acceptably low, comparable to LWR risks, the staff concludes that, when balanced against the detrimental effects of relocation on achieving the demonstration plant's objectives, the reduction in potential consequences associated with accidents at the alternative sites does not warrant relocating the proposed plant. Should the results of the staff's review (as presented in the staff's forthcoming Safety Evaluation Report) indicate that the accident risks would not be, and perhaps cannot be, made acceptably low, the application would be reconsidered. In the event the applicant is permitted to proceed with site preparation under a Limited Work Authorization, it is the staff's opinion that the environmental impacts of such work would not be significant. However, the staff will require a commitment from the applicant to redress the affected areas if an adverse safety determination is subsequently made and the site is abandoned.

In balancing the factors discussed above, the staff's judgement is that the applicant's preferred proposal, utilizing the Clinch River site, is reasonable and that no substantially better alternative is available.

9.3 FACILITY SYSTEMS

9.3.1 Cooling System Exclusive of Intake and Discharge

The applicant chose a predominantly "closed-cycle" system employing two mechanical draft wet cooling towers. A linear array probably would be used, that is 60 ft by 70 ft by 250 ft long, although a circular array also is a possibility. The two towers would have a 21°F range and 11°F approach and use 14 cells for cooling. Additional water would be added to the condenser-cooling tower circulation system to replace losses due to cooling tower evaporation, drift and blowdown.

Alternatives considered by the applicant were (ER, Sec 10):

- Open cycle system
- Predominantly "closed-cycle" systems
  - Natural draft wet cooling towers
  - Cooling lake
  - Spray pond
  - Mechanical draft wet cooling towers - circular array
  - Wet-dry mechanical draft cooling towers
- Totally "closed-cycle" systems
  - Dry cooling towers

9.3.1.1 Open-cycle

Under no flow conditions of the Clinch River, if they should occur, the condenser heat load could not be dissipated adequately in an open-cycle system. Therefore, this alternative was not considered viable.

9.3.1.2 Natural Draft Wet Cooling Towers

Cooling by this alternative would require a single tower 385 ft high with a 310 ft base diameter. The visible plume would extend to a greater distance than under the base case, but the potential for ground fogging and icing would be nonexistent. Compared to the base case, the amount of deposited drift would be reduced, but a 0.3% increase in makeup flow would be required. Except for the aesthetic impact of the higher and longer plumes and the size of the tower itself, this alternative is viable and is included in the benefit-cost analysis.

9.3.1.3 Cooling Lake

Use of a cooling lake to dissipate waste heat would require sufficient land suitable for impoundment. CRBRP would require a 350 to 400 acre lake. Due to the uneven topography and competing land uses, the cooling lake is not a viable alternative.

9.3.1.4 Spray Ponds

The spray pond cooling system considered for the site would require about 8 acres including two rectangular channels each 80 ft wide and 2175 ft long. To dissipate the anticipated heat load, a floating platform spray system consisting of 54 modular cells would be required. A potential for fogging, icing and drift would occur. This alternative is viable and is evaluated in the benefit-cost section.

9.3.1.5 Mechanical Draft Wet Cooling Tower-Circular Array

This alternative is the same as the base case except for tower configuration. With a circular cell configuration, greater plume rise can be obtained, thereby reducing ground fog potential and recirculation of the exhausted air stream. The alternative is evaluated in the benefit-cost section.

9.3.1.6 Wet-dry Mechanical Draft Cooling Towers

Two systems were considered for the CRBRP: a series wet/dry mechanical tower and a parallel wet/dry tower. Currently, such systems are used for controlling plume formation. The flexibility of the system would allow efficient evaporative cooling in the warmer months, combined with a variable dry heat exchange section for control during colder months. Besides the environmental advantage of plume control, the wet/dry tower would reduce water consumption and drift when compared to all-wet cooling. However, the use of the dry section in the winter results in a warmer blowdown and reduced generating capacity. This alternative is carried forward to the benefit-cost analysis.

9.3.1.7 Dry Cooling Towers

Dry cooling towers are mainly designed for areas of critical water supply that require no makeup from a natural water body. Instead, dry cooling towers remove heat from a circulating fluid through radiation and convection to the air being circulated past the heat exchanger tubes. Because of the poor heat transfer properties of air, tubes are generally finned to increase the heat transfer area. Additionally, since the heat transfer process does not include the latent heat of evaporation, dry cooling towers require both greater air flows and larger air temperature increases in order to dissipate the same amount of heat as a comparable evaporative cooling system. The theoretical lowest temperature that a dry cooling system can achieve is the dry bulb temperature of the air.

Dry tower systems are of three different types:

(1) For small units (up to 300 MWe), steam is ducted from the turbine to the heat exchanger for direct steam condensing.

(2) The direct-contact type can be built in which the cooling water and steam mix in a direct-contact condenser. This type requires a significant increase in water treatment and storage costs, since the entire cooling system uses steam generator quality water (Beck 1972).

(3) Depending on turbine design, conventional surface condensers or multi-pressure (zoned) surface condensers can also be used, with the dry tower replacing the wet tower in a system similar to existing wet tower systems. This system does not require steam generator quality water.

The principal disadvantage of dry cooling towers is economic. Plant capacity can be expected to decrease by about 5 to 15%, depending on ambient temperatures and assuming an optimized turbine design. Busbar energy costs are expected to be on the order of 20% more than a once-through system and 15% more than a wet cooling tower system, assuming 1982 operation. Environmentally, the effects of heat releases from dry cooling towers have not yet been quantified. Some air pollution problems may be encountered; noise generation problems for mechanical draft towers would be equivalent or more severe than those of wet cooling towers; and the aesthetic impact of natural draft towers, despite the probable absence of a visible plume, would remain. The system would produce no fogging or icing and might, under appropriate meteorological conditions, reduce local natural fogging effects by ventilation. Dry cooling towers now being used for European and African fossil plants are limited to plants in the 200 MWe or smaller category.

Because of the small electrical output of the plant, this alternative is considered in the benefit-cost analysis.

9.3.2 Intake Systems

Based on the balancing of economic and environmental benefits and costs the applicant has chosen a perforated pipe system as the preferred intake for the CRBRP. In this system, two large double wall perforated pipes would be submerged 70 ft from shore and parallel to stream flow. The 3/8-in. perforations would result in a 40% open structure in the 4 ft diameter outer pipe and a 7% open structure in the 3 ft diameter inner pipe, minimizing entrapment and impingement of fish.

Placing the pipes parallel to the river would allow natural water currents to facilitate the passage of debris and aquatic biota past the pipes. The system has these advantages, which in combination, should help reduce fish entrapment and impingement: 1) low intake velocities (0.3 fps through the perforations when both pipes are operating or 0.5 fps when only one pipe is operating) with uniform velocities due to internal sleeving of pipes; 2) clear escape pathways in all directions except directly into the perforations [9.5 mm (3.8 in.) in diameter]; 3) low approach velocities (0.12 fps at 0.75 in. from the pipe); and 4) elimination of need for trash racks or vertical traveling screens.

Other intake systems considered by the applicant were:

- Conventional traveling screens
- Traveling screens mounted at angle to flow
- Single entry-double exit traveling screens
- Horizontal screens
- Louver system
- Electric screens
- Bubble, sound and light barriers, and
- Infiltration bed

9.3.2.1 Conventional Traveling Screens

A conventional vertical traveling screen, flush mounted with the supporting wall (to minimize entrapment in dead water areas) and with fish escape ports on the side walls (to minimize impingement), was considered by the applicant (Figure 9.6)(ER, Sec 10.2). Fish escape passages are not likely to be completely effective because the passages would also draw water into the intake structure, creating a current flow which must be overcome by the entrained fish.

The design screen approach velocity is 0.5 fps (Section 5.3.1.1), considered as an upper permissible limit to reduce impingement losses. With traveling screen alternatives, however, there is a wide distribution of velocities across the face of the screens, possibly exceeding 0.5 fps.

Shoreline intake structures of this type are large structures, presenting more of an aesthetic impact than submerged intakes with smaller pumphouses.

In spite of the disadvantages discussed above, traveling screen intake systems have been successfully used at many stations and are considered as a viable alternative to the submerged perforated pipe system proposed for the CRBRP. Further consideration of this system is given in the benefit-cost section.

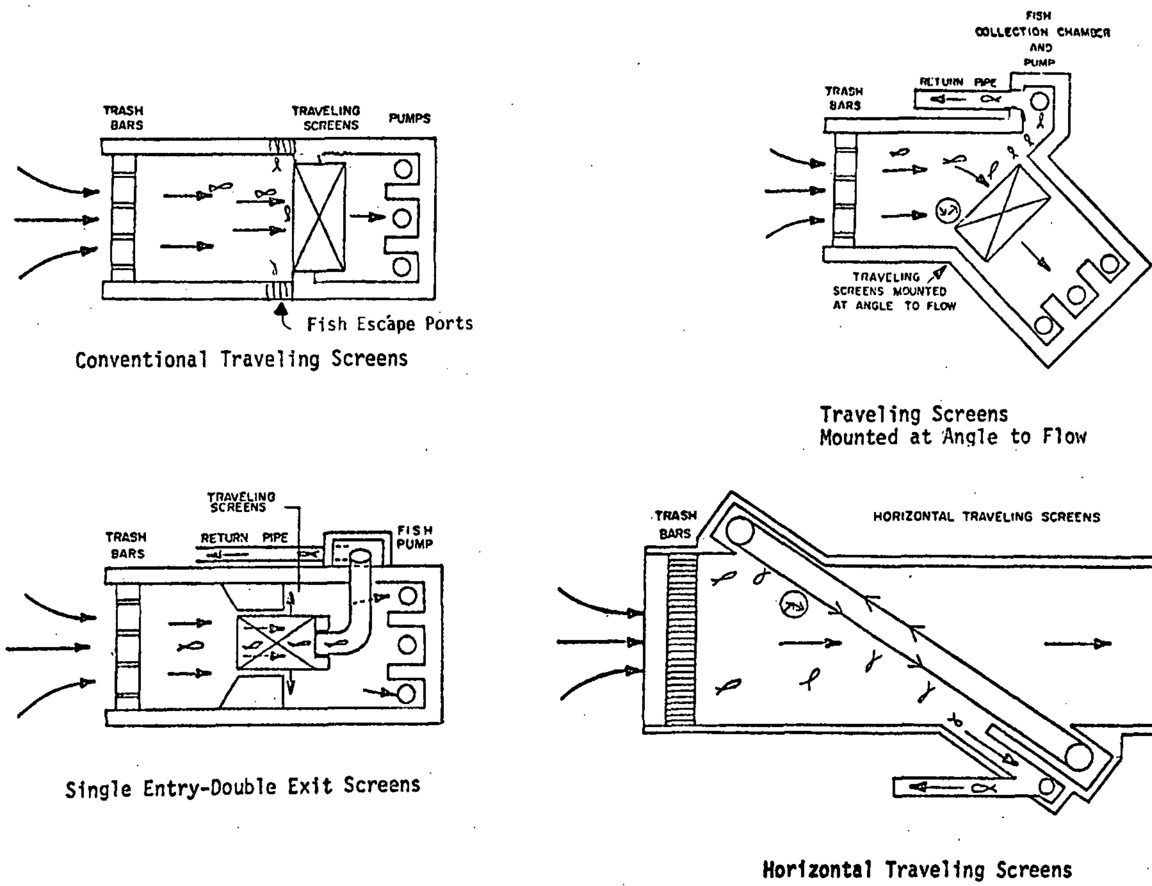


FIGURE 9.6 Fish Protection Features of Traveling Screens Intake Alternatives

9.3.2.2 Traveling Screens Mounted at Angle to Flow

This system is a variation on the conventional traveling screen system accomplished by positioning the traveling screens at a 45°-60° angle to the incoming flow instead of normal to the incoming flow as shown in Figure 9.6. This offset permits use of a fish escape port at one end (outside corner angle) of the screen, which is outfitted with a fish pump to create a positive flow in that direction. Escape is further aided by a natural flow vector in that direction as a result of the water's meeting the screen at an angle. Further consideration of this viable alternative is given in the benefit-cost section.

9.3.2.3 Single Entry-Double Exit (Passavant) Screens

In this variation of the traveling screen concept, the screen surfaces are placed parallel to the intake flow. The water passes from the inside to the outside (both surfaces) of the traveling screen, making a right angle flow path. Fish pass straight on through to an escape passage beyond the screen, and their progress is aided by the natural flow vector in that direction augmented by a fish pump beyond the screen (Figure 9.6). The major advantage is that fish do not need to change direction to make an escape; therefore, lethargic fish may be drawn to safety more easily. Further consideration of this alternative is given in the benefit-cost section.

9.3.2.4 Horizontal Traveling Screens

A horizontal traveling screen (Figure 9.6), when mounted at an angle to the water flow and operated at high rotational speeds, can produce a large velocity component parallel to the screen face and thus assist fish to escape. In the experimental stage, this is an attractive scheme but it has the basic disadvantage of not being able to accommodate the large water level fluctuations such as found at the site. The staff concludes that this is not a viable alternative.

9.3.2.5 Louver Screens

Louver screens are placed in the water upstream of the intake and deflect fish into a by-pass channel away from the main stream flow. The optimum size and spacing of the louver panels are determined by the flow in the stream. In the case of the Clinch River, where flows can range from 0 to 22,000 cfs, and in winter the water level can fluctuate daily by as much as 8 ft, a louver system that would be effective at all times could not be designed. The staff concludes that a louver system is not a viable alternative.

9.3.2.6 Electric Screens

Fish are known to be repelled by high voltage pulses, forming a fish barrier in front of an intake structure. The most effective barrier voltage is determined by the size and species of fish to be repelled. In a stream with the natural species variety of the Clinch River, designing an electric screen completely effective for all species would not be possible. Furthermore, fish that are momentarily stunned by the voltage would be drawn into the intake and impinged since the water flow is in that direction. Electric screens are more suitable as barriers to upstream migrating species, where temporarily stunned fish are swept back downstream and can recover. The staff concludes that an electric screen is not a viable alternative.

9.3.2.7 Bubble, Light, and Sound Barriers

A curtain of air bubbles, generated by passing compressed air through a perforated pipe, is an effective barrier to most fish. However, when fish are in a lethargic state (at low water temperature) their response to an air bubble curtain is not as acute, and they may drift through it.

An intense light sometimes can be used to repel fish and keep them from entering an intake structure, but this is temporary. Fish become acclimated to light and then will pass through it.

Multi-frequency pulsating sound will also act as a barrier to fish movement, but the fish response is dependent on the species. In a species diverse stream such as the Clinch River, this would not be very effective for driving fish away from an intake structure.

In the opinion of the staff, none of these methods is a viable alternative for repelling fish from the proposed intake structure.

9.3.2.8 Infiltration Beds

In this system, the intake pipe is buried in a porous media beneath the water supply. This can be the stream bed itself or an underlying aquifer. The large area from which the water is drawn results in very low approach velocities, with a resulting negligible impingement loss. The natural geology of the CRBRP site precludes the use of this type of filtration system unless constructed with an artificial filtration media. To do this would disturb a large part of the river bottom, which would be harmful to the benthic life. The artificial beds are also prone to clogging which could occur in the Clinch River. For example, during the March 1974 collecting period, the turbidity of the Clinch River was 70-80 JTUs, indicating that clogging would be a potential problem for this type of intake. The staff concludes that this is not a viable alternative for the CRBRP intake system.

9.3.3 Discharge Systems

All liquid effluents from the CRBRP are discharged to the Clinch River with the cooling water blowdown. The discharge structure selected by the applicant is a high momentum, submerged single-port system. The system was selected because of its superior mixing characteristics and reduced thermal and chemical plume. Alternatives considered were low momentum, surface discharge and high-momentum, submerged multiport discharge.

9.3.3.1 Surface Discharge

This alternative consists of releasing the discharge at a shallow angle to the surface of the river and floating the discharge out onto the cooler surface of the river. Mixing with river water is avoided and the primary method of dispersing the heat is through an air-water exchange. In the particular manifestation of this alternative for the CRBRP site, the discharge actually would be a submerged discharge during the summer months when the river level is normally about 6 ft above the discharge trough. Under summer conditions, therefore, there is partial mixing with the river water, but not so much as for the high velocity submerged discharge alternatives.

Although this alternative results in a larger body of water being affected by the thermal plume than with the reference method, the impact is not considered severe enough to rule out its use. Further consideration of this alternative is given in the benefit-cost section.

9.3.3.2 Submerged Multi-Port Discharge

In this system, the cooling tower blowdown is discharged at high velocity through a multiplicity of nozzles located 4 ft below the minimum water level. This alternative achieves the greatest initial plume entrainment and greatest reduction in plume excess temperature in the near field mixing zone of all the systems considered for the CRBRP. This alternative is considered by the staff to be environmentally acceptable and is treated further in the benefit-cost section.

9.3.4 Chemical Waste Treatment

Methods selected for treating chemical waste at CRBRP are described in Section 3.6. These include neutralization and separation of suspended matter. Excluding cooling tower blowdown, which contains material withdrawn with the water taken from the river, the principal waste discharges from the plant would be sludges and dissolved salts. Alternatives considered for the waste discharges were:

- Mechanical dewatering of sludges.
- Reverse osmosis pretreatment of demineralizer feedwater.
- Zero discharge of surge and neutralizing tank effluent.

9.3.4.1 Mechanical Dewatering of Sludges

Mechanical dewatering of sludges is an alternative to the proposed drying beds for producing a more compact and drier sludge. The environmental advantages include reduction in solid waste volume and a slight increase in recyclable water. The mechanical dewatering processes considered were centrifugation and vacuum filtration. The major reasons for rejecting the alternative were: 1) available commercial equipment is too large for processing the relatively small quantity of sludge produced and 2) continuous operator attention would be required during equipment operation. Other disadvantages include higher noise levels, increased energy consumption, the need for weather-proof housing and the possible need for sludge conditioning chemicals.

9.3.4.2 Reverse Osmosis Pretreatment of Demineralizer Feedwater

Addition of a reverse osmosis system to the high purity makeup water treatment system was considered as a means of reducing the frequency of the demineralizer regenerations, thus reducing the quantity of regenerant chemical waste discharged. Reverse osmosis would be used as a pretreatment step to the ion exchange beds to remove the bulk of the dissolved salts by ultrafiltration. This pretreatment step generates product water, or a partially demineralized water stream, and a reject or brine stream. The former would be routed to the ion exchange demineralizers for further reduction in salt content while the latter would be discharged to the plant effluent stream. This alternative was rejected on the basis of the questionable reliability of the reverse osmosis system for the designated purpose and the fact that the demineralized waste is not eliminated but only reduced in frequency of generation. The size of the ion exchange demineralizers and the attendant waste treatment facilities cannot be reduced by this pretreatment step.

9.3.4.3 Zero Discharge of Surge and Neutralizing Tank Effluent

Three alternatives were considered for treating this waste stream to accomplish zero discharge: 1) offsite treatment, 2) percolation ponds, and 3) evaporation. Offsite treatment was rejected because the area has no treatment plants capable of handling the quantity and type of waste produced. Percolation ponds were not considered feasible because of the area's soil characteristics. Evaporation of this waste stream to produce purified water for recycle in the plant was rejected on the basis of high cost and only marginal improvement in the quality of the product water.

9.3.4.4 Additional Recycle of Circulating Water

Increasing the recycle of water in the cooling tower system over the proposed level was considered as a means of reducing both the volume of make-up water used and the volume of blowdown discharged. Increasing the recycle to increase the concentration factor from the proposed level of 2.5 to a higher level of 6, for example, would yield the following benefits:

- Reduction of discharge volume and waste heat by 73%
- Reduction of entrainment damage by 30%
- Smaller discharge piping and outfall structure is possible and a reduction in intake velocity would occur if the proposed intake structure is used.

Disadvantages include:

- Higher concentration of chemicals in the station effluent (no increase in quantity discharged)
- Greater quantity of chemicals dispersed to the environs by cooling tower drift
- Potential requirement of acid addition to circulating water for scale control
- Potentially higher concentrations of ammonia in the circulating water which may result in higher chloramine concentrations that would require longer periods to decay to acceptable levels for discharge.

Actual and potential disadvantages of higher recycle of circulating water appear to outweigh the benefits; however, in-plant studies during the operating stage, as proposed in the NPDES permit (Appendix H), will be required to confirm this conclusion.

9.3.5 Biocide Systems

Upstream of the main condenser, hypochlorite injection is planned equivalent to 2 to 5 mg/ℓ of chlorine for 20- to 30-minute periods 3 or 4 times daily in order to prevent colonization of algae, bacteria, and fungi in the cooling water system. Alternative biocide systems considered were:

- Organic biocides
- Ozone
- Mechanical cleaning systems

9.3.5.1 Organic Biocides

Several organic chemicals are effective in controlling growths of microorganisms in circulating water systems. Some of the more effective ones are acrolein (an unsaturated aldehyde), DE 508 (2, 2, dibromo-3 nitrilopropionamide), and quaternary ammonia compounds. Like chlorine, the substances are also toxic to many fish species. Unlike chlorine, however, they do not spontaneously decay in toxicity by exposure to sunlight, so they must be chemically detoxified before discharge. This is usually done by the addition of sodium sulfite. The addition of sodium sulfite to the receiving waters is not desirable if it can be avoided because it represents an additional COD load to the stream. Furthermore, many of these organic chemicals are applied as solutions, with the solvent (such as ethylene glycol) capable of being toxic itself and not neutralizable by the sodium sulfite. The staff concludes that the use of organic biocides is not a viable alternative to the chlorine injection system selected by the applicant.

9.3.5.2 Ozone

Ozone, prepared onsite by the passage of cold air (or oxygen) past charged plates, is receiving increasing attention as a biocide in circulating water systems. It dissipates even more quickly than chlorine, so there is no residual activity problem. Its specific biocidal effect is not so well known as is the effect of chlorine on the Asiatic clam, a prevalent infestation in the Clinch River. Therefore, more research would be needed before an ozone system could be properly designed for the CRBRP. Also, a byproduct of ozone degradation is oxygen, which could cause supersaturation at times and would be harmful to fish. For these reasons, ozone is not a viable alternative biocide for this application.

9.3.5.3 Mechanical Cleaning Systems

Condenser tubes can be kept free of biological fouling by periodic passage of sponge rubber balls or plastic brushes, but the systems have not gained widespread application. The materials mechanically scrub the inside surface of the condenser tubes and remove biological growths. Such mechanical systems would not altogether eliminate the need for a chemical biocide. They would not result in a major reduction in released biocide residuals.

The applicant has elected not to use a mechanical cleaning system in conjunction with chlorination, and the staff concurs in this decision. The level of residual chlorine to be discharged (0.2 ppm) is so low that it is not expected to create any harmful effects in the Clinch River. Therefore, further reduction is unnecessary.

9.3.6 Sanitary Waste System

A sanitary waste treatment system would be needed to provide treatment of a maximum of 8000 gpd of sewage generated during operation with the 210 man peak staff. The applicant plans on a packaged aeration/filtration/chlorination facility with a liquid effluent discharge to the Clinch River to meet this need. Alternatives considered were:

- Tap-in to existing facility
- Ground discharge
- Incineration
- Activated sludge/membrane filtration
- Clarification/filtration/carbon adsorption.

9.3.6.1 Tap-In to Existing Facility

This alternative involves pumping the sanitary waste to an existing treatment plant having sufficient excess capacity to handle an additional 8000 gpd. Neither of the two closest processing plants (one at the Oak Ridge Gaseous Diffusion Plant and the other at the Clinch River Industrial Park) have the capacity necessary to handle the CRBRP sanitary waste. The Oak Ridge municipal sewage treatment plant is 15 miles away, too far to be practical. The tap-in alternative, therefore, is not considered a viable sanitary waste treatment system.

9.3.6.2 Ground Discharge

In the ground discharge alternative the sanitary waste would be discharged directly to the ground (by way of a tile field, percolation pond, or spraying) and be filtered and neutralized by the natural assimilative capacity of the soil. This system has the advantages of eliminating any discharge to the river and of not requiring very much energy. At the site, however, the top 20 to 30 ft of earth is clay and not suitable for a ground discharge sanitary waste system. The staff does not consider this to be a viable alternative sanitary waste discharge system.

9.3.6.3 Incineration

It is possible to dewater raw sewage and incinerate the residual sludge to produce an ash which is disposed of as a solid. This system has very high capital and operating costs, and consumes large amounts of energy (typically, the burner is fired with No. 2 oil). For these reasons, the staff does not consider incineration to be a reasonable alternative for sanitary waste disposal.

9.3.6.4 Activated Sludge/Membrane Filtration

In this alternative, a biological decomposition process is used on the sanitary waste, and suspended solids are removed by membrane filtration. This results in a higher quality effluent than the reference process and eliminates any chlorine discharge to the receiving waters. This alternative is given further consideration in the benefit-cost section.

9.3.6.5 Clarification/Filtration/Carbon Adsorption

This process involves clarification of the waste stream by flocculation, as a secondary level treatment process, to reduce suspended solids. Filtration through sand (as in the reference process) further removes solids before the final effluent is passed through activated charcoal. The charcoal adsorbs organic matter, resulting in a final effluent with a lower BOD than the reference system. There would probably be no need to chlorinate the effluent. Further consideration is given to this alternative in the benefit-cost section.

9.3.7 Transmission System

The alternate transmission line route is shown along with the proposed route in the ER (Fig 10.9-1). The alternate route is 0.2 mile longer (3.4 miles compared to 3.2 miles) and would require clearing 8.7 more acres of forest. The composition of forest to be cleared is similar to the proposed route except that the alternate route would disturb 8 more acres of pine, 11.7 more acres of unforested land (old fields), and 12.1 fewer acres of hardwood. Thus the impact to biota would be slightly different for the two routes, with the preferred route removing a few more acres of hardwood which is preferred by squirrels and many bird species. However, both routes would present favorable habitat for deer, rabbits and upland game birds after construction and revegetation. Soil erosion potential would be about the same for both routes, but the alternate route would have a slightly greater potential impact from heavy equipment and a slightly less favorable revegetation potential than the proposed route. The alternate route would be visible for one mile at Bethel Valley Road. Neither route would cross highways, railroads, or historical or archaeological sites. Neither route would require new access roads.

The proposed route is preferred because it is shorter, lacks major visual impact, affects fewer forested acres and presents less construction impact than the alternate route. Therefore, the staff does not consider the alternative route to be a preferable alternative.

9.4 BENEFIT-COST COMPARISON

9.4.1 Cooling System

The costs and benefits of the viable cooling system alternatives are summarized in Table 9.8.

TABLE 9.8 Summary of Environmental and Economic Costs for the Alternative Cooling Systems

		Mechanical Draft Wet Tower				Mechanical Draft Wet/Dry Tower		
	Unit of Measure	Linear Array	Circular Array	Natural Draft Wet Tower	Spray Pond	30% Plume Severity	0% Plume Severity	Mechanical Draft Dry Tower
Environmental Costs								
Plume Formation								
Ground Fog Potential	Hrs/yr (all directions)	146	146	0	NA	138	138	0
Visible Plume Extent	Mean length in miles (95% R.H., C stability)	1.8	1.9	2.9	NA	1.5	1.6	-
Drift Deposition	lbs/acre/mo	89	74	3	~90	44	37	-
Water Use								
Entrainment	Percent/yr(a)	0.46	0.46	0.46	0.46	0.42	0.42	0
Impingement	Qualitative	Same	Same	Same	Same	Same	Same	0
Water Consumption	Percent of Melton Hill Dam releases(b)	0.20	0.20	0.20	0.20	0.19	0.19	0
Heat Rejection	Heat load to river in winter as percent of total plant heat duty	0.048	0.048	0.049	0.052	0.055	0.055	0
Initial Temperature Difference	Blowdown temperature minus river ambient (in winter), °F	30	30	31	36	48	43	-
Effect of Chemicals	Qualitative	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	None
Land Use	Acres	0.5	1.0	1.7	8	2.1	3.3	4.3
Visual Impact		Negligible	Negligible	Severe	Negligible	Negligible	Negligible	Negligible
Economic Costs								
Plant Net Output	MWe differential	Base	Base	0.2	(2.9)	(2.2)	(1.4)	(13.6)
Total System Cost	Present worth in millions of $	Base	Base	2.19	2.52	2.06	2.19	15.49

(a) Assumptions are in Table 5.1.
(b) Evaporation and drift losses as percentage of annual releases.

With a natural draft cooling tower, there is a marked reduction in ground level fogging and icing and in drift deposition, but this is offset by a more visible plume at higher elevations. The natural draft tower presents the most notable visual impact of all the cooling alternatives. The 385 ft high tower would be visible from many populated areas, including Gallaher Bridge, Interstate 40, ORNL, and Melton Hill Dam. The natural draft tower does not offer enough environmental advantages over the reference mechanical draft tower to offset the added cost of $2.19 million. The staff concurs in its rejection.

The spray pond alternative would be an acceptable alternative cooling system from an environmental standpoint. Its effect on water resources and aquatic ecology would be comparable to the reference system except the slight disadvantage of requiring more land (8 acres). The present worth cost differential is $2.52 million. Because the system does not offer any real environmental advantage and because it is more expensive than the reference system, the applicant chose to reject it for the CRBRP. The staff concurs in that decision.

The circular array mechanical draft cooling tower system has a slight environmental advantage over the linear array in that a higher loft is generated. Slightly reduced ground level effects (drift, fog, ice) result at the expense of a higher and more noticeable plume. If the total economic cost for either system should be nearly the same as suggested by the amended ER (Table 10.1-10), the staff recommends use of the circular cooling system, with its environmental advantage.

The totally closed cycle system (dry cooling tower) is judged by the staff to be an acceptable choice. However, it imposes an added power penalty of 13.6 MWe and an added equivalent investment cost of $15.49 million. Since the environmental impact of the reference cooling system would be negligible (see Section 5.3.3), the staff concludes that the marginal improvement of the dry cooling tower system would not be justified at this higher cost.

The advantages and penalties of the mechanical draft wet cooling tower can be averaged with those of the mechanical draft dry cooling tower by using a combination system, operated in either or both modes. The staff concludes that there are no significant environmental advantages to be gained by such averaging in this application. Since the economic penalty is greater than $2 million, this alternative was rejected.

9.4.2 Intake Systems

The monetary and environmental costs of the most viable alternative intake systems are summarized in Table 9.9. The most sensitive environmental factor influencing the choice of intake system is impingement loss, with construction effects and aesthetic factors being weighted less heavily. The perforated pipe and Passavant screen systems afford the greatest protection from impingement losses. The perforated pipe system has a lower water velocity at the screens, and the velocity distribution is more uniform. Furthermore, it affords clear escape pathways in all directions except directly into the perforations. Trash racks and vertical traveling screens are unnecessary with the perforated pipe. It is also the least expensive of the viable systems. For those reasons the applicant has selected the perforated pipe system, and the staff concurs in this selection.

TABLE 9.9 Summary of Monetary and Environmental Costs of Alternative Intake Systems

	Proposed Perforated Pipe	Conventional Traveling Screens	Angle-Mounted Traveling Screens	Passavant Screens
A. Monetary Costs				
1. Capital Cost Differential	Base	$127,000	$141,000	$216,000
2. Equivalent Investment Operating-Cost Differential	Base	1,000	1,000	1,000
3. Total Differential Cost	Base	$128,000	$142,000	$217,000
B. Environmental Costs				
1. Entrainment	Complete	Complete	Complete	Complete
2. Impingement				
a. Fish escape passages	Good	Fair	Good	Good
b. Water velocity at screens	0.2 fps @ 0.75 inch[a]	0.5 fps @ 1.0 inch	0.5 fps @ 1.0 inch	0.5 fps @ 1.0 inch
c. Velocity distribution	Excellent	Poor	Poor	Poor
3. Construction Effects	Little shore-line disturbance Some off-shore dredging	Shore-line disturbance	Shore-line disturbance	Shore-line disturbance
4. Aesthetic Impact	Small Pumphouse	Large structure	Large structure	Large structure

(a) With both pipes operating

9.4.3 Discharge Systems

The monetary and environmental costs of the alternative discharge systems are summarized in Table 9.10 (ER Table 9.5.3-1). The total differential costs for the various alternatives are very small in the context of the absolute cost of the discharge system. Thus, cost is not considered by the staff as a determinant in the selection of the discharge system alternative.

The staff concludes that for the small quantities of water being discharged from the CRBRP relative to the receiving body, the submerged single-port diffuser is quite adequate for promoting mixing and for ensuring protection of the aquatic resources. Mixing in the river would be slower with surface discharge. In Chapter 5 the staff discussed the probable impacts of discharges of chemicals and heated water to the Clinch River. The conclusion was that the reference system would have no significant effect on phytoplankton, zooplankton, drift invertebrates, benthic invertebrates, ichthyoplankton, or fish. The staff concurs in the selection of the submerged single-port discharge.

TABLE 9.10 Summary of Environmental and Economic Costs for the Discharge Alternatives

Environmental Costs	Submerged Single-Port	Surface Discharge	Submerged Multiport
Mixing Effectiveness			
Thermal:			
- Typical Case - Winter	Excellent	--	Good
- Typical Case - Summer	Good	--	Good
- Extreme Case - February	Good	Poor	Good
- Extreme Case - July	Very Good	Fair	Good
Chemical:			
- Typical Case - Winter	Good	--	Good
- Typical Case - Summer	Good	--	Good
- Extreme Case - February	Good	Fair	Good
- Extreme Case - July	Good	Fair	Good
Navigation Effects	Slight	None	Slight
Aquatic Life Effects	Less	Some	Less
Construction Effects	Slight	Very Slight	Slight
Aesthetic Effects	None	Some	None
Economic Costs			
Capital Cost:			
- Material Costs	Base	($1,000)	$1,000
- Installation Costs	Base	($5,000)	$3,000
- Total Differential Capital Costs	Base	($6,000)	$4,000

9.4.4 Sanitary Waste Systems

The effluent water quality parameters of the reference system and the two alternative systems selected for the benefit-cost analysis are compared with various standards in Table 9.11. All three systems would discharge an effluent well within the standards; therefore, marginal differences between them are not considered to be significant. The applicant selected the extended aeration/filtration/chlorination system based on its proven technology, reliability and overall system cost while producing a discharge within applicable standards and not having any harmful effect on the receiving waters. The staff concurs with the selection.

TABLE 9.11 Effluent Quality of Sanitary System Alternatives[a]

	EPA Guidelines	Tennessee Standards	Extended Aeration/ Filtration/ Chlorination (Proposed System)	Activated Sludge/ Membrane Filtration	Clarification/ Filtration Carbon Adsorption
BOD	30 mg/l	30 mg/l	10 mg/l	10 mg/l	5 mg/l
Suspended Solids	50 mg/l	40 mg/l	5 mg/l	1 mg/l	5 mg/l
Residual Chlorine	--	0.5-2.0 mg/l	1.0 mg/l	0	NA[b]
Ammonia Nitrogen	--	5.0 mg/l	0.5 mg/l	NA[b]	NA[b]
pH	6.0-9.0	6.0-9.0	6.0-9.0	6.0-9.0	6.0-9.0
Estimated Total Monetary Cost of Treatment System			\$1.50/1000 gal[c]	\$1.90/1000 gal[d]	\$6.75/1000 gal[e]

(a) Monthly averages
(b) Not available
(c) ER, Section 10.6.5
(d) Reference: Blecker, H.G., and T. M. Nichols "Capital and Operating Costs of Pollution Control Equipment Modules," Vol II Data Manual PB-224 536, ICARUS Corp., Report prepared for EPA, July 1973.
(e) Does not include cost of sludge disposal.

10. EVALUATION OF THE PROPOSED ACTION

10.1 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

10.1.1 Abiotic Effects

10.1.1.1 Land

Site preparation and construction activities related to the CRBRP would disturb only 253 acres of land which is largely forest including 58 acres for transmission line right-of-way. Approximately 73 acres of this amount would be dedicated on a long-term basis to plant structures (4 acres), graded areas around the plant structures (30 acres), access roads and railroad (20 acres on-site, 4 acres off-site), impounding ponds (8 acres), barge unloading area (2.5 acres) and other facilities. All of the transmission tower bases would occupy less than one additional acre.

Erosion would result from construction and subsequent rainfall, but the control practices and revegetation planned by the applicant would minimize this effect (Sect. 4.3).

Construction traffic would add to congestion on local roads, particularly on State Road 58 at shift change times. This congestion could be alleviated somewhat by staggering work schedules (Sect. 4.6.2).

Fog resulting from cooling tower operation could be a minor nuisance on nearby roads, but this should occur only a few hours per year. The visible plume would usually extend no more than 1.5 miles, but it could be as long as six miles 6% of the time the plant is operating (Sect. 5.3.3).

The plant containment dome would be visible from Gallaher Bridge and several residences south of the river. Ridges and hills would otherwise provide natural screening (Sect. 5.1).

10.1.1.2 Water

Water consumed by the project would be a maximum of 190,000 gpd (132 gpm) for construction purposes and an average of 8 cfs (3584 gpm) during plant operation. Water use during plant operation represents about 0.2% of the annual average river flow (Sects. 4.3 and 5.2).

Minor amounts of silt would be added to the river due to construction activities, but these would be minimized by erosion control (Sect. 4.3).

Plant operations would add total residual chlorine to the river at an intermittent 6 cfs rate in concentrations of up to 0.5 mg/ℓ and to an average of 0.2 mg/ℓ. Chlorine would not be discharged for more than 2 hours in any 24-hour period (Sect. 5.4.1).

Plant operation would increase the river's copper concentration to less than 0.02 mg/ℓ and iron to 0.7 mg/ℓ 100 ft downstream. Insignificant adverse effects are expected due to these concentrations (Sect. 5.4.1).

10.1.1.3 Air

Construction noise would be noticed by a few residents south of the site. Dust would not have a significantly adverse effect (Sect. 4.5.6).

Noise during plant operation would not likely be noticeable beyond the site boundary (Sect. 5.1).

The plant would discharge heat to the atmosphere at a rate of 2.17×10^9 Btu/hr with the initial reactor core or 2.34×10^9 Btu/hr at later design capability (Sect. 3.4.1).

About 57 lb/yr of pollutants would be released to the atmosphere as a result of operating the emergency diesel generators (Sect. 3.7.2).

10.1.1.4 Other

Tax receipts would not compensate for the increased public services needed by the additional work force associated with the CRBRP, particularly during construction (Sects. 4.5.4.4 and 5.1.6.1).

Historic and archeological resources on site should not be affected if borrow pit activity is restricted as planned (Sect. 4.2.1).

10.1.2 Biotic Effects

10.1.2.1 Terrestrial

Construction would result in harvesting some timber and destruction of other plant and animal life on the 253 acres disturbed. All but 73 acres would be revegetated after completion of the CRBRP (Sect. 4.4.1).

At most, 1000 lb/acre/yr of dissolved solids from the cooling tower would be deposited on surrounding land and foliage. No significantly adverse impact is expected (Sect. 5.3.3).

10.1.2.2. Aquatic

The thermal, chemical, and mechanical effects are treated together and consist of the following:

- Excavation - Approximately 20,000 m^3 of river bank and bottom temporarily would be lost during construction as a habitat for benthic organisms (Sect. 4.4.2).
- Impingement - 0.5% susceptible fish passing the perforated pipe intake may be killed (Sect. 5.3.1.1).
- Entrainment - Phytoplankton, zooplankton, drift invertebrates and ichthyoplankton all would suffer the same losses based on the fraction of total river flow withdrawn by the plant. Losses at the average river flow of 4800 cfs would be 0.46%; maximum loss occurring at the low river flow of 1000 cfs would be 2.2% (Sect. 5.3.2.2).
- Thermal discharge - Potential 8% maximum loss of phytoplankton, zooplankton, drift invertebrates, benthic macroinvertebrates, ichthyoplankton, fish, and other organisms during the winter season; less than 1% during all other seasons (Sect. 5.3.2.2).
- Cold shock - Estimated effects would be insignificant due to the small number of fish likely to be within the 2.5°C (4.5°F) isotherm ($<$ 8% of river cross-sectional area and 0.01 surface acre of water) (Sect. 5.3.2.3).

10.1.3 Radiological Effects

The average annual dose to an individual living, playing, and working at the site boundary and eating fish, beef, and milk exposed to plant effluents by various pathways would be 1.6 mrem/yr. This value, which is less than 2% of the natural background exposure of 100 mrem/yr, is below the normal variation in background dose, and represents no radiological impact. The average dose from the plant effluents to other individuals among the population would be significantly less than 1.6 mrem/yr.

A total dose of about 0.29 man-rem/yr would be received by the estimated 2010 population of 987,000 living in unrestricted areas within a 50-mi radius of the plant. By comparison, an annual total of about 9.9×10^4 man-rem would be delivered to the same population as a result of the average natural background dose. The 1000 man-rem estimated as occupational onsite exposure is about 1% of this annual total background dose (Sect. 5.7.3).

Most of the 17 man-rem annual dose from transport of radioactive materials to and from the CRBRP and probably all of the 1.4 man-rem annual dose from its supporting fuel cycle facilities would be received outside the 50-mi radius of the plant. These are also insignificant fractions of the dose from natural background radiation (Sect. 5.7.3).

The risks associated with accidental radiation exposure would be very low (Chapter 7).

10.2 SHORT-TERM USE AND LONG-TERM PRODUCTIVITY

10.2.1 Scope

This section sets forth the relatively short-term uses of the environment for construction and operation of the breeder demonstration facility and the actions that could maintain and enhance the long-term productivity. Based on its analysis in the previous sections of this statement, the staff concluded that the resources committed to the proposed CRBRP represent an acceptable balancing of near-term usage and long-term productivity.

10.2.2 Enhancement of productivity

The major result from the project would be a demonstration of the LMFBR parameters necessary to its development for commercial size power plants. If the demonstration is successful and it leads to large-scale use of such plants, available reserves of uranium fuel would be extended. The degree to which the reserves would be extended depends upon the fuel doubling time realized with the breeder reactor and on future growth in the country's demand for electric power.

Electrical energy that would be produced is estimated to be an average of two billion kWH/yr over a 30-year operating life. The electricity would be distributed through the TVA system.

10.2.3 Uses Adverse to Productivity

10.2.3.1 Land Usage

The site has been owned by the U.S. Government and in the custody of the TVA for many years. It has been restricted from public use since the 1940s and designated for industrial development, but the land is presently idle, unsettled, and uncleared. The property contains no resources not found in the surrounding area except for some items of historic and archeological interest that would be preserved. In the opinion of the staff, use of the land for the CRBRP would be consistent with long range development plans for the property.

New transmission lines for the proposed facility would parallel existing ERDA and TVA lines. The staff concluded that the transmission lines would have no important effect on alternative productive uses of the land (Section 5.5).

10.2.3.2 Water Usage

Since the average consumptive use of 8 cfs of river water would be only about 0.2% of Melton Hill Dam releases, the plant would have no effect on the availability of the river for recreational, municipal, agricultural or commercial uses.

10.2.4 Decommissioning

10.2.4.1 Experience

Sufficient experience is available from the decommissioning of licensed power reactors and demonstration nuclear power plants to indicate that decommissioning of the CRBRP would introduce no new or unknown technical problems of a safety or environmental nature. The Fermi 1 reactor was decommissioned by removing the fuel, the depleted uranium blanket and the sodium from the reactor and decontaminating accessible areas. The fuel was shipped to a reprocessing facility and the blanket material to a retrievable waste storage facility. The sodium was removed from the reactor primary and secondary systems and is now stored in tanks and drums at the Fermi 1 site. The sodium will be held there until it is shipped to the CRBRP for reuse.

The Fermi 1 facility remains in a protective storage status with access to the facility controlled by security guards. Radiation surveys are done quarterly to assess the containment of residual radioactivity within the facility. Decommissioning of the Fermi 1 reactor is quite applicable to CRBRP decommissioning as Fermi 1 was also a sodium cooled breeder reactor (PRDC, 1974).

The Southwest Experimental Fast Oxide Reactor (SEFOR), a sodium-cooled reactor with mixed-oxide fuel, was placed in protective storage when decommissioned. All fuel and sodium were removed and accessible areas were decontaminated.

Another sodium cooled reactor, the Hallam Nuclear Power Facility, was decommissioned by entombing all radioactive structures below ground level after removing the above ground structures.

Experience in complete dismantlement and removal of all radioactive components was obtained at Elk River, MN, site of a water cooled demonstration nuclear power plant.

A total of 9 civilian nuclear power facilities were or are in the process of being decommissioned. In addition to Fermi 1, Hallam and Elk River discussed above, decommissioning experience has been obtained at 6 other facilities: Carolina Virgina Tube Reactor (CVTR), Boiling Nuclear Superheater (BONUS) Power Station, Pathfinder Reactor, Piqua Reactor, Vallecitos Boiling Water Reactor (VBWR) and the Peach Bottom Unit No. 1.

10.2.4.2 CRBRP Plans

No specific plan for decommissioning the CRBRP has been developed at this time, consistent with NRC's current regulations which contemplate detailed consideration of decommissioning near the end of a reactor's useful life. The licensee initiates such consideration by preparing a proposed decommissioning plan that is submitted to the NRC for review. The licensee would be required to comply with regulations then in effect and decommissioning of the facility could not commence without authorization from the NRC.

10.2.4.3 Costs

Estimated costs of decommissioning of a 1000 MWe nuclear plant at the lowest level (protective storage) are about $1 million plus an annual maintenance cost of about $100,000 (AECH). Estimates vary from case to case, the variation largely arising from differing assumptions as to level of site restoration. For example, complete restoration, including regrading, has been estimated to cost $70 million (Pacific, 1972).

10.2.4.4 Decommissioning Alternatives

Regulatory Guide 1.86 describes decommissioning alternatives acceptable to the Nuclear Regulatory Commission:

- Mothballing, which consists of placing a facility in protective storage. In general, the facility may be left intact except that all fuel assemblies, radioactive fluids and radioactive waste would be removed. Adequate radiation monitoring, environmental monitoring, maintenance and access control would have to be continued at the facility. The reactor license and license conditions would remain in effect until radioactivity reaches levels acceptable for release to unrestricted access by radioactive decay or through removal of certain components. Maximum acceptable surface contamination levels are given in Regulatory Guide 1.86. Activation levels would be considered on a case-by-case basis. Long-lived isotopes such as carbon-14, nickel-59 and nickel-63 may be of sufficient level that components containing these isotopes would have to be removed when terminating the license, even after a decay period of 100 to 150 years. However, removal of such components after that long a period would not require any remote handling operations, because of the decay of the high level gamma emitters.

- Entombment, which consists of sealing all the remaining radioactive and contaminated components within a structure integral with the biological shield after having removed all fuel assemblies, radioactive fluids and radioactive wastes. The structure should provide control of radioactive material over the period of time in which radioactivity remains above levels acceptable for release to unrestricted access. The licensee may have to remove certain reactor internal components prior to entombment to assure that long-lived isotopes such as carbon-14, nickel-59 and nickel-63 would not exceed levels acceptable for release to unrestricted access at the end of the predicted lifetime of the entombment structure. The facility license would remain in effect until the licensee is able to show through measurement or analysis that radioactivity has decayed to levels acceptable for release to unrestricted access.

- Dismantlement, which consists of removal of all radioactive materials from the site to levels acceptable for release to unrestricted access. The reactor license would be terminated upon satisfactory completion of dismantlement.

- Combinations of the above alternatives.

The degree of dismantlement would be determined by an economic and environmental study involving the value of the land and scrap versus the complete demolition and removal of the complex. The operation would be controlled by the Commission's current rules and regulations to protect the health and safety of the public and the environment.

10.3 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

10.3.1 Scope

Irreversible commitments generally concern changes set in motion by the proposed action which at some later time could not be altered so as to restore the present order of environmental resources. Irretrievable commitments are generally the use or consumption of resources neither renewable nor recoverable for later use. Commitments inherent in environmental impacts are identified in this section, while the main discussions of the impacts are in Chapters 4 and 5. Commitments that involve local long-term effects on productivity are discussed in Section 10.2.

10.3.2 Commitments Considered

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

Resources that, generally, may be irreversibly committed by the plant are: 1) biological species destroyed in the vicinity; 2) construction materials that cannot be recovered and recycled with present technology; 3) materials that are rendered radioactive but cannot be decontaminated; 4) materials consumed or reduced to unrecoverable forms of waste, including ^{235}U, ^{238}U and ^{239}Pu; 5) the atmosphere and water bodies used for disposal of heat and certain waste effluents, to the extent that other beneficial uses are curtailed, and 6) land areas rendered unfit for other uses.

10.3.3 Biotic Resources

Certain life stages of various aquatic organisms normally found in the vicinity of the intake and discharge would be entrained in the plant cooling water, entrapped within the intake, passed through the plant and/or entrained in the discharge plume. Organisms so exposed would suffer from a combination of mechanical, chemical, and thermal stress. An insignificant fraction would be lost to the total river ecosystem. The losses of both aquatic organisms and terrestrial biota are not judged to be irreversible resource commitments.

10.3.4 Material Resources

10.3.4.1 Materials of Construction

Materials of construction would be almost entirely of the depletable category of resources. Concrete and steel would constitute the bulk of those materials, but numerous other mineral resources would be incorporated in the plant. No commitments have been made on whether they would be recycled when their proposed use is terminated. Materials not incorporated in the plant, such as transmission line conductors and tower metal, would be recyclable with only a minor penalty.

10.3.4.2 Replaceable Components and Consumable Materials

Some materials are of such value that economics clearly promotes recycling. Plant operation would contaminate only a portion of the plant to such a degree that radioactive decontamination would be needed to reclaim and recycle the constituents. Some parts of the plant would become radioactive by neutron activation. Radiation shielding around the reactor and around other components inside the primary neutron shield constitute the major materials in that category, for which separating the activation products from the base materials would not be feasible. Components that come in contact with reactor coolant or with radioactive wastes would sustain variable degrees of surface contamination, some of which would be removed if recycling is desired. The quantities of materials that could not be decontaminated for unlimited recycling probably represent very small fractions of the resources available in kind and in broad use in industry. Estimated quantities of materials used in a 1000 MWe liquid metal fast breeder reactor plant, about three times the size of the CRBRP, are shown in Table 10.1, including field construction materials consumed. Although the data were developed for a light water power reactor plant, the staff's opinion is that the material requirements would be about the same for a similar-sized fast breeder plant, and significantly less for the CRBRP with its maximum output of 379 MWe net.

Precious metals, strategic and critical materials, or resources having small natural reserves must be considered individually, and plans to recover and recycle as much of those valuable depletable resources as is practicable would depend on need. Materials consumed during plant operation would be reactor control elements, other replaceable reactor core components, chemicals used in the laboratory and in processes such as reactor cooling and water treatment, and minor

TABLE 10.1 Estimated Quantities of Composite Materials Contained in a 1000 MWe LMFBR Power Plant, Including Field Construction Materials Consumed[a]

Material	Total Estimated Quantity
Aluminum, metric tons	18
Babbitt metal, metric tons	<1
Brass, metric tons	10
Carbon steel, metric tons	32,731
Concrete, yd^3	98,130
Copper, metric tons	694
Galvanized iron, metric tons	1,257
Inconel, metric tons	124
Insulation (thermal), metric tons	922
Lead, metric tons	46
Nickel, metric tons	1
Paint, gal	17,500
Silver, metric tons	<1
Stainless steel, metric tons	2,080
Wood, bd ft	4.8×10^6

(a) AEC, Estimated Quantities of Materials Contained in a 1000-MW(e) PWR Power Plant ORNL-TM-4515, Oak Ridge National Laboratory, Oak Ridge, TN, June 1974.

quantities of materials used in maintenance and miscellaneous operations. In the opinion of the staff, consuming those materials would have negligible effect on their reserves. About 1000 MT of sodium would be consumed, but it is one of the most abundant elements known.

The extent of fuel consumption over the plant's 30-yr life cannot be accurately predicted. The total requirement could be 20 metric tons (MT) of plutonium and 210 MT of uranium, although the breeder capability is expected to establish much lower requirements. Under ideal recycling, the plant's lifetime uranium requirement would be 56.6 MT with 39.4 MT recoverable at the time of plant decommissioning. The applicant estimates that over the plant's 30-yr life, 2.06 MT of ^{239}Pu would be required and the same amount would be produced; 0.04 MT of ^{235}U would be consumed, and 17.65 MT of ^{238}U would be consumed. A supply of depleted uranium would be available as spent fuel from light water reactor power plants. About 410 MT of fuel cladding would become contaminated with radioactive material, making it irretrievable since recycling is uneconomical (ER, pp 3.8-2, 5.8-4, and 5.8-4; and Am I, Part II, G6).

10.3.5 Water and Air Resources

Air and water would be used as carriers for chemical and radioactive materials released by the plant. The 8 cfs consumptive use of river water would not curtail downstream uses, even during extremely low flow.

10.3.6 Land Resources

Thirty of the 34 acres committed to plant use could be restored for other purposes, with a moderate decommissioning effort. The 4 acres for principal plant buildings and the 2.5 acres for the barge unloading facility could be restored only at very high costs.

10.4 BENEFIT-COST

10.4.1 Benefits

10.4.1.1 LMFBR Concept Demonstration

The principal benefit of the proposed facility would be to demonstrate the liquid metal fast breeder nuclear reactor concept for commercial use in generating electrical power. If the applicability can be demonstrated, the useable energy in our uranium resources would be extended and the country would become more self-sufficient in energy production.

10.4.1.2 Power Produced

The electricity generated by the plant would be a secondary benefit. If it operates at the 68.5% average capacity factor estimated by the applicant (ER, p. A1-73) over the 30-yr plant life, a total of 6.2×10^7 MWh would be produced. An equivalent amount of electricity supplied by burning coal in a steam generator would consume about 800,000 tons of coal per year (based on 2.54×10^6 tons of coal to produce 6.57×10^9 kWh (WASH-1535)).

10.4.1.3 Research

The applicant has proposed an extensive preoperational monitoring program to characterize the environment prior to construction, and a similar operational phase monitoring program to determine any adverse effects due to plant construction or operation. Surface and groundwaters, local meteorology, terrestrial and aquatic ecology, and radiological surveys would be conducted (Chapter 6).

The ERDA has undertaken a large research program in support of the LMFBR concept. Research and development (R&D) by ERDA in support of the CRBRP is expected to total $314 million between 1975 and 2020 with an additional $891 million for safety related R&D applicable to the total LMFBR program (WASH-1535, Table 11.2-3).

10.4.1.4 Environmental Enhancement

The results of onsite archaeological investigations by the University of Tennessee will be made available to the public.

10.4.1.5 Employment and Payroll

The primary and secondary work force and associated payrolls were discussed in previous sections. The data are summarized in Table 10.2.

The direct payroll of $292 million during the construction period is expected to induce a secondary payroll of $38.6 million through creation of local demand for goods and services. In a similar fashion, during the demonstration period, the $50.9 million direct payroll is expected to induce a secondary payroll of $7.7 million.

TABLE 10.2 Summary of Employment Benefits

Item	Construction Period (1976-1983)	Demonstration Period (1984-1988)
Direct Employment[a]	1520	275
Induced Employment[a]	910	220
Direct Payroll[b]	$291,800,000	$38,600,000
Induced Payroll[b]	$ 50,900,000	$ 7,700,000

(a) Annual average based on Table 4.1.
(b) See Table 4.8.

10.4.1.6 Taxes

State and local sales taxes generated from payroll spending would be the principal source of public funds generated by the project for use in the project area. The staff estimate of the value of tax revenues is summarized in Table 10.3. These revenues would be generated principally in the counties of Anderson, Knox, Loudon, and Roane.

TABLE 10.3 Tax Revenues from CRBRP Payroll Spending[a]

Period	State Sales Tax (4.5%)	Local Sales Tax (1.5% max)	Total
Construction (1976-1983)	$6,500,000	$2,100,000	$8,600,000
Demonstration (1984-1988)	875,000	290,000	1,165,000
Total (1976-1988)	$7,375,000	$2,390,000	$9,765,000

(a) All dollar values are present values (8% discount rate) after escalation (8% rate) for inflation.

In the absence of local authority to tax the CRBRP project directly through property taxes, or sales and use taxes on materials and supplies used in construction, the in-lieu-of-tax payment becomes an important factor. In the opinion of the staff, the local public costs arising as a result of the project would not be covered unless in-lieu-of-tax payments are made (Table 5.9).

10.4.2 Cost Description of the Proposed Facility

10.4.2.1 Environmental Costs

Environmental costs discussed in Chapters 4 and 5 are summarized in Table 10.4.

10.4.2.2 Monetary Costs

The estimated cost of the CRBRP is $1.95 billion for construction and operation through 1989. The 1976 revised estimated cost breakdown is presented in Table 10.5. The base cost estimates are in 1974 dollars. The applied escalation rate is 8%/year. Estimated revenue from electricity sold to TVA totaling $200 million is credited to operating costs.

A capital cost of $1.5 million and annual operating costs not exceeding $2 million have been estimated by the staff for safeguards measures necessary to protect the CRBRP, and the related fuel cycle facilities and transport of radioactive materials from acts of sabotage, theft or diversion (Sect. 7.3.5). These additional costs would not significantly affect the cost/balance relative to the project.

10.4.3 Benefit-Cost Summary

The staff reviewed the applicant's proposed plant (Chapter 3) and made an independent evaluation of the environmental effects of its construction and operation (Chapters 4 and 5) at the proposed site (Chapter 2). Further consideration was given to technical alternatives (Chapter 8) and the environmental and monetary factors associated with alternative plant-site combinations and plant system alternatives (Chapter 9).

On the basis of its evaluations the staff concludes that 1) constructing and operating the CRBRP at the proposed location would be possible without causing any significant impact on the physical environment of the area, 2) locating the project at an alternative TVA site using the hook-on arrangement would be less expensive but attendant technological risks could jeopardize the ability of the project to meet its intended objectives, and 3) local costs for additional public services needed by project personnel and their families may exceed the local benefits from the project and therefore should be assessed by the applicants to determine the need for offsetting in-lieu-of-tax payments. Furthermore, on the basis that accident risks at the CRBRP site will be made acceptably low, comparable to LWR risks, the reduction in potential consequences associated with accidents at alternative sites does not warrant relocating the proposed plant when balanced against the detrimental effects of relocation on achieving the demonstration plant's objectives; the staff therefore concludes that no substantially better alternatives are available to achieve the demonstration plant's objectives. The staff also concludes that the CRBRP would meet the demonstration plant's objectives within the LMFBR program (see Chapter 8).

TABLE 10.4 Summary of Environmental Costs, CRBRP

Effect	Reference Section	Summary Description
Land Use		
Construction Activities	4.2.1	About 195 acres disturbed during construction of the plant and support facilities.
Long-Term Dedication	4.2.1	About 73 acres permanently dedicated, including 24 acres for access roads and railroad.
Transmission Lines	5.5	A total of 3.2 miles of right-of-way would be widened, causing a disturbance of about 58 acres. Two streams and several intermittent streams would be crossed.
Water Use		
Construction	4.3	190,000 gpd (132 gpm) maximum rate.
Operation	5.2	8 cfs (3584 gpm) water consumptively used during operation.
Thermal Effects	3.4.1	Cooling water would be heated 25°F by passage through the condensers.
	3.4.1	Maximum outfall temperature would be 90.5°F (July).
Intake Velocities	3.4.2	Intake velocity is expected to be about 0.4 fps.
Discharge Volume	3.4.3	Minimum rate of 1,900 gpm; maximum rate of 2,600 gpm.
Chemical and Sanitary Waste	5.4	Rapidly diluted to harmless concentrations under flowing river conditions.
Siltation	4.3	Removal of 20,000 m^3 material for construction of access road and railroad, intake and discharge structures and barge slip, and suspended solids in site turnoff would have minor, temporary effects.
Terrestrial Ecological Effects		
Rare and Endangered Species	2.7.1.2.2	The Southern Bald Eagle, a threatened species, has been observed on the site.
	4.2.1	Rare wild flower collection areas on the site would not be disturbed.
Vegetation and Animal Life	4.4.1	Some timber would be harvested but other vegetation and some animals on land disturbed by construction would be lost.
Cooling Tower Drift	5.3.3	Worst case deposition would be 90 lb/acre/mo of salts; no adverse effect is expected.
Aquatic Ecological Effects		
Benthic Losses		
a. During Construction	4.4.2	Benthic organisms lost as a result of dredging would be easily reestablished.
b. During Operation	5.3.2.4	The maximum scour area around the discharge would be 10 m^2 and produce a permanent loss of benthos in that area.
Impingment	5.3.1.1	A maximum of 0.5% of fish passing the intake could be impinged.
Entrapment	5.3.1.1	Negligible.
Entrainment	5.3.1.2	An average loss of 0.46% and a maximum loss of 2.2% of phytoplankton, zooplankton, drift invertebrates and ichthyoplankton is estimated.

TABLE 10.4 Summary of Environmental Costs, CRBRP (Cont'd)

Thermal Effects	5.3.2.2	No significant impact on the ecosystem is expected as a result of drift or passage of aquatic species through the thermal plume.
Cold Shock	5.3.2.3	Fish loss is unlikely from any interruption of heated effluents.
Sanitary Waste	5.4.2	Negligible.
Radiological Releases		
Individual Dose	5.7.3	1.6 mrem/yr average annual dose to an individual at site boundary, less than 2% of 100 mrem/yr natural background dose.
Cumulative Dose	5.7.3	0.29 man-rem/yr to total 987,000 population within 50 miles in year 2010, insignificant compared to 9.9×10^4 man-rem/yr from natural background.
Occupational Dose	5.7.3	1000 man-rem/yr conservatively estimated, 1% of 50 mi population natural background dose.
Transportation Dose	5.7.2.6	17 man-rem/yr total to transport workers and population along entire shipping routes.
Accidental Dose	7.1, 7.2	The risks associated with accidental radiation exposure are very low.
Community Effects		
Archaeological Sites	5.1	None of the several archaeological sites on the property would be disturbed by construction activities. Access to Hensley Cemetery would be allowed.
Visual Impact	5.1	The structures would be partly visible from the Gallaher Bridge and scattered residences south of the river.
	5.3.3	It would be possible to have a 6 mile long plume 6% of the time during plant operation. Fog could be a minor nuisance on nearby roads a few hours per year.
New Population	5.6	275 employees during operational phase would generate a total new population of 1200 persons.
Payroll	4.5.4	During the life of the project a $330.4 million payroll should generate a secondary payroll of $58.6 million.
Public Services	4.5.1	No firm provisions have been made for funds to provide public sector services; however, ERDA has recognized its responsibility to make payments if adverse impacts occur.
Traffic	4.6.2 5.3.3	Excessive traffic congestion on State Road 58 in Roane County during construction could be mitigated by staggered shift schedules. Fogging could have a small effect on local transportation.
Physical Resources		
Uranium	10.3.4.2	Less than 210 metric tons
Plutonium	10.3.4.2	Less than 20 metric tons

TABLE 10.5 Cost of Construction and Operation of CRBRP[a]

	Cost ($ in millions)	% of Total Project Cost
Plant Investment		
Base	$ 729.1	
Escalation	364.4	
Contingency & Escalation	267.5	
Plant Investment Total	1361.0	69.8%
Development		
Base	364.0	
Escalation	124.9	
Contingency & Escalation	36.1	
Development Total	526.0	26.9%
Operating		
Base	26.2	
Escalation	8.5	
Contingency & Escalation	29.7	
Operating Total	64.4	3.3%
Project Total	$1950.4	100.0%

(a) Source: Table 8.3-1, Amended ER.

11. DISCUSSION OF COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL STATEMENT

Pursuant to Paragraph 51.24 of 10 CFR Part 51, the Commission's Draft Environmental Statement related to construction of the Clinch River Breeder Reactor Plant was transmitted, with a request for comments, to the agencies listed in the Summary and Conclusions on page ii of this statement. In addition, comments were requested from interested persons by means of a notice in the *Federal Register* on February 12, 1976. In response, comment letters were received from:

Advisory Council on Historic Preservation (ACHP)
Department of Agriculture (AG)
Department of the Army, Corps of Engineers (AR)
Department of Commerce (C)
Department of Health, Education, and Welfare (HEW)
Department of Housing and Urban Development (HUD)
Department of the Interior (DOI)
Department of Transportation (DOT)
Energy Research and Development Administration (ERDA)
Environmental Protection Agency (EPA)
Federal Power Commission (FPC)
State of North Carolina (NC)
State of Tennessee (TN)
Anderson County, TN (AC)
Roane County, TN (RC)
Oak Ridge, TN (OR)
East Tennessee Development District (ETDD)
Concerned Californians (CC)
Environmental Coalition on Nuclear Power (ECNP)
Geothermal Energy Institute (GEI)
Natural Resources Defense Council, Sierra Club, and
  East Tennessee Energy Group (NRDC)
Mr. Brad Neff (BN)
Dr. Edward Passerini (EP)
Project Management Corporation (PMC)
Ms. Deborah Hurwitt (DH)

The comment letters are reproduced in Appendix A. Consideration of the comments by the staff is reflected by text revisions in preceding chapters and in the following discussions. Abbreviations in parentheses next to the subject titles identify the sources of the comments (see above) and page numbers where the comments may be found in Appendix A. The staff responses are organized according to the DES sections to which the respective comments primarily apply. Other changes and considerations by the staff are indicated in Section 11.13.

11.1 SUMMARY AND CONCLUSIONS, INTRODUCTION AND GENERAL COMMENTS

11.1.1 ERDA Involvement (CC, A-44; PMC, A-94, Encl. 2, Item 1)

Since the DES was issued in February 1976, ERDA has joined with PMC and TVA as a co-applicant for a Construction Permit and a Class 104(b) Operating License for the CRBRP (Application Amendment May 6, 1976). As discussed in Chapter 1 of the FES, ERDA has the overall responsibility for managing the design, construction, and operation of the plant and it will have custody of the plant and the site on behalf of the United States.

11.1.2 Operator of the Plant after the Demonstration Period (OR, A-38, Item D.1)

If, at the conclusion of the demonstration period of approximately five years, TVA does not exercise its option of purchasing the plant for its own use over the remaining plant life, ERDA will retain ownership of the facility and may continue its operation or effect its decommissioning (Application Amendment May 6, 1976, Exhibit A, p. 29).

11.1.3 NEPA Review After 5 Years (EPA, A-17, Item 3)

The licensing action presently being considered by the NRC concerns the construction permit only. If that is granted and the facility is constructed, the applicant's request for an operating license will be considered. EPA's suggestion that a full NEPA review be conducted prior to use of the project beyond the initial demonstration phase can more appropriately be considered during the operating license review.

11.1.4 State and Local Licenses and Permits (OR, A-39, Items D.5 & D.6; TN, A-25, 28)

The legal opinion of the NRC staff is that as a federal facility the CRBRP is not required to obtain licenses from State and local authorities.* This is a consequence of the fact that Federal facilities are exempt from State and local regulations. However, the CRBRP is required to comply with the substantive requirements of such regulations. Consequently, the demonstration of licensability should not be compromised. Effluent quality requirements to assure conformance with water quality standards have been incorporated in the Draft NPDES Permit (Appendix H).

11.1.5 Staff Contacts with State and Local Officials (OR, A-39, Item D.4)

Identification of the individuals contacted by the staff is unnecessary to the purpose of this statement. However, a list can be provided on request.

11.1.6 Completion Date and Cost Overruns (NRDC, A-51, 52)

As indicated in the application amendment dated May 6, 1976, the earliest scheduled date for reactor criticality is October 1983 and the total project cost estimate is $1950.4 million, including research and development expenditures of $364 million, 8% per year escalation during construction, substantial contingency allowances, and operating costs during the 5-year demonstration period. The latest date for reactor criticality is stated to be April 1986.

Experience with this project indicates that further delays and higher costs may occur, but assessments of these factors by NRC would be speculative in view of the developmental nature of the project. Consideration of cost overruns ultimately must rest with the Congress, which would review any request for an increase in appropriations.

11.1.7 Site Suitability (TN, A-25)

The Tennessee Division of Occupational and Radiological Health questioned whether the proposed site is appropriate to demonstrate the safety of an LMFBR. See 11.7.1 for a discussion of the accident risks.

11.1.8 Concentration of Water Impurities (TN, A-25)

A concentration factor of 2.5 in the discharge is indicated, based upon a water requirement of 5,835 gpm, evaporation from the towers at 3,475 gpm, 105 gpm of drift, and blowdown at 2,210 gpm (ER, Table 3.3-1, AM VI).

11.2 THE SITE AND ENVIRONS

11.2.1 Additional Baseline Information (BN, A-86 to A-91)

Most of the comments from Brad Neff suggest expansion of Chapter 2 so that the reader will not need substantial reference material in order to "have an effective grasp on potential impacts." Minor additions have been made in the FES; however, the staff does not treat every subject relevant to the proposal, only those needed to make the assessments in later chapters. The staff believes sufficient information is provided for the decision maker and sufficient references are supplied for Congress and the general public to make further inquiries. However, many of the subjects raised by Mr. Neff are addressed in the following responses.

11.2.2 Distance from CRBRP to Oak Ridge (OR, A-39, Item D.7)

The DES used 9 miles in Section 2.1 as the distance between the site and the approximate geographic center of Oak Ridge residences. The distance is made more specific by changing the figure

*In Hancock v. Train, ______ U.S. _____, Slip Opinion No. 74-220 (June 7, 1976), the Supreme Court held that federal facilities must comply with state and local air pollution control requirements but they need not obtain permits as a prerequisite to facility operation. In EPA v. California, _____ U.S. _____, Slip Opinion No. 74-1435 (June 7, 1976), the Supreme Court held that federal facilities must comply with state water pollution control requirements to the same extent as a nonfederal facility but the federal facilities do not need to obtain NPDES permits from states with approved programs.

to 10 miles, the approximate distance to the Route 62-Oak Ridge Turnpike intersection. According to information provided by the Oak Ridge Planning Office, the 10-mile distance between the plant and Oak Ridge places more than half the city's residences beyond the 10-mile radius and shows the nearest residence at 7 miles. Disproportionately large growth to the southwest, of course, could reduce the distance from the plant to residents of the city. However, the staff is not aware of forecasted growth weighted significantly to the southwest. Figures 2.1, 2.2, and 6.2 have been revised.

11.2.3 Jurisdictional Districts (OR, A-39, Item 8)

The political jurisdiction of Oak Ridge is shown on Figure 6.2 as revised. Showing the boundaries of the service districts cited in the Oak Ridge comment is not essential to this statement. However, the staff's assessment of costs of municipal services resulting from the project is intended to include additional costs to the service jurisdictions.

11.2.4 General Site Description (BN, A-86)

The staff has attempted to use abbreviations commonly understood; therefore, a list of abbreviations is not considered necessary.

Industrial 2 zoning includes manufacturing and processing; residences are excluded (Zone Ordinance, Oak Ridge, TN, Sec 6-179, pp. 123-5).

The staff's opinion is that the discussions of topography (including Figure 3.19), regional land use, and water withdrawal and discharge (Section 3.3) are sufficient to assess the impacts upon those resources that would be caused by the proposed action.

In view of the small number of river shipments planned for plant construction, the staff's opinion is that the statement adequately discusses the baseline recreational and commercial use of the river. Recent sport fishing data are given in Section 11.5.6. See also Section 4.3, with a revision pertaining to barge traffic.

The staff concurs that the baseline land transportation discussion is skimpy for assessing the impact of construction traffic. Additional information on highway routes, capacities, and between-junction distances is available in the ER (Figs 8.1-1 and -2). However, instead of incurring the expense of analysis and accepting the inaccuracies of early forecasting, the staff supports the applicant-Department of Highways agreement to develop a suitable plan.

11.2.5 Population Within 5 Miles of the Site (OR, A-39, Item 9; ETDD, A-43)

Section 2.2 is expanded to recognize the ORGDP, ORNL, and other workers within 5 miles, in addition to the references to them in Sections 2.1 and 2.8. The 2010 estimates shown in Figure 2.6 are taken from the ER. (Sec 2.2.1.1, par 5 and 7 including Tab 2.2-4 through 2.2-7.) The staff notes the possibility of temporary mobile home locations within 5 miles during construction, depending upon future decisions of the city government.

11.2.6 Relationship of Population to Agricultural Production (BN, A-86)

In rural areas remote from expanding communities, agricultural activity usually is the dominant factor in determining population. The staff is aware of no factors that would substantially change the amount of agricultural activity in the site vicinity.

11.2.7 Historic and Archaeological Values (BN, A-86; HUD, A-9)

The Advisory Council on Historic Preservation states that historic and archaeological values receive adequate consideration in the DES (page A-2). The staff considers the discussion in Section 2.3 adequate in view of the anticipated impacts, which are judged to be small (Sections 4.2.1 and 5.1). Construction areas have been added to Figure 2.7. Refer also to Figures 2.3 and 3.3.

11.2.8 Soils and Geologic Information (AG, A-2; NRDC, A-52)

The Department of Agriculture states that soils in the site area "would indicate moderate to mostly severe limitations for large buildings and roads." Soil and rock core borings have been made at the site (PSAR Chapter 2.5) and results of associated laboratory tests will be examined as part of the staff's safety evaluation. Horizontal ground acceleration is also a matter primarily of interest to safety considerations and will be treated in the staff's safety evaluation report. Also see Section 11.7.12.

11.2.9 Karst Features (BN, A-86)

The limestone underlying the site is not prone to extensive karst development. Karst features ar[e] discussed further in the ER (Sec. 2.4.5).

11.2.10 Surface Water and Groundwater (BN, A-86)

Quality of the river water is given in Table 3.5, based upon 6 monthly analyses. Water quality degradation by the plant is discussed in Sections 5.3.2, 5.3.3, and 5.4.1. A map of surface water appears as Figure 6.2. Additional discussion of groundwater monitoring is given in Section 11.6.11.

11.2.11 River Width (OR, A-39, Item D.11)

The seasonal river width estimates in the first paragraph of Section 2.5.1 apply to CRM 16.0, near the proposed CRBRP discharge.

11.2.12 Melton Hill Dam Releases and Milfoil (BN, A-86; TN, A-26; OR, A-39, Item D.12)

The DES incorrectly stated in Section 2.5.1 that the dam would be regulated to meet flow requirements of the CRBRP site; it should have stated that "should the need arise for any regulation of Melton Hill Dam which would result in long periods of zero release, the operation (of CRBRP) would be coordinated to meet flow requirements at the CRBRP site" (see PMC comment 1, p. A-92). Extended periods of zero flow in the past, specifically 29 and 11 days, were employed to aid in the control of Eurasian water milfoil. In the future, water level management and supplemental herbicide application will be used. The applicant has not identified the herbicides to be used but they would be EPA approved and would be applied according to the Federal Insecticide, Fungicide and Rodenticide Act (Van Nort, 14 Apr 1976).

11.2.13 1953 Tornado (BN, A-86; OR, A-40, Item D.14)

Based on information compiled by the former state climatologist, tornadoes were reported in Anderson and Knox counties at approximately 3:15 a.m. on May 2, 1953 (Vaiksnoras, 1971). The staff does not usually list specific tornadoes that occurred within the site region, but rather indicates the frequency of tornadoes which have occurred. Our data base has been expanded to include all tornadoes that occurred between 1953 and 1974 within a 10,000 square mile area surrounding the site.

11.2.14 Chi/Q Values (OR, A-40, Item D.15)

The staff does not attempt to duplicate the X/Q values which the applicant provides. Rather we perform an independent analysis, as described in FES Section 6.1.3. In our analysis we used meteorological data gathered between June 1974 and May 1975 and our values were higher by a factor of about 20 than those reported in the applicant's ER (Table 2.6-44).

11.2.15 Frequency of Heavy Fog (OR, A-40, Item D.16)

The numerical value listed in Section 2.6 for heavy fog was in error. Heavy fog occurs at the Weather Service office (about 10 miles northeast) an average of 34 days per year (USDC, Environmental Data Service, Local Climatological Data for Oak Ridge, Tennessee, Annual Summary, 1974). Expecting a slightly higher frequency at the site would be correct due to its location on the river.

11.2.16 Unfavorable Meteorology (NRDC, A-52)

Holzworth's data indicate that eastern Tennessee is a region of the U.S. in which atmospheric dispersion conditions are not so favorable as in some other regions of the country. The source for this reference contained in the applicant's Environmental Report is "Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States," AP 101, by G. C. Holzworth. In this publication, Holzworth states in his introduction that, concerning the report's data, "these upper-air data provide only very general indications of real diffusion and transport patterns in the urban boundary layer." For example, the size of the two pollutant sources he considers are cities 10 and 100 kilometers across (100 and 10,000 square kilometers, respectively). Even the smaller of these two sources is larger than the entire area within the low population zone at most nuclear power plants. To characterize dispersion conditions over small areas (such as a nuclear power plant site), more detailed local investigations must be done, as suggested by Holzworth. A meteorological program, such as recommended by Regulatory Guide 1.23, can collect the more detailed data needed for such an evaluation.

The staff agrees that the atmospheric dispersion at the Clinch River site, averaged for periods greater than eight hours, is less favorable than that at most nuclear power plant sites NRC has previously evaluated. However, based on field tests performed onsite, due to meandering of a plume under low wind speeds and stable atmospheric conditions, this statement may not be true to describe atmospheric dispersion for time periods of one or two hours. An evaluation of this will be provided in our Safety Evaluation Report for the Clinch River site.

X/Q values can be represented by an infinite number of combinations of atmospheric stability classes and wind speeds. For ease of reference, we usually relate the X/Q values that are not exceeded 95% of the time to Pasquill Type F and an associated wind speed. X/Q values that are not exceeded 95% of the time are used for conservatism in safety reviews, whereas values not exceeded 50% of the time are normally used in the environmental assessments.

Poor atmospheric dispersion conditions in themselves do not necessarily lead to the conclusion that an alternative site should be chosen since they are simply one of the factors used in the radiological dose assessments of radioactivity releases under both normal operating and postulated accident conditions. The radioactive waste systems in a nuclear plant can be designed to limit radioactive effluents so that the resulting doses are acceptable at virtually any site. Dispersion conditions at the Clinch River site are comparable to those at the Watts Bar, Sequoyah and Bellefonte sites, also in eastern Tennessee, for which the NRC has issued construction permits. The staff assessments of doses for the CRBRP indicate that they would be acceptable (Sections 5.7 and 7.1).

Meteorological conditions at alternative sites are considered in Section 9.2.

11.2.17 Air Quality (BN, A-86)

Semiannual summaries of air quality at Oak Ridge, Clinton, and Harriman are available from the Air Pollution Control Meteorologist, Tennessee Department of Public Health, Nashville. The office also provides emissions data for pollution sources in the site vicinity.

11.2.18 Terrestrial Ecology (BN, A-87; TN, A-102; ERDA, A-13)

The staff believes the terms "biology" and "ecology" are used properly in the statement. Extensive knowledge is needed about the biological components making up an ecosystem in order to understand the critical elements to be impacted. The acreage and location of each community type and plant species, along with their relative importance, are discussed in ER, Sec 2.7.1. Edge effects and ecotones are relatively unimportant, since the project would create very little new edge and would have no important impact on any ecotone.

Natural areas are defined to be "any near-climax community ecologically unusual in terms of extent or occurrence" (ER, Sec 2.7.1.3.3). Maps showing those areas were made for use by construction personnel to ensure minimal disturbances.

The site is typical of abandoned farmland in the area as pointed out in the statement. Far from being "undisturbed", the site has been managed for the production of forest products. The site is not unique since there are thousands of similar acres on the Oak Ridge Reservation.

Habitat types and their importance for wildlife are discussed extensively in the ER (Sec 2.7.1.4 and 2.7.1.6), including the relative abundance and importance of habitat types, unusual occurrences of mammals, cave locations, lists of fauna observed and potentially occurring on the site, and habitat quality.

Plant species to be expected for land undergoing secondary succession in Eastern Tennessee differ depending on the number of years since the land was allowed to revert to natural succession. Generally, there are annual and perennial herbs and grasses during the first several years, followed by a 10- to 60-year period when pine trees become established and dominate. Finally, hardwood trees become dominant. The hardwoods present depend on slope-aspect, elevation, and sometimes soil type. The ER has a good description of the species present in the various communities. The FES contains information sufficient to assess impacts, which are expected to be very small.

Misspellings of the scientific names of black snake root and Carey's Saxifrage noted by the Tennessee Department of Conservation have been corrected in Section 2.7.1.1. As indicated in the comment, they are on the Smithsonian Institution's list of endangered species.

Section 2.7.1.2.1 has been changed, showing deer population at the site to be one per 600 acres and higher.

The discussion of threatened species of mammals in Section 2.7.1.2.1 has been updated. A list of mammals is given in the ER with information on ranges of rare species, unusual occurrences, and habitat preferences of major species.

Several small caves on the north slope of Chestnut Ridge are mentioned in the ER (Sec 2.7.1.4.1).

"The August 1974 cave search and mist netting for bats was conducted by a nationally recognized bat expert. Caves on the site lack permanent running or standing water and terminate in sink holes on Chestnut Ridge. The largest caves are 24 meters (78 feet) and 42 meters (137 feet) deep and were large enough to stand comfortably. Only the larger contained a reddened area indicating past presence of 500 to 1,000 gray bats (*Myotis grisescens*), but no evidence of bat use within the past several years. This bat expert considered the caves on the CRBRP site to be unimportant as bat breeding or wintering habitat. The fact that neither individuals nor signs of the Indiana or gray bats were observed on the CRBRP site indicates that these species are not resident to the site or the immediate area and thus will not be adversely affected by construction or operation of the CRBRP.

"The absence of bat individuals or cave droppings and the relatively small caves on the site indicate that the site is not good habitat for either the gray or Indiana. The time of year during which the survey was conducted has no effect on cave size or on presence or absence of bat droppings in caves; therefore, the ER conclusion that the CRBRP site is not important for endangered or threatened bats is still valid." (Van Nort, 27 Apr 1976, Enc 1, p. 4.)

The ER (Sec 2.7.1.4.2) lists bird species, discusses ranges of importance, discusses the habitat quality of the site for birds, and notes any unusual occurrences. Waterfowl are not discussed in the statement because of the very small impact they would sustain. Few waterfowl species were found on the site. Wood ducks (*Aix sponsa*) were the most abundant with occasional sitings of Canada geese (*Branta canadensis*), American coots (*Fulica americana*) and various species of ducks. None of the waterfowl species cited is considered rare or threatened. The discussion of endangered and threatened species has been updated (p. 2-14).

No rare herptofauna were found on the site. The ER lists all species observed and discusses the quality of the site as habitat for them.

A discussion of terrestrial invertebrates may be found in the ER (Sec 2.7.1.4.4 and 2.7.1.6.2).

11.2.19 Aquatic Ecology (BN, A-88; TN, A-30)

The staff's opinion is that Section 2.7.2 is sufficient for assessing aquatic biological impacts.

Table 2.5 has been revised and now shows four additional species of minnows (ER, Table 2.7-87 and -88). The applicant states that the recent revisions included in the reference identify all species captured and found.

11.2.20 Social and Community Characteristics (BN, A-88)

The staff's opinion is that most of the items cited in the comment have been discussed sufficiently in Chapters 2, 4, and 5 to assess impacts. Section 6.1.6 adds a socioeconomic monitoring program.

Noise is discussed in Sections 4.5.4, 5.1, and 11.5.1.

Aesthetics are discussed in Sections 4.5.3 and 5.1.

11.2.21 Mobile Homes in Oak Ridge (OR, A-40, Item 18)

The Chapter 2 discussion of the site and its environs is based upon the current status of the elements considered. Speculating on the outcome of studies in progress is not included; however, removal of the mobile home restriction probably would result in an increase of construction workers residing in the city.

11.2.22 Overcrowding in Oak Ridge Schools (OR, A-40, Item 19)

Section 2.8, as revised, is consistent with Section 4.5.3.

11.2.23 Personal Property Tax (OR, A-40, Item 20)

Changes in the statement have been made in response to the narrower definition of personal property taxes.

11.2.24 Higher Costs for Low Income Citizens (ECNP, A-45, Item 1)

The construction of CRBRP would result in a large influx of people who would demand public and private services. In rural areas where supply for services is limited a rise in price could occur.

The staff's evaluation summarized in Section 4.5 recommends that the applicant perform a cost/benefit analysis to determine the need for in-lieu-of-tax payments. These payments should offset increased costs for providing public services to CRBRP employees. If this occurs, then individual property taxes would not finance increased public services. The staff has further recommended a monitoring program in Section 6.1.6 in order to determine actual impacts.

However, private goods and services that take time to expand, such as housing, would likely result in higher prices to all consumers. These high prices are a particular burden to the poor and a generous benefit to the private businessman. The staff notes that the construction of a major project such as the CRBRP affords local employment which partially neutralizes higher prices.

All residential customers pay the same rates for electricity, although the poor may pay a higher percentage of their income for it.

11.3 FACILITY DESCRIPTION

11.3.1 Public Use of the River (AR, A-5; DOI, A-11)

The applicant must exercise total control over the entire exclusion area described in Section 3.1 except portions traversed by "passageways" such as the river (ALAB-308, 1976). In an emergency the applicant must be able to clear and close the segment of the river within the exclusion area. Otherwise, this segment would be open for public use. Navigation, recreation, and other uses of the river and shoreline beyond the exclusion area would not be affected.

11.3.2 Reactor and Steam-Electric System (ECNP, A-45, Item 2)

Some additional descriptive material has been added to Sections 3.2 and 7.1. For a more complete description of the entire plant, see the applicant's PSAR and ER. Information on initial and equilibrium fuel compositions was given in DES Appendix E, Section 5.1, which has been merged into Section 7.3 of the FES.

11.3.3 Breeding (NRDC, A-53)

The staff statement in DES Section 3.2 to the effect that an objective of the LMFBR concept is to breed more fuel than is used might have been misinterpreted as setting some criterion for the CRBRP. The staff would not require that the CRBR breeding ratio be above any given figure. CRBR is expected to demonstrate the breeding potential inherent in the LMFBR concept in the following manner: The cross sections significant to breeding would be verified through experience with the CRBRP, and these cross sections would then be used to calculate the different breeding ratios of commercial fast reactors. This procedure has been carried out many times before on operating fast reactors, EBR-I, EBR-II, Dounreay, etc., none of which were designed for a specific breeding ratio and the results have always indicated that the composition of large scale commercial reactors will be such that their breeding ratios would be acceptable. With a projected breeding ratio of 1.2, the CRBRP would be a further demonstration of this procedure, but with the added restrictions of licensability and utility participation, and on a larger scale than previous U.S. experiments.

Other things being equal, the breeding ratio is increased by increasing the amount of U-238 in the core. Since the larger reactors require lower enrichment fuels, their breeding ratios normally increase accordingly. The increase in U-238 content has a favorable effect on the Doppler coefficient, but is accompanied by an unfavorable effect on the sodium void coefficient. New data on cross sections have been generated and new optimizations of the basic three parameters (Doppler coefficient, sodium coefficient, and breeding ratio) have been proposed. The concept that commerical size LMFBR's can be built with safety and with an adequate breeding ratio still appears to be tenable. It should also be noted that the breeding ratio is sensitive to the fuel cladding thickness. If experience under actual operating conditions in FFTF and CRBR indicate that this thickness can be reduced, the breeding ratio would be further improved.

11.3.4 Water Use at Maximum Power (TN, A-26)

Maximum water use would occur in the summer with a 15.1 cfs (6800 gpm) makeup need, of which 9.3 cfs (4200 gpm) would be consumed and 5.8 cfs (2600 gpm) would be discharged to the river. The applicant plans full load operation 60% of the year (Van Nort, Apr 14, 1976, Enclosure 5).

11.3.5 Design Parameters of Heat Dissipation System (PMC, A-95, Item 5)

Sections 3.3 and 3.4 have been revised to reflect revisions in the heat dissipation system which have resulted from the project's choice of turbine generator.

11.3.6 Intake and Discharge Locations (AR, p. A-6)

Figures 3.8, 3.12 and 3.14 have been revised in accordance with the Project's revised permit application to the Corps of Engineers (Caffey; July 8, 1976). Both the intake and discharge structures are recessed into the river bank to avoid obstructing navigation.

11.3.7 Impingement Losses (TN, A-26)

The staff's assessment is that impingement losses would not be a problem (Section 5.3.1.1), based upon present intake plans. If impingement losses become significant, the applicant would be required to report any such incident. Mitigating actions are possible and the applicant would be required to make those necessary. Leaves, for example, can be removed and added to the stream with no ill effect.

11.3.8 Use of Appendix I Criteria (EPA, A-17, 18; TN, A-25)

The CRBRP is licensable under the conditions of 10 CFR Part 50 and satisfies the requirements of Paragraph 50.34a (Design objectives for equipment to control releases of radioactive material in effluents - nuclear power reactors). Therefore, the use of the term "as low as is reasonably achievable" is appropriate for identifying the design objectives, and the means to be employed for controlling releases of radioactive material in effluents to unrestricted areas during normal operation of the CRBRP.

Appendix I of 10 CFR Part 50 provides quantitative significance to the meaning of "as low as is reasonably achievable" (ALARA) concerning releases of radioactive materials in liquid and gaseous effluents from light-water-cooled nuclear power reactors. We consider the numerical design objectives of Appendix I to be applicable to any nuclear power reactor regardless of type (LWR, HTGR, LMFBR). Therefore, in lieu of Federal Regulations quantitatively defining ALARA for LMFBR's, we have used the numerical guidance provided by Appendix I as an aid in determining conformance with 50.34a for LMFBRs. The precedent of assumed applicability of the requirements of Appendix I to other than light-water-cooled nuclear power reactors has been established in the case of HTGRs, e.g., SER for the Summit Power Station, Unit Nos. 1 and 2, issued January 1975. At present, the Commission has no plans to develop numerical guides, similar to those in Appendix I, for LMFBRs. (See 11.7.4 for our response on the use of 10 CFR Part 100.)

11.3.9 NRC's Release Estimates More Conservative than ER (PMC, A-94, Item 3.F4)

The staff's evaluation of the releases of radioactive materials in liquid and gaseous effluents resulted in estimates higher than those of the applicant's because of differences in the principal parameters used in estimating releases from the plant. The differences are discussed in Section 3.5.1.4 and 3.5.2.6 and are justified due to a lack of operating data and experience with LMFBR's.

11.3.10 Liquid Radwaste Dilution Flow (TN, A-26)

The staff does not consider radwaste dilution as a method of waste treatment. Evaporation and demineralization are the best available treatments. Liquid radwaste releases are not required to conform to P.L. 92-500 (BAT)* but the radwaste management systems must be capable of satisfying the "as low as is reasonably achievable" criteria of 10 CFR Part 50.34a. In addition, the systems must be capable of maintaining release concentrations to unrestricted areas below the limits specified in Appendix B of 10 CFR Part 20. Dilution is not used in place of best treatment for either radioactive or nonradioactive materials. Evaporation and demineralization are best available treatments.

*Train v. Colorado PIRG _____ U.S. _____; (Slip Opinion No. 74-1270 (June 1, 1976)).

11.3.11 Filter or Evaporator Malfunctions (TN, A-26)

The liquid radioactive waste subsystems are interconnected for operating flexibility. The staff's source term model used to calculate the expected releases of radioactive material in liquid and gaseous effluents for the FES includes adjustment factors to account for anticipated operational occurrences such as equipment malfunction and operator error.

11.3.12 Decay Time in Low-Activity System (PMC, A-95, Item 6)

In Section 11.2.1 of the PSAR, the applicant states that the 10-day decay assumption is connected to spare parts availability. Since the major input to the Low-Activity System is from sodium sample chemical analysis, sodium spills and cleanup during normal operation of the plant, the input to the LAS is unrelated to spare parts availability. The staff believes that 2 days decay for LAS waste is more realistic due to the nature of the input and the desirability of prompt disposition of such waste.

11.3.13 Chemicals in Low Activity System (TN, A-26)

Wastes processed by the Low Activity System would be low in volume and contain miscellaneous trace chemicals, low total dissolved solids, and relatively high COD and BOD. The treatment sequence of filtration, evaporation and demineralization for radionuclide removal also would be fully effective for removal of trace inorganic chemicals, total dissolved solids, COD and BOD. Total suspended solids limitations and pH requirements have been incorporated in the NPDES permit (Appendix H, p. 9).

11.3.14 Barriers to Tritium Releases (EPA, A-18)

In conjunction with a survey of the literature concerning cold trap removal efficiencies in liquid sodium systems, the staff evaluated and concurred with the distribution of radionuclides in the primary and intermediate (H-3) cold traps presented in PSAR Table 11.1.9. However, cold traps are not the only effective barrier against the release of the tritium produced by the CRBRP reactor. The Cell Atomsphere Processing System (CAPS) will collect and process through a tritium oxidizer the tritium that may diffuse into the cells housing the reactor, Primary Heat Transfer System (PHTS), PHTS pumps, and reactor overflow vessel. The CAPS tritiated water will be sent to the solid waste system for solidification and eventual offsite shipment to a licensed burial site.

11.3.15 Chemicals in Condensate-Feedwater System (TN, A-26)

For corrosion control, the chemistry of steam-water system is controlled by demineralization of the condensate from the condenser hotwell. The 1 gpm bleed from the condensate and feedwater system will contain only trace quantities of chemicals in addition to the small quantity of tritium.

11.3.16 Activity in the Cooling Water Intake (TN, A-25)

One of the purposes of the FES is to assess the radiological impact of the proposed operation of the plant. This impact assessment is performed independently of existing background levels of radiation which are useful only for establishing baseline activity for comparison with levels measured after the start of commercial operation.

11.3.17 Bottling the Noble Gases (NRDC, A-53, 54)

Concerning the disposition of processed noble gases from the Radioactive Argon Processing System (RAPS), the staff believes that periodic onsite releases under controlled conditions present a lower risk to public health and safety than bottling and subsequent offsite shipment to a licensed burial facility with the attendant risk of accidental uncontrolled release.

Regarding the applicability of the design objectives of Appendix I of 10 CFR Part 50 to evaluation of the CRBRP radwaste systems, see response to EPA (11.3.8).

11.3.18 Effluent From Cell Air Processing System (ERDA, A-13)

The effluent release rate from the CAPS will range from 0 to 72 scfm.

11.3.19 Radwaste Treatment Similarities to Other Reactor Types (DH, A-101)

Although the LMFBR may appear to be significantly different from other reactor types (light water reactors, high temperature gas reactors), it is a fission reactor and the basic mechanism for producing energy is the same for all fission reactors. All fission reactors generate fission products and neutron activation products although radionuclide distributions in the reactor fuel and primary coolant may vary from reactor type to reactor type. Small quantities of these radionuclides will enter the liquid and gaseous waste streams through various flowpaths and leakage pathways. For all practical purposes, the radionuclide distributions possess similar physical and chemical properties when subjected to standard methods of waste treatment. The methods used to process these waste streams, namely evaporation, filtration, demineralization, and adsorption, are similar regardless of reactor type.

11.3.20 Disposition of Sodium-bearing Wastes (EPA, A-17, 18)

Section 11.5.3 of the PSAR describes a conceptual sequence for cold trap removal and packaging. In Section 3.5.3 of the DES, the staff estimates that approximately 240 ft^3 of sodium bearing waste containing 2.3×10^4 Ci of activity would be shipped offsite annually due to the above operation.

There are various alternatives to be considered regarding the disposition of sodium bearing waste and the applicant has committed to procedures which will not result in any unacceptable environmental impact. Should the applicant deviate significantly from the conceptual sequence described in the PSAR, the staff will reassess the source term presented in Section 3.5.

The applicant states that FFTF related research and development efforts concerning the packaging, transporting, and disposition of sodium bearing wastes will be applied to the Clinch River Project. This approach is entirely reasonable considering the nature of the project as a demonstration facility.

11.3.21 Contradiction on Page 3-18 (TN, A-25)

Paragraph 4 on page 3-18 has been corrected by substituting the word "staff" for "applicant" in the fourth sentence.

11.3.22 Sodium Nitrate Waste (TN, A-26)

No discernible impact on water quality is expected from onsite processing of waste sodium metal, if it occurs. The resulting sodium nitrate would be concentrated as solid radwaste and transferred to a licensed burial ground. The distillate from the concentration of the sodium nitrate solution would be demineralized and reused in the plant.

11.3.23 Radioactive Waste Shipments (TN, A-25)

Environmental Report Section 5.3 states that approximately 140 55-gallon drums of solidified liquid wastes, 182 drums of non-compactable solids and 6 drums of metallic sodium will be shipped from the CRBRP to state and/or NRC-licensed disposal sites each year. Specific disposal sites have not been identified to date; hence the routes to be used are not established. Transportation of solid radioactive wastes from a reactor to disposal sites has been discussed generically for light water reactors in AEC's WASH-1238 report entitled, "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," and ERDA's report ERDA-40 entitled, "The Environmental Impact of Transportation of Nuclear Materials in the LMFBR Program." Much of the information in these reports is applicable to the transportation requirements of the CRBRP.

Establishment of radwaste shipment routes will be coordinated with the appropriate agencies within the State of Tennessee and will be made in accordance with (DOT, NRC, etc.) regulations. To the extent practicable, routes of shipments will be away from population centers. Shippers of waste are responsible for safe transport and cleanup in event of an accident. Also see Section 11.3.24.

11.3.24 Radwaste Disposal Site (EPA, A-17; TN, A-25, 26, 27)

The disposal site of radioactive waste from the CRBRP is not known at the present time, as indicated in ER Section 5.3. It will be on land owned by the Federal or a state government.

The term "licensed burial site" refers to any of six commercial burial sites which are licensed to receive and bury low-level radioactive solid waste. None of the six sites is located in the State of Tennessee. The sites are located in Richland, Washington; Beatty, Nevada; Barnwell, South Carolina; Morehead, Kentucky; Sheffield, Illinois; and West Valley, New York. Packaging and transport of all solid wastes will conform to NRC and DOT regulations.

The staff has estimated the environmental impact associated with all waste management operations, including a Federal repository. These impacts are shown in Table 2 of Appendix D of this FES.

In October 1976 the staff issued a report entitled, "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," NUREG-0116. The purpose of this report was to provide a basis for identifying environmental impacts associated with fuel reprocessing and waste management activities that are attributable to the licensing of a model light water reactor. In Table 2.8 of the report the environmental impacts of the management of high-level wastes for the light water reactor fuel cycle are summarized. These impacts are also consistent with those shown in the Final Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light Water Cooled Reactors, NUREG-0002 (Table IV H-21). The residual wastes from CRBRP would be generally equivalent to wastes from light water reactors, including such long-lived isotopes as Pu-239 solidified or packaged in a similar fashion. Thus, the analysis of waste disposal in NUREG-0116 is generally applicable to the CRBRP.

Table 4.18 of the task force report indicates negligible doses to the population resulting from operation of a waste repository. As shown in Table 2 of Appendix D to the FES, the nature of the waste from fast reactor fuel is not sufficiently different to change this result, and, therefore, we conclude that the environmental impact of short-term operation of the waste repository facilities is negligible.

11.3.25 Description of Licensed Burial Site (AR, A-6)

The primary operations of a licensed burial facility are the receipt, temporary storage, and burial of packaged radioactive wastes in trenches. Authorization to operate a commercial land burial facility is based on an analysis of the nature and location of potentially affected facilities; of the site topographical, geographical, meteorological, and hydrological characteristics; and of groundwater and surface water use in the general area which must demonstrate that buried radioactive waste will not migrate from the site. Packages shipped to the facility must meet the requirements of the DOT and the NRC for transportation of radioactive material.

Specific criteria for an acceptable burial site are determined by the NRC. As outlined in WASH-1535, an adequate land burial facility consists of 100 acres located in an area which is sparsely settled or virtually uninhabited, with access to highway transportation. Groundwater level should be well below the deepest trench, the average trench depth being about 20 feet. The site hydrology should provide for minimal flooding of trenches and leaching of buried radioactive material, and the soil should provide for good ion exchange. Site selection should require no nearby use of groundwater or well water downstream of the site.

Buildings on the burial site provide space for offices, a laboratory, temporary storage of packaged radioactive wastes and other wastes handled as necessary, such as solidification of low activity liquids. Storage space is provided for vehicles, earth-moving equipment, forklifts and other equipment necessary for the preparation of trenches and the handling of packages containing radioactive wastes.

The property is enclosed entirely by fencing, and access to the facility is controlled by the site operator. To insure long-time control of the site in the event of default or abandonment of the site by the commercial operator, commercial burial facilities must use either state or Federally-owned land.

Trenches which have been completed are cared for to minimize erosion and are marked to specify the contents. An environmental monitoring program including air, water and vegetation sampling is established to detect any migration of radioactive material.

After radioactive materials are buried at the site, the land will not be used for any other purpose. Individual states and/or the Federal government are responsible for perpetual care and maintenance and for ensuring restriction from other uses.

11.3.26 Health Consequences from Stored Solid Waste (NRDC, A-54)

A comment on Section 3.5.3 is that the staff should analyze the health consequences of "delayed releases" of solid radioactive waste from burial grounds. The Commission has recognized the need to upgrade its program for the regulation of commercial burial sites and a reassessment of the waste management regulation program (principally health effects) by the NRC is in progress. Initial conclusions indicate that "combinations of improved site engineering, waste management, and packaging and solidification of wastes can minimize migration from the site."* For further discussion, see "Alternatives for Managing Wastes from Reactor and Post-Fission Operation in the LWR Fuel Cycle," ERDA 76-43, Vol. 4.

*Statement of Marcus A. Rowden before the Joint Committee on Atomic Energy, May 12, 1976 on the subject of Nuclear Waste Management.

11.3.27 Chemicals in Plant Discharge (TN, A-27)

Table 3.5 presents in detail the concentration of waste constituents in neutralized plant wastes, sanitary wastes, cooling tower blowdown and the total discharge to the river. The concentrations of waste constituents in individual effluent streams pertinent to Federal Effluent Standards and State Water Quality Criteria are given in Table 3.6.

The sources of ammonia, BOD, COD, and nitrates in the plant discharge are river water used for makeup and sanitary wastewater. The sanitary wastewater contributes only a small fraction (<10%) of the nitrate already in the makeup water and is well within State of Tennessee criteria. Nitrate in sanitary wastewater is formed by the oxidation of ammonia. A highly nitrified or well oxidized wastewater normally is high in nitrate-nitrogen and low in ammonia-nitrogen.

BOD values in the river are based on results obtained during the aquatic baseline study. The results periodically were cross-checked with results from the TVA laboratory and reference samples provided by EPA. The BOD results varied only slightly among the three laboratories which suggests adequate BOD analyses by the laboratory contracted to do the work.

A reduction in the concentration of dissolved oxygen (DO) below the State standard of 5 mg/ℓ is not anticipated in the river as a result of CRBRP operation. Assuming the highest expected temperature increase in summer (0.7°C) occurs during the highest temperature (23.8°C) observed during the baseline study, the solubility of oxygen would be reduced by only 0.1 mg/ℓ from the low of 5.6 mg/ℓ DO observed at the highest temperature. The only significant BOD and ammonia laden wastewater generated at the plant would be collected from the sanitary system, and would be highly nitrified or oxidized prior to discharge.

The orthotolidine method for determining chlorine residuals is an accepted analytical method given in Standard Methods and can be used easily in the field (chlorine residuals must be determined immediately upon sampling). The orthotolidine method is subject to greater error from interfering substances than the amperometric method which is not readily adapted for field use.

Filtration of the sanitary waste effluent is expected to reduce the suspended solids to a small fraction of those found in normal secondary effluents.

11.3.28 Corrosion Inhibitors, New Source (ERDA, A-13; EPA, A-22, Item 3)

Table 3.6 has been corrected, reflecting corrosion inhibitor standards for a new source of water pollution, the plant's status as determined by the EPA (See page A-15). The standards of performance relating to "best available technology" have been removed.

11.3.29 Hypochlorite Use at Intake (OR, A-40, Item 21)

Oak Ridge noted that the necessity for chlorination to control Asiatic clams and the time required have not been established, according to Section 3.6.2; whereas continuous injection at 1 ppm is an alternative considered in Section 9.3.5. The latter has been revised in the FES, eliminating the 1 ppm chlorine addition. NPDES chlorine requirements are in Appendix H, p.2.

11.3.30 Oil and Grease Discharge (TN, A-27)

Wastewaters potentially contaminated with oil and grease would be routed through oil separators to assure oil and grease concentrations below 15 mg/ℓ (an EPA effluent limitation shown in Table 3.6).

11.3.31 Wastewater Characteristics (TN, A-27)

The applicant is willing to supply details desired by the State (Van Nort, 14 Apr 1976, Enclosure 5).

11.3.32 Use of Polychlorinated Biphenyls (TN, A-27)

If PCBs are used, the electrical gear containing them would be located indoors and would be adequately diked and drained to prevent loss to the environment. Should spillage occur, the spilled material either would be reused or sent to the manufacturer for recovery or disposal (Van Nort, 14 Apr 1976, Enclosure 5, and Appendix H, p. 17, NPDES Part IIIc).

11.3.33 Storm Drainage (TN, A-27)

Criteria for sizing catch basins for collecting storm drainage are set forth in 40 CFR Part 423, Effluent Guidelines and Standards for Steam Electric Power Generating Point Source Category, Subpart D, issued by the EPA.

11.3.34 Off-Site Disposal of Non-Radioactive Waste (OR, A-40, item 22; TN, A-27)

Non-radioactive liquid and solid waste not processed at the plant would be disposed of offsite by licensed contractor. The contractor presumably would use local, approved disposal facilities.

11.3.35 Sanitary Waste (TN, A-27)

a) The applicant is willing to provide engineering data requested by the State (Van Nort, 14 Apr 1976, Enclosure 5).

b) Flow splitting to the sand filters normally would be conducted by manual valving through one of two filters, each designed to process 100% of the flow. Provisions also would be incorporated to permit flow splitting by means of a flow splitting box.

c) Vending machines and a small kitchenette would be provided for food preparation on site.

d) Showers would be available.

e & f) The staff has verified that the values shown in Table 3.7 are realistic and correspond to vendors' estimates.

g) Table 3.5 shows nitrate as such and Table 3.7 shows nitrate as nitrogen.

11.3.36 Residual Chlorine in Sanitary Waste Effluent (ERDA, A-13)

A minimum of 0.5 ppm residual chlorine in the sanitary waste effluent is needed to assure a good kill of pathogenic organisms. Limiting the chlorine to 0.5 ppm would increase the risk of inadequate disinfection and would result in only a minimal reduction in the total chlorine residual discharged from the plant. The sanitary waste would be diluted over 400-fold by discharge in the cooling tower blowdown, reducing the chlorine below detectable concentration.

11.4 ENVIRONMENTAL IMPACTS DUE TO CONSTRUCTION

11.4.1 LWA and NEPA Procedures (AR, A-5)

A limited work authorization would not be granted by NRC until the environmental and site suitability hearings by the Atomic Safety and Licensing Board have been completed and unless an appropriate decision is made by the Board. Additional permits and licenses which must be obtained by the applicant are listed on page 1-3. Among these are several Corps of Engineers' permits which would be needed prior to initiation of the construction activities mentioned in Section 4.1. Acting as the "lead agency" in accordance with its Memorandum of Understanding with the Corps of Engineers, the NRC has incorporated material in this statement which is pertinent to the Corps' NEPA review.

11.4.2 Construction Employment (OR, A-40, Item 24; PMC, A-93, Item 3.B.1)

Section 4.1 has been revised to show recent construction employment data.

11.4.3 Secondary Employment (PMC, A-93, Item 3.B.2)

The staff's analysis of the size of the secondary work force generated by the construction and operation of the CRBRP is discussed in Sections 4.5 and 5.6 of the FES.

11.4.4 Exxon Nuclear Fuel Plant (OR, A-40, Item 23; PMC, A-93, Item 3.B.3)

Reference to construction of the fuel plant and other projects has been modified in Section 4.1.

11.4.5 Erosion Control (AG, A-2)

Plants which may be planted for erosion control include broomsedge, purpletop, aster, goldenrod, plumegrass and *Lespedeza*. Short-term erosion control is considered in FES Sections 3.8, 4.2.1, 4.4, and 4.6.1. Item (9) of Section 4.6.1 has been expanded to include vegetation other than trees. The staff's opinion is that the precautionary measures would be adequate (Section 4.6.2).

11.4.6 Revegetation of Transmission Line Corridor (DOI, A-11)

The staff's opinion is that planting of fescues (Section 3.8) and allowing natural invasion of native species would be sufficient. Many native species provide good cover and food for wildlife.

11.4.7 Terrestrial Impacts (BN, A-89)

The staff's assessment emphasizes the lack of any special habitat onsite, with thousands of neighboring acres available for wildlife. Adequate precautions to be taken by the applicant in order to minimize adverse impacts are discussed in Section 4.4.1.

11.4.8 Barge Traffic (AR, A-3)

Section 4.3 has been modified to include consideration of increased barge traffic associated with plant construction. No barge traffic is expected relative to plant operation.

11.4.9 Materials Barged (AR, A-3)

The applicant plans to barge construction equipment and plant components; some require special handling because of their large sizes. Explosives, abrasives, toxics, oil, and other hazardous or harmful materials would not be shipped from or received at the CRBRP barge unloading facility (Van Nort, 14 April 1976, Enclosure 13).

11.4.10 Disposal of Dredged Material (ERDA, A-13; TN, A-27; PMC, A-96, Item 16)

The amount of dredged material estimated for disposal has been reduced from 40,000 m^3 to 20,000 m^3. The material would be placed on a land disposal site near the barge unloading facility. The area is above normal water elevation and existing topography would be used to form an enclosed retention basin. Sections 4.2.1 and 4.3 have been altered in accordance with the Project's revised permit application to the Corps of Engineers (Caffey, July 8, 1976).

11.4.11 TWQCB Certification (TN, A-27)

The Tennessee Division of Water Quality Control stated that Section 4.4.2, paragraph 2 implies (TWQCB 1973) certification. As a federal project, CRBRP is exempt from State certification but is required by Executive Order 11593 to meet the State's substantive standards.

11.4.12 Minimizing Socioeconomic Impacts (HEW, A-8, HUD, A-9)

Sections 4.5 and 5.6 have been extensively revised and now incorporate a staff analysis of the project effects on schools, wastewater treatment, etc. The applicant's recent analysis (ER Section 8 and Appendix C, Amendments VI & VII) shows extensive vacancies among hospital beds presently in the immediate four-county region.

Various methods are available for expanding public services and facilities to accommodate the influx of CRBRP workers. For example, schools can expand their capacity by building new classrooms or by using mobile classrooms, by busing students to uncrowded schools or rescheduling (evening, Saturday, or summer classes). The optimum solution for handling additional students will generally be a combination of methods.

11.4.13 School Impacts (PMC, A-93, Item 3.C)

The staff believes that predicting at this time which specific schools would be impacted is not possible with any degree of accuracy; therefore, the problem is addressed from an area-wide viewpoint. Under the monitoring program recommended by the staff, the data accrued would be useful in planning to relieve impacts before they become acute.

A 10% excess capacity factor is a desirable level to be maintained for unforeseen problems and not forecasted problems. Some allowance would be needed to permit flexibility in the overall school system to permit reallocation between schools, should one area expand faster than another in an unexpected way.

11.4.14 Impact on Housing (HUD, A-9; RC, A-33, Item 4)

The staff concurs with the view that the impact of the project on housing conditions and local services requires further definition. In ER Amendment VI the applicant presents the results of a study to define some of the impacts. This study indicates that approximately 35 percent of the workers are expected to locate in mobile homes (ER, Tables 8.3-5 and 8.3-7). There is abundant land available for mobile home development, but availability of water and wastewater systems may constrain such development. Deleterious or blighting effects of any kind of developmental growth, be it temporary housing or other types of development, can be minimized and controlled by appropriate use of local ordinances and building codes. The staff recommends a monitoring program to inform community leaders of changes in time to assist in their planning (see FES Section 6.1.6).

11.4.15 Water, Wastewater and Solid Waste Impacts on Communities (TN, A-27)

Impacts on individual communities would depend upon the incoming employees' options and choices of residential locations. Their distribution and resulting impacts cannot be forecast accurately, although Section 4.5.2 suggests some important factors. A staff analysis of water and wastewater capacity and demand has been incorporated in Section 4.5.3. Operating and maintenance costs are met by user fees the districts charge property owners (ER, AM VI, App C). In rural areas the use of septic tanks would depend upon soil conditions and enforcement of zoning regulations. Solid waste from construction activities would be disposed of by the applicant's contractor (FES Section 4.6.1). Municipal solid waste would be disposed of in existing facilities.

11.4.16 General Impacts on Roane County (RC, A-31, 32)

Construction of the CRBRP could likely attract sufficient new population to Roane County (primary and secondary workers) to require expansion of public sector services. In the absence of any financial contribution to Roane County by the applicants, the staff concludes that the tax revenues generated by the new population may be insufficient to offset the newly generated public sector service costs. The staff's opinion is that the only reliable way to establish the degree of socioeconomic impact caused by CRBRP construction is for a monitoring program to be established. By this means, the number of new residents brought into the area by the project, their family compositions, and their places of residence can be determined. From these data and supplementary sources of information, the required additional public sector services can be established. A monitoring program has been added to Section 6.1.6 and adoption of such a program is recommended by the staff as a condition for granting a construction permit.

Responses to specific comments by Roane County and similar comments by Oak Ridge and others are given below:

11.4.17 Traffic Congestion (TN, A-29; RC, A-32, Item 1; OR, A-36, Item A.1)

The Project has agreed (Van Nort, April 14, 1976) to meet with the State of Tennessee Department of Transportation in order to develop a plan to alleviate traffic congestion in the vicinity of the CRBRP site during construction of the CRBRP. The Department of Transportation should be made cognizant of any concerns likely to be known only by Oak Ridge.

11.4.18 Sanitary Sewage Discharges (RC, A-32, Item 2)

The FES addresses the standards to be applied to discharges of sanitary wastes on project property. The regulation of sanitary wastes resulting from creation of new residential areas (temporary or permanent) is the responsibility of local governmental bodies, and can be accomplished by ordinances and zoning regulations. If new treatment facilities or trunk lines are needed, it is presumed that they would be constructed and financed from revenues (hook-up or service charges) and possibly taxes.

11.4.19 Solid Waste Disposal (RC, A-32, Item 3)

a. The licensed contractor has not been selected as of this time. The contract will be awarded by competitive bid.

b. The contractor selected will be required to have all necessary licenses issued by the appropriate government agency. (See FES Section 4.6.1.1.7)

c. The disposal facility location will be determined at the same time as selection of a contractor (see part a, above). A description of the type of construction waste is provided in ER Sections 4.1.1.4 and 4.1.1.5. Quantitative estimates of these wastes will be available for the contractors at the time of bidding.

   In the right-of-way clearing process for the transmission line, most small stumps would be removed from the ground. These would be winnowed on the right-of-way along with the other slash (trees, limbs, brush, etc.), removed from the clearing operation and burned in compliance with appropriate guidelines. Larger stumps would be sheared off at the ground level and would remain in the ground to decay. In general, other solid waste generated by transmission line construction would be very small. The minor construction waste items would consist of protective wood cribbing attached to conductor reels, cardboard shipping cartons and steel bands used to bind structural items and other line hardware. All waste material which accumulates would be transported to dumps or land fill sites. All trash and garbage would also be regularly carried out of the area. Portable sanitary facilities would be provided for construction workers.

d. The Project would directly bear part of the cost for equipment replacement and landfill development by way of the fee charged by the contractor for waste removal.

With regard to municipal solid waste disposal it is the position of the staff that the cost for providing such services could probably be adequately covered by revenues from user charges to the new population. Detailed consideration of county by county or city by city employee and equipment needs to handle incremental solid waste disposal requirements of a new population are considered to be part of the planning function of local governments, and beyond the scope of the staff review.

11.4.20 Local Planner (RC, A-33, Item 5)

The staff concurs that a better assessment of impact is needed, but recommends that this be done as part of the applicant's monitoring program (see Section 6.1.6). The formation of the East Tennessee Energy Project Coordinating Committee will assist the planning of the local areas. If Roane County feels that additional outside help is needed, the staff suggests that a direct assistance request be processed with ERDA.

11.4.21 Assessment of Socioeconomic Impact (RC, A-33, Item 6)

The staff assessment of socioeconomic impacts resulting from CRBRP indicated that significant impacts could occur within the local rural counties. The staff further recommended that the applicant assess the local costs for additional public services to determine the need for offsetting in-lieu-of-tax payments. The applicant subsequently provided such estimates in Amendments VI and VII to the ER.

The assessments made by the staff and the applicant were based on various assumptions, such as the percent of in-movers into Roane County. The accuracy of the assessments depends on the various assumptions based on past data and how well past data corresponds to CRBRP construction.

In order to remove the uncertainties associated with these projections, the staff recommends in Section 6.1.6 that the applicant set up a monitoring program. The data gathered would be used for determining the need for in-lieu-of-tax payments to offset increased costs of public services.

11.4.22 Tax Revenues (RC, A-34, Item 7; OR, A-36, Item A.2)

Revenue from private investment in the plant is discussed in FES Section 4.5.4. Sales and usage taxes levied under the Tennessee Retailers Sales Tax Act are applied to materials, supplies, and equipment acquired for use in plant construction. However, materials, supplies, and equipment that would become a plant component or a component associated with the distribution system are exempt from the Tennessee Sales and Use Tax.

The staff's conclusion that the portion of increased state sales tax, gas tax, cigarette taxes, and liquor taxes which would be returned to the communities as a result of the project would not be equal to increased expenditures for public services was based on fiscal budgets for the counties in the area. For example, for Roane County in 1974-1975 the local sales tax was only 8.19% of the total budget, whereas property taxes were 24.35% of the total budget. This indicates that local sales tax is a minor part of the total budget.

The applicant has expressed its intention to act within the statutory authority of Section 168 of the Atomic Energy Act of 1954, as amended, and Chapter 4 of the Atomic Energy Community Act of 1955, as amended, to provide assistance to local entities affected by the project (Appendix F). All benefits accruing to the state or local government as a result of CRBRP would be taken into account in determining the ERDA in-lieu-of-tax payments (Section 168 of the Atomic Energy Act of 1954, as amended). Under Section 91 of the Atomic Energy Community Act, as amended (42 USC 2391), payments may be made notwithstanding the provision of Public Law 81-874.

11.4.23 Miscellaneous Roane County Questions (RC, A-34, Item 8)

a. Since no portion of the project is owned by private parties, no property tax would be applicable to the project.

b. Material, supplies and equipment which become part of the plant (including purchases by contractors and subcontractors) and its associated distribution system are exempt from sales and use taxes levied under the Tennessee Retailers Sales Tax Act.

c. A source of revenue created by the CRBRP may include sales or use taxes on materials, supplies, and equipment acquired for use in constructing the plant but which do not become a component of the plant itself and the related distribution system.

d. Power sales to the project for construction of CRBRP would be subject to applicable state sales and use tax. Under the Project agreement, TVA will reimburse the project for power produced by CRBRP at the highest incremental cost otherwise incurred at its generating plants. The reimbursement is a transaction by and between the United States, which is not subject to the sales and use tax.

e. If TVA should acquire the plant and operate it as part of its system, power generated by CRBRP would not be subject to the sales and use tax since it would not constitute a sales transaction.

f. The staff recommends that during the operational phase the socioeconomic monitoring program consist only of an annual collection of data on the workforce composition.

g. PMC, TVA and ERDA are co-applicants. The NRC construction permit would be issued to them jointly.

h. ERDA is the proper entity with which to discuss mitigation of CRBRP impacts.

i. In the judgement of the staff, the private (business) sector of the economy need not incur any additional costs. Expansion of the private sector to meet a growing economic market is an opportunity, not a requirement.

j. The magnitude of the increased county services required, as suggested by Roane, have been estimated by the applicant (ER Amendment VI), but should become further quantified as a result of monitoring by the applicant (see Section 6.1.6) and possibly the East Tennessee Energy Project Coordination Committee.

k. Emergency procedures for the CRBRP are outlined in the Preliminary Safety Analysis Report, Section 13.3. Arrangements for contacting local agencies will be coordinated with the Tennessee Department of Public Health and the Department of Civil Defense.

11.4.24 Mitigation of Impacts on Oak Ridge (OR, A-37, Item A.3)

Oak Ridge should negotiate with ERDA for mitigation of CRBRP impacts. A prerequisite to determining compensation of mitigation of impacts is a determination of what the impacts are. Therefore, the staff recommends a monitoring program (see Section 6.1.6) which will assist in such determination.

Construction residents would require the same facilities and services as operating phase residents in order to achieve the same quality of life. However, because of the temporary nature of construction employment, the services are usually not provided in the same proportion. Therefore, a table for these services is not meaningful, and would perhaps be misleading.

11.4.25 Combined Construction Effects (OR, A-37, Item A.4)

The staff has given further consideration to other planned projects in the area and has addressed this topic in Section 4.1.

11.4.26 Costs to Local Businessmen (OR, A-37, Item A.5)

The ability of the existing firms' employees to readily substitute for construction workers is not evident to the staff. For example, production line and sales personnel probably would not seek work at construction projects.

Private business would not be required to make investments in capital facilities. If they so desire, they may take advantage of the opportunity to expand to meet a growing demand for their products and services.

11.4.27 Source of Work Force (ETDD, A-43)

Because of other construction projects planned for the future within the area (see Section 4.1), jobs related to CRBRP operation could not be filled solely from local unemployment.

11.4.28 Morgan County Impacts (ETDD, A-43)

Although it is possible that some in-moving construction workers would choose to reside in Morgan County, the staff believes the impact will be so small that a detailed socioeconomic impact analysis is not warranted. However, the monitoring program of Section 6.1.6 should indicate the extent of induced impacts, which the staff expects to be much less than similar impacts to be sustained by Roane, Anderson, and Loudon Counties, which have more direct transportation routes, less rugged terrain, and wider choices of community sizes.

11.4.29 Local Government Costs for Services (ETDD, A-103)

The East Tennessee Development District expressed concern about financial burdens (capital and operating) placed on local governments as a result of the project. The staff is of the opinion that an in-lieu-of-tax payment should be negotiated between the local units of government and the applicant so that the financial burden is compensated in a fair manner. Furthermore, the staff recommends on-going socioeconomic monitoring by the applicant to assist local units of government in planning to meet the expansion and help establish a basis for distribution of impact funds (Section 6.1.6).

11.4.30 In-Lieu-of-Tax Payment Applications (ETDD, A-103; AC, A-30)

The Energy Research and Development Administration has stated its willingness to consider the impacts of its activities on local entities (Appendix F). ERDA's authorization to make in-lieu-of-tax payments is presently limited to the City of Oak Ridge and Anderson and Roane Counties. However, the staff understands that the State of Tennessee Energy Office has developed proposed legislation which would authorize ERDA to make similar payments to other communities in the vicinity of the site and to the State (see the September 10, 1976 letter from ERDA to NRC in Appendix G).

11.4.31 Local Government Services for Mobile Homes (ETDD, A-104)

ETDD points out that mobile home owners do not pay taxes as other home owners do, but only pay a vehicle tax. This is no longer true in Tennessee. Mobile home owners pay ad valorem tax on the units as well as on the land and the tax formula is the same as for a permanent dwelling, i.e., a rate against 25% of the assessed valuation (market value) for single units. (Commercial rates apply to multiple unit mobile homes or apartment complexes.)

The only real difference between ad valorem taxes on a mobile home and a permanent dwelling is that mobile homes on the average tend to have a lower market value than permanent dwellings and hence return less total ad valorem tax revenue per unit.

11.4.32 Availability of Socioeconomic Impact Data (ETDD, A-104)

The ETDD is concerned that detailed information used by the applicant to project the socioeconomic impacts discussed in Amendment 6 will not be made available. In this regard, the staff understands that the applicant provides copies of its socioeconomic analyses upon request and will continue to provide local officials and committees with such information (Buhl, July 22, 1976).

11.4.33 Impacts on Lake City (ETDD, A-105)

Lake City expresses the opinion that it will experience some effects of construction and operation of the CRBRP. In the opinion of the staff, relatively few CRBRP construction workers would elect to live in Lake City because: (1) the Anderson County tax rate is unattractive, (2) Lake City is farther from the site than other areas offering similar attractions, (3) needing to commute through Oak Ridge to reach the site is undesirable, and (4) the present distribution of Oak Ridge-ERDA project workers is more to the south and to the east than towards Lake City.

11.4.34 Health Services (ETDD, A-106)

The East Tennessee Health Planning Council, Inc., expresses the opinion that additional medical services will be required in the area to accommodate the expected population increase resulting from CRBRP construction. The staff prefers to make a distinction between private sector supplied medical services and public sector supplied medical services. The former respond to the normal laws of supply and demand and cannot really be controlled by staff or applicant. Tax supported medical facilities in the area might be expected to experience a small financial impact to the degree that the project is exempt from ad valorem taxes.

11.4.35 Property Taxes During Construction (PMC, A-93, Item 3.D)

The staff recognizes that increased property taxes would be a source of revenue and notes it in FES Section 4.5.4 as one of the taxes resulting from payroll spending.

11.4.36 Plant Appearance (OR, A-40, Item 25)

Discussion of the atmospheric plume has been added to Section 5.1. The staff concurs that most people would notice the plume more than the plant buildings.

11.5 ENVIRONMENTAL IMPACTS OF PLANT OPERATION

11.5.1 Switchyard 60-cycle Hum (OR, A-40, Item 26)

The staff's opinion is that the switchyard noise would be acceptable at the closest residences, 0.6 mile from the plant. An analysis indicates they would sustain a sound level of 45 dBA or less from all operational noise (ER, Sec 5.7.2.2).

11.5.2 Melton Hill Dam (AR, A-6; PMC, A-92, Item 1; TN, A-28)

The DES was incorrect with regard to releases from Melton Hill Dam. It should have stated that "should the need arise for any regulation of Melton Hill Dam which would result in long periods of zero release, the operations (of CRBRP) would be coordinated to meet flow requirements at the CRBRP site." (See PMC comment 1, p. A-92.) Effects on Melton Hill Lake under zero release would thus be attributable to the dam operation rather than CRBRP requirements.

11.5.3 Closure of the Waterway (AR, A-3)

Plant operation would not require use of the river for transport of materials; therefore, its closure to commercial navigation would have no impact upon plant operation.

11.5.4 Downstream Water Use (ERDA, A-13, TN, A-28)

In Section 5.2, the reference to Lenoir City has been deleted and the distance to the Harriman intake along the Emory tributary is given in river miles. Even with occasional Clinch River flow reversal, the staff's opinion is that dilution in the immediate vicinity of the plant would be fully sufficient for meeting TWQCB domestic water use standards at the Harriman intake and at the ORGDP intake 1.5 miles downriver.

11.5.5 Classified Uses of the River (TN, A-28)

Protecting the river for classified uses is anticipated through conformance to the State's water quality criteria. Since the discharge is small and its temperature and chemical concentration elevations above ambient are modest, degradation of water quality that could affect classified uses would be confined to a very small area (less than a tenth of an acre) in the vicinity of the discharge point. The small area very likely would be considered to be a part of the allowable mixing zone for plant effluents. Tennessee-applicant-EPA discussions have resulted in generally acceptable effluent conditions for assuring water quality protection.

11.5.6 Sport Fishing Activity (OR, A-41, Item 29)

Sport fishing activity may at times exceed the activity indicated in Section 2.7.2 and 5.2. Recent data coming to the staff's attention show about 1000 fishermen per month during the winter and 1600 per month during the summer at the Melton Hill Dam tailwater (Van Nort, 14 Apr 1976).

11.5.7 Cumulative Effects of Discharges (DOI, A-11)

The cumulative effects of thermal, chemical and radioactive discharges from the Oak Ridge National Laboratory (ORNL) and the Oak Ridge Gaseous Diffusion Plant (ORGDP) have not been analyzed specifically in the staff's review of the proposed Clinch River Plant. Such discharges presumably do contribute to the background conditions that exist in the vicinity of the CRBRP site. However, the discharges from CRBRP would be so small that the incremental effects of its operation would be insignificant. As discussed in Section 5.3.3, the atmospheric conditions are such that airborne materials from CRBRP would rarely interact with those from ORGDP and probably never with those from ORNL; hence, no cumulative effects would result to the ecosystem. The impacts of chemicals released in the plant's liquid effluent have been judged against the baseline chemical burden, including upstream contributions, and found to be insignificant; under no-flow river conditions, a concentration within an area of less than 0.1 acre would occur; there would be no chemical interaction with releases elsewhere. Thermal releases to the river cover so small an area (Figure 5.3) as to assure no interaction with any others. The estimated doses to individuals and populations from CRBRP radioactive effluents are very small (Section 5.7.3) and would represent a negligible incremental impact.

11.5.8 Impingement Losses (OR, A-41, Item 30)

Enlarging the openings through which the intake water passes, or increasing their number, would decrease the intake water velocity and, hence, the chances of fish impingement. This is not necessary in view of the low velocity (0.3 to 0.5 fps) that would result from the present design. Also see Section 11.3.7.

11.5.9 Compliance with FWPCA (EPA, A-17, Item 4 and A-21)

The staff used mathematical models to characterize the chemical and thermal plumes, assuming 30 days of zero river flow. Based upon the revised plant operation (Sections 3.3 and 3.4), analysis of the near field plume shows that the effluents would experience a 30-fold dilution within 25 feet from the discharge point. In the far field, the plume would spread laterally after reaching the surface and effluents would be diluted to near ambient levels within 100 feet of the discharge. The thermal plume would achieve a steady-state condition within the 30-day period. Figure 11.1 shows the lateral extent and intensities of the chemical and thermal plumes at the end of 30 days. The staff's opinion is that the plant would meet Federal and State water quality standards under all conditions of minimum flow, including zero flow as discussed above. See 11.5.2 re operation of Melton Hill Dam.

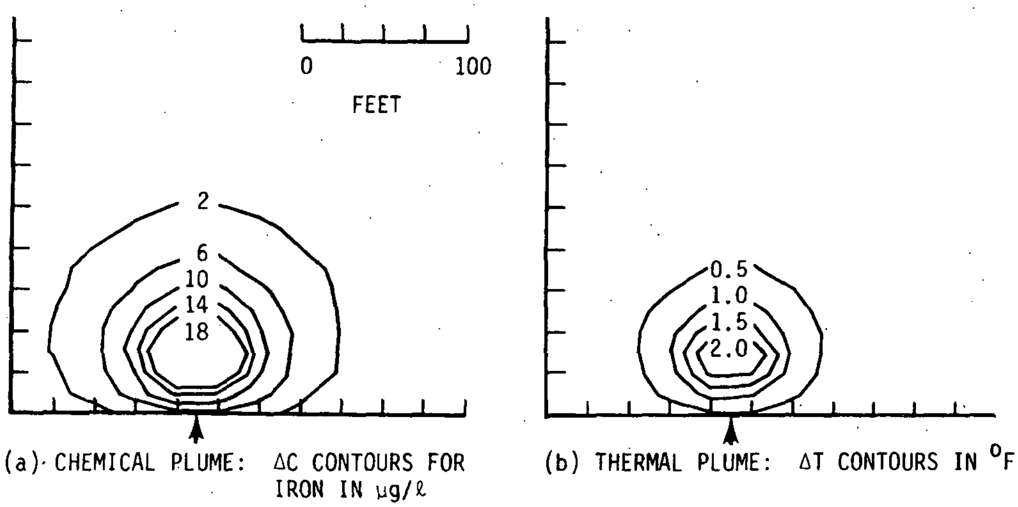


FIGURE 11.1 Chemical and Thermal Plumes, 30-Day No River Flow

11.5.10 Impacts of Cooling Water Discharge (PMC, A-92, Item 2)

Changes have been made in Sections 5.3.2.1 and 5.4.1 appropriate to assessments of the new cooling water discharge parameters (listed on page A-95, Item 5) which were determined following procurement of the turbine generator.

11.5.11 Cooling Tower Drift Rate (OR, A-41, Item 32)

The design drift rate for the cooling towers is 0.05% as quoted in Sections 3.4.1 and 5.3.3. That rate was also used in the drift impact analysis. However, based on recent field studies, measured drift rates are approximately an order of magnitude smaller. Therefore, the staff notes in Section 5.3.3 an anticipated drift rate in the 0.005 to 0.008% range.

11.5.12 Interaction With Atmospheric Plume from ORGDP (OR, A-41, Item 33)

The ORGDP dissipates a relatively large amount of waste heat compared to that expected from the CRBRP to the southeast. To dissipate the heat a relatively larger flow rate is needed at ORGDP, releasing large amounts of water vapor to the atmosphere via the evaporation process. In turn, relatively long plumes result. The CRBRP plumes would be much shorter. With a south or southeast wind, a very low probability may be expected for interaction of the two plumes.

11.5.13 Fog on Route 95 and Bear Creek Road (OR, A-41, Item 34)

The effects of fogging on Route 95 would be similar to those for ORNL. Where the highway crosses the Clinch River, the value for Melton Hill Dam is more appropriate. Since Bear Creek Road is separated from the CRBRP site by Chestnut Ridge, it probably would sustain no impact from the CRBRP cooling towers. Plume rise most likely would be enhanced from two parallel banks of five cells compared to a linear array of 10. The amended ER indicates that if a linear cooling tower array is used, it will consist of two cooling towers each with 14 cells. However, a circular array of cells also is under consideration. Section 9.4.1 reflects the change.

11.5.14 Chlorine in the Cooling Tower Drift (OR, A-40, Item 27)

The concentration of chlorine in the drift from the cooling towers would be about the same as that of most municipal water systems, normally not considered harmful for irrigation.

11.5.15 Long-Term Drift Deposition (OR, A-40, Item 28)

The statement (Section 5.3.3) takes an extremely conservative view of drift deposition by overlooking mineral leaching and runoff. In the long-term, accumulation in biological components probably would be unimportant to the health of the ecosystem because of the operation of those processes alone during the life of the project.

11.5.16 Drift Effects on Cave-related Species (BN, A-89)

The staff does not believe that cave-related species would be affected by cooling tower drift. Onsite caves are located approximately 1.1 miles north of the site. Entrance of drift directly into the cave environment would be unlikely because openings of the caves do not face the downwind traverse of the plume. At this distance and direction from the plant, if no hills existed between the caves and the plant, less than 7/lb/acre/month of total dissolved solids might conservatively be expected to be deposited. Most of it would be deposited on the surfaces of the leaves and trunks of trees in the area and would eventually be deposited in the litter. The deposits would be added to the minerals cycling in the soil-plant system. They would have minimal impact on the cave environment even if they entered the groundwater.

11.5.17 Downstream Chemical Concentrations (PMC, A-95, Item 8)

Section 5.4.1 has been revised to reflect new information supplied by the applicant in ER Amendment VI. Chemical concentrations would be almost fully diluted to ambient within 100 feet of the discharge.

11.5.18 Disposal of Nonradioactive Waste (TN, A-26, 28)

Cafeteria, office, other solid waste, and liquid waste not processed at the plant would be collected and disposed of offsite by a licensed contractor. The contract would be awarded by a competitive bidding procedure and the contractor would be required to have all necessary licenses. Offsite treatment and disposal of waste materials would conform to applicable regulations and should have minimal impact on the environment. Wastes disposed of offsite would be in solid form and small in volume relative to that from municipalities.

11.5.19 Medical Facilities (HEW, A-8)

As discussed in Section 7.1, the staff's objective in the safety review is to assure that accident risks with the CRBRP are acceptably low, comparable to light water reactors (LWRs). Burdens on facilities should therefore be no greater than those associated with LWRs, which thus far have been small.

11.5.20 Required Community Services (PMC, A-93, Item 3.E.1)

The staff concurs that other values for some DES Table 5.9 ratios may be equally as appropriate. In fact, using a range of values may be a more accurate way to make the presentation. The purpose of the table, however, is to point out that there are often public sector service costs that are overlooked, and in the absence of treatment of the topic in the originally submitted ER, the staff wishes to note the approximate magnitude of the services. The values recently provided by the applicant have been reviewed by the staff and found to be reasonable approximations (ER, App C).

11.5.21 Population Increase During Plant Operation (PMC, A-93, Item 3.E.2)

The staff analysis of population increase during plant operation is summarized in Section 5.6. In the judgment of the staff it is appropriate to consider a higher fraction of secondary workers attracted to the area than the values used by the applicant. The higher value is justified particularly in view of other projects contemplated for the area (Section 4.1). Therefore, the resulting impacts of this possibility must be assessed.

11.5.22 Personal Property Taxes During Operation (PMC, A-93, Item 3.F.1)

Section 5.6.1 has been modified to incorporate personal property taxes. Revenues from personal property taxes generally are combined with real property taxes.

11.5.23 In-lieu-of-Tax Payments by TVA (PMC, A-93, Item 3.F.2)

Since TVA will not be an owner of the CRBRP during the demonstration phase, there is no basis for TVA to make in-lieu-of-tax payments. (See PMC comments, Enclosure 5, on page A-100.) The last paragraph of Section 5.6.1 has been modified accordingly.

11.5.24 Reference to Radiation Pathway Model in Section 5.7 (AC, A-31)

ICRP Publication 2 (1959) presents models for calculating the dose to various organs from radionuclides once they have entered the body. Regulatory Guide 1.109 (March 1976) presents models for calculating doses to man from reactor effluents. WASH-1258 (1973) presents models for calculating doses to biota other than man from reactor effluents. The dose models in ICRP-2 are incorporated into the models presented in Regulatory Guide 1.109 and WASH-1258. These references are clarified in the FES.

11.5.25 Radiological Impact on Biota Other Than Man (NRDC, A-54)

Experts on the subject generally agree that the human dose limits are conservative for other species. The staff did not say that such conservatism is an established fact. We do, however, believe that the general agreement of experts is adequate and is the best evaluation available to date.

11.5.26 Concentration of Radioactive Elements in Wildlife (DOI, A-11)

Section 5.7.1.3 includes a discussion of the doses that might be received by wildlife in the vicinity of the plant. The doses estimated for biota other than man include bioaccumulation factors where they are known to be applicable.

11.5.27 Bioaccumulation Factor in Table 5.1 (ERDA, A-13)

Measurements taken to date have generated a wide range of values for bioaccumulation factors. ANL-75-3, part III, includes a statement that their data should not be used to estimate concentration factors. ANL-8060, part III, was a study of the Great Lakes; Clinch River presents a very different environment. The staff chose to use the well-recognized results presented in the reference cited in the DES to approximate the bioaccumulation factors for all sites. In any case, for the Clinch River plant, changing the bioaccumulation factor for plutonium in freshwater aquatic plants from 350 to 5000 would result in no increase in the dose to humans; the dose to fish, algae, and ducks would increase by much less than 1%. The staff is continually examining experimental data to keep our bioaccumulation factors up-to-date. Presently, neither sufficient data nor sufficient potential significance exist to warrant changing this factor.

11.5.28 Dispersion of Gaseous Releases (C, A-8)

While the frequency and duration of gaseous releases from the Radioactive Argon Processing System have not been determined, the staff considers the use of an annual average concentration factor (chi/Q) to be a reasonable approach in performing dose calculations at this stage of review considering the high degree of control that can be exercised with the small volume involved.

11.5.29 Dose to Most Critical Individual (EPA, A-22, Item 2)

In both the draft and final statements, the dose calculations are based on conservative assumptions regarding the dilutions of radionuclides in the liquid discharge and effluent gases and the use by man of the plant surroundings. This conservatism includes the use of above average ingestion rates and above average time spent in the plant environs. Age groups corresponding to adults, teens, children, and infants are evaluated depending on the pathways and the radioisotopes involved.

The sentence from the draft statement which is quoted in the comment by EPA has been corrected in the final statement. For the CRBRP in general, the doses presented in the statement are for an adult. In the FES, an adult was used as the receptor ("most critical individual") for all pathways except ingestion of milk from cows drinking Clinch River water. An infant was taken as the receptor for the cow-milk-pathway case.

11.5.30 Occupational Radiation Exposure (NRDC, A-55)

Section 5.7.2.5 is not intended to show that the facility meets the requirements of 10 CFR 20 regarding occupational radiation exposure. Nor is it intended to demonstrate that the plant design will lead to "As Low As Reasonably Achievable" occupational radiation exposures. This section does present an estimate of the occupational radiation exposure which can be used to assess the environmental impact of the plant. Chapter twelve of the Clinch River PSAR describes the radiation protection design of the plant; the staff's evaluation of this design will be presented in its SER.

As stated by NRDC, its petition requesting lower occupational radiation exposure limits is pending before the Commission. Clinch River and all other plants will be required to meet the radiation exposure limits decided upon by the Commission. Until such time as a decision is made, the staff's evaluation will be based on the current regulations.

11.5.31 Radioactive Waste Transport Route (NC, A-24)

If a transportation route for new or spent fuel or radioactive waste is selected through North Carolina, the applicant states that appropriate state authorities will be notified (Caffey, May 19, 1976).

11.5.32 Summary of Annual Radiation Doses (EPA, A-18; NRDC, A-55)

The responses given below are related by number to the NRDC comment items on page A-55.

1) An estimate of the cumulative dose to the U.S. population due to CRBRP's releases is included in FES Section 5.7.2.8.

2) The population dose estimates presented in Chapter 5 represent the 50-year dose commitment associated with the population's annual exposure to and uptake of radioactivity at the midpoint of plant-life. Thus, the dose estimates have considered the total release to the end of plant-life and the projected population. The staff considers these estimates to be an adequate evaluation of the environmental impact.

3) Calculation of health effects from very low level population doses is subject to great uncertainties. The staff feels that a presentation of relative impact (i.e., comparison with natural background radiation) is sufficient. Exposure of workers at nuclear facilities is carefully monitored and controlled. The occupational exposure limits stated in 10 CFR 20 are based on the recommendations of international bodies of experts and are believed to result in minimal risks to individual workers.

4) See Section 11.11.3 for a discussion of doses associated with the supporting fuel cycle (Appendix D).

5) The staff believes the FES adequately documents the references, methodology, and assumptions necessary to make a critical evaluation of the radiological impact of the plant.

11.6 ENVIRONMENTAL MEASUREMENT AND MONITORING PROGRAMS

11.6.1 Radionuclide Analyses (ERDA, A-13)

The monitoring program for Clinch River includes analyses for Sr-89, Sr-90, H-3, Pu, U, and at least ten gamma emitting nuclides. The staff finds these analyses of specific radionuclides to be adequate.

11.6.2 Radiological Monitoring of Filter Feeders (C, A-7)

The Asiatic Clams entry in Table 6.2 was not clear. The clam meat will be analyzed for gamma emitting nuclides, gross beta, and gross alpha. Only the shells will be analyzed for Sr-89, Sr-9 and Pu. Only very small quantities of Pu are expected to be found; the gross alpha measurement will detect Pu along with the other alpha emitters. If the gross alpha measurements are higher than expected, more analyses of the plutonium isotopes would be required.

11.6.3 Surface Water Radiological Monitoring (DOI, A-10)

Revised Table 6.1, along with Figures 6.1 and 6.2, should adequately identify the reservoir locations where samples will be taken. Consideration will be given to monitoring storm drainage from buildings and yards in design of the operational monitoring program.

11.6.4 Environmental Monitoring for Tritium (EPA, A-20)

The staff has estimated that the CRBRP gaseous releases will contain substantially less tritium than gaseous releases from light water reactors. For light water reactors, we do not require tritium analysis of soil, vegetation, pasture grass, milk, or food crops unless the dose assessment suggests that these pathways are significant. As indicated in the DES, our assessment shows that the total maximum dose from these pathways is very small. The ER states that Clinch River water is not used for irrigation, although river water is pumped to cattle to drink during periods of low groundwater. Our assessment indicates that the total maximum doses from the milk and meat from this pathway are very small. Therefore, the staff believes that the tritium monitoring system is adequate.

11.6.5 Preoperational Radiological Monitoring (TN, A-25)

As stated in the DES, the purpose of the preoperational radiological monitoring program is to identify background levels of radioactivity and radiation. Input to the decision to operate the CRBRP is not a purpose of the program; the program does not need to start until two years before plant operation.

11.6.6 Health Survey (ECNP, A-45, Item 3)

A health survey identifying health effects from nuclear plants would be extremely difficult, if not impossible, to perform because releases from nuclear facilities are limited to values which should result in no detectable effects on surrounding populations. The radiological environmental monitoring system presented in the FES will monitor the significant pathways by which humans might be exposed to or intake radioactivity originating at the plant.

11.6.7 Enforcement of Applicant's Monitoring Programs (NRDC, A-55)

The environmental radiological monitoring program would be part of the plant's technical specifications. The Office of Inspection and Enforcement of NRC is responsible for ensuring that applicants fulfill the program as set forth in the technical specifications. Further discussion of the enforcement program is not appropriate to the purpose of this statement.

11.6.8 Modifications to Meteorological Tower (PMC, A-97, Item 22)

Section 6.1.3 has been revised to include new information supplied by the applicant in ER Amendment VI.

11.6.9 Commercial Fisheries (C, A-7)

The applicant's operational monitoring plan encompasses the number of species composition (including commercial species) of adult, juvenile and larval fish in the vicinity of the plant site. The staff's opinion is that monitoring required under the NRC technical specifications at the operating license stage, together with the monitoring prior to construction (Section 6.1.4.1) and operation, would provide adequate information for detecting CRBRP-caused changes in commercial fisheries and assessing their significance.

11.6.10 Heavy Metals in Biota and Sediments (C, A-7)

The staff agrees that analyses would be necessary to detect effects of heavy metals released from the plant. The necessity for appropriate measurements will be considered by the staff when devel ing technical specifications at the operating license stage.

11.6.11 Groundwater Monitoring (DOI, A-10)

All water requirements for plant operation would be met by the Clinch River (Section 3.3). Consequently, the plant would have no direct or indirect interactions with the aquifer and would produce no changes in groundwater levels. The potential for water quality changes in the river and the groundwater resulting from plant chemical releases is extremely remote. Since the anticipated releases would meet State and Federal standards, there is little basis for requiring the applicant to perform monitoring additional to that outlined in Section 6.2; however, the need for such monitoring would be considered during the operating license review.

11.7 ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS

PLANT ACCIDENTS

11.7.1 Acceptability of Reactor Accident Risks (EPA, A-15, A-20; DOI, A-10; TN, A-25; CC, A-44, 45)

Several comments on the DES indicate that, because of inexperience with the LMFBR concept, the discussion in Section 7.1 does not provide assurance that accident risks would be acceptably low. In particular, Concerned Californians expressed the view that the potential impact of accidents on the environment beyond the plant site had been ignored. This is so contrary to the intent of NRC that a summary of the safety review procedures and the principles on which they are based is provided here. The safety review is normally carried on in parallel with the environmental review.

The NRC does not ignore the potential impact of accidents beyond the confines of the plant site and did not intend to leave that impression in the DES. A principal safety objective of the NRC in reviewing the design, construction, and operation of nuclear power plants is to protect the health and safety of the public. This objective is achieved through a defense-in-depth concept whose starting point is the requirement that a nuclear plant be designed and built so that, with a high degree of reliability, it will operate without failures or malfunctions that could lead to accidents. The next level of safety is based on the belief that it is prudent to anticipate that some incidents or malfunctions will occur during the service life of a nuclear plant and to provide measures to cope with such events. The third level of safety supplements the first two by incorporating additional systems and margins in the plant design to protect the public even in the event certain highly unlikely accidents should occur. To establish these additional margins, major failures of plant components and systems are postulated and the accident sequences that would follow therefrom are analyzed. A series of postulated events is established as a set of design basis accidents, and safety systems are designed to control them.

The radiological consequences of these design basis accidents are compared to the exposure guidelines given in 10 CFR Part 100, "Reactor Site Criteria," which contains the Commission's principal safety requirements for the siting of nuclear power plants. 10 CFR Part 100 requires that an exclusion area and a low population zone be specified for a nuclear power plant site. The sizes of the exclusion area and the low population zone are determined by assuming a fission product release hypothesized for purposes of site analysis, or postulated from consideration of possible accidental events, that would result in potential hazards not exceeded by those from any accident considered credible.

An exclusion area is defined as that area surrounding the reactor in which the reactor licensee has the authority to determine all activities including exclusion or removal of personnel and property from the area. Residence within an exclusion area is normally prohibited. The exclusion area is of such size that an individual located at any point on its boundary for two hours immediately following onset of the postulated fission product release would not receive a total radiation dose in excess of 25 rem to the whole body or 300 rem to the thyroid, or equivalent doses to other organs (150 rem to bone and 75 rem to lungs).

A low population zone (LPZ) is defined as the area immediately surrounding the exclusion area which contains residents, of which the total number and concentration are such that there is a reasonable probability that appropriate protective measures can be taken in their behalf in the event of a serious accident. The LPZ is of such size that an individual located at any point on its outer boundary who is exposed to the radioactive cloud resulting from the postulated fission product release (during the entire period of its passage) would not receive a total radiation dose in excess of 25 rem to the whole body or 300 rem to the thyroid, or equivalent doses to other organs.

Another basic objective of the criteria in 10 CFR Part 100 is to assure that the cumulative exposure dose to large numbers of people as a consequence of any nuclear accident should be low in comparison with what might be considered reasonable for total population dose. This objective is achieved by specifying that the distance from the reactor to the nearest boundary of a densely populated center 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. Where very large cities are involved, a greater distance may be necessary because of the total integrated population dose consideration.

An exclusion area of 1364 acres with a minimum exclusion distance of 670 meters (2,200 feet) and an LPZ of 2.5 miles have been specified by the applicant for the CRBR site. Oak Ridge, Tennessee, is the nearest population center to the site. Conformance of the CRBR exclusion area, LPZ and population center with the requirements of 10 CFR Part 100 is being evaluated by the staff as part of the radiological safety review. At the present time, the staff does not believe that a 50-mile "zone of special protection" suggested by Concerned Californians is necessary (See 11.12.9 and 11.12.10 for discussions of emergency preparedness plans and insurance liability).

The staff believes that through the safety review process CRBR accident risks can be made acceptably low, comparable to LWRs. EPA was in error when it stated in its cover letter, paragraph 3 (page A-16), that "the NRC was unable to conclude...that risks from reactor core disruptive accidents will be acceptably low." It appears that the basic thrust of Section 7.1 has been incompletely understood. The last paragraph of DES Section 7.1 states the following:

> "The design information and evaluations available at this time have been reviewed. Our preliminary conclusion is that the accident risks can be made acceptably low through a combination of methods. It is expected that the Commission's safety evaluation can provide the basis for determining what plant features and research and development programs are acceptable in this regard. As the safety review progresses and the design develops, more precise assessments will be performed to confirm this preliminary conclusion."

Similarly, Concerned Californians and the Tennessee Department of Public Health expressed the view that the experimental nature of the plant increases the risks to an unacceptable level. However, the experimental and developmental nature of the plant is fully factored into the review procedures outlined above. In the final analysis, the CRBRP is being treated by the NRC with the same regard for public safety as applies to any other project. At the top of page 8 of the EPA comment letter (p. A-20), it was stated that LMFBR siting questions are considerably different from those relevant to LWR siting. We are not aware of any technical basis for this view. However, the design differences between LWRs and the CRBR have been considered by both the applicant and the staff, resulting in, for example, a set of general design criteria* to be applied specifically to the CRBRP. Both the applicant's objective and the NRC requirement are to assure that accident risks are acceptably low for the proposed reactor at the proposed site.

With regard to the dose guidelines identified for bone (Table 7.2, footnote 5), it should be noted that these guidelines have been used on various cases since the early 1960s. While this matter is properly a subject of the safety review effort, additional discussion is provided in Section 11.7.5.

The Department of the Interior noted that events cited on DES page 7-8 could have consequences greater than 10 CFR 100 guideline values. That discussion referred to core melt accidents of the sort generally reviewed in WASH-1400 for LWRs. A considerable discussion of this subject was provided to indicate the general nature of the risks associated with this type of event and the measures available to mitigate these risks, should the staff's review indicate a need to do so. WASH-1400 was discussed only as required to provide better perspective of such risks and to illustrate one assessment of the results of implementing the staff's safety criteria.

In summary, the potential accident risks in the CRBRP will be reduced to an acceptable level by incorporating the necessary safety features. In doing this, a conservative analysis is introduced where lack of experience prevents a precise analysis. Such analyses assure that safety features are provided which will mitigate these conservatively calculated accident consequences to acceptable levels.

---

*Clinch River Breeder Reactor Plant Design Criteria issued by the Division of Project Management, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, January 9, 1976.

11.7.2 Comparability of Accident Risks to LWRs (HEW, A-8; EPA, A-19; TN, A-26; ECNP, A-46)

The Environmental Coalition on Nuclear Power raises questions about how the accident classes are determined, particularly class 9 accidents. The classification of accidents into classes 1-9 is based on the expected frequency and consequences of the accidents. The frequency of occurrence is estimated principally from:

(a) frequency of failures noted for similar equipment in other plants
(b) the active or passive nature of the equipment
(c) operating stress levels.

The classification in Tables 7-1 and 7-2 of the DES was developed by the staff. While Table 7.1 does not specifically identify events in the Class 9 category, there is a considerable discussion of such events in the body of Section 7.1.

The staff agrees with the EPA comment that the DES did not provide "convincing assurance that CRBRP accident risks are comparable to those from LWR's or can be made comparable without incorporating the 'parallel design' features." However, we do not agree that the DES was incomplete, inasmuch as accident risks were discussed with the CRBR having, and alternatively not having, specific features to accommodate core disruptive accidents. The staff's safety review is being carried on in parallel with the staff's environmental review. We believe it is appropriate to continue to present the results of our review of proposed safety R&D needs and related matters of the design in, and as part of, the safety review process. The results to date were reported in the DES. The FES provides, where appropriate, updated information outlining the more recent results of the staff's review process. The results of the staff's safety review will of course be more fully discussed in the Safety Evaluation Report.

The NRC's basic position with regard to the CRBR and plant accidents involving radioactive materials is that accident risks in the CRBR must be acceptably low, comparable to the current generation of light water reactor (LWR) plants. During the course of our radiological safety and environmental review, a major portion of the review is being devoted to the prevention of accidents leading to core melt and disruption, for a wide range of possible initiators.

Based on the evaluation to date, the staff has identified some needed features and characteristics. These include (1) the provision of at least two independent reactor shutdown systems, (2) the provision of at least two independent decay heat removal systems, (3) means to detect and cope with subassembly faults and to protect against progressive subassembly fault propagation, (4) maintenance of a high level of heat transport system integrity including, if necessary protective features to cope with pipe failures, and (5) protection of the containment system from the effects of sodium releases.

The NRC's current position concerning core disruptive accidents (CDAs) is that the probability of core melt and disruptive accidents can and must be reduced to a sufficiently low level that they need not be considered in the spectrum of design basis accidents. Nevertheless, because of the difference in the state of technology and experience between LMFBRs and LWRs, the consequent inability to evaluate the safety of the CRBR design as precisely as can be done for LWRs, and the absence of a quantitative risk assessment based on experience and data such as the Reactor Safety Study for LWRs, prudence dictates that additional measures be taken to limit consequences and reduce residual risks from potential CRBR accidents having a lower probability than design basis accidents. The basic approach will be to protect the containment system from the unique effects of CRBR core disruptive accidents in order to maintain comparability with LWR safety.

It does not follow, as suggested by HEW, that just because the CRBRP is a developmental facility, accident probabilities will be higher. As discussed in the DES, it is the staff's objective to assure that the accident risks in the CRBRP are acceptably low, comparable to LWRs.

We would agree with a conclusion that, if core disruptive accidents are likely, the project should be delayed. However, for reasons described in the DES (see for example, the last para. of Section 7.1), the staff has concluded that the likelihood of such an event is very low.

11.7.3 The Feasibility Of Accident Assessment At This Time (DOI, A-10; EPA, A-17, 20; TN, A-30; NRDC, A-49, 56, 57)

A number of respondents raised the question of whether the DES was premature on the basis that, at the time of the DES, the designation of design basis accidents (DBAs) had not been made firm and, consequently, several design features remained as options. The safety review was not completed, and future R & D programs were alleged to be unspecified. The NRC customary procedure, which is being followed in the CRBR case, is for the safety review to proceed in parallel with the environmental review.

These reviews must reach a stage where the project can be approved in both respects before construction can proceed. The environmental review may presume that adequate safety standards will later be shown to be met, or the project abandoned. There is a risk in this procedure in that a limited work authorization (LWA) allowing site preparation can be granted on the basis of acceptable environmental and site safety reviews, but a construction permit, allowing structural work to proceed, must await completion of the safety review. The rationale for an LWA is based on the premise that the risk of initial site preparation prior to completion of the full safety review is an acceptable risk, and this risk is actually assumed by the applicant if he proceeds under an LWA.

In response to the Department of the Interior and EPA, we reiterate that it is the objective of the Commission's Safety Evaluation to determine whether the risk from potential accidents is acceptable. The DES summarized the then-current status of the staff's review, emphasizing those elements of the CRBR which were regarded as of greatest significance. Because the facility has significant developmental aspects, the DES discussion necessarily was less firm regarding the specific event consequences and risks. However, in an attempt to assure that the discussion was complete, greater emphasis (as compared with typical LWR statements) was placed on the staff's requirements and criteria, and the relevant factors being considered in the safety review process.

EPA raised the issue of incompleteness of the design and of the programs for future R&D. The staff responds that they have now progressed sufficiently in their safety review to allow preparation of the FES. One set of findings from this review will be documented in a site suitability report which will be issued about the same time as the FES and will detail the major elements of the safety review and its decisions. The requirements for safety related research and development efforts are estimated by the applicant in section 1.5 of the PSAR and will be reviewed by the staff in the SER.

As is indicated in Section 7.1, there remain to be conducted areas of R&D necessary to resolve present uncertainties and to confirm the adequacy of various design features of the CRBRP. Since the CRBRP is a developmental facility to be licensed under Section 104.b of the Atomic Energy Act it is to be expected that the R&D needs will be more extensive than found in a typical LWR application. However, it is required, prior to the granting of a construction permit, that the staff conclude that the schedule of proposed R&D is sufficient to provide reasonable assurance that the plant can be constructed and operated safely in conformance with applicable NRC criteria.

EPA (third paragraph, p. A-20) suggested incompleteness in the presentation of the range and basis of test data. The accidents analyzed in Table 7.2 were drawn from the examples in Table 7.1 and were, as in the case of LWRs, included with the intent of indicating representative consequences for the various classes of events in Table 7.1. To do so required that specific numerical estimates be made for various parameters. Key parameters are listed in the FES. We do not believe it appropriate, given the general nature of these evaluations, to include a detailed survey of the experimental data relative to selected parameters. However, the applicant's ER and PSAR do provide considerable information of this type.

The comment that the environmental statement will be precedent setting appears at odds with the earlier EPA suggestion that precedent-setting concerns should not be factored into the decisions on safety requirements.

The Tennessee Wildlife Resources Agency questioned "the advisability of commitment to a project with this inherent danger (from radiation) until greater assurance than 'preliminary' can be provided for the future safety of the affected resources."

Words such as "preliminary" were used in the DES because the safety review, being conducted in parallel with the environmental review, had not progressed sufficiently to permit more conclusive findings. Before a construction permit is granted, it will be necessary for the applicant and staff to conclude that there is reasonable assurance that the reactor can be constructed and operated without undue hazard to the public (and, by implication, fish and wildlife resources).

In the NRDC comments on pages A-49, A-56 and A-57, essentially all of the above topics were raised, namely the completeness of the safety review, the design, the R&D programs and the status of DBAs. The staff believes the discussions above adequately respond to them.

11.7.4 Adequacy Of Criteria And Standards (AR, A-5; EPA, A-17, 20; ECNP, A-46)

In particular, the Army Corps of Engineers pointed out that the statement does not reference any codes and standards for building and fire protection. The PSAR, Chapter 3, identifies the applicable codes being used in the CRBRP design: Standard (Southern) Building Code, American National Standards Institute requirements, and the National Fire Protection Association Codes. The applicant states (Caffey; May 19, 1976) that the use of combustible materials would be maintained at the minimum practicable, and that fire detection and protection measures of appropriate capabilities and capacities have been incorporated in the design. These features are being examined as part of NRC's safety review, and the results will be included in the staff's Safety Evaluation Report on the CRBRP.

The Environmental Coalition questioned whether it is adequate to rely on rigorous design codes and standards for LWRs in view of their generally low capacity factors and the occasional occurrence of incidents such as Brown's Ferry, and inquired if independent testing is used to assure compliance with codes. The application of codes and standards is only one element in the total design safety picture that also includes elements of judgement and experience. To allow for the inability to codify and standardize every element, design safety margins are incorporated in the form of extra strength, redundancy, diversity, etc. These design margins have been sufficient in the case of LWR's to assure that public safety has not been violated, even when components have led to down time as a result of failure, incipient failure or questionable reliability. The referenced paragraph of the DES asserts that the standards currently applied to LWR's will be applied to CRBRP where appropriate, and that new criteria will be developed where necessary because of new conditions of operation. The point here is that every effort will be made to assure that CRBR will operate at the same high level of public safety and with the same design safety margins as have been achieved for LWR's. No consideration will be given by NRC to achieving high capacity factors at the expense of safety.

In regard to independent testing, the acceptance of a code by NRC generally implies that NRC considers the amount of testing specified in the code to be adequate. Where inadequacies are foreseen, the code may be rewritten to include more testing, or supplemental testing programs may be specified in the design requirements of the plant.

EPA alleged that the lack of detailed design information limits the accuracy of the assessment of the environmental impacts of accidents. The staff agrees. However, as noted in the DES, it was concluded that the risks associated with accidents could be made acceptably low. 10 CFR 100 can be applied to LMFBRs (it has been so used previously) provided that due allowance is made for the limited experience with this type of plant. It is considered by the staff to be fully applicable to the CRBRP. The principles inherent in 10 CFR 50 Appendix I can also be applied to LMFBRs; for more discussion of this matter, see 11.3.8 on page 11-8.

11.7.5 Plutonium Dose Guidelines (ERDA, A-14; EPA, A-20; TN, A-30; OR, A-39; CC, A-44; NRDC, A-57)

Questions were raised concerning bone doses (EPA), lung doses due to hot particles of alpha-active materials (NRDC) and plutonium doses generally (Concerned Californians).

The potential hazards of plutonium are duly recognized. Since the harmful alpha-radiations from plutonium have a short range (a few centimeters in air), its presence in the reactor presents no public hazard. The ICRP and NCRP have recommended limits for the allowable body burden of plutonium, and these recommendations are based on a substantial history of human and animal exposures. The CRBR plant is designed so that under normal conditions no plutonium is released, and even under credible accident conditions, releases would be limited to quantities below those that could cause the ICRP/NCRP allowable body burden to be reached in members of the surrounding population.

The NRC has formally responded to the NRDC petition on the so-called "hot-particle" thesis. Subsequent to the receipt of comments on the DES, the petition referred to has been denied (see Federal Register 41, p. 15371, denial of NRDC's Petition for Rulemaking, 12 April 1976). In denying the petition, NRC stated in part that "NRC's... present standards for long-lived, alpha emitting radionuclides in insoluble form are, with respect to the spatial distribution of dose, radiobiologically sound and that the NRDC corollary to the hypothesis describing an injury mediated mechanism of carcinogenic response to alpha emitting particles is speculative and not supported by the body of scientific data and knowledge on this subject. Consequently, the NRDC position does not provide a sufficient scientific basis for changing or supplementing existing radiation standards", and that "the (NRDC) corollary to the hypothesis is shown in the (NRC's) analysis to be based on a pattern of arbitrary interpretations of selected portions of the available information."

The staff does not feel that further discussion of the "hot particle" theory is necessary in the environmental statement or in response to the comment. The staff uses the latest recommendations of the ICRP in preparing the method of estimating the dose equivalent to bone. To date, the ICRP has not recommended the method of estimation presented by Dr. Karl Z. Morgan.* However, the staff is independently evaluating Dr. Morgan's presentation and maintaining communication with other experts in the field of plutonium dosimetry. The staff will implement any part of Dr. Morgan's methodology that is adopted by the NCRP/ICRP.

The staff in its May 6, 1976 letter to the applicant specified that plutonium dose values 1/10 of those identified in the DES (Table 7.2, footnote 5) were to be used at the CP stage of review. This is believed to provide a large margin for uncertainties that may pertain to the site suitability and CP stage assessments. (See Appendix I)

The Tennessee Wildlife Resources Agency raised a question about the environmental hazards of long half-life substances. However, the half-lives and generic pathways of all relevant isotopes are taken into consideration in the accident calculations of the safety evaluation. Oak Ridge requested clarification of the dose units used. The staff response is that condition (c) on page iii refers to an individual, generally assumed to be at the nearest site boundary. This is clarified in Section 7 and in the Summary and Conclusions.

In response to the ERDA comment on page A-14, population dose estimates are included in the FES.

11.7.6 Design Details Affecting Accident Analysis (ECNP, A-46; PMC, A-97; DH, A-101)

The Environmental Coalition raised the question of the inclusion of a core catcher in the design, and the use of TNT equivalence in accident descriptions.

Whether a "device" such as a core catcher is important from a safety standpoint depends in great measure on the likelihood of events leading to core melting and on the relative consequences (and risks) with and without such a device.

Subsequent to publication of the DES, the applicant has submitted a design that merges some features of the parallel design and some additional safety features with the reference design. This is the design that is now under consideration for final evaluation. The merged design has a containment - confinement system with provision for scrubbing and filtering the containment atmosphere in the event of an accident. The reactor cavity would be steel-lined, but would not include a core catcher, as suggested in the parallel design. The staff has never recommended that a core catcher be required, but will evaluate the design submitted and will require whatever features, if any, are needed to provide insulation, containment, dilution or heat dissipation.

TNT equivalence has not been found to be a suitable means for characterizing the structural damage consequences of nuclear reactor accidents. The structural response of components is evaluated by a more appropriate and somewhat more sophisticated procedure, taking into account the time scale on which the energy is transmitted, and the detailed time displacement and structural response of the reactor components, heads, seals, etc. The conservative use of this approach leads to a more realistic evaluation of containment integrity under accident conditions than TNT equivalence.

The applicant pointed out that the decay-heat removal system includes features not addressed in the DES. The staff acknowledges this point and has revised the description of this system in Section 7.1.

11.7.7 Quality Assurance (ECNP, A-46)

The Environmental Coalition raised the question of whether quality assurance would be compromised by the pressures of manufacturing economics and scheduling. This subject is extremely important in assessing the second level of safety and is appropriate for consideration in the safety review rather than the FES.

---

*Dr. Morgan's examination of the comparative toxicity data for radioactive substances in animals and man has led him to the conclusion that a number of known physiological differences affecting this toxicity have not been properly taken into account. Such differences between animals and humans as the inhomogeneity of plutonium deposition, the surface-to-volume ratio of trabecular bone (the tissue in which it is believed most bone cancers originate), the rate of burial of deposits of α-emitting radionuclides by growth of new bone, and the general sensitivity levels of the tissues of higher primates compared to dogs are alleged by Dr. Morgan to be omitted from the considerations on which the acceptable doses are based. He suggests that a proper accounting of these differences would reduce the acceptable bone dose of plutonium in humans by over two orders of magnitude. (Morgan, Karl Z., "Suggested Reduction of Permissible Exposure to Plutonium and Other Transuranium Elements," Journal of American Industrial Hygiene (August 1975).)

11.7.8 Table 7.1 (PMC, A-97, Item 23A)

The examples of Class 4 accidents in Table 7.1 were included because the safety review effort had not progressed sufficiently to permit agreeing with the project view that no fuel failures would occur. Further, any of the listed events could be considered as off-design transients.

The core component pot leak is generically a refueling accident inside containment and hence is appropriately listed.

11.7.9 Table 7.2 (PMC, A-97, Item 23B)

The possible action of the CAPS was ignored as its functioning is not assured through ESF grade components.

11.7.10 Accidental Releases of Stored Noble Gases (EPA, A-20)

EPA suggested that the impact of a storage tank rupture should be considered. The staff did consider a postulated storage tank rupture; however, it was judged that the event analyzed as 3.3 in Table 7.2 was of greater significance and was a more representative event of this category.

11.7.11 Table 7.3 (PMC, A-97, Item 23c)

It appears that the intent of Table 7.3 item C needs clarification. At the time of writing the DES, insufficient progress had been made for the staff to share the conclusions in the PMC comment concerning "reactivity transients" and "single unlikely faults." The related discussion in the FES has been expanded.

11.7.12 Seismic Considerations (NRDC, A-52)

NRDC stated that the staff should discuss the earthquake aspects of the analysis. As indicated on p. 2-8, the parallel safety review will cover the seismic aspects of the plant. It has been determined that an earthquake of intensity MM VIII with a horizontal ground acceleration of 0.25g is appropriate for CRBR structural design. Plant features required to maintain containment and essential heat sinks will be required to be designed to withstand such accelerations without serious risk to the public or to the environment.

11.7.13 Sodium Behavior (CC, A-44)

Concerned Californians noted the incompletely known behavior of sodium and the possible volatility of this substance. Sodium is not volatile in the sense of readily evaporating to generate pressures within the reactor vessel. Research and development on the behavior of sodium and its reaction products are continuing. However, it is possible to place limits on the consequences of its reactions. As discussed in the DES, the staff believes that these features can be accommodated by accepted engineered methods.

11.7.14 Self-Activated Shutdown Systems (EPA, A-19, 20)

To the staff's knowledge, self-activated shutdown systems are not developed sufficiently to be factored into the design of CRBRP. The applicant has not incorporated such a system in his proposals and they are not being considered by NRC in connection with the licensing of CRBRP.

11.7.15 Flooding (DOI, A-10)

The Department of Interior noted that the statement does not contain a detailed flood analysis, and inquired whether pumphouse flooding would be a safety problem. As part of its safety review, the staff has independently evaluated the water level at the site, and has determined that all safety related structures are protected from the design basis flood. The water intake pumphouse is not a safety related structure and is not required for plant shutdown. Adequate emergency water supplies are available on site, independent of the river intake, and above the level of the design basis flood.

11.7.16 Emergency Preparedness Plans (OR, A-38; CC, A-45)

NRC regulations require that plans for coping with emergencies be addressed in both the Preliminary and the Final Safety Analysis Reports. Thus, applicants for a construction permit (CP) are required by Section 50.34(a) of 10 CFR Part 50 to include a discussion of their preliminary plans for coping with emergencies in the Preliminary Safety Analysis Report rather than in the Environmental Report. Furthermore, applicants for an operating license (OL) are required by Section 50.34(b) of 10 CFR Part 50 to submit their plans for coping with emergencies with their Final

Safety Analysis Report. (cf. Regulatory Guide 1.70, Rev. 2, Section 13.3.) The requirements to be addressed by an applicant, at both the CP and OL stage, are set forth in Appendix E to 10 CFR Part 50. In addition, the Commission has issued Regulatory Guide 1.101 "Emergency Planning for Nuclear Power Plants" for the purpose of providing detailed guidance to applicants for the preparation of plans to cope with emergencies. The regulatory requirements and guidance contained in the aforementioned documents addresses those matters contained in the comments pertaining to emergency preparedness received from the City of Oak Ridge and Concerned Californians.

As noted in Regulatory Guide 1.101, emergency planning criteria are based upon the recognition that the nuclear facility operator has a primary responsibility for planning and implementing emergency measures within the site boundary. These measures include protective and corrective actions onsite as well as aid to affected persons onsite.

Since facility operators may require assistance in dealing with emergencies, their planning normally includes arrangements with offsite organizations for such services as ambulance, medical, hospital, fire, and police.

In addition, the facility operator has a primary role with respect to accident assessment. This includes prompt action to evaluate potential risks to the public health and safety both onsite and offsite, and timely recommendations based upon coordinated planning to State and local governments concerning offsite protective measures. The NRC staff considers it reasonable and sufficient that the scope of such emergency preparedness efforts should be based on the potential consequences of accidents of severity up to and including the most serious design basis accidents analyzed for siting purposes in the Safety Analysis Report. Consistent with the above, the NRC staff in its safety review of an applicant's plans for coping with emergencies, must be able to conclude that there is a reasonable assurance that appropriate protective measures can and will be taken both onsite and offsite in behalf of the public health and safety.

11.7.17 Insurance Liability (OR, A-38; CC, A-45, Item E)

Under the Price-Anderson Act, there is a system of private insurance and government indemnity totaling at present $560 million to pay public liability claims for personal injury and property damage resulting from a nuclear incident. Under this law, owners of commercial nuclear power plants having a rated capacity of 100 electrical megawatts or more must provide proof to the NRC that they have private nuclear liability insurance, or another form of financial protection approved by the NRC, in an amount equal to the maximum amount of insurance available from private sources, currently $125 million. In addition, a licensee is required to execute an indemnity agreement with the NRC which provides up to but not more than $500 million in Government indemnity to satisfy public liability claims in excess of the amount of insurance or other financial protection required of the licensee. As a licensed facility, the operators of CRBRP will be expected to meet the above requirements of the Price-Anderson Act including the execution of an indemnity agreement with the Commission. The Price-Anderson Act provisions would, therefore, apply to any nuclear incident occurring at the CRBRP.

On December 31, 1975, Public Law 94-197 was enacted into law. This legislation, which extends the present Price-Anderson legislation for ten years to August 1, 1987 provides, among other things, for the phasing out of Government indemnity through a mechanism whereby the utility industry would collectively share in the risk of damages from a nuclear incident exceeding the basic amount of private insurance available through the payment of a retrospective premium to the insurance pools. The Commission must establish before December 31, 1976, a retrospective premium figure of between $2 million and $5 million per reactor. As a licensed facility, the CRBRP would be assessed this premium in the event of a nuclear incident resulting in damages exceeding the amount of the current $125 million primary insurance layer.

P.L. 94-197 also provides that the present $560 million limit on liability for a single nuclear incident be retained until the combined primary and retrospective insurance layers reach the $560 million level. After that point the limit on liability would rise corresponding to increases in the primary and retrospective insurance layers. While no ultimate dollar limit on liability would be set, there is also no liability on the part of the licensees above the limit of liability, whatever it may be.

Concerning the liability of the other participants in the CRBRP project, through an "omnibus coverage" feature, the basic financial protection and Government indemnity would extend not only to the licensee, but to "any other person who may be liable." For example, should offsite damage be caused by failure of a component, the public would presently have up to $560 million available to pay claims even though the vendor of the component might otherwise be without substantial coverage. The licensees of the CRBRP would not be exempt from claims for offsite personal injury or property damage up to the limit of liability.

Concerning the question about the prompt settlement of claims, it is impossible to determine how soon after a claim is submitted to the insurance pools who provide the basic $125 million insurance and the Commission settlement would be made. Settlement would depend on the nature and facts for each specific claim. The insurance pools are usually notified by letter from a claimant or his attorney as to the nature of the claim. The pools then investigate the claim either directly or by relying on outside claims investigation organizations.

If a nuclear incident occurred in which it were likely that the liability may exceed the current $125 million insurance maintained by the operators of large power reactors, the incident would undoubtedly qualify as an "extraordinary nuclear occurrence" as defined in Subsection 170 n. and o. of the Atomic Energy Act of 1954, as amended and 10 CFR Part 140 of the Commission's regulations. If the Commission determines that an extraordinary nuclear occurrence has taken place, the U. S. District Court in the district where an extraordinary nuclear occurrence has taken place has original jurisdiction of any public liability action arising out of or resulting from the occurrence. When the court determines that public liability from a single nuclear incident may exceed the limit of liability, currently $560 million, total payments of up to 15 percent of the limit can be made by or for all indemnitors without the prior approval of the court. Payments in excess of that figure may be made only after a determination by the court that such payments are or will be in accordance with a plan of distribution which has been approved by the court or that such payments are not likely to prejudice the subsequent adoption and implementation by the court of a plan of distribution.

11.7.18 Packages of Radioactive Materials Shipped (OR, A-41, Item 35a)

As of April 1976, based on ERDA surveys of spent fuel shipments, about 4000 shipments have been made within the continental U.S. limits. Total mileage is estimated to be several million miles. The value of 3,600 shipments is a 1974 spent fuel shipment estimate quoted from WASH-1339, "Shipments of Nuclear Fuel and Waste --- Are They Really Safe?" Additional reference material is reported in Chapter I of NUREG-0034, DES on the "Transportation of Radioactive Material by Air and Other Modes," March 1976.

11.7.19 Category 5 Shipping Accidents (OR, A-41, Item 35b)

The category accident descriptions taken from WASH-1238 are listed below. The DES indicates in the title of DES Table 7.4 that dose estimates are for Category 5 accidents.

Accident Severity Category	Vehicle Speed at Impact (mph)	Fire Duration (hr)
1. Minor	0-30	0-1/2
	30-50	0
2. Moderate	0-30	1/2-1
	30-70	<1/2
3. Severe	0-50	>1
	30-70	1/2-1
	>70	0-1/2
4. Extra Severe	50-70	>1
	>70	1/2-1
5. Extreme	>70	>1

11.7.20 Spent Fuel Shipment (OR, A-41, Item 35d)

The destination of the spent fuel from the CRBRP has not yet been established. Shipment will be, to the extent practicable, routed away from population centers. As described in the Environmental Report (Section 3.8), current spent fuel cask design is for transportation on a 100 ton capacity railroad flatcar.

11.7.21 Beta-Gamma Waste Shipment (OR, A-41, Item 35e)

The destination of the beta-gamma waste has not yet been established. Shipment routes to the destination will, to the extent practicable, be routed away from population centers. As noted in Table 5, current plans call for trucking of the low-level beta-gamma waste from the CRBRP.

11.7.22 Doses From A Postulated Transportation Accident (OR, A-41, Item 35f)

The predicted year 2010 population within 50 miles of the CRBRP site (987,000) was assumed by the staff for the postulated transportation accident. Calculated doses would be higher for adults or children within 3 meters (or any other distance less than 50 meters) from an accident in which there is a ground level release of radioactivity. The doses at 3 meters would be about 150 times greater than the doses at 50 meters. The likelihood that anyone would receive such doses, however, is very small since the person would have to remain 3 meters from the spent fuel shipping cask for the duration of the release to obtain such doses.

11.7.23 Table 7.4 - Doses from Category 5 Accidents (OR, A-41, Item 35g; ERDA, A-14)

The table in the DES was misleading. Section 7.2 on transportation accident effects has been revised for the FES and the table was omitted. Comparison of an estimated population dose from an accident with a background dose is not deemed necessary to an adequate description of the impact in this section since the comparison has already been made in the WASH-1238 and GESMO documents. Based on the arguments presented in those documents, an accident is judged to produce a small impact in the unlikely event it should occur.

11.7.24 Risk in Shipping Fresh Fuel (OR, A-41, Item 35h)

This risk is not considered to be serious because of measures taken to prevent criticality and releases of radioactivity for fresh fuel shipping accidents. Such accidents, as mentioned by Oak Ridge, have always been "considered very seriously." Paragraph 8, Section 7.2, of the DES provides the NRC assessment of risks involved due to transportation accidents and its conclusions as to the probability of such events.

The applicant in ER Amendment VI (Section 3.8), has provided an updated description of fresh fuel shipping containers. ERDA will use its own transportation and safeguards systems to carry strategic quantities of non-weapon ERDA-owned strategic nuclear materials (SNM) to and from its facilities. (CRBRP fuel will be ERDA owned and of strategic quantities.) This has been ERDA policy and will be applied on licensed ERDA facilities, the CRBRP being the first.

SAFEGUARDS CONSIDERATIONS

11.7.25 Safeguards Approach (EPA, A-17, Item 2(2))

The DES states that the safeguards-related environmental impact of other fuel cycle activities stemming from the CRBRP operation would be substantially dependent upon the nature of the activities and their relationship to the CRBRP fuel cycle and that a detailed assessment of this impact is precluded by future uncertainties associated with supporting fuel cycle activities. Paragraph 5.2 of Appendix E to the DES refers to the NRC determination that the safeguards framework of existing and proposed regulations, as discussed in the Commission's statement of November 14, 1975,* permit the discharge of its responsibilities to protect the public health and safety and the common defense and security insofar as existing licensed plutonium facilities are concerned. Paragraph 5.2 also notes that the CRBRP could be supplied by either existing fuel facilities or by future facilities. Therefore, if a decision is made to defer or deny the wide-scale use of mixed oxide, it appears that existing facilities could produce CRBR fuel. While experience and continuing study may indicate areas where revisions to Commission regulations applicable to these facilities should be made, the production of CRBRP mixed oxide fuel in conjunction with these activities should not involve substantially different safeguards issues or costs.

11.7.26 Effect of Safeguards Studies on Use of Plutonium (NRDC, A-59)

The purpose of the DES was to evaluate the environmental impact of the CRBRP; it was not intended to evaluate the LMFBR program in its entirety or the wide scale use of plutonium as a fuel. Information relative to safeguards studies was included in paragraphs 5.2, 5.3 and 5.4 of Appendix E to the DES. Additional material has been included in Section 7.3.1 of the FES. The staff believes that physical protection programs and materials accountability measures designed to meet the requirements of existing and proposed regulations will provide adequate assurance for the protection of the CRBRP against sabotage and theft of special nuclear material. Therefore, we believe that the environmental impact of safeguards for the CRBRP can be rationally judged at this time and is not dependent on programmatic type studies. Safeguards considerations for the proposed wide scale use of mixed oxide fuels will be addressed in a supplement to GESMO.

---

*(See footnote on page 7-18.)

11.7.27 Civil Liberties and Institutional Changes Associated with Safeguards (NRDC, A-59)

The NRC does not believe that an effective safeguards system would result in violations of civil liberties or in institutional changes. This conclusion is based on experience gained during the application of a comprehensive security program during 30 years of protecting restricted data. These programs included the use of armed guards and security clearances for employees and were implemented without violation of the fundamental rights of individuals.

11.7.28 Petition For Adoption of Emergency Safeguards (NRDC, A-59)

By letter of March 22, 1976 the Director of the Office of Nuclear Material Safety and Safeguards made a detailed response to this petition by NRDC which was dated February 2, 1976. That response specifically stated that a determination has been made that "your requests for emergency and summary action are not warranted by the evidence presently available." There have been no developments which would warrant any change in this position.

11.8 NEED FOR THE PROPOSED FACILITY

11.8.1 Objectives of the CRBRP (ECNP, A-46, Item 9)

The following discussions relate to comments by the Environmental Coalition on the "principal objectives" set forth in Section 8.2 of the DES:

a. The availability factor rather than capacity factor was used in the DES in recognition of the developmental nature of the project. The inclusion of developmental features in a program can sometimes reduce overall plant capacity factor; therefore, availability is more meaningful for projection to typical plants. Both characteristics, however, are to be recorded by the applicant and can be analyzed and used as needed.

c. Since the pioneering Enrico Fermi project, the LMFBR Program has been incorporated as a major factor in national energy goals, a decision that has been recognized by ERDA, the FEA, Congress and the Administration with the concurrence of a broad range of other government agencies.

d. Considerable evolution in the concepts of licensability has taken place since the Fermi plant. It is now possible to draw on a great deal of experience from the licensing and operation of LWR's. Procedures have been set up by statute and by publication in the Federal Register (which has the force of statutory law) for the licensing of nuclear reactors. The Environmental Coalition on Nuclear Power suggests that a conflict of interest exists in NRC's "trying to critically review the applicant's submitted materials, while its purpose is to license the plant." It should be noted that the Nuclear Regulatory Commission is charged with the licensing responsibility, and this, together with the development and enforcement of nuclear safety and security matters to the benefit of the general public, is its sole interest. Thus, there is no conflict of interest involved here. The licensing procedures that have been adopted include the submission of a great deal of material by the applicant and the independent review of this material by the NRC staff and its expert consultants. Furthermore, all correspondence related to the licensing review are available in the public records. NRC believes that these procedures assure the objectivity of its review.

11.8.2 Progress Since Fermi (ECNP, A-46, Item 10)

Environmental Coalition on Nuclear Power raised questions related to the lessons learned from the Fermi plant, and the method of financing, namely that CRBRP is financed largely through public funds whereas Fermi was largely privately funded.

The faults that led to the meltdown accident in Fermi are not generic to LMFBRs and have been corrected in subsequent designs. The experience with Fermi and other smaller liquid metal cooled fast reactors that have been operated in the U.S. has been extensively utilized in the design of the CRBRP. NRC staff experience related to these smaller reactors is most certainly drawn upon in evaluating CRBRP proposals. In addition, published information from foreign LMFBR programs is available to U.S. designers.

The decision to provide public funding was made by Congress. Since the pioneering Enrico Fermi project, the LMFBR Program has been incorporated as a major factor in national energy goals, a decision that has been recognized by ERDA, the FEA, Congress and the Administration with the concurrence of a broad range of other government agencies.

11.8.3 Need for the CRBRP (NRDC, A-59, 60)

NRDC commented that "the staff has chosen to independently assess only the costs (of CRBRP) and to uncritically accept the applicant's assessment of the benefits." The staff's position is that the Final Environmental Statement on the LMFBR Program (ERDA-1535), the ERDA Administrator's Findings of December 31, 1975 based upon that FES, and authorization by the Congress have already established "the need for a demonstration-scale facility (CRBRP) to test the feasibility of liquid metal fast breeder reactors when operated as part of the power generation facilities of an electric utility system, including its timing and objectives. This position is supported by the Nuclear Regulatory Commission's Memorandum and Order dated August 27, 1976, pertaining to the admissibility in this case of NRDC Contentions 10 and 11. The Commission's Order directed that the following considerations are relevant to this proceeding:

(1) The likelihood that the proposed CRBR project will meet its objectives within the LMFBR program--a "benefit" in the NEPA cost/benefit balance.

(2) Alternatives for meeting the objectives--to be evaluated in terms of the objectives defined in the ERDA impact statement.

(3) Alternative sites outside the TVA service area.

The staff attempted to address some of these matters in the DES and has expanded its discussion in the FES to reflect the concerns espoused by the NRDC and by the Commission's ruling.

11.9 ALTERNATIVES

11.9.1 Alternative Energy Sources (EP, A-91; GEI, A-47; NRDC, A-60, 61)

The principal purpose of the CRBRP is to demonstrate a specific new energy concept rather than to provide electrical power; consequently, this statement considers only alternatives permitting attainment of that objective. Alternatives to the LMFBR concept are described in ERDA's LMFBR Program FES (WASH-1535, Sec 6 and ERDA-1535, Sec F-1).

11.9.2 Alternatives to the CRBRP (NRDC, A-60, 61)

The "deficiencies" noted by NRDC with respect to discussions in the DES concerning alternatives to the LMFBR program and the CRBP demonstration are essentially the same as those submitted in its Contentions 10 and 11 as intervenors in these proceedings. Following a series of hearings in 1976 before the cognizant Atomic Safety and Licensing Board (ASLB), the Atomic Safety and Licensing Appeal Board (ASLAB), and the Nuclear Regulatory Commission, the Commission issued a Memorandum and Order on August 27, 1976, directing that the following be assumed as established by the FES on the LMFBR program (ERDA-1535) and associated processes:

"a. The need for a liquid metal fast breeder program, including its objectives, structure and timing;

b. The need for a demonstration-scale facility to test the feasibility of liquid metal fast breeder reactors when operated as part of the power generation facilities of an electric utility system, including its timing and objectives."

In so directing the further conduct of this proceeding, the Commission recognized that ERDA is the agency with the primary responsibility, under the Energy Reorganization Act, for energy research and development programs and that ERDA's impact statement "is dispositive of the issue of need in this proceeding." The Commission therefore concluded that "its licensing process must be tailored in this case to avoid the Commission's substituting its judgement for that of ERDA with respect to the broad planning decisions embodied in the LMFBR statement" (ERDA-1535).

However, the Commission's Order also stated that "matters of greater specificity, such as selection of the Clinch River site and reactor design involve implementation of planning decisions," and hence are cognizable in this proceeding. Consideration could be given to the "specifics of the project's design and siting," as well as to "alternative modes to meet the established need." The Commission therefore directed that the following are relevant to this proceeding:

(1) The likelihood that the proposed project will meet its objectives within the LMFBR program--a "benefit" in the NEPA cost/benefit balance.

(2) Alternatives for meeting the objectives--to be evaluated in terms of the objectives defined in the ERDA impact statement.

(3) Alternative sites outside the TVA service area.

Accordingly, the staff has expanded the DES discussion of these matters in the FES. In doing so, the staff has observed the general principle indicated by the board that "consideration of alternatives need go no further than to establish whether or not substantially better alternatives are likely to be available." The staff has also noted the Commission's judgement that this agency does not need to determine that CRBR is the "best" or "optimal" alternative, but only that the applicant's preferred approach is "reasonable."

11.9.3 Sites With More Favorable X/Q Values (NRDC, A-61)

The staff agrees that atmospheric dispersion conditions over the southern Applachians are generally not as favorable as those in other areas of the country. The CRBRP site area is also smaller than potential sites at numerous locations. Consequently, there is no doubt that a site with a more favorable X/Q value could be located. However, the effects of poor dispersion conditions at most sites, including the proposed Clinch River site, can be compensated by plant design features to assure that doses from normal and accidental releases of radioactivity are not an unacceptable hazard to the health and safety of the public.

11.9.4 Sites at Hanford, Idaho, and Nevada (NRDC, A-61)

These alternative sites are considered in Section 9.2 of the FES.

11.9.5 Co-Location with Fuel Cycle Facilities (EPA, A-20, A-21; NRDC, A-61)

Co-locating the CRBRP with other fuel facilities might have a small advantage in the convenience of the security measures taken during transportation, and a small effect on the probability of accidents during transportation. Since a reprocessing plant is proposed in the Oak Ridge area, the CRBR site is probably well selected with respect to this consideration, but it does not appear to have been a major factor in the choice. The staff did not consider the combined center alternate since the CRBRP is a single demonstration plant for which there would be little incentive to construct and operate fuel cycle facilities solely for its service.

The co-location concept, as discussed in NUREG-0001, Nuclear Energy Center Site Survey-1975, is the location of one reprocessing facility and one matching mixed oxide fuel fabrication plant on the same site. The same document uses the term "combined centers" for the situation in which reactors are also included. NUREG-0001 considered LMFBR's as a later "phase-in" at a nuclear energy center when the technology is sufficiently developed. The conclusion of that study was that there is no decided advantage to either co-locate or not co-locate.

11.9.6 Underground Sites (NRDC, A-61)

The staff position regarding underground siting has not changed significantly since publication, in July 1973, of WASH 1250 ("The Safety of Nuclear Power Reactors (Light Water Cooled) and Related Facilities"). It was stated at page 8-34 of that document that, "From the information thus far available...the AEC has found little technical basis for encouraging the general use of underground siting. The weight of evidence currently suggests that underground siting: (a) has necessary features (e.g., penetrations) which tend to offset the presumed containment advantages, (b) would add significantly to the costs of nuclear power plants, (c) requires extensive and costly R&D for unresolved engineering problems, and (d) does not offer a general solution to siting problems in the U.S."

No engineering design currently exists for a large underground nuclear power plant in the U.S. While there have been a number of conceptual studies of the feasibility of locating nuclear power plants underground, analysis of the advantages and disadvantages as well as the treatment of increased costs have been very generalized.

Generic problems associated with the underground concept are:

1. Flooding potential.

2. Potential hazards to on-site personnel related to closing ventilation and access shafts during time of off-normal operation.

3. Design and cost of closure systems to seal large access shafts or tunnels in order to provide adequate containment.

4. Difficult maintainability and inspectability of components in confined areas, especially in vertical pipe runs.

5. High-pressure condenser design and operation, if located underground.

6. Increased static and thermal loads on long piping systems to the surface.

7. Licensing difficulties and delays which can be expected to accompany any first design-of-class and particularly those associated with such a radical departure from existing plants; also guides and standards for an underground plant do not exist. Methods of satisfactory demonstration of stability and safety of the enclosing cavity would have to be developed for licensing assurance.

8. Cost and time for extensive underground site exploration.

9. Increased risk of accidents during fuel-handling operations.

Most of the generic problems probably could be overcome given sufficient time and money. Development time for an engineering design for placing this, or any other large plant, underground would be great. Added to this would be the time required to validate the site, and the time required for excavation of the underground cavities. Licensing delay time would be considerable. These activities combined would increase the period required for plant completion by a minimum of 5 years, assuming the site is acceptable and a feasible design is attainable, both of which are in some doubt. Consequently, undergrounding the demonstration plant is not an alternative which would permit operation in a timely manner to achieve its objectives within the LMFBR program.

Early in 1975 a study was initiated by the NRC to obtain authoritative answers to generic questions associated with the underground siting concept. This confirmatory research is being conducted under contract at the Sandia Laboratories, Albuquerque, New Mexico. In the course of evaluating the concept and specifying needed research, the staff has tried to objectively evaluate the proposed advantages and disadvantages postulated for the concept. Also, alternative methods of obtaining the same advantages, but in surface mounted plants, will be examined for cost and quality comparisons. This study is expected to be completed early in 1977. Development of detailed cost estimates and operation and safety analyses based on reference plant designs turned out to be beyond the scope of the present study; their need will be reevaluated on the basis of recommendations in the final report.

11.9.7 Cooling Tower Arrangement (PMC, A-97, Item 24)

In the judgment of the staff, the proposed linear cell array of two parallel mechanical draft cooling towers is environmentally acceptable. If the applicant decides to propose a circular array, the environmental effects of its operation would probably be found acceptable; however, the design data submitted with the changed configuration would be examined to assure that this judgement is correct.

11.9.8 Corrections in Table 9.5 (ERDA, A-14)

Drift deposition rates expressed in Table 9.5 represent the maximum amount of drift deposition per acre over a one month period of time for all one-acre sections within a 360° circumference and a 50-mile distance of the CRBRP cooling towers. Entrainment estimates are now consistent with those of Section 5.3.1.2.

11.9.9 Thermal Effects at the Discharge (OR, A-41, Item 31)

The staff's opinion is that temperature at the discharge would not be a problem (see 11.5.9). Relatively high pumping costs would be required under the multi-port mode in order to achieve the same jet velocity (and mixing) as under the single-port mode with fewer and larger openings. These pumping costs would be in addition to the $4000 incremental cost for the multi-port design and these additional costs are not justified in view of the minimal impact expected with the proposed system.

11.9.10 Ease of Monitoring (TN, A-26)

Site selection is based on the evaluation and balancing of a number of factors, of which ease of monitoring is a minor consideration. The staff does not expect that the applicant would be unable to carry out all monitoring required at the Clinch River site.

11.9.11 Proximity to the Gaseous Diffusion Plant and ORNL (NRDC, A-62)

The Oak Ridge Gaseous Diffusion Plant is about 3 miles NNW from the CRBRP; Oak Ridge National Laboratory is about 4 miles ENE from CRBRP. Both of these facilities are ERDA-controlled; ERDA also has lead responsibility for CRBRP. Activities at the Oak Ridge reservation are under the control of ERDA; long range land-use planning and selection of sites for future activities are governed by official ERDA procedures and instructions. In accordance with such requirements, consideration will be given by ERDA to potential impacts on CRBRP operation as well as on operation of other ERDA facilities. Therefore, as a CRBRP "applicant", ERDA appears to have sufficient authority to control activities at and near the CRBRP site.

The NRC staff, in the course of its radiological safety review for CRBRP, requires that calculated radiological consequences of postulated accidents be evaluated and, in accordance with 10 CFR Part 100, necessary protective measures be identified and assessed for the area within the CRBRP Low Population Zone (LPZ). Furthermore, it has been the staff practice to also consider the need, if any, for protective measures beyond the LPZ on a case-by-case basis. In this regard, evacuation is only one aspect of emergency planning; other measures are available and may be implemented dependent on the existing situation. It must also be recognized that due to the nature of operations at the gaseous diffusion plant and other Oak Ridge facilities, there are existing plans and facilities for coping with emergencies, such as a release of toxic material for example; therefore, consideration for mitigating any impact on the operation of such facilities due to postulated accidents has been included.

Nonetheless, based on our past practice, it is our present opinion that CRBRP conformance with Part 100 dose guidelines and their equivalent will provide reasonable assurance that the consequences beyond the LPZ due to postulated accidents at CRBRP will not necessarily result in long-term evacuation. These matters are receiving attention in the course of the staff safety review and our conclusions will be documented in the staff's safety evaluation report.

11.10 EVALUATION OF THE PROPOSED ACTION

11.10.1 Risks Associated with Accidental Radiation Exposure (NRDC, A-62)

See the staff's response in Section 11.7.1.

11.10.2 Health Consequences (NRDC, A-62)

NRDC's comment implies that health consequences due to radiation from the CRBRP should be included among the costs weighed against the benefits of the proposed action. As indicated in 11.5.32, the staff feels that a presentation of relative impact (i.e., comparison with natural background radiation) is sufficient.

11.10.3 Alternative Development of Site (OR, A-38, Item B)

The "loss of taxes to the city as a result of the Site being developed as the CRBRP Site" are not loss of present real taxes, but loss of speculated future taxes. Since this is not an actual loss, the staff has not factored it into the analysis. The property has been owned by the U.S. Government for many years.

11.10.4 Complementary Uses of Site (OR, A-38, Item B)

Under 10 CFR § 100.3 (a) and the decision of the Appeal Board in the San Onofre proceedings (ALAB-308), the applicants must exercise <u>total control</u> over the entire exclusion area except those portions which are traversed by "passageways" (including waterways such as the Clinch River). To the staff's knowledge, the applicants do not intend to permit complementary uses of land within the exclusion area.

11.10.5 Public Uses of "Restricted Area" (OR, A-38, Item 3B)

The river within the exclusion area would be available for public uses except under emergency conditions. As described in 10 CFR 100.3, "exclusion area" means that area surrounding the reactor, in which the licensee has the authority to determine all activities including exclusion or removal of personnel and property from the area. This area may be traversed by a highway, railroad or waterway, provided these are not so close to the facility as to interfere with normal operations of the facility, and provided appropriate and effective arrangements are made to control traffic on the highway, railroad or waterway, in case of emergency, to protect the public health and safety.... Activities unrelated to operation of the reactor may be permitted in an exclusion area under appropriate limitations, provided that no significant hazard to the public health and safety will result."

11.10.6 Decommissioning (NRDC, A-63)

NRDC states that it considers the discussion of decommissioning (in Section 10.2.4) inadequate for the reasons outlined in its Contention 14, which is reproduced on pages A-84 and A-85. The technical statements in the contention and the staff's responses are as follows:

Comment: A recent report "Decommissioning of Nuclear Reactors" by N.Y. PIRG indicates that (with the exception of the Elk River reactor) the isolation period following decommissioning of power reactors has been based on the time required for Co-60 to decay to safe levels. Harwood, et al. believe that the previous analyses are in error because they underestimate the significance of radionuclide Ni-59.

Response: The isolation period has been indicated in the decommissioning plans for only three reactors, Piqua, Hallam and Bonus, which were entombed. Decommissioned reactors which have been placed in a moth-balled status (Protective Storage) will remain in protective storage until the radioactivity is at a level acceptable for release to unrestricted access. Radioactivity decay and/or component removal will determine the time involved before unrestricted access to the facility can be allowed. The analysis of those reactors in which an isolation period was indicated did consider long-lived isotopes including Ni-63 (92-year half-life). In the Piqua decommissioning report (AI AEC 12832 April 1, 1970), Ni-59 inventory was determined to be about 1% of the Ni-63 inventory. The amount of Ni-59 in the Hallam and Bonus facilities would also be about 1% of the Ni-63 inventory. For these three entombed reactors, the controlling long-lived isotope was Ni-63, which was analyzed in the decommissioning reports.

Comment: The time period for Ni-59 to decay to safe levels is estimated by Harwood, et al. for LWR to be at least 1.5 million years. The economic and societal implications of this 1.5 million year decay period are at present unknown.

Reponse: The estimates by Harwood et al. as to the direct radiation effect of Ni-59 in a decommissioned reactor are too high by at least two orders of magnitude. The assumption that control of a reactor site would have to exist for 1.5 million years is not realistic because a licensee would logically be able to terminate the maintenance and surveillance of the site in 100 to 150 years for one of the two following reasons:

a) The remaining radioactive material (Ni-59, Ni-63 and C-14) which may be above levels acceptable for release to unrestricted access could be easily removed to a more desirable location (waste burial ground) because high level gamma isotopes (Co-60, Fe-55) would have decayed to levels which would allow their removal without remote handling operations.

b) All remaining radioactive material may have decayed to a level acceptable for release to unrestricted access.

Comment: Petitioner believes the NRC must systematically analyze all neutron activation products that may be produced in the proposed CRBR to determine the potential isolation period, following decommissioning, and then provide a comprehensive analysis of the costs (both economic and societal) of decommissioning.

Response: The staff conducts a preliminary environmental analysis of decommissioning costs and impacts at the time of an application for a reactor construction permit or operating license. A detailed environmental analysis will be performed when the applicant submits specific decommissioning plans. In addition, as explained above, the facility must meet radioactivity levels acceptable for release to unrestricted access prior to termination of a license. This acceptable level may be reached by radioactive decay or by removal of selected components after high level gamma emitters have decayed.

11.10.7 Achieving CRBRP Objectives (NRDC, A-63)

The staff's views concerning the likelihood that the CRBRP will meet its objectives are presented in Chapter 8.

11.10.8 Payroll 1991-2013 (EP, A-91)

CRBRP payroll is estimated in ER Section 8.2.2.1 for the years 1975 through 2013. The estimated salary for 1991 through 2013 is expected to total $100 million.

11.10.9 Cost Estimates (EP, A-91)

The cost estimate for the CRBRP has been revised in Section 10.4.2.2 to a project total of $1950.4 million. Capital cost information for commercial LMFBR reactors is provided in WASH-1535, Sec 11 and ERDA-1535, Sec III F.2.

11.10.10 Benefit Cost Balance (EP, A-91)

The staff takes a conservative view in balancing benefits and costs. Since the amount of in-lieu-of-tax payments has not been determined at this time, and if it should eventually be lower than the sum of any increase in costs for local services, the possibility for an unfavorable benefit-cost ratio does exist for the local area. The applicant is aware of that possibility and plans to consider compensating assistance to local entities (see Appendix F).

For the nation at large, the staff finds a favorable benefit-cost balance (Section 10.4.3).

11.11 APPENDIX D - ENVIRONMENTAL EFFECTS OF THE CRBRP FUEL CYCLE AND TRANSPORTATION OF RADIOACTIVE MATERIALS

11.11.1 Individual Doses From Fuel Cycle Effluents (ERDA, A-14)

The staff agrees that doses for fuel fabrication and fuel reprocessing plants listed in DES Table 3 are too low by a factor of 10^3 and that an error in dose due to transportation was made in the earlier calculations. Corrections have been made in the FES. The revised values, however, are still insignificant with respect to overall impact and do not alter the conclusions.

11.11.2 Population Doses from Fuel Cycle Effluents (ERDA, A-14)

The staff has reviewed and reaffirms its assumptions and calculations derived for the values listed in Table 4, and as further qualified in the footnotes.

11.11.3 Basis for Estimates Used in Tables of Appendix D (NRDC, A-63, 64)

The NDC comment raised the concern, as referenced and contained in Contention 9 of their contentions filed with their petition to intervene, that scaling down the assessment of fuel cycle impacts in the LMFBR FES does not provide a proper basis for fuel cycle impacts related to the CRBRP, and was therefore inappropriate in the staff's DES. In this FES, the staff has not relied upon a scaling down of the impacts in the LMFBR FES but instead has considered the designs and irradiation characteristics of the proposed fuels, noting the significant differences as compared to LWR fuels. Using this information, the staff estimated on a prorata basis the likely quantities of effluents released from fuel cycle facilities to the environment which would be attributable to operation of the CRBRP.

All values used in Table 2 can be considered as assumed since a fast reactor fuel reprocessing plant has not yet been designed, much less constructed and operated. Enough is known, however, about how such a plant would be built to provide estimates of its environmental impact, and, as a consequence, the share of that impact attributable to a single fast reactor.

The reprocessing plant and fuel fabrication plant for fast reactor fuels probably would be quite similar to those designed for LWR fuels, the primary adjustment being to accommodate increased fissile fuel content in the reprocessing plant's initial process steps. A secondary consideration is the shift in the fission yield spectrum from the LWR because of the fast flux spectrum in the fast reactor. As an example, the thermal fission yield for iodine-131 from plutonium-239 is 3.74 percent while the fast fission yield is 4.08 percent. Calculations of fission product content in spent fuel, as, for example, by the ORIGEN computer code, account for this difference and for others such as the absorption cross-section of neutrons in uranium-238.

Another minor effect to be recognized is that at the very high burnups possible in the case of a fast reactor, i.e., on the order of 100,000 megawatt-days per tonne, a significant amount of fuel has been consumed. If a fuel core assembly contains 20 percent fissile plutonium, then one metric tonne of that fuel would contain about 200,000 grams of fissile plutonium. One megawatt-day of energy is roughly equivalent to one gram of plutonium. It follows that about one-half of the fissile content or about ten percent of the total heavy metal content would be consumed at 100,000 megawatt-days per tonne burnup. The effect of this change is a need to replenish the fuel consumed and a decrease in the processing throughput necessary at the reprocessing plant. Another effect, of course, is the increased quantity of fission products per tonne of fuel which will require extra shielding (or fewer assemblies) in casks for transport and, perhaps, for other purposes.

Non-radioactive effluents from a fast fuel reprocessing plant or a fast fuel fabrication plant would not be substantially different from light water reactor fuel plants. There would probably be some increase in fluoride released because of its probable use in dissolving fast fuel cores, although other chemicals such as hydriodic acid are being tested. Most of the non-radioactive effluents are the result of auxiliary systems, such as steam boilers, common to any kind of plant.

The share of the reprocessing or fabrication plant which can be ascribed to the single CRBRP is based on the fraction of the total fuel treated by the plant. For reprocessing this is 6.5/1500; for fabrication it is 2.2/755 (mixed oxide) and 4.3/745 (uranium oxide). The 6.5 tonne is the mass of fuel, both core and blanket, expected to be discharged from the CRBRP each year for reprocessing. The 1500 tonnes is the similar mass considered for the LMFBR programmatic FES (WASH-1535). The other ratios are the parallel values for the fabrication plants. In each instance of a natural resource use identified in Table 2 of Appendix D, where the staff agrees with the values shown in WASH-1535, the direct ratios above were used to obtain the values in Table 2. In all other instances the values were adjusted by the staff to accommodate some difference between WASH-1535 and the staff's own evaluations.

Land

About 300 acres of land out of 2000 acres might be disturbed at a reprocessing site and about 80 acres out of 1000 acres at a fabrication site. Although the intent of Commission regulations is clearly to avoid permanently committing any land, it has been conservatively assumed that a small portion of the reprocessing site, viz. the plant containing radioactive cells, is not sufficiently decontaminated to release the land (50 acres) for unrestricted use. By far the greatest amount of land which would be permanently committed as a result of the CRBRP operation would be that used for waste disposal. The main contributors to this land use are the low-level waste burial grounds and the mill tailings. As indicated before, about 10 percent of the core discharge each year (0.2 MT) must be replaced by fresh UO_2. If a 40-year life is assumed, then 20 metric tons of fuel will be needed, plus the original mass, or about 47 metric tons total. The Generic Environmental Statement for Mixed Oxide Fuel (GESMO) indicates about 0.0082 acres of tailings per metric tonne of uranium mined. On this basis about 0.4 acres of land would be permanently committed for tailings from the CRBRP. The burial of low level waste might add about another 0.1 acre; therefore, the committed land for fuel cycle waste would be about 0.5 acre.

Water

In the reprocessing plant water is discharged into both the air and water bodies. A large portion of the water discharge is related to cooling. The LMFBR FES shows 1.4 million gallons of water per day required for makeup; the AGNS FES supplement* shows about 4 million gallons per day. When waste solidification is added, the water requirements at AGNS go to about 7.5 million gallons per day. A fast reactor fuel reprocessing plant of identical throughput would require additional cooling water because of the great burnup and consequent heat output in the high level waste. We estimate this as 22 million gallons per day, of which about 90 percent, or 20 million gallons, would be released to water bodies while the remaining would be released principally by evaporation in a cooling tower.

*Draft Supplement No. 1 to the Final Environmental Statement for the Barnwell Nuclear Fuels Plant, Docket No. 50-332, U.S. Nuclear Regulatory Commission, NUREG-0082, June 1976.

For the mixed oxide and uranium oxide plants we can accept the Westinghouse Recycle Fuels Plant Environmental Report (as reviewed for the DES [unpublished]) and the LMFBR FES and ratio accordingly.

Fossil Fuel

The staff has reexamined the basis for the DES values for electrical energy use in Table 2 and agrees with it. WASH-1248 shows 115 MT coal/317 MW-hr equivalency or 0.363 MT coal/MW-hr. This is a reasonable number. A constant ratio was used throughout the table.

Effluents-Chemicals

Information in WASH-1248 was used for hydrocarbons from reprocessing. Other non-radiological effluents were estimated from p. III-5 and reliance on staff prepared environmental statements for the appropriate type of plant. Hydrogen fluoride release was not estimated for the reprocessing plant as it may not be used and its impact would be insignificant when compared with the uranium fabrication plant output.

For the mixed oxide fabrication plant the staff has evaluated the environmental impact of the Recycle Fuels Plant, a 200 metric tonne per year plant proposed by the Westinghouse Corporation. We have used the staff's estimate from this evaluation. The data presented in Tables 3 through 7 follows largely from the work described above.

Radioactivity Releases

To estimate the radioactive content of the CRBRP fuel, the ORIGEN isotope generation computer code was used. The LMFBR cross-section set was used, although for certain isotopes the fission yields were "corrected" by using more recent data contained in "Compilation of Fission Product yields, Vallecitos Nuclear Center, 1974," NEDO-12154-1, by M. E. Meek and B. F. Rider, a compendium of evaluated fission yield data.

In the reprocessing plant a general decontamination factor of 10^9 was used for particulate releases, which includes most nuclides. Decontamination factors should be greater since filtration requirements of about 99.99 percent per filter or greater can be expected. For the specific nuclides, tritium, carbon-14, krypton-85, iodine-129, iodine-131, ruthenium-103, and ruthenium-106, estimates were based on the staff evaluations of the Barnwell Nuclear Fuels Plant operation as proposed by Allied General Nuclear Services, Inc. Ten percent of the tritium is estimated as retained in the fuel. The staff is aware of current development work at the Oak Ridge National Laboratory on methods for collecting and retaining tritium, krypton-85, iodines, and carbon-14. It could develop that these systems are actually tested at full scale or near full scale in a hot pilot plant at ORNL. Although the development work prognosis indicates good collection efficiencies for each of the isotopes, we recognize that the nature of start-up, initial, and testing operations may result in decreased decontamination factors. Therefore, we have applied some credit for improved decontamination performance, but not to the extent of what might be predicted for later demonstrated performance.

Our estimated improvements in decontamination factors are: tritium (2), krypton-85 (10), iodines (25), and carbon-14 (10).

The Recycle Fuels Plant evaluation was used for the mixed oxide releases, as was done for the non-radiological releases.

11.11.4 Radiological Consequences of Fuel Transportation (PMC, A-98, Item 26)

The staff, in reviewing PSAR Section 9.1.4.1, noted the applicant's remarks that "...After spent fuel has decayed for ∿100 days in the EVST, it may be loaded into the spent fuel shipping cask. Control, radial shield, and some low-power blanket assemblies can be shipped offsite before the 100-day cooling period, but fuel and high-power blanket assemblies are held until they decay to ∿6 kw or less. The spent fuel shipping cask is designed for a maximum heat load of 26 kw and a maximum single fuel assembly heat load of 6 kw...." and, "...Spent fuel assemblies to be loaded in the cask are transferred in sodium filled CCP's (core component pots) from the EVST to the fuel handling cell (FHC) by the ex-vessel transfer machine. In the FHC, they are stored temporarily in a ten-position sodium-filled spent fuel storage tank. The assemblies are removed, one at a time, from the storage tank by a gas cooling grapple, the exterior is dimensionally and visually examined if desired, and residual sodium is drained prior to loading.

"The spent fuel shipping cask (SFSC) is brought on site by a special railroad car. The cask is removed from the railroad car, lowered down a shaft onto a transport dolly by the Reactor Service Building Crane, and the outer containment shipping cover removed. The dolly moves the cask under the fuel handling cell floor, where it is sealed to the bottom of the cell. An access plug in the floor of the cell is removed by an in-cell crane, and up to nine assemblies are loaded in the case. The cask is then decoupled from the FHC, the shipping cover is reinstalled, the cask is removed from the FHC shaft, loaded onto the rail car and checked for radioactive contamination prior to shipment...."

The staff agrees that the information noted would lead to further reduction in the estimated transportation doses to transportation workers and the general population along the transportation routes. However, in the staff's independent evaluation, greater emphasis was placed on the fuel shipping casks' maximum heat load design and assumptions of fuel assembly heat loads thereby requiring a larger number of shipments per year (i.e., a more conservative approach) in the analysis. The resulting data indicate that an insignificant impact would accrue from the shipments.

11.11.5 Coolant for Fuel Transport Casks (EPA, A-17, Item 2 (4))

Appendix D describes the performance conditions to be met in transporting radioactive materials associated with the CRBRP fuel cycle. All shipments would adhere to 49 CFR 170-179 requirements so that the standards for external radiation levels, temperature, pressure and containment are met.

Identification of specific coolant medium to be used in spent fuel has not been established yet. It has been indicated, however, in the applicant's PSAR Section 9.1, that the AMCO LMFBR spent fuel shipping cask will be utilized. This cask would use Dowtherm A as the coolant. Alternative coolants, however, are also under investigation. Even if the cooling medium is subsequently changed, the environmental assessment in the DES would not be affected.

11.12 APPENDIX E - SAFEGUARDS RELATED TO THE CRBRP FUEL CYCLE AND TRANSPORTATION OF RADIOACTIVE MATERIALS

11.12.1 Plutonium Accountability (ECNP, A-46, Item 11)

ECNP's comment concerning the reference on DES page E-17 to plutonium accountability reads as follows: "It is difficult to conceive of how safeguards can be effective if measurement uncertainty can be as high as 1% for any plant process."

The overall safeguards program is made up of a number of diverse and redundant systems which, when combined, are designed to provide a high degree of protection against the theft or diversion of plutonium and highly enriched uranium. These activities fall into two broad categories: physical security and material control. Physical security--including physical barriers, intrusion alarms, and armed guards--provides the first line of safeguards protection. Material control--comprised of access controls, containment, and material accounting--reinforce the protection provided by physical security measures and provides a quantitative basis for material accountability. Material control measures are especially effective against internal diversion where the participants have authorized passage through barriers and access to material in the normal course of business.

The material accounting system can deter and detect, but not prevent, the theft or diversion of material. The accounting system should be capable of continuously tracking the location and the movement of all discrete items and containers of SNM on inventory and of monitoring the in-process inventory for indications of diversion. Through shipper-receiver comparisons, data monitoring programs, and periodic physical inventory checks, the accounting system provides positive assurance that SNM is indeed present. Should a significant loss of material occur, the system should be capable of identifying the general location and the quantity of material involved. The accounting system provides backup detection capability for theft and diversion which circumvent detection capabilities provided by physical security and other material control measures. Internal audits are directed to assuring that records have not been falsified.

All physical measurements are subject to measurement uncertainty. The 1% uncertainty referenced in the comment is specified in the regulations as a limit value for one type of plant over a single inventory period. Materials in most fuel cycle plants are controlled within a 0.5% limit for measurement uncertainty. Because these errors tend to randomize over time, the cumulative uncertainty for a number of inventory periods will be less than the percentage limit specified for a single period. Nevertheless, reliance cannot be placed solely on material accounting to detect theft and diversion because the effectiveness of the system is limited by timeliness and measurement uncertainties. Accordingly, NRC requires in-depth protection systems to prevent, deter, detect, and defeat any attempt to illicitly remove nuclear material from facilities.

(Additional responses to comments on safeguards are in Section 11.7. For convenience of the reader, the bulk of the discussion in DES Appendix E has been moved to Section 7.3 in the FES.)

11.13 OTHER CONSIDERATIONS AND CHANGES

Mechanical errors in publishing the draft have been corrected in this final environmental statement without explanation. Most of the draft information requiring minor changes as a result of ER Amendment VI (April 2, 1976) also has been changed in the FES without explanation. Other considerations and changes appearing in the FES are identified below in the order of their occurrence in the draft.

Summary and Conclusions 2 - The last paragraph has been modified, showing the use of two cooling towers instead of one and lower water use in accordance with Sections 3.3. and 3.4.

Summary and Conclusions 3(d), Section 5.1 and Section 10.1.1.4 - The reference to security restrictions has been removed based upon TVA's practice of unlimited access to all areas outside the plant fence during operation. Access during construction would be limited by construction activity.

Summary and Conclusions 3(h) - The change reflects the fact that transmission line structures installed for the project would not be visible offsite.

Summary and Conclusions 3(k) and related part of Table 10.4 - The reference to copper, iron and suspended solids was deleted because the staff believes that chemicals will cause no problem under the revised plant operation identified in Sections 3.3 and 3.4.

Section 3.3 - The section was changed, reflecting smaller water requirements.

Section 3.4 - Section 3.4.1 was changed, reflecting the use of two cooling towers instead of one.

Section 3.4.2 was changed according to a change in design of the intake structure. Section 3.4.3 was changed, reflecting the use of a discharge at the present riverbank.

Section 3.6 - The last four columns of Table 3.5 were deleted since chemical plumes would be much smaller than originally projected.

Section 4.1 - The applicant provided NRC (Buhl, September 24, 1976) with information concerning an on-site quarry which may be developed and describing the expected environmental impacts. Accordingly, the staff has considered this information and incorporated appropriate changes in Sections 4.1, 4.2, 4.3, 4.4, 4.6, 10.4 and the Summary and Conclusions.

Section 4.2.1, Paragraph 3 - The possibility of onsite garbage disposal has been added.

Section 5.4.1 - The text is changed, reflecting no adverse chemical impacts with or without riverflow.

Section 6.1.3 - Changes reflect meteorological information in the amended ER.

Section 6.1 and 6.2 - Since issue of the draft statement the applicant has further analyzed the projected socioeconomic effects of project construction and operation. The results were presented as material added to Chapter 8 of the ER, including a new Appendix C, and were part of ER Amendment VI. The staff reviewed the additional analysis and has revised its discussions of socioeconomic impacts in Sections 4.5 and 5.4. Allowing for the possibility that there may be differences between the CRBRP project and other ERDA Oak Ridge projects in regard to in-movers, for example, and desiring to establish a factual basis rather than a conjectural basis for any possible differences, the staff recommends that the applicant undertake a socioeconomic monitoring program during the construction and demonstration phases. The staff recommendations for such a program consist of Sections 6.1.6 and 6.2.6, added to the statement.

Section 7.1 - This section regarding environmental effects of postulated plant accidents has been modified to recognize progress in the continuing safety review which is proceeding in parallel with the environmental review.

Section 7.3 - For clarification of NRC safeguards considerations, the discussion in this section now includes most of the material that was in Appendix E of the DES.

Chapter 8 - In recognition of the Atomic Safety and Licensing Board's (ASLB) Order regarding NRDC's restated Contention 10, dated October 5, 1976, this chapter has been modified to include further consideration of "the likelihood that the proposed CRBR project will meet its objectives within the LMFBR program" in a timely fashion. Also in this chapter is an evaluation of alternative design features.

Section 9.2 - Also in recognition of the ASLB's Order dated October 5, 1976, this section has been modified to include consideration of alternative sites on TVA-owned land outside of TVA's power system and on land in the custody of ERDA other than the Oak Ridge Reservation.

Section 9.4.1, Paragraph 3 - The staff added a recommendation for a circular array mechanical draft cooling tower system, with its slight environmental advantage over the linear array, in the event that the cost of both systems should be about the same, as indicated by the amended Table 9.5.

Appendix D - The discussion and data have been revised by the staff in the course of its preparing responses to comments on the DES.

Appendix E - For clarification of the safeguards discussion, most of the DES material in this appendix has been shifted to Section 7.3.

Appendices added are the following:

Appendix F - Letter to NRC from ERDA dated April 9, 1976, regarding ERDA's authority to make in-lieu-of-tax payments to local entities.

Appendix G - Letter to NRC from ERDA dated September 10, 1976, concerning the need for monitoring socioeconomic impacts of the CRBRP.

Appendix H - Draft EPA Permit No. TN 0028801, "Authorization To Discharge Under the National Pollutant Discharge Elimination System."

Appendix I - Letter to Mr. Lochlin W. Caffey, Director, Clinch River Breeder Reactor Project Office, from NRC dated May 6, 1976, regarding the CRBR design.

REFERENCES

AECH, Atomic Energy Clearing House, Congressional Information Bureau, Inc., Washington, DC, Vol 17, No. 6, p 42; Vol 17, No. 18, p 7; Vol 16, No. 35, p 12.

AEC 12832, "Retirement of the Piqua Nuclear Power Facility," U.S. Atomic Energy Commission, Research and Development Report, Atomics International, April 1, 1970.

Air Quality for Tennessee, Quarterly and annual compilation of air quality data, Tennessee Department of Public Health, Division of Air Pollution Control, Nashville, TN.

Alabaster, J. S. "Effects of Heated Discharges on Freshwater Fish in Britain," Biological Aspects of Thermal Pollution. P. A. Krenkel and F. A. Parker (Ed), Vanderbilt Univ. Press, pp. 161-185, 1969.

American Public Health Assoc., Standard Methods for The Examination of Water and Waste Water, Wash. DC, 1971.

American Soc. of Testing Materials, Proposed Tentative Method of Test for Selenium in Water, Nov 1970.

Anderson County Budget Committee, Anderson County Budget for 1974-1975, Clinton, Tennessee, 1974.

ANL-8060, Argonne National Laboratory, Radiological and Environmental Research Division, Annual Report, period January-December 1973.

ANL-75-3, Argonne National Laboratory, Radiological and Environmental Research Division, Annual Report, period January-December 1974.

Appendix D of 42 CFR 410.

Application, "Schedule for and Description of Site Preparation Activities to be Conducted Pursuant to 10 CFR 50.10(E)(1)," Apr 1975.

Application, "Statement of General Information Pursuant to 10 CFR 50.33 of NRC Regulation," p. 12, April 1975.

ALAB-308, 10 CFR 100.3(a) Southern California Edison Company (San Onofre), Slip. Op. at 4-6 (January 22, 1976).

Auerbach, S. J., "Ecological Considerations in Siting Nuclear Power Plants, the Long Term Biota Effects Problems," Nuclear Safety, 12, 25, 1971.

Bacas, R. G., "A Computer Program for Thermal Plume Modeling," Technical Memo, Battelle, Pacific Northwest Laboratories, Richland, WA, 1971.

Baskin, J. M., E. Quarterman, and C. Caudle, "Preliminary Check List of the Herbaceous Vascular Plants of Cedar Glades," Jour. of the Tennessee Academy of Science 43: 65-71, 1968.

Becker, C. D. and T. O. Thatcher, Toxicity of Power Plant Chemicals to Aquatic Life, WASH-1249, 1973.

Bell, M. C., Fisheries Handbook of Engineering Requirements and Biological Criteria, Fisheries-Engineering Research Program, Corps of Engineers, North Pacific Division, Portland, OR, 1973.

Braun, E. L., Deciduous Forests of Eastern North America. Hafner, NY, 1972.

Brewington, P. C. (ERDA-ORDO), memorandum to Karen McGinnis (Battelle-Northwest), April 30, 1976.

Briggs, G. A., "Plume Rise," AEC Critical Review Series, AEC Division of Technical Information Extension, Oak Ridge, TN, Jun 1970.

Briggs, G. A., "Plume Rise from Multiple Sources," ATDL Contribution No. 91, Oak Ridge, TN, 1974.

Brungs, W. A., Effects of Residual Chlorine in Aquatic Life, J Water Pol Con Fed, 45, 10 pp 2180-2184, Oct 1973.

Budget, The Appropriation Resolution, The Tax Levy Resolution of Roane County, Tennessee for the Fiscal Year Jul 1, 1973 to Jun 30, 1974.

Budget, The Appropriation Resolution, The Tax Levy Resolution of Loudon County, Tennessee for the Fiscal Year Jul 1, 1974 to Jun 30, 1975.

Buhl, Anthony R., ERDA, letter Roger S. Boyd, NRC, 8 July 1976, enclosing revised permit application to the Corps of Engineers.

Buhl, A. R., ERDA, letter to R. S. Boyd, NRC, dated July 15, 1976.

Buhl, A. R., ERDA, letter to R. S. Boyd, NRC, dated July 22, 1976.

Buhl, A. R., ERDA, letter to R. S. Boyd, NRC, dated September 24, 1976.

Buhl, A. R., ERDA, letter to R. S. Boyd, NRC, dated November 18, 1976.

Buhl, A. R., ERDA, letter to R. S. Boyd, NRC, dated December 29, 1976.

Bush, R. M., E. B. Welch and B. W. Mar, Potential Effects of Thermal Discharges on Aquatic Systems, Dept. of Civil Eng., Univ. of Wash., Seattle, WA, 1972.

Caffey, L. W., ERDA, letter to R. S. Boyd, NRC, dated May 19, 1976.

Caffey, L. W., ERDA, letter to H. L. Hatch, Corps of Engineers, dated July 8, 1976.

Carner, R. J., Transfer of Radioactive Materials from the Terrestrial Environment to Animals and Man, CRC Critical Reviews in Environmental Control, 2:337-385, 1971.

Comptroller General of the U.S., Report to the Joint Economic Committee: Can the U.S. Breeder Reactor Development Program be Accelerated by Using Foreign Technology? May 6, 1976.

Cry, G. W., Laboratory of Climatology, U.S. Weather Bureau, Tropical Cyclones of the North Atlantic Ocean, Technical Paper No. 55, U.S. Dept. Commerce, Washington, DC, 1965.

Council on Environmental Quality, Memorandum for Heads of Agencies, R. W. Peterson, Chairman, February 10, 1976.

Culkowski, W. M., "An Anamalous Snow at Oak Ridge, Tennessee," Mon. Wea. Rev. 90(5), May 1962.

Culkowski, W. M., The ATDL Lidar Program, ATDL Contribution No. 41, Oak Ridge, TN, 1970.

Culkowski, W. M., and S. D. Swisher, Average Aerosol Scale Heights over Oak Ridge, TN, unpublished manuscript, ATDL, Oak Ridge, TN, 1974.

Darley, E. F., and J. T. Middleton, "Problems of Air Pollution in Plant Pathology," Annual Reviews of Plant Pathology, 4:103-118, 1966.

Davies, R. M. and L. D. Jensen, Effects of Entrainment of Zooplankton at Three Mid-Atlantic Power Plants. The Johns Hopkins Univ. Dept. of Geog. and Environ. Eng. Prepared for the Electric Power Research Institute Report No. 10, 1974.

Directorate of Licensing, USAEC., Draft Environmental Statement: Newbold Island Units 1 and 2, Docket Nos. 50-354 and 50-355, 1972.

Doudoroff, P. and M. Katz, Critical Review of Literature on the Toxicity of Industrial Wastes and Their Components to Fish, II, The Metals, as Salts, Sewage and Industrial Wastes, Vol 25, No. 7, pp 802-839, Jul 1953.

Draft Regulatory Guide 1.BB, "Calculation of Releases of Radioactive Materials in Liquid and Gaseous Effluents from Pressurized Water Reactors (PWRs)."

Duncan, W. H., Endangered Rare and Uncommon Wildflowers Found in the Southern National Forests. U.S. Dept. of Agriculture. Forest Service. Southern Region, 1970.

ER, The Environmental Report for the Clinch River Breeder Reactor Plant, Project Management Corp., Chicago, IL, Apr 7, 1975, and amendments I through VII.

ERDA-1535, U.S. Energy Research and Development Administration, "Final Environmental Statement for the Liquid Metal Fast Breeder Reactor Program," December 31, 1975.

ERDA, 76-14, The LMFBR Program in France, December 1975.

EURFNR 1258, Design Prinicples of Large Sodium-Cooled Breeder Reactors, K. Schramm, April 1975.

Federal Water Pollution Control Administration, Water Quality Criteria, National Technical Advisory Rept to Sec of Int., FWPCA, 1968.

Fern, W. J. and R. I. Brabets, "Field Investigation of Ozone Adjacent to High Voltage Transmission Lines," IEEE Transactions, Power Apparatus and Systems, Paper T 74 057-6, 1974.

Frydman, M., et al., "Oxidant Measurements in the Vicinity of Energized 765-kV Lines," IEEE Transactions on Power Apparatus and Systems, Paper T 72 551-0, pp 1141-1148, 1973.

Gartrell, P.H., Director of Environmental Research and Development, TVA, letter with attachments to W. P. Kelleghan, Assistant General Manager, PMC, Nov 20, 1972.

General Accounting Office, "Cost and Schedule Estimate for the Nation's First Liquid Metal Fast Breeder Reactor Demonstration Plants," RED-75-358, May 22, 1975.

General Water Quality Criteria for the Definition and Control of Pollution in the Waters of Tennessee, Quality Control Act of 1971.

Geraghty, J., D. Miller, F. Van der Leeden, and F. Troise, 1973 Water Atlas of the United States, Water Information Center, Inc., NY.

Goff, F. Glenn, R. L. Stephenson, and Diane Lewis, Rare, Endangered and Endemic Taxa and Habitats of the East Tennessee Development District, Oak Ridge National Laboratory Environmental Sciences Division Publication No. 684, EDFB-IBP 75-2, 1975.

Gray, J., "How Fishes Swim", Sci. Am, Vol. 197, pp 48-54, 1957.

Grella, A. W., "A Review of Five Years Accident Experience in the U.S.A. Involving Nuclear Transportation (1971-1975)," Seminar on Design, Construction, and Testing of Packaging for Safe Transport of Radioactive Materials, IAEA-SR-10/5, August 1976.

Gross, E., The National Air Pollution Potential Forecast Program, ESSA Technical Memorandum WBTM 47, National Meteorological Center, Washington, DC, 1970.

Hanna, S. R. and S. D. Swisher, Air Pollution Meteorology of the Rockwood-Harriman, TN, Industrial Corridor, ATDL Contribution No. 40, Oak Ridge, TN, 1970.

Hanna, S. R., "Rise and Condensation of Large Cooling Tower Plumes," J. of App. Met., Vol. 11, No. 5, Aug 1972a.

Hanna, S. R., An Air Quality Model for Knox County, Tennessee, ATDL Contribution No. 55, Oak Ridge, TN, 1972b.

Hanna, S. R., Relating Emissions to Air Quality in Tennesse, ATDL Contribution 90, Oak Ridge, TN, 1974.

Hanna, S. R., "Meteorological Effects of the Cooling Towers at the Oak Ridge Gaseous Diffusion Plant - Part II, Predictions of Fog Occurrence and Drift Deposition," ATDL Contribution No. 88, Oak Ridge, TN, 1974a.

Hanna, S. R., "Meteorological Effects of the Mechanical Draft Cooling Towers of the Oak Ridge Gaseous Diffusion Plant," ATDL Contribution No. 89, Oak Ridge, TN, 1974b.

Hanna, S. R., "Fog and Drift Deposition from Evaporative Cooling Towers," Nuclear Safety, Vol 15, No. 2, Mar-Apr 1974c.

Hatcher, R., Tennessee Wildlife Resources Agency, Personal Communications, 1975.

Hett, J. M. Land-use Changes in East Tennessee and a Simulation Model Which Describes These Changes for Three Counties, ORNL-IBP-71-8, 1971.

Holzworth, G. C., Mixing Heights, Wind Speeds and Potential for Urban Air Pollution Throughout the Contiguous United States, AP-101, Environmental Protection Agency, Office of Air Programs, Research Triangle Park, NC, 1972.

Howell, J. C. and P. B. Dunaway, Long-term Ecological Study of the Oak Ridge Area: II, On the mammals with special reference to Melton Valley. ORNAL File 59-10-126, 1959.

Hubbard, W. B., "Amendment to Petition for Lease to Intervene on Behalf of the State of Tennessee," p. 3 of attached stipulation, 16 March 1976.

ICRP, "Recommendations of the International Commission on Radiological Protection," ICRP Publication 2, Pergamon Press, 1959.

ICRP, "Implications of Commission Recommendations that Doses be Kept as Low as Readily Achievable," ICRP Publication 22, 1973.

Jallouk, P. A., G. J. Kidd, Jr., and T. Shapiro, Environmental Aspects of Cooling Tower Operation; Survey of the Emission Transport, and Deposition of Drift from the K-31 and K-33 Cooling Towers at ORGDP, (K-1859), Union Carbide Corporation, Gaseous Diffusion Development Division, Oak Ridge Gaseous Diffusion Plant, Oak Ridge, TN, Feb 1974.

Jensen, L. D., R. M. Davies, A. S. Brooks and C. D. Meyers, The Effects of Elevated Temperatures Upon Aquatic Invertebrates, The John Hopkins Univ., Dept. of Geol. and Environ Eng. Prepared for the Edison Electric Institute, Report No. 4, 1969.

Jensen, L. D. (Ed.), Entrainment and Intake Screening; Proc. of Second Entrainment and Intake Screening Workshop, Baltimore, MD," EPRI Rept No. 15, Publ. No. 74-049-00-5, 1974. Kerr, J. E., Studies on the Fish Preservation of the Contra Costa Steam Plant of the Pacific Gas and Electric Company, State of Calif., Dept of Fish and Game, Fish Bull., No. 92 p. 66, 1953.

Kerr, J. E., Studies of Fish Preservation at the Contra Costa Steam Plant of the Pacific Gas and Electric Co., Cal Fish and Game Bul 92, pp. 63, 1953.

Kolico, N., et al., "Radio Influence and Corona-Loss Aspects of AEP 765-kV Lines," IEEE Transactions on Power Apparatus and Systems, Vol PAS 88(9):1343-1355, 1969.

Landsberg, H. E., (Ed), Climates of North America, Volume 11 of World Survey of Climatology, American Elsevier Publishing Company, Inc., New York, NY.

Larimore, R. W. and M. J. Duever, "Effects of Temperature Acclimation on the Swimming Ability of Smallmouth Bass Fry," Trans. Am. Fish. Soc. Vol 97, No. 2 pp 175-184, 1968.

Lee, R. N., J. W. Sloot and M. A. Wolf, Measurements of Chromate Resulting from Cooling Tower Drift at the Oak Ridge Gaseous Diffusion Plant, Final report prepared for Union Carbide Nuclear Company by Battelle, Pacific Northwest Laboratories, Richland, WA, 1973.

Lee, W. S. (Duke Power Company) letter to P. Van Nort (PMC) dated November 4, 1976.

Levenson, M. and Zebroski, E., "The Nuclear Fuel Cycle," Annual Review of Energy (1975).

Levin, A. A., T. J. Birch, R. E. Hillman and G. E. Raines, A Comprehensive Appraisal of the Effects of Cooling Water Discharge on Aquatic Ecosystems. Battelle Memorial Institute, Columbus, Ohio, 1970.

Markowski, S. "The Cooling Water of Power Stations: A New Factor in the Environment of Marine and Freshwater Invertebrates." J. Animal Ecol., Vol. 28, pp. 243-258, 1959.

McConathy, Ron K., Land use changes on the proposed LMFBR site, Oak Ridge Reservation (1924-1972). ORNL-TM-4838, (Manuscript in review).

McCullough, C. R., S. E. Turner and R. C. Lyerly, "An Appraisal of the Potential Hazard of Industrial Sabotage in Nuclear Power Plants", SNE-37/UC-80, July 1968.

McKee, J. E. and H. K. Wolf (Ed) Water Quality Criteria, 2nd Edition, California Water Resources Control Board, 1963.

McNeely, D. L. and W. D. Pearson. "Distributional and Conditions of Fishes in a Small Reservoir Receiving Heated Waters". Trans. Am. Fish. Soc. Vol. 103 No. 3, pp. 518-530, 1974.

Milhursky, J. A. and U. S. Kennedy, "Water Temperature Criteria to Protect Aquatic Life", A symposium on Water Quality Criteria to Protect Aquatic Life, Am. Fish. Soc. Spec. Publ. No. 4, pp. 20-32, 1967.

Moyer, S. and E. C. Raney, "Thermal Discharges from Large Nuclear Plants," ASCE Jour. Sanitary Engin. Div., Dec 1969.

NAS-NRC, "Radioactivity in the Marine Environment," Panel on RIME of the Committee on Oceanography, 1971.

NAS-NRC, "The Effects on Populations of Exposure of Low Levels of Ionizing Radiation," Report of the Advisory Committee on Biological Effects of Ionizing Radiations, 1972.

Nebeker, A. W. and A. E. Lemke, "Preliminary Studies on the Tolerances of Aquatic Insects to Heated Waters," J. Kansas Ent. Soc. Vol. 41, No. 3, pp. 413-418, 1968.

Neill, W. H., Distributional Ecology and Behavioral Thermo-regulation of Fishes in Relation to Heated Effluent from a Steam-Electric Power Plant. (Lake Monona, WI), PhD. Dissertation. University of Wisconsin, Madison, WI, 1970.

Nuclear Engineering International, S. Rippon, July 1975, p. 545.

NUREG-0002, Final Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light Water Cooled Reactors, August 1976.

NUREG-75/039, U.S. Nuclear Regulatory Commission "Final Environmental Statement related to construction of proposed Hartsville Nuclear Power Plants of the Tennessee Valley Authority" Jun 1975.

NUREG-0073, Transport of Radioactive Material in the U.S., U. S. Nuclear Regulato'y Commission, May 1976.

NUREG-0098 - Tennessee Valley Authority, Draft Environmental Statement for the Phipps Bend Nuclear Plants, Units 1 and 2, August 1976.

Nyland, R. E. (U.S. Dept. of Interior, Bonneville Power Administration) letter to P. Van Nort (PMC) dated November 10, 1976.

Oakley, D. T, "Natural Radiation Exposure in the United States," ORP/SID 72-1, Office of Rad. Prog., USEPA, Jun 1972.

Oak Ridge National Laboratory, Environmental Sciences Division, Annual Report, ORNL 4935, 1972.

ORNL-4678, Effects of Fast Neutrons on Polycrystalline Alumina and Other Electrical Insulators at Temperatures from 60° to 1230°C, by Z. W. Keilholtz, R. E. Moore, and H. E. Robertson, May 1971.

ORNL-4628, Calculations by the ORIGEN Code, described in Bell, M. J. "ORIGEN, the ORNL Isotope Generation and Depletion Code," May 1973. The CRBRP fuel is assumed to be represented by a blend of upper axial blanket, inner core, and lower axial blanket elements. Burnup is 100,000 MWD/MT.

ORNL-4848, Environmental Science Division of Oak Ridge, Environmental Science Annual Progress Report Period Ending September 30, 1972, Oak Ridge, Tennessee, 1973.

Pacific Gas and Electric Co., Units 1 and 2, Diablo Canyon Site, Sup No. 2 to the Environmental Report, Jul 28, 1972.

Patrick, R., "Some Effects of Temperature on Freshwater Algae," Biological Aspects of Thermal Pollution, P. A. Krenkel and F. A. Parker, (Ed.) Vanderbilt Univ. Press pp. 161-185, 1969.

Pennak, R. W., Freshwater Invertebrates of the United States, New York, Donald Press, 1963.

Power Reactor Development Company, Retirement of the ENRICO FERMI Atomic Power Plant, "Chapter 4", March 1974.

Proposed Appendix I of 10 CFR 50, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criteria 'As Low as Practicable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactors" (Docket No. RM 50-2), Feb 1974.

PSAR, Preliminary Safety Analysis Report for the Clinch River Breeder Reactor Plant, Project Management Corp., Chicago IL, Apr 11, 1975.

Rabinowitch, E. I., Photosynthesis and Related Processes, Vol. I Interscience, New York, 1945.

Research Division, Washington Department of Revenues, Financing K-12 Education in Washington Report II: Washington State School Revenues Compared to Other States, Olympia, Wash., 1975, Table 1.

RM-50-2, Attachment to Concluding Statement of Position of the Regulatory Staff Public Rulemaking Hearing on: Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low As Practicable" for Radioactive Material in Light Water Cooled Nuclear Power Reactors, Docket No. RM-50-2, Feb 20, 1974.

Roberts, R. W., ERDA, letter to B. C. Rusche, NRC, 9 April 1976.

Roffman, A and R. E. Grimble, "Prediction of Drift Deposition from Salt Water Cooling Towers," Annual Meeting of the Cooling Tower Institute, Houston, TX, Jan 29-31, 1973.

Roisman, A. R., letter to NRC, Restated Contention No. 10, September 17, 1976.

Sagendorf, J., A Program for Evaluating Atmospheric Dispersion from a Nuclear Power Station, NOAA Technical Memorandum ERL ARL-42, Idaho Falls, ID, 1974.

SAND-0069, "Safety and Security of Nuclear Power Reactors to Acts of Sabotage", Unclassified Summary of Sandia Laboratories Report, March 1975.

SELS Unit Staff, National Severe Storms Forecast Center, Severe Local Storm Occurrences, 1955-1967, ESSA Technical Memorandum WBTM FCST 12, Office of Meteorological Operations, Silver Spring, MD, 1969.

Schmidt, Fred H. and Bodansky, D., The Energy Controversy: The Role of Nuclear Power (Seattle: University of Washington, 1975).

Schroedl, G. F., Archaeological Reconnaissance and Test Excavation in the Clinch River Liquid Metal Fast Breeder Reactor Plant Site. Report submitted to TVA, December 1972.

Schroedl, G. F., Salvage Archaeology in the Clinch River Liquid Metal Fast Breeder Reactor Plant Area. Report submitted to TVA and PMC.

Sharp, A. J., Rare Plants of Tennessee. The Tennessee Conservationist 40(7): 20-21, 1974.

Shofner, F. M., G. O. Schrecker and K. R. Wilber, Characterization of Drift Emissions and Drift Transport for Representative Cells of K-31 and K-33 Cooling Towers, Final Report prepared for Union Carbide Nuclear Company by Environmental Systems Corp., Knoxville, TN, 1973.

Slade, D. H., (Ed), Meteorology and Atomic Energy, 1968, TID-24190.

Smith, M., 1968: Recommended Guide for the Prediction of the Dispersion of Airborne Effluents. The American Society of Mechanical Engineers, New York, New York.

Spigarelli, S. A., G. P. Romberg, W. Prepejcal and M. M. Thomas, "Body-Temperature Characteristics of Fish at a Thermal Discharge on Lake Michigan," Thermal Ecology, pp. 119-132, NTIS, Springfield, VA, 1974.

Stern, A. C., (Ed), Air Pollution, Vol 1, 2nd ed., Chapters 12 and 13, Academic Press, 1968.

Strock, W. G. Jr., Forest Management Plan, AEC Oak Ridge Reservation: 1970-1975, ORNL-TM-3175, Holifield National Laboratory, Oak Ridge, TN, 1975.

Tattleman, P. and I. I. Gringorton, Estimated Glaze Ice and Wind Loads at the Earth's Surface for the Contiguous United States, Air Force Cambridge Research Laboratories, Bedford, MA, 1973.

Tax Study Committee, Quarterly Court of Anderson County, "Study of the Financial Impact of The USAEC on the Anderson County Government." Clinton, TN, Feb 1, 1971.

Taylor, M. P., "Phytoplankton Productivity Response to Nutrients Correlated with Certain Environmental Factors in Six TVA Reservoirs," Reservoir Fisheries and Limnology, Gordon E. Hall (Ed), Spec. Publ. No. 8, Am Fish Soc. Washington, DC, pp 209-218, 1971.

Tennessee Air Pollution Control Regulations, Tennessee Department of Public Health, Division of Air Pollution Control, Nashville, TN.

Tennessee Valley Authority, Environmental Report for the Yellow Creek Nuclear Plant, Units 1 and 2, Volumes 1-3, Docket Nos. STN 50-566 and STN 50-567, December 1976.

Tennessee Water Quality Control Board, General Water Quality Criteria for the Definition and Control of Pollution in the Waters of Tennessee, Oct 1973.

Thom, H. C. S., Tornado Probabilities, Monthly Weather Review, pp 730-737, Oct-Dec 1973.

Thomas, P. M., Jr., A Map of Two Historical Sites in the Clinch River Liquid Metal Fast Breeder Reactor Plant Area, March 26, 1973.

Treshaw, M., Environmental and Plant Response, McGraw-Hill, 1970.

TWQCB, 1973.

Unger, R. A., Environmental Engineer, Division of Water Quality Control, State of Tennessee, Department of Public Health, Letter to W. H. Young, CRBRP Project Manager, Burns & Roe, Inc., Jan 21, 1974.

USAEC, Environmental Monitoring Report, UCC-ND-244, 1972.

USAEC, 1969, U.S. Atomic Energy Commission, "Invitation for Proposals - Fourth Round, The LMFBR Demonstration Plant Program under the Commission's Power Reactor Demonstration Program", May 1969 (subject material is also presented in pp 43-108 of WASH-1201, USAEC, Mar 1972).

USAEC, 1962, U.S. Atomic Energy Commission, "Civilian Nuclear Power, A Report to the President, 1962," USAEC Report (unnumbered), Nov 1972.

U.S. Army Corps of Engineers, Shore Protection, Planning and Design, Tech. Rept No. 4, 1966.

U.S. Dept. of Commerce 1, Environmental Data Service, Local Climatological Data, Annual Summary with Comparative Data - Oak Ridge, TN, Published annually.

U.S. Dept. of Commerce 2, Environmental Data Service, Local Climatological Data, Annual Summary with Comparative Data - Knoxville, TN, Published annually.

U.S. Dept. of Commerce 3, Environmental Data Service, Climatic Atlas of the United States, Environmental Science Services Administration, Washington, DC.

U.S. Dept. of Commerce 4, Environmental Data Services: Tropical Storm and Atlantic Hurricane Articles from the Monthly Weather Review, Dec 1973.

U.S. Dept. of Commerce 5, National Severe Storms Forecast Center: Listing of Tornadoes for the Period 1953-1974. National Oceanic and Atmospheric Administration. Kansas City, Mo., 1975 (Unpublished).

U.S. Dept. of Interior, Office of Endangered Species and International Activities, Bureau of Sport Fisheries and Wildlife, Resource Publication 114, Government Printing Office, Washington, DC, Mar 1973.

U.S. Dept. of Interior, Threatened or Endangered Fauna or Flora, Federal Register Volume 40 No. 127, Part V, Tuesday, Jul 1, 1975.

U.S. Environmental Protection Agency, Methods for Chemical Analysis of Water and Wastes EPA, Water Quality Office, Analytical Quality Control Lab.; Cinn., OH, 1971.

U.S. Environmental Protection Agency, Proposed Criteria for Water Quality, Vol 1, Oct 1973.

U.S. Environmental Protection Agency, Biological Field and Laboratory Methods for Measuring the Quality of Surface Waters and Effluents, EPA Office of Research and Development.

U.S. Environmental Protection Agency, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, EPA Office of Noise Abatement and Control, pp iii and 3, 550/9-74-004, Mar 1974.

U.S. Environmental Protection Agency, Steam Electric Power Generating Point Source Category: Effluent Guidelines and Standards, FR39:196, part III, October 8, 1974.

U.S. Environmental Protection Agency, EPA-520/3-75-023, Transportation Accident Risks in the Nuclear Power Industry, 1975-2020.

U.S. Energy Research and Development Administration, "Administrator's Findings on the Liquid Metal Fast Breeder Reactor Program Proposed Final Environmental Statement," (unnumbered, dated Jun 30, 1975).

U.S. Energy Research and Development Administration, "Administrator's Findings on the Liquid Metal Fast Breeder Reactor Program", (unnumbered, dated December 31, 1975).

U.S. Nuclear Regulatory Commission, Final Environmental Statement Related to Construction of Skagit Nuclear Power Project Units 1 and 2, Docket No. 50-522 and 50-523, Section 11.7.6, May 1975.

Vaiksnoras, J. V., Tornado Occurrences in Tennessee, 1916-1970, State Climatologist for Tennessee, National Weather Service Office, Nashville, TN, April 15, 1971.

Van Nort, P. S., PMC, letter to R. S. Boyd, NRC, 14 April 1976.

Van Nort, P. S., PMC, letter to R. S. Boyd, NRC, dated April 27, 1976.

Van Nort, P. S., PMC, "Application for Department of the Army Permit for Activities in Waterways," to District Engineer, Department of the Army, Corps of Engineers, Nashville, 13 February 1976.

Van Nort, P. S. (Project Management Corp.), letter to R. S. Boyd (USNRC), March 29, 1976.

Van Slyke, D. D. and J. H. Neil, Jour. of Biological Chemistry, 61: 523, 1924.

WASH-1201, U.S. Atomic Energy Commission, "LMFBR Demonstration Plant Program; Proceedings of Senior Utility Steering Committee and Senior Utility Technical Advisory Panel for the period of April 1971 through January 1972", USAEC, Mar 1972.

WASH-1238, U.S. Atomic Energy Commission, "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants", December 1972; Docket No. 71-9026, LMFBR Spent Fuel Shipping Cask Model I-(182)-1, Aerojet General Manufacturing Company.

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

WASH-1258, U.S. Atomic Energy Commission, "Final Environmental Statement on ALAP-LWR Effluent," July 1973.

WASH-1354, Comparison of Foreign and U.S. LMFBR Plant Parameters, November 29, 1974.

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

WASH-1509, U.S. Atomic Energy Commission, "Environmental Statement-Liquid Metal Fast Breeder Reactor Demonstration Plant", Apr 1972.

WASH-1535, U.S. Atomic Energy Commission Proposed Final Environmental Statement - Liquid Metal Fast Breeder Reactor Program, Dec 1974.

Westinghouse Electric Corporation, Environmental Systems Department, "Socioeconomic Assessment of CRBRP Construction and Operation," Pittsburgh, Pa., April 1976.

Willrich, M. and Taylor, T. B., Nuclear Theft: Risks and Safeguards (Cambridge, Mass., Ballinger Publishing Company, 1974).

Wilson, E. O. et al., Life on Earth, Stamford, Conn: Sinauer Assoc., Inc., 1973.

Wojtalik, T. A. and T. F. Waters, "Some Effects of Heated Waters on the Drift of Two Species of Stream Invertebrates", Trans. Am. Fish. Soc., Vol. 99, No. 4, pp. 782-788, 1970.

10 CFR 71, Packaging of Radioactive Material for Transport and Transportation of Radioactive Material under Certain Conditions.

APPENDIX A

COMMENTS ON DRAFT ENVIRONMENTAL STATEMENT

Advisory Council
On Historic Preservation
1522 K Street N.W.
Washington, D.C. 20005

March 23, 1976

RECEIVED MAR 23 1976 U.S. NUCLEAR REGULATORY COMMISSION Mail Section

Mr. B. J. Youngblood, Chief
Environmental Projects Branch 2
Division of Site Safety and Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Youngblood:

Thank you for your request of February 11, 1976 for comments on the environmental statement for the Clinch River Breeder Reactor Plant, Docket No.: 50-537. Pursuant to our responsibilities under Section 102(2)(C) of the National Environmental Policy Act of 1969 and the Council's "Procedures for the Protection of Historic and Cultural Properties" (36 C.F.R. Part 800), we have determined that your draft environmental statement appears adequate concerning our area of interest, and we have no further comments to make.

Should you have any questions on these comments or require any additional assistance, please contact Ernest R. Holz of the Advisory Council staff (202-254-3380).

Sincerely yours,

John D. McDermott
Director, Office of Review
and Compliance

3078

The Council is an independent unit of the Executive Branch of the Federal Government charged by the Act of October 15, 1966 to advise the President and Congress in the field of Historic Preservation.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
561 U. S. Courthouse, Nashville, Tennessee 37203

March 17, 1976

Mr. B. J. Youngblood, Chief
Environmental Projects Branch 2
Division of Site Safety and
Environmental Analysis
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

50-537
3-24-76

Dear Mr. Youngblood:

Your letter of February 11, 1976 to Paul M. Howard, Soil Conservation Service, transmitted for comment the draft environmental statement for the Clinch River Breeder Reactor Plant.

We have reviewed the draft statement and offer the following comments for your consideration:

1. The soils (Soil Survey - Roane County, Tennessee) in the area of the proposed project are mainly clayey, rolling to hilly (Talbott, Colbert, Clarkville, stony land, Upshur) with a narrow area along the river of a high water table soil (Wolfever) and a small area of Sequatchie. These soils would indicate moderate to mostly severe limitations for large buildings and roads. Mainly, because of slope, rock, shrink-swell potential, low bearing strength, and other factors. Core drilling of the proposed site would give additional soils and geologic information.

2. Permanent erosion conservation practices are discussed in the report including landscaping with no names or species:

   (a) No mention in the report of the need of temporary vegetation or other short time erosion control measures during construction.
   (b) The report states 228 acres of land would be disturbed during site preparation and construction activities including new transmission lines. Excessive erosion and sedimentation from the site during construction would probably have an adverse environmental effects on downstream (site is on the Clinch River) water quality, fish, and aquatic resources.

3. There is little prime farmland within the proposed area.

4. This project will have no adverse effect on SCS existing conservation systems, or any proposed projects.

We appreciate the opportunity to review this draft environmental impact statement.

Sincerely,

Donald C. Bivens
State Conservationist

CC: R. M. Davis
Office of the Coordinator of
Environmental Quality Activities

2763

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
1720 Peachtree Road, N. W.
Atlanta, Georgia 30309

50-537

8400
March 25, 1976

4-1-76

Mr. B. J. Youngblood, Chief
Environmental Projects Branch 2
Division of Site Safety and
Environmental Analysis
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Youngblood:

The United States Forest Service, State and Private Forestry has reviewed the draft environmental statement covering construction of the Clinch River Breeder Reactor Plant. Since this is a demonstration project and disturbance of forested land will be held to a minimum consistent with actual construction needs, we have no comments except to compliment you on the clarity and content of the statement. We especially commend the decision to place in commerce all merchantable wood products removed from the construction site and to continue management of surrounding forested lands under the ERDA Oak Ridge Forest Management Program.

Thank you for the opportunity to review and comment on this good draft EIS.

Sincerely,

ROBERT K. DODSON
Area Environmental Coordinator

Copy: State Forester, Tenn.

3292

6200-11 (1/69)

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
P. O. BOX 1070
NASHVILLE, TENNESSEE 37202

50-537

IN REPLY REFER TO
ORNOP-W

22 MAR 1976

Mr. Paul Leech
Environmental Projects
US Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Leech:

Reference is made to our letter dated 9 December 1975 from Mr. Joseph R. Castleman, Chief of our Permits Section, which contained a limited number of suggested inclusions for the Draft Environmental Statement (DES) for the Clinch River Breeder Reactor Plant (CRBRP). At that time, the co-applicants had not submitted an application for a Department of the Army Permit with detailed drawings describing the proposed activities in navigable waters.

We are now in receipt of the required application dated 13 February 1976. Based on our review of the application and the DES, we submit the following additional information for inclusion in the Final Environmental Statement (FES):

a. The DES and the Environmental Report (ER) do not include information regarding the impact of increased commercial navigation that would be generated during the construction and operation of the proposed plant. Although Table 2.2-15 of the ER indicates the use of the Clinch River for recreational and commercial navigation from 1966 through 1972, it makes no reference to increased barge traffic resulting from plant construction and operation. This increased commercial barge traffic constitutes an impact that should be addressed in the FES.

b. The Department of the Army Permit application, as well as the DES and ER, do not indicate the types of commodities or equipment that would be transported over navigable waterways. This information should be provided in the FES, including any special handling, safety requirements or precautions related thereto.

c. What impact would closure of the waterway to commercial navigation have on operation of the Breeder Reactor Plant?

2952

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

22 MAR 1976

ORNOP-W
Mr. Paul Leech

The ER (see Section 4.1.2.3) adequately describes the aquatic life of the Clinch River in the vicinity of the plant site and adequately assesses the probable impact of dredging and filling on these resources. We, therefore, offer no additional information regarding the impact of these activities.

If you have further questions or desire to discuss the above information in more detail, please advise.

Sincerely yours,

HENRY J. HATCH
Colonel, Corps of Engineers
District Engineer

DEPARTMENT OF THE ARMY
OHIO RIVER DIVISION, CORPS OF ENGINEERS
P. O. BOX 1159
CINCINNATI, OHIO 45201

ORDCO-W

29 March 1976

50-537

Director, Office of Nuclear
Reactor Regulation
Nuclear Regulatory Commission
ATTN: Mr. Paul H. Leech, Project Manager
Washington, DC 20555

Dear Mr. Leech:

Our Planning and Operations staff have reviewed your Draft Environmental Statement related to the construction of the Clinch River Breeder Reactor Plant and offer comments presented in the inclosed review memorandum.

Sincerely yours,

/JOHN H. COUSINS
Colonel, Corps of Engineers
Deputy Division Engineer

1 Incl
As stated

RECEIVED APR 20 1976 U.S. NUCLEAR REGULATORY COMMISSION MAIL SECTION

3936

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

REVIEW MEMORANDUM

Draft Environmental Statement
Clinch River Breeder Reactor Plant
Docket No. 50-537
February 1976

DEIS

a. Page 3-1, External Appearance (3.1), 3rd Paragraph. The proposed limitations in use of or control over the "exclusion area", which includes the full width of Clinch River, should be described in detail, particularly as it would affect navigation and recreational use of the water and adjacent shoreline.

b. Page 4-1, Construction Schedules and Manpower (4.1). It is stated that the applicant requested a Limited Work Authorization effective 11 months prior to the anticipated date of the construction permit. This statement should be clarified, taking into account CEQ guidelines for NEPA procedures required prior to taking administration actions; and requirements for permit actions under the Federal Water Pollution Control or River and Harbor Acts, etc.

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
P. O. BOX 1070
NASHVILLE, TENNESSEE 37202

IN REPLY REFER TO
ORNED-P

50-537

RECEIVED
APR 26 1976
U.S. NUCLEAR REGULATORY COMMISSION
Mail Section

Mr. B. S. Youngblood, Chief
Environmental Projects Branch 2
Division of Site Safety and
Environmental Analysis
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Youngblood:

This is in response to your 11 February 1976 letter forwarding the Draft Environmental Statement, Clinch River Breeder Reactor Plant, Docket No. 50-537 (DES), for comment. Comments concerning the navigation aspects of this project were contained in my 22 March 1976 letter to U. S. Nuclear Regulatory Commission (copy enclosed). Additional comments follow.

In reviewing the DES and the Environmental Report (ER), I do not find in the list of references (DES pages R-1 and D-15; ER pages 13.0, 14.7-2, 14.8-1, B-31 and B1-58) any reference to the use of federal, regional or private codes and standards, such as National Bureau of Standards, Southern Building Code, National Fire Protection Association (NFPA), American National Standards Institute (ANSI) and Underwriters Laboratories (UL). These documents should be studied and used by staff members informed on hazards, safety and fire protection of structures in general and of nuclear reactors in particular. I call your special attention to the National Fire Codes published by NFPA, 470 Atlantic Avenue, Boston MA 02210. I have enclosed several references (three) on the fire codes for your convenience and quick reference by your staff. In light of recent press reports of fires in nuclear plants, I recommend that, to the greatest possible extent, use of combustible construction materials, shielding, apparatus, equipment, instruments, furnishings, finishes, and parts thereof be discontinued. Nonflammable fluids, such as for hydraulic controls, might well be found or developed. This is also applicable to usage of noncombustible insulation for electrical cable and apparatus. The availability of nonflammable material and synthetic materials is increasing rapidly and such items sould be utilized in the Clinch River plant.

4249

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

ORNED-P
Mr. B. S. Youngblood

The DES states that solid waste would be packaged and shipped to a licensed burial site in accordance with NRC and Department of Transportation regulations. I recommend that a concise but adequate description be made of a "licensed burial site." What are the criteria for an acceptable site? What is the nature of its construction and protection? Does the selection consider probable future land use in the area? Other details pertinent to comprehension of present impacts and future effects of these sites should be included in the DES.

Figure 3.8 shows the tops of two intake pipes at approximately elevation 733 msl or higher. Figure 3.14 shows "intake pipes to be located within this area," the top of which is 724 msl. These figures should be checked for errors or discrepancies.

The DES states that water releases from Melton Hill Dam will meet the nuclear plant requirements during zero flow conditions of the Clinch River. The effects of this release on Melton Hill Lake should be discussed.

I appreciate the opportunity to review the draft statement.

Sincerely yours,

HENRY J. HATCH
Colonel, Corps of Engineers
District Engineer

4 Encl
1. Ltr, 22 Mar 76
2-4. NFPA Codes

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Science and Technology
Washington, D.C. 20230

March 19, 1976

Mr. B. J. Youngblood
Chief, Environmental Projects Branch 2
Division of Site Safety and Environmental
Analysis
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

50-537

Dear Mr. Youngblood:

This is in reference to your draft environmental impact statement entitled, "Construction of the Clinch River Breeder Reactor Plant." The enclosed comments from the National Oceanic and Atmospheric Administration, National Marine Fisheries Service, and Environmental Research Laboratories are forwarded for your consideration.

Thank you for giving us an opportunity to provide these comments, which we hope will be of assistance to you. We would appreciate receiving ten (10) copies of the final statement.

Sincerely,

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

Enclosures - Memo from: NOAA - National Marine Fisheries Service (3-5-76)
NOAA - Environmental Research Laboratories (3-5-76)

2941

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Duval Building
9450 Gandy Boulevard
St. Petersburg, FL 33702

March 5, 1976

FSE21/FC

TO: Director
Ofc of Ecology & Environmental Conservation, EE

MAR 11 1976

THRU: Associate Director for
Resource Management, F3

FROM: William H. Stevenson
Regional Director

SUBJECT: Comments on Draft Environmental Impact Statement - Clinch River Breeder Reactor Plant - (NRC) (DEIS #7602.45)

The draft environmental impact statement for the Clinch River Breeder Reactor Plant (NRC) that accompanied your memorandum of February 19, 1976, has been received for review and comment.

The statement has been reviewed by Dr. F. A. Cross of the National Marine Fisheries Service (NMFS) Atlantic Estuarine Fisheries Center, and the following comments are offered for your consideration.

GENERAL COMMENTS:

In our opinion, the environmental monitoring program is not adequately designed to ensure that commercial fisheries will not be adversely affected during plant operation. We assume that the purposes of the ecological, chemical and physical aquatic baseline sampling surveys described on pages 6-4 to 6-10, sections 6.1.4 and 6.1.5, are to provide estimates of selected parameter values prior to plant construction and operation. Further, we assume that these estimates and additional estimates made after the plant is in operation are to be statistically compared to test whether the plant has caused a significant change in the environment. However, with the information provided it is impossible to determine whether the sampling programs are adequate. We suggest that information be included concerning the level of change that is judged to be environmentally significant and the level of change that the sampling programs are designed to detect.

RECEIVED

SPECIFIC COMMENTS:

6. Environmental Measurement and Monitoring Programs

6.1.2 Radiological

Because filter feeders such as clams have a high capacity for accumulating radionuclides (Lowman, Rice and Richards, 1971), we recommend that radiological measurements be made on meats of Asiatic clams, as well as on the shells. In addition, the specific isotopes of plutonium to be measured should be identified.

6.1.5 Chemical and Physical

Although the DEIS states that the heavy metals released from the reactor will not affect the biota adversely, no provision is made to routinely measure heavy metal concentrations in either representative biota, particularly commercial species, or in sediments. Without such analyses, any increase in the concentrations of heavy metals in the aquatic environment near the plant cannot be detected, as measurements of water alone will not provide this information.

It is requested that one copy of the Final EIS be provided Dr. F. A. Cross, National Marine Fisheries Service, Atlantic Estuarine Fisheries Center, P.O. Box 570, Beaufort, North Carolina 28516.

cc:
F34, NMFS, Washington, D.C. (3)
F15, F.A. Cross, Beaufort, NC

Lowman, F.G., T.R. Rice and F.A. Richards. 1971. Accumulation and redistribution of radionuclides by marine organisms, pp. 161-199. In: Radioactivity in the marine environment. National Academy of Sciences, Washington, D.C.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL RESEARCH LABORATORIES
Silver Spring, Maryland 20910

March 5, 1976

MAR 5 1976

TO: Director, Office of Ecology and Environmental Conservation

FROM: Isaac Van der Hoven
Air Resources Laboratories

SUBJECT: Comments on NRC DEIS #7602.45
Clinch River Breeder Reactor Plant, TN

With regard to radiological impact on man from operational release of gaseous effluents to the atmosphere, the report states on p. 5-19 that "all dose calculations were performed using annual average site meteorological conditions and assuming that releases would occur at a constant rate." For the gaseous release from the Radioactive Argon Processing System (RAPS) which accounts for 90% of the total release in terms of Ci/year, it is not at all clear whether the release is at a constant rate. The applicant proposes to permanently bottle the residual radioactive gaseous waste while NRC assumes that the contents of the storage vessel would be released to the environment. The frequency and duration of such releases is not discussed but the likelihood is that the releases would be infrequent and of short duration. If such is the case the assumption of an average annual relative concentration factor (chi/Q) is inappropriate.

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

50-537

APR 15 1976

RECEIVED APR 21 1976 U.S. NUCLEAR REGULATORY COMMISSION Mail Section

Mr. B. J. Youngblood, Chief
Environmental Projects Branch 2
Division of Site Safety and
Environmental Analysis
Nuclear Regulatory Commission
Washington, D.C. 20055

Dear Mr. Youngblood:

We have reviewed the draft Environmental Impact Statement concerning the Clinch River Breeder Reactor Plant, Docket No. 50-537.

On the basis of our review, we note that the construction and subsequent operation of this plant will, to some extent, overburden the existing school and hospital facilities located in the area. It is estimated that 3 additional hospital beds will be required to adequately accomodate the proposed influx of population. In addition, the water and sewage treatment plants will be overextended, requiring an estimated increase in capacity of 72,000 gallons per day for each.

It appears that the radiological monitoring programs designed for the pre-operational and operational phases of the plant will be able to adequately evaluate any possible radiological effects on food and milk supplies produced in the area. This evaluation also includes sampling of game fish and edible molluscs growing in the Clinch River near the plant site.

The proposed plant will be the first commercial scale fast breeder reactor to be constructed and operated. However, a number of systems and subsystems designed to provide for safe operation of the reactor have not been proven. In fact, for some, the design work has not yet been completed. Consequently, there is a higher probability that radiological incidents could occur at this plant thereby contaminating the surrounding area. Also, potential injuries and exposure to the unusually high levels of radiation could place a burden on existing medical facilities. Although the probability of this happening is extremely remote, we feel that it should be addressed in the final document.

3987

Mr. Youngblood - Page 2

It should be noted that the State and surrounding localities, not ERDA or NRC, have the legal responsibility of assuring that adequate response systems are available and in operational readiness to provide an adequate emergency response to the off-site civilian personnel located adjacent to the plant in the event of a nuclear accident. It is the responsibility of the several Federal agencies involved to provide the technical assistance needed to the State and localities to insure that adequate response systems are available and operational.

Thank you for the opportunity to review the document.

Sincerely,

Charles Custard
Director
Office of Environmental Affairs

REGION IV
Peachtree-Seventh Building
50 Seventh Street, N.E.
Atlanta, Georgia 30323

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
KNOXVILLE AREA OFFICE
ONE NORTHSHORE BUILDING
1111 NORTHSHORE DRIVE
KNOXVILLE, TENNESSEE 37919

March 16, 1976

IN REPLY REFER TO:
4.7SS (Steve Shields, 637-9300, Ext. 1228)

50-537

Mr. B. J. Youngblood
Environmental Projects Branch 2
Division of Site Safety and
Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Youngblood:

Subject: Draft Environmental Impact Statement, Clinch River Breeder Reactor Plan, Tennessee

We have the following comments on the above document:

1. We feel more attention should be given the impact associated with additional development in the project area as a result of the work force that is needed for this project. It is stated on page 4-1 that about "1230 of those would move into the area by the construction peak." What impact will these people have on the rental market in the area? Are there sufficient units available to house these workers? Are a lot of them expected to live in mobile home parks? If so, is there sufficient space available in this area? What will be the impact on local services if additional mobile home areas have to be set up?

2. We feel more attention needs to be given measures to minimize some of the impacts associated with the project. An example would be to explain how the schools could handle the additional students generated by the construction of this project.

3. Since there are historical and archaeological findings in this general area, special attention should be given the comments by the President's Advisory Council on Historic Preservation.

Thank you for the opportunity to review this statement.

Sincerely,

for C. G. Oakes
Director

2917

RECEIVED
3 1976

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

RECEIVED
APR 5 - 1976
U.S. NUCLEAR REGULATORY COMMISSION
Mail Section

In Reply Refer To:
PEP ER-76/134

MAR 3 1 1976

Dear Mr. Youngblood:

Thank you for your letter of February 11, 1976, requesting our comments on the draft environmental statement for the Clinch River Breeder Reactor Plant, Roane County, Tennessee [Docket No. 50-537].

Our comments are submitted according to the format of the statement or by subject.

Reactor Accidents

The discussion of reactor accidents gives the impression of being incomplete and possibly premature. The draft statement indicates on page 7-2 that the preliminary safety analysis relating to two types of accidents is not finished and that the design is still under review.

Potential consequences for one of the two accidents for which the preliminary safety review is not completed are also mentioned in a scenario on page 7-8, item II(b), in which it is indicated that consequences may exceed 10 CFR 100 guideline values.

Of further concern is the reliance placed on WASH 1400 to predict reactor safety in the CRBRP. WASH 1400 was concerned with a Light Water Reactor (LWR) while the Clinch River Plant is a Liquid Metal Fast Breeder Reactor (LMFBR). While the probability for catastrophic consequences was claimed to be exceedingly small for light-water reactors in WASH 1400, no such claim can be made for the Clinch River Breeder Reactor because of the lack of experience, nor is such a claim made in the draft statement.

The final statement should address these concerns and provide assurance that sufficient information is available to properly assess the reactor safety of the Liquid Metal Fast Breeder Reactor.

Flooding

The statement does not contain a detailed flood analysis of the Clinch River at the site under present conditions. While the reactor itself appears to be well above the level of a probable maximum flood, the water intake pumphouse (page 3-6) could be flooded. If such flooding would create safety problems, more detailed flood analysis should be presented.

Surface Water Monitoring

The pre-operational monitoring program at reservoir locations does not list these locations and the accompanying Figure 6.2 has no legend (pages 6-2, 6-3). In the later design of the operational radiological monitoring program (page 6-11), consideration should also be given to monitoring of storm drainage from buildings and yards, among other items.

Ground Water Monitoring

We suggest that the ground-water monitoring system should include the collection of baseline and operating-period water-level measurements and quality-of-water data at strategic points along the south side, that is, the outside of the Clinch River meander in which the plant is to be located. Data of the environmental report (pages 215-23 through 57) suggest that a rather steep gradient southward away from the stream may already exist in the vicinity of well 64 (Figure 2.5-12; page 2.5-72; and page 2.5-55).

As indicated by the data of the environmental report (pages 215-10 through 20 and pages 2.5-44 through 52), the characteristics of the aquifers are such that comparatively small withdrawals can produce significant local drawdown of water levels; thus, any future increase in use of ground water, which may or may not be indirectly related to the existence of the proposed plant, can reverse gradients over appreciable areas. The proposed downstream monitoring of the more distant public supplies and the monitoring of water quality at two more farms (page 6.2-9) may partially serve the purpose of the above suggestion (depending on the locations involved), but water-level information along the south side of the stream could signal the development of potential for quality-of-water effects and indicate when and where monitoring of water quality will definitely become significant.

A

Mineral Resources
The area is underlain at shallow depths by sedimentary rocks (siltstone and limestone) of Ordivician age. Minerals produced in the county are limestone, sand and gravel, and coal. None are produced near the site, and the project should have no significant effect on mineral production or resources.

The statement omits any mention of mineral production and resources and contains only the briefest of geologic descriptions. Since impact on mineral resources or their production appears to be only minor, we suggest that the final statement contain a statement to this effect.

Outdoor Recreation
Although the draft statement is otherwise adequate with regard to the interests of outdoor recreation, we believe that there is a discrepancy in the section on Environmental Impacts of Plant Operations. The penultimate paragraph on page 5-1 states that, "Plant operation would have no effect on fishing and navigational use of the river.", yet the last sentence of the Facility Description on page 3-1 states that, "The exclusion area would include the full width of the river touching the site property...." We believe the word "exclusion" should be explained or modified to indicate the nature of any restrictions or controls that might affect recreation use of the river since the two statements appear contradictory.

Environmental Impacts Due to Construction
Planting used to revegetate the transmission line right-of-way should be selected with a view to providing species particularly useful for wildlife, food and cover.

Environmental Impacts of Plant Operation
This section should discuss cumulative effects of the thermal, chemical, and radio-active waste discharges of this plant together with the discharges from the Oak Ridge National Laboratory and the Oak Ridge Gasseous Diffusion Industrial Park, on terrestrial and aquatic ecology. With several sources of radio-active wastes in proximity to each other, the cumulative effect of these elements could be an important consideration.

Evidence shows that certain wildlife species are capable of concentrating radio-active elements. These are of significance since there are several sources of radio-active wastes in the area. Subsection 5.7.1.3, covering Dose Rate Estimates, should address these possible impacts.

We hope these comments will be helpful to you.

Sincerely yours,

Stanley D. Doremus

Deputy Assistant Secretary of the Interior

Mr. B. S. Youngblood, Chief
Environmental Projects Branch 2
Division of Site Safety and
Environmental Analysis
Nuclear Regulatory Commission
Washington, D. C. 20555

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS: (G-WS/73)
U.S. COAST GUARD
WASHINGTON, D.C. 20590
PHONE: (202) 426-2262

9 APR 1976

RECEIVED APR 14 1976 U.S. NUCLEAR REGULATORY COMMISSION Mail Section

50-537

Mr. B. J. Youngblood, Chief
Environmental Projects Branch 2
Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Youngblood:

This is in response to your letter of 11 February 1976 addressed to Mrs. Judith T. Conner concerning a draft environmental statement for the Clinch River Breeder Reactor Plant, Roane County, Tennessee.

The concerned operating administrations and staff of the Department of Transportation have reviewed the material submitted. We have no comments to offer nor do we have any objection to this project.

The opportunity to review this draft statement is appreciated.

Sincerely,

D. J. RILEY
Captain, U. S. Coast Guard
Acting Chief, Office of Marine Environment and Systems

3788

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

MAR 29 1976

50-537

3-30-76

Mr. B. J. Youngblood, Chief
Environmental Projects Branch 2
Division of Site Safety and
Environmental Analysis
Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Youngblood:

This is in response to your letter of February 11, 1976, inviting the Energy Research and Development Administration (ERDA) to review and comment on the Draft Environmental Statement, NUREG-0024, prepared by the Commission relating to the proposed construction of the Clinch River Breeder Reactor Plant. We have reviewed the draft statement and, in our opinion, the statement presents a satisfactory description of the possible environmental impacts, which may occur during construction and operation and appropriately reflects the December 31, 1975, Administrator's Findings regarding the Liquid Metal Fast Breeder Reactor Program final environmental statement. However, we have several comments that we would like to present to the Commission for consideration in the preparation of the final statement. These are provided in the enclosed staff comments.

Thank you for the opportunity to review and provide comments on the statement.

Sincerely,

W. H. Pennington, Acting Director
Office of NEPA Coordination

Enclosure:
Staff Comments

cc w/Enclosure:
CEQ (5)

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

3126

ERDA STAFF COMMENTS
ON THE
NUCLEAR REGULATORY COMMISSION'S
DRAFT ENVIRONMENTAL STATEMENT
RELATED TO THE CONSTRUCTION OF THE
CLINCH RIVER BREEDER REACTOR PLANT (CRBRP)

Page 2-13, Section 2.7.1.2.1

The deer population is believed to be underestimated by a factor of 15-20.

Page 3-11, Section 3.5

The description of the facility exhaust ventilation flows could be clarified if a schematic sketch indicating flow rates of the various gaseous effluents were included in this section.

Page 3-16, Section 3.5.2.2

The rate of effluent release from the Cell Air Processing Systems (CAPS) is not stated, although it is indicated that it is variable and can be inferred to be less than 50 scfm. It would be helpful to include a range of effluent release flow rates for the CAPS.

Page 3-21, Table 3.6

If CRBRP is considered a new source, the EPA regulations are Part 423.15, and the correct standard for corrosion inhibitors is "no detectable amount added." If CRBRP is considered an existing source, then EPA regulations Part 423.13 apply and the standards in table 3.6 for zinc, chromium and phosphorus are applicable. The present table is confusing in that both sets of standards are included.

Page 3-24, Table 3.7

We feel that the range of 0.5 to 2.0 ppm residual chlorine in the sanitary waste effluent may not be acceptable, and a peak limit of 0.5 ppm as used in NPDES permits would be more appropriate.

Page 4-3, Section 4.3

The disposal of approximately 40,000m^3 of dredged material should be clarified. We would suggest that disposal plans should be identified.

Page 5-1, Section 5.2

There is a mistake regarding downstream users of the river water. The nearest downstream withdrawal of water from the river is at the ORGDP intake, 1.6 miles downstream. Lenoir City and Harriman do not use the Clinch River for water supply purposes.

Page 5-5, Table 5.2

Footnote "h" appears in the table but not in the list of footnotes.

Page 5-5, Section 5.3.2.1

The "worst" cases should be defined.

Page 5-18, Table 5.1

The bio-accumulation factor for plutonium in aquatic plants should be 5000 pCi/liter water rather than the 350 stated. This higher figure is based upon studies conducted by the Argonne National Laboratory in the Great Lakes (ANL-8060, part III) and the Miami River in Ohio (ANL-75-3, part III).

Page 5-21, Section 5.7.3

First line - insert "total body" between "annual" and "dose."

Page 5-22, Table 5.13, Footnote "a"

This footnote is misleading since the bulk of the transport dose is to transport workers (see appendix D, page D-14).

Pages 6-1, 6-2, Section 6.1.2

It is noted (Table 6.2) that baseline monitoring on the Clinch River will include gamma scans and gross alpha, gross beta, Sr-89, Sr-90, tritium, Pu, and U measurements. Table 3.3 (page 3-14) provides a list of estimated annual releases of radioactive material in the liquid effluent. We suggest that it might be useful if the monitoring program included specific radionuclide analyses.

Page 6-3, Section 6.1.3

Insert "relative" before "humidity" and delete "of the indicated value" under "Humidity."

Page 6-7, Section 6.1.4.1

In the second sentence on the page, delete the words "and fish" to be consistent with the second paragraph which states that fish will not be monitored during construction which will be the case.

Page 7-3, Table 7.1

We suggest that acronyms such as EVST and EVTM be explained either as footnotes to the table or in the text.

Page 7-5, Table 7.2

There are no population exposure estimates due to accidental releases in the table. It is our opinion that such estimates should be included.

Page 7-11, Paragraph 5

Add "individual" before "dose" and change "5" to "4."

Page 7-12, Footnote "d"

Add " - short term release at ground level for the spent fuel cask accident - and tables 4.5-33 and 4.5-34 for low-level beta-gamma shipment accident."

Page 8-1, Section 8.1

The proposed final environmental statement was issued in January 1975, not February 1975.

Page 9-15, Table 9.5

Drift deposition row should specify acreage covered as well as pounds per acre per month. Entrainment row - these numbers are not consistent with those in section 5.3.1.2.

Appendix D, Page D-3

There appears to be a line omitted in the first sentence of the last paragraph.

Appendix D, Page D-4, Table 2

Typographical errors in this table have been discussed with NRC staff and revisions are being made.

Appendix D, Page D-8, Table 3

Doses for fuel fabrication and fuel reprocessing plants appear to be too low by several orders of magnitude. Error in dose due to transportation has been discussed with NRC staff.

Appendix D, Page D-9, Table 4

The fuel fabrication and fuel reprocessing plant doses appear to be too high and the transportation dose appears to be relatively too low.

Appendix D, Page D-14, Table 7

The total under "Transport Workers" should be "8.45" rather than "8,45."

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

APR 9 1976

RECEIVED APR 12 1976 U.S. NUCLEAR REGULATORY COMMISSION Mail Section

50-537

Dr. Bernard C. Rusche
Director
Office of Nuclear Reactor Regulation
Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Rusche:

We have reviewed the Nuclear Regulatory Commission's (NRC) recently issued Draft Environmental Statement (DES) related to construction of the Clinch River Breeder Reactor Plant (CRBRP). Contained in the DES is an evaluation of the cost and benefits of the CRBRP during construction and operation. One conclusion reached was that the Energy Research and Development Administration (ERDA) should assess and determine the need for payments in lieu of taxes to mitigate any adverse impacts in the local area affected by construction and operation of the CRBRP.

Sec. 168 of the Atomic Energy Act of 1954, as amended, and Sec. 91 of the Atomic Energy Community Act of 1955, as amended, provide a specific statutory mechanism for the evaluation and determination of the need for financial assistance to local entities which may be affected by ERDA activities. The locality in which CRBRP activities will be carried on are within the scope of this statutory authority.

It is our purpose to call to your attention these sections of the Acts which were enacted by the Congress for the express purpose of dealing with such matters and to assure you that ERDA will act in accordance with this statutory authority.

Sincerely,

Richard W. Roberts
Assistant Administrator
for Nuclear Energy

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

3577

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

5 MAY 1976

RECEIVED 5-6-76 U.S. NUCLEAR REGULATORY COMMISSION Mail Section

50537

Mr. Voss A. Moore
Assistant Director for
Environmental Projects
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Moore:

The Environmental Protection Agency has reviewed the U.S. Nuclear Regulatory Commission's Draft Environmental Impact Statement issued February 11, 1976, in conjunction with the application of the Project Management Corporation and the Tennessee Valley Authority for a permit to construct the Clinch River Breeder Reactor Plant (CRBRP). Our detailed comments are enclosed.

EPA has declared the CRBRP a "new source" in terms of Section 306 of the Federal Water Pollution Control Act Amendments of 1972 (FWPCA). As such, Section 511 of the Act charged EPA with fulfilling the requirements of the National Environmental Policy Act of 1969, including that for environmental impact statements. Thus, EPA joins NRC in having such responsibilities for nuclear facilities. However, as the two agencies have agreed in the "Second Memorandum of Understanding" (40 Fed. Reg. 60115 Dec. 31, 1975), NRC is to prepare the impact statements with assistance from EPA in water quality, aquatic impacts and other areas where EPA has jurisdiction and expertise. Toward this end, EPA has met (October 6 and November 6, 1975) with the NRC staff and Battelle consultants to discuss various aspects of the CRBRP and to exchange data and information. EPA's concerns and assessments aired in those meetings have generally been well addressed in the draft statement. We appreciate the cooperation extended to EPA during its preparation and look forward to continued cooperative efforts with NRC through the issuance of the final statement on this project and beyond.

After a thorough review of the draft statement, we have identified several areas where, in our opinion, the assessment or presentation of the potential impacts of the CRBRP is inadequate. The most serious example of this, in our view, is the treatment of the "reference" and "parallel" reactor safety designs, which are two separate design efforts being conducted by the applicants concurrently with the research and development needed to determine the safety design requirements. Because of the resultant uncertainty in the safety

4570

design, the NRC was unable to conclude, in the draft statement, that risks from reactor core disruptive accidents will be acceptably low. We believe this situation must be resolved before a construction permit is issued on this project. In our comments on the LMFBR programmatic environmental statement (WASH-1535), we urged ERDA to utilize conservative design and siting practices with the CRBRP. ERDA's final programmatic statement (ERDA-1535) describes their safety goal, in the interim while the LMFBR safety program progresses, as follows: "The goal is to apply an overall degree of conservatism appropriate to the state-of-the-art, utilizing sound engineering judgment." If NRC determines that this design philosophy points to use of the design conservatisms such as those in the applicants' parallel design, we urge NRC to require them to be incorporated.

Other examples of deferred questions are (1) the use of LWR criteria to determine acceptability of design objectives and limiting operating conditions, in lieu of applicable criteria which have not yet been developed specifically for LMFBR's; (2) the general approach to safeguards; and (3) the disposition of the radioactive spent cold traps. We recognize that there are some questions that cannot be completely resolved at this stage, because the technology has not been fully developed (this is especially true with respect to safeguards, where the requirements are not yet defined). However, we believe that, in some other areas, the statement can be improved by providing more discussion of the criteria. For example, we believe more of the rationale should be provided, in the final statement, for the application of 10 CFR Part 50 (Appendix I) and 10 CFR Part 100 to the project, since these regulations are primarily directed at LWR's, on which experience has been developed. In general, we believe there is a need to develop additional licensing criteria for application to non-LWR licensing processes.

Except for our reservations relative to the treatment of core disruptive accidents, our review did not disclose any problems serious enough to impact on the question of whether a construction permit should be issued for this plant, for its intended use as a demonstration project under full ERDA control. However, we believe that a full NEPA review should be completed prior to use of the plant beyond the demonstration phase. The future NEPA review should fully explore the environmental and safety implications of the CRBRP operational information and the latest R & D results.

Sincerely,

Rebecca Hanmer

Rebecca Hanmer
Acting Director
Office of Federal Activities (A-104)

Enclosure

D-NRC-A 06158-TN

U.S. ENVIRONMENTAL PROTECTION AGENCY

ENVIRONMENTAL STATEMENT COMMENTS

Clinch River Breeder Reactor Plant
April 1976

INTRODUCTION AND CONCLUSIONS

The Environmental Protection Agency (EPA) has reviewed the U.S. Nuclear Regulatory Commission's Draft Environmental Impact Statement (draft statement) issued on February 11, 1976, in conjunction with the application of the Project Management Corporation and the Tennessee Valley Authority (TVA) for a permit to construct the Clinch River Breeder Reactor Plant (CRBRP). The U.S. Energy Research and Development Administration (ERDA) is also part owner of the plant and will have overall management responsibility. The proposed plant will be located in Roane County, Tennessee, about 25 miles west of Knoxville, on the north side of the Clinch River. The site is within the city limits of Oak Ridge but is owned by the United States of America and is presently in custody of TVA. The purpose of the proposed plant will be to demonstrate the feasibility and acceptability of LMFBR central electric power stations, and to confirm the value of the LMFBR for conserving natural (uranium) resources. The reactor core will be cooled by liquid sodium metal instead of the more conventional coolant -- water, and is specially designed to enhance the production of plutonium, which can be recycled as nuclear fuel. The plant will produce 975 megawatts thermal initially and up to 1121 megawatts with future core designs. Waste heat will be rejected via a mechanical-draft, wet cooling tower which draws makeup water from, and discharges blowdown to, the Clinch River.

EPA has declared the CRBRP a "new source" in terms of Section 306 of the Federal Water Pollution Control Act Amendments of 1972 (FWPCA). As such, Section 511 of the Act charged EPA with fulfilling the requirements of the National Environmental Policy Act of 1969, including that for environmental impact statements. Thus, EPA joins NRC in having such responsibilities for nuclear facilities. However, as the two agencies have agreed in the "Second Memorandum of Understanding" (40 Fed. Reg. 60115 Dec. 31, 1975), NRC is to prepare the impact statements with assistance from EPA in water quality, aquatic impacts and other areas where EPA has jurisdiction and expertise. Toward this end, EPA has met (October 6 and November 6, 1975) with the NRC staff and Battelle consultants to discuss various aspects of the CRBRP and to exchange data and information. EPA's concerns and assessments aired in those meetings have generally been well addressed in the draft statement. We appreciate the cooperation extended to EPA during its preparation and look forward to continued cooperative efforts with NRC through the issuance of the final statement on this project and beyond.

After a thorough review of the draft statement, we have identified several areas where, in our opinion, the assessment or presentation of the potential impacts of the CRBRP is inadequate. Our major conclusions are as follows:

1. Our review indicated the draft statement to be inadequate with respect to its treatment of reactor core disruptive accidents, since design basis accidents have not been defined, hence the safety-design

requirements have not yet been finalized for the CRBRP. We are pleased to note, however, the recent public statement by NRC staff that they plan to take steps to correct this deficiency prior to issuance of the final environmental statement.

2. In addition to the safety design question above, we also found that a number of other issues were not treated definitively in the draft statement, but rather were noted as being uncertainties or problems for which detailed solutions are not yet available, but which would be answered or resolved in the future. We regard these omissions as deficiencies which limit the accuracy of the description of the environmental impact of the plant. Some examples were (1) the use of criteria such as 10 CFR Part 100, which applies primarily to LWRs, and 10 CFR Part 50, Appendix I, which applies exclusively to LWRs, in place of specific corresponding LMFBR criteria, which have not as yet been developed; (2) the general approach to safeguards, which relies heavily on the convictions of the NRC staff that solutions can be provided for specific problems as the technology develops and the problems are identified; (3) the disposition of the spent sodium cold traps, which will contain large amounts of radioactivity, possibly in combination with metallic sodium, has not yet been determined; (4) the coolant medium for the spent fuel transport casks has not yet been determined; and (5) the disposal site for radioactive waste generated at the plant has not yet been determined.

3. Except for the treatment of reactor core disruptive accidents (item 1 above), we conclude that (notwithstanding the omissions and deficiencies we noted elsewhere in our review) the draft statement fulfills the appropriate requirements in satisfaction of the licensing action to construct the CRBRP for use as a demonstration project under ERDA's management and control. The CRBRP schedule calls for an initial five year demonstration period, when the plant would be operated in a manner similar to a commercial power plant to demonstrate safety, environmental acceptability, reliability, high availability, systems and components development, industrial and utility capabilities, and licensability. Following that period, TVA has the option to purchase the plant for its own use beyond the initial demonstration phase. We believe that, at that time, a full NEPA review would be appropriate prior to use of the project beyond the initial demonstration phase. That NEPA review should address the success achieved by the project during the demonstration phase and should update, in particular, the safety and environmental analyses based on the latest CRBRP operational information and R & D results.

4. EPA believes that the Clinch River Breeder Reactor can operate under most conditions in compliance with the FWPCA. However, under river conditions of low flow, or no flow, due to the operation of Melton Hill Dam, chemical and thermal discharge standards could be violated. EPA recommends that a detailed discussion be presented in the final statement on the coordination and agreements developed, prior

to actual plant operation, with Melton Hill Dam that would be necessary to assure a continued minimum river flow.

Radioactive Waste Management

The NRC staff recognized in the draft statement that Appendix I of 10 CFR Part 50 does not apply to LMFBR's, but proceeded to conclude that the liquid and gaseous radioactive waste systems would result in releases and doses that would not exceed the design objective levels of the Proposed Appendix I, that the effluents will therefore be reduced to "as low as practicable" levels, and the systems are therefore acceptable. We do not believe that Appendix I design objective levels necessarily provide appropriate criteria for a liquid metal fast breeder reactor (LMFBR). However, since LMFBR's are in an early stage of development and appropriate design criteria have not yet been proposed for radioactive materials in effluents from this reactor type, we would agree that Appendix I numerical criteria are reasonable to use as a comparison. However, we believe that descriptors such as, "as low as practicable," and, "as low as reasonably achievable," should not be used to describe the effluent levels that will be achieved by LMFBR's that meet Appendix I numerical criteria. In the context of Appendix I criteria, such descriptors can apply only to the generic class of light-water reactors, since they are applied in consideration of the various past and projected practices used in the design and operation of LWR radwaste treatment systems, and in LWR siting. The final statement should clarify that Appendix I does not provide numerical criteria by which to judge acceptability, but only serves as a basis of comparison. As the LMFBR evolves in the future, and the numbers of planned and operating facilities increase, we believe numerical design criteria, along the lines of those in Appendix I for LWR's, will have to be developed for this reactor type. The final statement should discuss any such NRC plans to develop such criteria.

Although, historically, cold traps were incorporated in liquid metal system designs principally for purposes of chemical purity control, they are also very effective at trapping a variety of fission and radioactive corrosion and activation products when used in reactor liquid metal coolant systems. The radioactive source terms and dose estimates were developed in the draft statement based on the assumption that removal of radionuclides by cold trapping takes place; however, this important role of the sodium cold traps is not indicated in Section 3.5, where the source terms are developed. In particular, since tritium diffuses freely through the fuel cladding and across the walls of the sodium heat exchangers and steam generators, and even through the heated sodium piping, the primary and intermediate cold traps comprise the only effective barrier to the ultimate release to the environment of essentially all of the tritium produced by the reactor. The primary cold trap also collects, to various degrees, a variety of other significant radioactive species, including plutonium, uranium, cobalt, iodine, cesium, strontium, tellurium, manganese and antimony. Past operational experience with cold traps shows mixed success with respect to optimal performance, with some designs performing better or

worse than other, very similar designs. Designs have been based largely on empirical methods, and in all cases we have examined, performance has been less than optimum. Although not explicity stated in the draft statement, the primary and intermediate cold traps in combination are apparently assumed to be 98 to 99% effective for tritium control. The final statement should include the assumptions used, and the bases for the assumptions, regarding cold trap decontamination factors for all the significant radionuclides, and regarding the effects of expected operational difficulties and equipment downtime.

At the end of their operating life, the primary cold traps will contain a considerable quantity of highly concentrated mixed radionuclides, possibly in combination with metallic sodium, which is pyrophoric. The intermediate cold traps will contain a large quantity of tritium, also possibly in combination with metallic sodium. The draft statement indicates that the final disposition of these cold traps has not yet been determined. We believe the final statement should include at least minimum criteria for disposition of these wastes. For example, it would seem that a commitment to alter the metallic sodium to a more benign chemical state, prior to disposal as waste, would be an appropriate requirement.

Dose Assessment

Recent NRC environmental statements have included estimates of the potential annual dose to the U.S. population, which is a partial evaluation of the total potential environmental dose commitment (EDC) from H-3 Kr-85, C-14, iodines and "particulates." This has been a big step toward evaluating the EDC, which we have urged for several years. The draft statement for the CRBRP does not include such estimates. Even though the 50-mile population doses appear to be low compared to those for other (LWR) nuclear plants recently evaluated, we believe the final statement should include population dose estimates for the total U.S. population. We make this suggestion to emphasize that several of these radionuclides (particularly C-14 and Kr-85) will contribute to long-term population dose impacts on a world-wide basis, rather than just in the U.S. For a nuclear plant which uses mixed oxide (uranium and plutonium) fuel, such as the Clinch River LMFBR, the EDC from transuranic effluents from the reactor and elsewhere in the fuel cycle also should be considered, particularly plutonium - 241. To the extent that dose estimation techniques (1) limit the EDC to an annual discharge of these radionuclides; (2) are based on the assumption of constant population size; and (3) assess the doses delivered only during the year following release to the environment, they do not fully provide the total environmental impact. Such a total impact would (1) incorporate the projected releases over the lifetime of a facility (rather than just an annual release); (2) extend to several half-lives, or 100 years, beyond the period of release; (3) consider at least qualitatively or generically, the world-wide impacts; and (4) consider a growing exposed population. Thus, the final statement should provide an analysis of the EDC and should recognize these influences on the total environmental impact, or clearly specify the limitations of the model used.

Reactor Accidents

EPA does not have regulatory authority or responsibility, nor do we have significant in-house expertise, in the detailed area of fast reactor safety. However, we have an interest in this subject because of our general responsibility for overall environmental protection, and because of the unique nature of some of the accident sequences that have been postulated for LMFBR power plants. We have followed developments in this area for several years and have maintained a strong interest throughout the recent programmatic review of the LMFBR technology. We are therefore presenting our general views and findings on this subject, for NRC's consideration during the continuing safety evaluation of the CRBRP.

The discussion of plant accidents reveals that some basic areas of disagreement exist between the applicants and NRC regarding the possible consequences of a core disruptive accident. We consider this subject to be of particular importance because of the potentially serious environmental implications of the more extreme scenarios that have been postulated for this accident. Disagreements revolve around the question of whether, in the absence of certain special safety provisions (which include an ex-vessel core-catcher and a special active cooling system to remove post-accident decay heat), this accident will progress in such a way as to exceed 10 CFR 100 guideline values. This question leads, in turn, to the issue of whether such provisions, currently included in the applicants' "parallel design," should be required by NRC. The draft statement does not provide convincing assurance that CRBRP accident risks are comparable to those from LWR's or can be made comparable without incorporating the "parallel design" features. We recognize that, because there are some unresolved safety issues, NRC considers that an insufficient basis exists at this time on which to make such a determination, and that NRC has underway safety studies to provide the basis for the determination, which will be made at a later date. However, until this issue is settled, we believe the draft environmental statement is incomplete. It is our opinion that the final environmental statement must be definitive on this issue. One way to be definitive, of course, would be to shift the emphasis on the parallel design efforts to require the special safety provisions at issue to be incorporated into the plant design, pending an outcome of the NRC's safety studies which shows they are not needed. Both "reference" and "parallel" design efforts could still be continued, as described in the draft statement, concurrently with the Commission's studies to determine the safety system needs. If the safety studies should be completed in time, and do ultimately provide a solid basis for the determination that the added features are not needed, then the features could be deleted. In any event, we assume that an amended environmental statement will be required if the special safety provisions are not incorporated. This approach to safety appears to be entirely consistent with ERDA's final

programmatic statement,(1) with respect to the use of design conservatisms in demonstration or early commercial LMFBR plants to compensate for uncertainties in knowledge, and also with the recommendations in the report of ERDA's Internal Review Board on the AEC's proposed programmatic final environmental statement, and would also be in line with EPA's previous comments(2) to ERDA on the use of conservative design requirements for the CRBRP to minimize safety risks. To summarize, it is our view that the final environmental statement should provide assurance that the risks from core disruptive accidents at the CRBRP will be less than or comparable to the accident risks predicted for LWR's. As noted in the draft statement, this can be done by demonstrating that the combination of probability and consequence can be made very low, or, alternately, by including in the plant design any special safety provisions which might be needed to assure that the risk is comparably low. Since, in our opinion, the draft statement does not demonstrate that accident risks are very low, we believe the commitment must be made to the more conservative design criteria requirements, pending a favorable outcome of the concurrent probabilistic/consequence approach to demonstrate acceptable risk without the special safety provisions (conservatisms).

As discussed above, the draft statement places great emphasis on the anticipated results of the safety review to show whether special safety provisions will or will not be needed for the core-melt event. However, the future R & D and further work mentioned in the draft statement, which will be required as part of the safety review, are not described in any detail. We believe the final statement should provide the detailed program elements of the safety review required to provide timely information on which to base the CRBRP safety decisions. Further, the statement should outline the specific tasks and milestones, identify the critical information needed to reach the decisions, discuss the timing of informational needs, and identify any go no-go decision points inherent in this approach. In this connection we are pleased to note that NRC staff have recently indicated(3) that they plan to reach a decision on the parallel versus reference designs in time to meet the target release date for the final statement. It is our understanding that, at that time, either the reference or parallel design will be selected, or that required design criteria will be defined. This will help to clarify the safety analysis for the CRBRP.

Although not specifically mentioned in the draft statement, it is commonly known that a self-activated shutdown system (SASS) is under development for possible application to LMFBR's. The SASS would be

(1) Final Environmental Statement on LMFBR Program, ERDA-1535, December, 1975, pages IV B-10-11, and S-6-7, respectively.

(2) Letter to Mr. W.H. Pennington from Sheldon Meyers, reproduced in Section V.94 of ERDA's Final Environmental Statement on the LMFBR Program, ERDA-1535 (page 2).

(3) Testimony presented by NRC staff at Special ASLB Prehearing Conference on CRBRP held in Oak Ridge, Tennessee, on March 22, 1976.

contained within the reactor; would be actuated by the inherent effects of the transient; would be tolerant of structural deformations, such as might result from earthquakes; and would serve as a totally independent and diverse reactor shutdown device as backup for the two independent scram systems. If shown to be reliable and effective, the SASS would greatly increase confidence that core disruption accident scenarios will be terminated early, before reaching the disruption stage. We do not know whether an SASS is under consideration for the CRBR, and believe the status of SASS development should be discussed, at least briefly, in the final statement.

We recognize that the decision on special safety provisions at the CRBRP is of considerable importance because of the concern that a precedent might be established for future designs, and the possibly important impact that elaborate safety systems might have on the economics of future commercial plants. We believe that such concerns should not be factored into the decisions on CRBRP safety requirements, and that CRBRP safety should be treated as a separate case, with safety systems designed conservatively for safe operation in accordance with current understanding of hypothetical accident scenarios. We do not believe safety provisions included in the design of a demonstration plant, which are later shown to be overly conservative and unnecessary, should or will constitute a precedent for later designs.

The Summary of Radiological Consequences, Table 7.2, reflects that a fairly wide range of detailed representative and bounding calculations were carried out by the staff in their analysis of the spectrum of possible accidents associated with the CRBRP. Such detailed calculations imply the use of a considerable amount of experimental and test results, as well as a number of critical assumptions regarding the likelihood and progression of certain accident sequences, operation of safety systems, partition and decontamination factors, etc. Some of the assumptions and bases for the analyses are documented in the draft statement. The list is not complete, and we recognize that an exhaustive list would not be practical. However, we believe all the important or critical assumptions and their bases should be documented in the environmental statement at this stage in the development of LMFBR technology. Also, where research and development test data were utilized, the range of the data should be indicated along with the basis for selection of data within the range for use in the accident analyses. This is important because the CRBRP is the first LMFBR to undergo a full regulatory review under NEPA, and the environmental statement will be a precedent-setting one for future evaluations. Thus, we believe it is important that the final environmental statement clearly define the models and data used.

We concur with the use of 10 CFR Part 100 guideline values in evaluating the accident consequences and siting characteristics of the CRBRP, since we believe LMFBR safety should be considered, where practical to do so, in comparison with LWR safety. However, the analyses and comparisons should more clearly emphasize that 10 CFR 100 applies primarily to

LWR siting, and that LMFBR siting questions are considerably different from those relevant to LWR siting. We believe these differences should be examined in detail, and 10 CFR 100 supplemented in the near future as necessary to provide specific criteria for future LMFBR siting. In this connection, we note that new provisional criteria for bone dose have been established for Accident Classes 8.3 and 8.4 (Parallel Design). The final statement should provide the rationale and bases for the new criteria, and should clearly indicate that these criteria for the CRBRP are design objectives but not formal regulations.

Although the applicants propose to bottle gases from the noble gas storage vessel for temporary onsite storage and eventual offsite shipment to a licensed burial facility, it is assumed in the draft statement for radiological dose estimation purposes that the contents of the storage vessel would be released to the environment. This is clearly a conservative assumption with respect to estimating doses from routine operational releases. However, it is not clear that the impacts from possible accidental releases of the contents of the stored bottles have been factored into the analysis of plant accidents, Section 7.1. The final statement should include an analysis of accidental releases of stored radioactive noble gas wastes, or clarify that this accident has been taken into account in the analysis.

Environmental Monitoring

Tritium is of particular interest and importance at LMFBR plants because of the ease with which it diffuses through high temperature sodium systems (see comments on Radioactive Waste Management). We believe the radiological sampling and analysis schedule, presented in Table 6.1, is not adequate with respect to tritium. We believe operational tritium analysis should be performed on soil, vegetation, pasturage grass, milk, and food crops in addition to rainwater and public water supplies. The preoperational schedule should include sampling and analysis of these media to establish background tritium concentrations for comparison. It is important to establish general background levels of environmental radioactivity, in particular at the CRBRP site, because of the varied nuclear operations already associated with the local Oak Ridge area and upstream of the Clinch River.

Materials Safeguards and Plant Siting

The draft statement notes (p.E-6) that the issue of transport security is presently being studied by the NRC on a generic basis, and identifies the transport of unirradiated (new) fuel elements to the plant as possibly, "...the most attractive and vulnerable segment in the entire fuel cycle" with respect to materials safeguards. In general, the detailed safeguards measures to be used in the CRBRP fuel cycle are not as yet determined; however, examples of some of the measures that could be used are itemized, and it is concluded that a transit protection system can be produced which would be "essentially undefeatable." This approach to the problem provides assurance that appropriate recognition has been given to the potential threats and that solutions can be developed, but puts off the detailed resolution of the problems to a later, unspecified date. This is perhaps unavoidable because of uncertainty both in the magnitude of the threats that must be protected against, and in the detailed criteria that will be developed in the future for the LMFBR fuel cycle. However, we expected this subject to be factored into the section on site alternatives, Section 9.2, since it is apparent that the magnitude of the threat can be influenced by siting variables. We believe the section on siting criteria should be expanded in the final statement to include consideration of safeguards aspects. In general, we found that the site selection criteria used in the analysis, although relevant, appeared narrow in scope, since they did not treat reactor siting in relation to the total LMFBR fuel cycle.

We understand that studies are underway to determine the adequacy of present nuclear facility siting criteria and current facility design practices, with respect to possible sabotage attempts. We believe the final statement should include a brief summary of these studies as they relate to the CRBRP and the overall LMFBR fuel cycle.

NON-RADIOLOGICAL ASPECTS

FWPCA Requirements

As presently proposed, condenser cooling at the CRBRP will be achieved by the use of a mechanical-draft wet cooling tower. Under normal plant operating conditions, water will be withdrawn from the Clinch River at the maximum average rate of 15.8 cubic feet per second (cfs). Discharge will be accomplished by means of a submerged single-port discharge structure. EPA will be responsible for issuance of a discharge permit for the CRBRP under the National Pollutant Discharge Elimination System (NPDES) - Section 402 of the Federal Water Pollution Control Act of 1972, as amended (FWPCA). Issuance of the permit will be based upon review and analysis of all relevant information as provided and discussed in the draft statement. Consideration will be given to requirements of Sections 301, 316(a), 316(b) and other provisions of the FWPCA and the final permit will be conditioned accordingly.

Section 306 of the FWPCA stipulates that effluent limits for various new point source discharges to navigable waters shall require the application of "Best Available Demonstrated Control Technology." The level of technology corresponding to this term is defined in EPA's "Steam Electric Power Generating Point Source Category Effluent Guidelines and Standards," Federal Register of October 8, 1974. These guidelines call for closed-cycle cooling.

The CRBRP employs a mechanical draft cooling tower, and can operate under most conditions in conformance with these guidelines and standards. However, EPA is concerned about thermal and chemical discharges during low or no-flow conditions possible at the Clinch River Plant due to operation of Melton Hill Dam, Watts Bar Dam, Norris Dam, and Fort Loudon Dam. Thermal discharges during extended low or no flow conditions may create substantial and permanent impact on the localized aquatic environment. Also, a Section 316(a) waiver for the thermal component of discharge has not been requested and, therefore, it will be necessary that a mixing zone be assigned in lieu of such a waiver. Furthermore, the concentrations of copper, iron, and suspended solids in the effluent will exceed the applicable effluent guidelines and standards set by EPA.

The draft statement states (page 2-9) that "Since completion of TVA's Melton Hill Dam in 1963, the average year has included a total of 46 days when no water was released." The statement also mentions on page 5-11 that:

> "However, the applicant has stated that water flow by the plant would be regulated in the future to meet requirements and to prevent extended periods of no river flow. Detailed information on how maintenance of river flow near the CRBRP would be coordinated with the release of water at Melton Hill Dam has not been developed. After the plant begins operating, river flows should be monitored to identify potentially harmful periods of no flow."

Minimum flow requirements must be developed in the final statement and included in the permit, or the requirements must be included in the NPDES permit that they be developed prior to operation.

The draft statement also mentions (page 5-13) that potentially adverse aquatic impacts due to copper and iron may occur under river conditions of extended no flow. It is also stated on the same page that:

"The technical specifications at the operating stage would require monitoring copper, iron, and TSS during plant operation in order to determine flow regulation needs for preventing potentially adverse impacts."

EPA recommends that flow requirements be established prior to plant operation so that appropriate conditions can be included in the NPDES permit to assure that effluent standards will not be violated.

ADDITIONAL COMMENTS

1. The text of Appendix D makes the point that depleted uranium, a byproduct of past enrichment processes carried out in this country, will be used as blanket and make-up fuel material for the CRBRP core. However, Figure 1 of Appendix D, and Section 5.1 of Appendix E, indicate that natural uranium could be used in place of or in addition to depleted uranium. In our view, the reduction of uranium mining and milling impacts by utilizing existing stocks of depleted uranium, is an important benefit of the LMFBR. Such use also is in direct accord with NEPA's mandate to achieve the, "...maximum attainable recycling of depletable resources." We hope the use of natural uranium, as opposed to depleted uranium stocks, will be minimized in the CRBRP fuel cycle.

2. On page 5-18 of the draft statement, it is stated that, "In general, radiation doses calculated by the staff are intended to apply to an average adult." The EPA believes that the most critical individual, which will vary with the exposure pathway and radioisotope, should be considered when making dose estimates. If this approach is not taken, applicable standards or guides may be exceeded.

3. On page 3-21, Table 3.6 lists EPA's effluent limitations for zinc chromium, and phosphorous as 1.0 mg/l, 0.2 mg/l and 5.0 mg/l, respectively; these are "best available demonstrated control technology" (BAT) requirements. Since CRBRP is presently classified as a new point source discharge, the standards of performance which relate to BAT are not applicable. The standards applicable to the CRBRP require that materials added for corrosion inhibition including but not limited to zinc, chromium, and phosphorous shall be limited to discharge concentration of no detectable amount.

4. In Table 3.6, the EPA Effluent Limitations cited are not adequately referenced.

5. On page 5-8 line 6, Figure 5.2 should read Figure 5.4.

FEDERAL POWER COMMISSION
WASHINGTON, D.C. 20426

50-537

MAR 22 1976

Mr. Voss A. Moore
Assistant Director of
Environmental Projects
Division of Site Safety and
Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Moore:

This is in response to your letter requesting comments on the Nuclear Regulatory Commission's (NRC) Draft Environmental Statement (DES) related to the proposed issuance of a construction permit to the Project Management Corporation and the Tennessee Valley Authority for the construction of the Clinch River Breeder Reactor Plant (Docket No. 50-537). The Federal Power Commission has already commented on the U.S. Energy Research and Development Administration's Proposed Final Environmental Impact Statement and the Atomic Energy Commission's Draft Environmental Statement on issues related to the Liquid Metal Fast Breeder Reactor Program. Copies of these letters are included in the respective Final Environmental Statements.

These comments by the Federal Power Commission's Bureau of Power staff are made in compliance with the National Environmental Policy Act of 1969 and the August 1, 1973, Guidelines of the Council on Environmental Quality, and are directed to the need for the Clinch River Plant as it relates to the reliability and adequacy of bulk electric power supply and related matters.

It is noted that the Clinch River Plant would be built at Oak Ridge, Tennessee, with a net output capacity of about 350 megawatts. It is scheduled for operation by 1983. It will be operated by the Tennessee Valley Authority (TVA) as part of its power system. TVA is a member of the Southeastern Electric Reliability Council (SERC), one of the nine reliability councils which cover the contiguous United States.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

2964

The Federal Power Commission staff views the Clinch River Breeder Reactor Plant as having the potential for improving the critical energy supply situation. Recent experience regarding energy shortages emphasizes the need for the timely development of all our potential energy sources while giving full consideration to overall environmental interests. The Clinch River Plant, if brought to fruition, would be an important beginning in maintaining the reliability and adequacy of future bulk electric power systems for two reasons: it will extend our uranium resources considerably and provide electric power to meet an increasing electrical load.

Although it now appears that actual electric demands through 1980 may be below the projections of the 1970 National Power Survey, the FPC staff believes it is quite possible that electric loads by 1990 could equal or exceed the National Power Survey projections if there is extensive substitution of electricity for present oil and gas applications. Environmental problems place obstacles to greatly expanded coal use; additionally, exclusive dependence on coal as the energy source for electricity could greatly deplete the Nation's coal reserves in less than a century. It therefore seems prudent to make use of nuclear fuel to generate electricity, in order to conserve our fossil fuels.

To take advantage of nuclear generation, more nuclear fuel must be made available. A fast breeder provides for significantly greater recovery of the energy potential of natural uranium resources than that now obtained from current light water reactors; thus, the nuclear fuel supply is extended over a much longer period of time. Securing a long-term supply of fuel (in this case, nuclear fuel) is vital to the reliability of an electric system.

The Bureau of Power staff concludes that construction and operation of the Clinch River Breeder Reactor Plant would contribute to the reliability and adequacy of future bulk electric power systems by demonstrating the feasibility of extending our nuclear resources and by providing power to meet future electrical demand.

Very truly yours,

W. Ridgway
Acting Chief, Bureau of Power

North Carolina Department of Administration
OFFICE OF INTERGOVERNMENTAL RELATIONS
EDWIN DECKARD
DIRECTOR
JAMES E. HOLSHOUSER, JR., GOVERNOR • BRUCE A. LENTZ, SECRETARY

April 7, 1976

50-537

4-12-76

Mr. Paul H. Leech
Project Manager
Office of Nuclear Reactor Regulation
Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Leech:

Re: Draft Environmental Statement - Clinch River Breeder Reactor Plant; Roane County, Tenn.; SCH File No. 018-76

The North Carolina State Clearinghouse has completed its review of the above referenced statement. As a result of this review we have no comment to offer on the statement at this time.

The Department of Human Resources, Division of Health Services did question whether or not new or spent fuel or radioactive wastes will be transported through North Carolina. The State would like to be notified of such transport and on what routes the transport will take place when this information is available.

We appreciate the opportunity to comment on this project.

Sincerely,

Jane Pettus

Jane Pettus (Miss)
Clearinghouse Supervisor

JP:mw

3586

116 WEST JONES STREET RALEIGH 27603 (919) 829-2594

STATE OF TENNESSEE
OFFICE OF URBAN AND FEDERAL AFFAIRS
SUITE 108 • PARKWAY TOWERS BUILDING • NASHVILLE 37219 • 615-741-2714
RAY BLANTON
Governor
WASHINGTON BUTLER, JR.
Director

March 25, 1976

50-537

Mr. Bernard Rusche, Director
Division of Reactor Licensing
P-722, NRC
Washington, D. C. 20555

SUBJECT: Draft Environmental Statement
Clinch River Breeder Reactor Plant
Roane County, Tennessee

Dear Mr. Rusche:

As the officially designated State Clearinghouse under the Office of Management and Budget Circular A-95 Revised, we are transmitting the enclosed comments by the Tennessee Department of Transportation, the Tennessee Wildlife Resources Agency, and the Tennessee Department of Public Health on the subject document. We will forward comments by additional Tennessee State agencies upon receipt of those comments.

If this office can be of assistance, please contact me.

Sincerely,

Stephen H. Norris

Stephen H. Norris
Grant Review Coordinator

SHN:mn

Enclosures

RAY BLANTON
GOVERNOR

STATE OF TENNESSEE
DEPARTMENT OF PUBLIC HEALTH
NASHVILLE 37219

Eugene W. Fowinkle, M.D., M.P.H.
Commissioner

March 26, 1976

Mr. Stephen H. Norris
Grant Review Coordinator
Office of Urban and Federal Affairs
Parkway Towers Building, Suite 108
Nashville, Tennessee 37219

Re: Draft Environmental Statement, Clinch River Breeder Project, U.S. Nuclear Regulatory Commission

Dear Mr. Norris:

The following divisional comments are submitted in response to your request for review of the above referenced project (NUREG-0024):

DIVISION OF AIR POLLUTION CONTROL

We have reviewed the above report with respect to our particular areas of concern and it appears that this project would not significantly affect ambient air quality.

DIVISION OF OCCUPATIONAL AND RADIOLOGICAL HEALTH

Page xiii states "Members of the staff (of NRC) may meet with State and local officials . . . . ." Such a meeting was held on 9-17-75. The comments that we made at that time concerning corrosion, monitoring, condition of the Clinch River, and site selection seem to be only partially resolved.

Page 1-1 states that among other things the project is to demonstrate reliability, safety, and environmental acceptability of a LMFBR. It seems reasonable to question whether this is an appropriate site to demonstrate the safety of such a potentially dangerous device.

Page 1-1 states that a water intake will occur during operation of 15.8 cfs with an exhaust of 6.1 cfs. The balance is lost by evaporation. We can expect, therefore, that non-volatile impurities in the CRBRP intake will be concentrated by a factor of 15.8/6.1 = 2.6.

Page 1-2 states that since the plant would be titled in the United States and built on Federal land the project is not required to obtain licenses and permits from state and local authorities. Also page 1-3 gives a list of authorizations necessary. We should note that there is no mention of the state's interests even though non-Federal land and streams will be contaminated radiologically by this device.

Page 3-11. Appendix 1 of 10 CFR Part 50 is applicable only to light water cooled reactions but is used for the CRBRP. This is just one example of the use of experience gained with light water reactors to evaluate LMFBR's, an obviously questionable practice.

Page 3-13 and 3-18 indicates that much waste radioactive sodium, concentrated liquids, and solids would be shipped off annually. Several questions arise and should be answered. What roads will be used? Where will these wastes go? Who licenses these disposals? Who monitors these transfers? Who cleans up accidents? Who pays for the above services? Appendix E sections 6.1.2. and 6.1.3. is relavent to this comment.

Page 3-18 paragraph 4 is internally contradictory.

Tables 3.3 and 3.4 are only CRBRP releases. No comment is made on activity in intake. Since the activity in the intake is not well known at this site, total activities are not available. Again the question of site selection arises.

Page 5-16. NRC recommends that a study should be made to determine the magnitude of payments in-lieu-of tax and to whom they should be paid. We should pursue this to cover our environmental monitoring, emergency response planning and monitoring costs and costs of aid to local governments. (See page 10-7 also)

Page 6-1 indicates that preoperational radiological monitoring should be initiated by the applicant two years before operation. This would be about 1981. This look at the environment would occur well after an essentially irreversable commitment to operate the CRBRP. For this reason and those above we believe that we should vigorously pursue an immediate revival of the Clinch River study with participation by all of the interested parties and funding by ERDA and/or NRC. Our position with respect to the Clinch River should be as follows.

In general the CRBRP management have not satisfactorily evaluated the radiological environment in the Clinch River. One consequence is that they do not have the information necessary to properly carry out site selection. Specifically the behavior of the effluent from White Oak Creek has not been evaluated with respect to mixing or streaming.

In addition the quantity, nature, and behavior of the radionuclide inventory on the bed of the Clinch has not been evaluated recently or satisfactorily.

Page 7-2, last paragraph. We believe this paragraph can be reworded to say that the likelihood of core disruptive accidents and their associated radioactive releases are not well understood and the applicant wishes to build the CRBRP before they are understood. This suggests that the project should be delayed or moved to a remote site. It would be instructive in this regard for the NRC staff to estimate the likelihood of both the Brown's Ferry and the Enrico Fermi Breeder events and compare these probabilities with the numbers in Section 7 of this report.

Page 9-5 last paragraph states that there appears to be no significant environmental benefits to be gained from locating the plant at either Phipps Bend or Murphy Hill. Both of these alternative sites would be more easily monitored than the present site. It seems, therefore, that the environmental benefits exist and are obvious.

DIVISION OF SOLID WASTE MANAGEMENT

The waste generated by the employees such as cafeteria and office waste are not covered in the statement. Roane County does have a county-wide container collection system and agreement for handling this type waste. This type waste would be compactible but would not fall under the definition used in this statement.

DIVISION OF WATER QUALITY CONTROL

A review of the above referenced statement has been made and comments and concerns are as follows.

Section 2.5.1 Surface Water: "Melton Hill Dam would be regulated to meet the flow requirements of the CRBRP site".

Remarks: What is the impact on upstream reservoirs and water uses if TVA alters existing flow regulation? Does TVA plan to give equal consideration to municipal and industrial discharges to allow similar reduction in waste treatment cost?

Section 3.3 Water Requirements: "Average Annual Water Use"

Remarks: What are the maximum 24-hour uses and discharge figures at maximum power? What is the projected number of 24-hour days of continued maximum power?

Section 3.4.2 "Removal of debris fron the inlet pipe can be accomplished by flow reversal."

Remarks: Further conclusions by NRC staff indicate impingement of fish will not be significant. If impingement is significant, will the applicant reimburse the State for loss of fish and what impact will the dead or distressed fish (when flow reversal) have on classified uses?

Section 3.5 "As low as reasonably achievable."

Remarks: Is this consistent with the goal and requirements of PL 92-500 (BAT) by 1983? The Division is aware of the "so-called" agreement between NRC and EPA. It is aware of the fact that the courts have required EPA to address radioactive waste systems in the NPDES Permit.

Fig. 3.15 Liquid Radioactive Waste System

Remarks: What are the provisions for handling radioactive waste when filter or evaporator malfunction.

3.5.1.2 Low Activity System

Remarks: Waste characteristics (chemical) not shown for liquid radioactive waste stream. Adequate biological and chemical treatment must be provided prior to release into the final discharge pipe.

3.5.1.3 " ... bleed (tritium) from the condensate and feedwater system"

Remarks: Waste characteristics (chemical not shown). Dilution by river water is questionable treatment.

Table 3.2 "Radwaste Dilution Flow"

Remarks: The Division of Water Quality Control does not concur with NRC policy of dilution in place of best treatment, nor is this policy in conformance with PL 92-500 (BAT). The use of 2700 GPM reflects applicant's average flow based on wet bulb temp. and does not reflect minimum discharge conditions.

Section 3.5.3 "Sodium Nitrate" on-site process. What is the impact on water quality if on-site processing occurs?

Section 3.5.3.1 "Staff concludes that the solid waste system is acceptable."

Mr. Norris
Page Five
March 26, 1976

Remarks: The Division cannot agree. Failure to define or identify "off-site" facilities for handling semi-liquid and solid radwaste places additional burden on the state and local governments without adequate planning information.

Section 3.6 Chemical Effluents

Remarks: Individual process wastewater character not shown in adequate detail to indicate difference between waste treatment and dilution of waste in the cooling tower blowdown.

Table 3.5 Chemicals or chemical species expected to be in CRBRP discharge

Remarks:

Amonia Nitrogen	What is the source(s) of 6,900 lbs/yr.?
Amonia Nitrogen	Question 0.5 MG/L in sanitary waste effluent?
BOD	What is the source of 43,000 lbs/yr.?
BOD	Question values of 2.1 MG/L and 6.0 MG/L in Clinch River?
BOD, NH_3-N & Temp	Has adequate model been developed to show that State's DO of 5 MG/L will not be violated as a result of CRBRP discharge in combination with other area discharges?
COD	Question projected value of 25.0 MG/L in sanitary waste? (COD:BOD ratio is not consistent.)
Chloring Residual	Question reported results based on use of orthotolidine Colometric?
Nitrates	What is the source(s) of 66.0 MG/L in sanitary waste and 28,000 lbs/yr. in combined source?
Suspended Solids	Question the projected ratio of suspended solids BOD in sanitary waste?

Section 3.6 (cont.) "Oil and Grease below 15 MG/L"

Remarks: On what assumption is this conclusion based?

Fig. 3.17 Chemical Waste Treatment System

Remarks:
a. Request projected wastewater inventory or characteristics for each process, including flow (GPD) and proposed treatment methods in detail.

Mr. Norris
Page Six
March 26, 1976

b. "Off-Site" - Request identification of Tennessee locations under consideration for treatment and/or disposal of liquid and solid waste generated.

Section 3.6.7 (PCB) " . . . loss to the receiving stream"

Remarks: Prevention of soil contamination must be provided.

Section 3.6.9 Storm Drainage

Remarks: What is the basis for sizing of catch basin?

Section 3.6.11 "Chemical Coolants"

Remarks: Where off-site?

Section 3.7.1 Sanitary Waste

Remarks: Request adequate engineering data to evaluate proposed treatment, including:

a. Facilities designed and sized for peak flow and organic loading?
b. What procedure is to be used for flow splitting (equalization) between the two plants?
c. What type of on-site food service will be provided, if any?
d. Are showers available?
e. Question realistic evaluation of obtaining 0.5 MG/L NH_3-N in final effluent.
f. Question COD:BOD:Suspended Solids ratio?
g. Nitrate in Table 3.7 and 3.5 does not agree.

Section 4.3 Impact on Water Use . . . "Applicant has not indicated the procedures to be used in disposing of 40,000 M^3 of material to be dredged . . ."

Remarks: The Division of Water Quality Control is required to provide certification of COE applicants. Section 4.4.2, Paragraph 2, implies (TWQCB 1973) certification. Verification is requested.

Section 4.5 Impact on Community

Further impact on the water, wastewater, and solid waste problems associated with the local communities is needed. Environmental/economic consideration should be given to the needs of each location, including short-term and long-term effects.

Section 5.2, Paragraph 3 " . . . nearest downstream use of the river for public water supplies at Lenoir City and Harriman, 10 and 11 miles away."

Remarks: Tennessee Water Quality is not aware of named intake(s) on Clinch nor does it agree with statement. Correction is needed. ORGDP intake at CRM 14.4 is a recognized public (domestic) water supply and is in the immediate influence of the discharge. The River at the point of discharge is classified for domestic water use and the classified use cannot be altered. Adequate evaluation must consider protection of the Clinch River water at the point of discharge for domestic use if withdrawn at that point. Due to reverse-flow conditions in the Clinch, the NRC cannot omit evaluation of CRBRP proposed intake in terms of effect on domestic use. Consideration must also be given to PL 92-523 (SDWA) existing and future requirements for public water supplies.

Section 5.7.2.2 "The consumption of water by man would not be a potentially significant pathway because there are no potable water intakes on the Clinch River downstream of the plant."

Remarks: Has ORGDP Intake at CRM 14.4 been shut down? If not, does ORGDP produce a domestic water for employee use? Does the Clinch on occasion reverse flow? Does the CRBRP propose a domestic water supply? Further evaluation and response is needed.

SUMMARY AND CONCLUSIONS

The statement repeatedly states that the applicant (TVA) will provide water to meet requirements for any necessary purpose, including dilution of chemical and radwaste liquid discharges to the Clinch River. It has not evaluated the impact(s) of the proposed action on upstream uses. The statement repeatedly states that CRBRP will use "off-site" locations for treatment and/or disposal of waste materials. It does not identify or evaluate the impact(s) relating to "off-site" disposal.

The report concludes no significant problems involving water use. (TWQ assumes classified uses.) It does not state that degradation of existing water quality will not result, due to construction and operation of the CRBRP.

The CRBRP will be a Federal facility; thus, blocking TWQC evaluation and review of proposed waste treatment plans. The Statement and the Environmental Report are insufficient in detail to assume that an adequate review has been made by TWQC; therefore, no conclusion will be made by TWQC as to whether or not water quality in the Clinch River will

be adequately protected.

Based on available information, TWQC can only assume that existing water quality will be degraded by the discharge of concentrated organics, cumulative chemical waste (heavy metals), dissolved solids, and radioactive waste materials. TWQC must also assume that all or part of the classified uses of the Clinch River will be restricted or prohibited in the area of the discharge. TWQC must also assume that the applicant will, or may, attempt to control the classified uses by restricting or prohibiting access through the discharge area.

Thank you for the opportunity to comment on this project.

Very truly yours,

C. Ron Culberson

C. Ron Culberson
Programs Coordinator
Bureau of Environmental Health Services

CRC/vse 5-3

TENNESSEE DEPARTMENT OF TRANSPORTATION
NASHVILLE 37219

RAY BLANTON
GOVERNOR

EDDIE SHAW
COMMISSIONER

W. A. GOODWIN
DEPUTY COMMISSIONER

March 22, 1976

RECEIVED

Mr. Washington Butler, Jr.
Director of Urban and Federal Affairs
Office of Urban and Federal Affairs
Suite 108, Parkway Towers Building
Nashville, Tennessee 37219

Subject: A-95 Notification: Clinch River Breeder Reactor Plant, Draft Environmental Statement, Roane County

Dear Mr. Butler:

The construction of the Clinch River Breeder Reactor Plant itself should not conflict with any existing or future highway improvements. An indepth analysis of traffic congestion and patterns has not been done for the proposed plant; however, it is known that construction traffic will cause congestion on State Route 58 in the vicinity of the plant. We feel that a definite commitment should be made on the part of the developer to assume responsibility for making needed improvement to this route which is a direct result of the construction traffic.

Our Design Division has previously met with representatives of ERDA to discuss possible improvements on State Route 58 and other access roads in the area.

If I can be of further assistance, please do not hesitate to call on me.

Sincerely,

E. R. Terrell
Director,
Bureau of Transportation
Planning and Programming

HEC/sn

BUREAU OF HIGHWAYS ★ BUREAU OF PLANNING ★ BUREAU OF BUSINESS MANAGEMENT ★ BUREAU OF AERONAUTICS
★ BUREAU OF AREA MASS TRANSIT ★ BUREAU OF INDUSTRIAL MARINE & WATERCRAFT TRANSPORTATION

TENNESSEE WILDLIFE RESOURCES AGENCY
ELLINGTON AGRICULTURAL CENTER
P. O. BOX 40747
NASHVILLE, TENNESSEE 37204

HARVEY BRAY, Executive Director
ROY H. ANDERSON, Asst. Director
GARY T. MYERS, Asst. Director

March 19, 1976

Mr. Stephen H. Norris
Grant Review Coordinator
Office of Urban and Federal Affairs
Suite 108
Parkway Towers Building
Nashville, Tennessee 37219

Re: NRC - DEIS - Clinch River Breeder Reactor Plant

Dear Mr. Norris:

We have reviewed the Nuclear Regulatory Commission's (NRC's) DEIS for the Clinch River Breeder Reactor Plant (CRBRP) to be located near Oak Ridge in Roane County.

The Energy Research & Development Administration (ERDA) has the lead role for technical supervision and administration of the design and construction of the nuclear steam supply system and TVA has the responsibility for operation and maintenance (page 1-1). This DEIS provides NRC's evaluation of the adequacy of the applicants' plans, as submitted in: the Environmental Reports, Chapter 2 of the PSAR (Preliminary Safety Analysis Report), Proposed FEIS (WASH-1535) and ERDA's FEIS on the LMBR (Liquid Metal Breeder Reactor) Program.

We agree with NRC's following analyses of fish and wildlife impacts:

1. Since impingement losses are estimated to be 0.5% of the susceptible fish passing the perforated pipe intakes, impingement would not be a problem at the CRBRP (page 5-2).

2. Since entrainment would cause an average loss of 0.46% and a maximum loss of 2.2% of entrainable organisms (phytoplankton, zooplankton, drift invertebrates, and ichthyoplankton), losses would be small due to this source (page 5-4).

3. Since the greatest surface water increases will be 4.8°F. in the winter and 1.3°F. in the summer, the thermal impact on the aquatic environment would be minimal (pages 5-5 through 5-11).

Thirty fish species that were collected in the Clinch River near the site are listed (page 2-61). Not listed are 17 "minnows" that are yet to be identified. We recommend identification and listing of these species in the FEIS.

Annual radiation exposure to people living and working in the area and eating fish, beef, and milk exposed to plant effluents is cited at less than two percent of the natural background exposure. This is rated as no radiological impact (page 5-21). No acceptable limits have been established for species other than man, but safe limits for people are rated as conservative for other species (page 5-16). We do not object to this analysis for normal opeerations.

NRC reports, "our preliminary conclusion is that the accident risks can be made acceptably low through a combination of methods" (page 7-10). Since some of the radiological materials have extremely long half-lives, the impact of an accident could be for several hundred years for both man, fish and wildlife. Our Agency claims no expertise in the field of radiation. However, we question the advisability of commitment to a project with this inherent danger until greater assurance then "preliminary" can be provided for the future safety of the affected resources.

Thank you for this opportunity for comment.

Sincerely,

Harvey Bray, Executive Director
Tennessee Wildlife Resources Agency

RMH/ss

cc: Mr. Hudson Nichols
Mr. Reid Tatum
Mr. Harold Hurst

50-537

ANDERSON COUNTY

CLINTON, TENNESSEE 37716

HOME OF NORRIS DAM, BULL RUN STEAM PLANT AND OAK RIDGE

ALBERT B. SLUSHER
COUNTY ADMINISTRATOR

March 16, 1976

3-29-76

Mr. Roger Boyd, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Boyd:

This letter is in response to the request for comments by Anderson County on the Draft Environmental Statement, (NUREG-0024) prepared by the U. S. Nuclear Regulatory Commission on the construction and operation of the Clinch River Breeder Reactor Plant (CRBRP).

We are very pleased to see in the report a recognition that the costs to the local governments are likely to exceed the economic benefits in the case of a tax exempt facility. The point is well made and detailed estimates on the particular socioeconomics effect of the CRBRP do show the need for in-lieu-of-tax payments to local governments beyond the assistance alloted to school systems by Public Law 874.

It is gratifing to read that the staff of the commission is of the opinion that a study should be made to determine the magnitude of the in-lieu-of-tax payments that should be made and to whom they should be paid. However, there is a general disclaimer that the participants have no authority to make such payments. This seems to be in contradiction to the established practice of the T. V. A., and the fact that private Utilities are involved. In addition, a story in the Oak Ridger of April 9th, 1974, indicated that the Project Management Corporation (PMC) is in the legal position to pay taxes if the PUC board makes the determination that taxes should be paid. Consequently, the Environmental Statement should contain a discussion of the authority of the (PMC) to make such payments and a recommendation should be included that this payment be made a requirement for licensing since the evaluation of the socioeconomic impacts of the CRBRP indicates an increased tax burden to the local governments.

We have reviewed the excellent and detailed comments by the City of Oak Ridge that were developed by a sub-committee of the City's Environmental Quality Advisory Board. This sub-committee was composed of a group of prominent

a

local citizens with a wide range of expertise in these matters. We are in agreement with their conclusions that the draft Environmental Statement, in general, adequately discusses the risk to the terrestial and aquatic environments and to the local populace attendant with the construction and routine operation of the CRBRP. We also agree with their conclusion that there are several deficiencies in the area of socioeconomic impacts, particularly the previously discussed in-lieu-of-tax payments.

The comments of the City of Oak Ridge also included 37 specific items in the Environmental Statement that appear to be in error or needing clarification, but are generally of small significance in the overall assessment. We have noted an additional minor deficiency in regards to the radiological impact on man and organisms. These evaluations are based on so called pathway models. The reference to a standard model is given as ICRP, 1959, which stands for the international commission on Radiological Protection bulletin issued in 1959. This reference does not contain any pathway models; it merely gives recommendations on permissable doses. There are a number of pathway models that have been used in these evaluations. One is the model incorporated in the HERMES computor code developed by the Pacific Northwest Laboratory. Probably this model or similar one was used. The reference should be clarified.

We thank you for requesting our comments on the Environmental Statement. We fell sure that the noted deficiencies can be resolved to the satisfaction of all parties.

Very truly yours,

A. B. Slusher

Albert B. Slusher
Anderson County Administrator

ABS/jp

ROANE COUNTY
OFFICE OF THE COUNTY JUDGE
KINGSTON, TENNESSEE 37763

S. WALLACE BREWER, JUDGE
Mrs. Betty Till, Secretary
Phone 376-6541 Ext. 260

TOM WARD, Director of Purchasing & Accounting
Phone 376-6541 Ext. 244

March 29, 1976

DIRECTOR
U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D.C.

RE: Comment on Draft Environmental Statement related to construction of the Clinch River Breeder Reactor Plant published February 1976. Docket No. 50-537

Dear Sir:

Roane County, Tennessee, hereinafter referred to as "Roane", subscribes to staff conclusions in 8.4 that applicants' discussions of the need for the CRBRP are consistent with existing and prior determinations by ERDA (AEC) arising from the NEPA review of the LMFBR Program. Roane agrees that benefits derived from the program would be of major national significance. Roane agrees that the Clinch River LMFBR, as a key element in the program, can provide a benefit significantly greater on a national level than that which might be attributed to the generation of electricity in a generating station of its size.

Roane should not be expected to subsidize to any extent from existing local citizen resources that increased cost of local governmental activities attributable to the impact of CRBRP on said activities. Local jurisdictions should be able to at least "break even" on such a project. Private sector projects, even those experimental and/or developmental in nature, are expected to do much more than "break even" for the local jurisdictions in which they locate and impact, i.e., by paying taxes to support needs of their employees as well as those who work at plants in neighboring jurisdictions. Local governments are expected by their citizens to fulfill common needs that cannot be physically or economically fulfilled on an individual basis. Roane accepts that responsibility.

Roane respectfully submits that there should be required by NRC of the applicants' two conditions for granting the construction

3301

license; that (1) increased costs of local governmental activities attributable to CRBRP impact be quantified by the applicants to the satisfaction of the affected jurisdictions and, (2) that specific and equitable provisions be developed by the applicants to the satisfaction of the affected jurisdictions that payments in lieu of taxes will be made in sufficient amounts to assure the "break even" condition. There should be further specific recognition (with mitigation therefor supplied by applicants) that the situs local jurisdictions (i.e., Anderson and Roane and the cities of each) will be affected by the project in a manner peculiar to those jurisdictions different from all other surrounding "area jurisdictions", and in a manner greater than those "area jurisdictions".

Compliance with the first condition would require a mutually agreeable plan of monitoring so that payments under the proposed commitment could be reduced or increased from year to year depending on the level of payments from others applicable to the same impacts, such as P.L. 874 money. It should be noted that P.L. 874 payments are not made in full satisfaction of entitlements. Class B P.L.874 payments have also been the subject of many efforts of federal budget deletion. An example of need for requiring mitigation according to monitored impact is distribution of school children in the public school system. It is generally true that construction workers are of child-bearing age. It is further anticipated by applicants that "temporary" residences of construction workers will be mainly mobile homes located in sites along Highway 70 and alternate Highway 58, from one end of Roane to another. Roane submits that, assuming best efforts are made by Roane and applicants, it will be impossible for either applicants or Roane to accurately predict the number of "new" school students, the exact schools to be attended by those students and the exact grade-level distributions of those students. School students do not register in specific schools in exact multiples of thirty in specified predictable grade levels. Lack of available ground space at some schools excludes the location thereon of moveable or temporary classrooms. Some school sites do have such available space. Only an actual experience factor, amendable on an annual basis during project life, can aid in accurately determining local increased costs. Compliance with the second condition should not depend solely upon the "excess capacity" of schools and other affected governmental activities, but should also take into account the number of workers who settle in Roane and in the cities of Roane. In short, satisfactory compliance by applicants with condition one should aid in ultimate compliance with condition two because enough will be known to devise an effective monitoring plan.

The foregoing comments are somewhat general in nature. The remainder of this document deals with a few specific areas of the DES that should be considered by applicants in fulfilling the two above requested conditions.

1. Roane is concerned about loss of time (money) to its citizens from new traffic tie-ups and would like to see more definite mitigation plans as well as more precise assessments.

   (a) What are the current traffic capacities on the travel routes leading to the CRBRP site (see Fig. 2.2), and what is current road use in vehicles per hour during hours of rush traffic?

   (b) What are the expected traffic increases and times of day of increased traffic flow during construction of CRBRP?

   (c) What co-ordinated activities will be taken by applicants to assure the much discussed staggering of work shifts during construction of CRBRP?

   (d) What alternative actions, in addition to staggered shifts, can be taken to prevent or lessen traffic impacts during CRBRP construction? Who would be responsible for implementing each alternative?

   (e) What future plans have been made by ERDA, the counties, the cities, and the State for area roads? Will any of these plans need to be implemented to minimize traffic impacts from CRBRP construction? Who will implement them? Who will bear the costs?

2. Roane is concerned that substandard health conditions could occur in "temporary" housing for construction workers. DES in section 5.2 states that sanitary sewage discharges would meet all applicable standards and would have no significant effect on the quality of water in the Clinch River. Roane assumes this statement is related to sanitary sewage discharges from facilities at the plant site. Roane is concerned about sanitary sewage discharges from temporary housing for workers located off the plant site. The anticipated mobile home locations from one end of Roane to another are in an area where sewer lines and/or treatment plants are either limited or non-existent. Further, many of these same areas cannot accept current private sewage discharges, because of soil consistency, especially in the Midtown area of Roane. If public sector efforts and private developments that may arise cannot provide facilities for preventing raw sewage running out on the ground in temporary housing areas, the applicants should render specific assistance. Applicants' commitments in 4.6.1. should be expanded to mitigate this concern. Dyllis, Blair Road, and Oliver Springs areas will also be impacted by students, traffic, temporary housing, etc. Applicants have neither identified, quantified or even mentioned impacts on those areas in reports to date.

3. Roane is concerned about applicants' commitment number 7 in 4.6.1. to the effect that garbage from plant and transmission line construction would not be burned, but would be discarded by a licensed contractor in regulated disposal facilities.

(a) Who or what would be the licensed contractor?

(b) What are licensing requirements for the contractors and what entity issues the license?

(c) Most importantly what "regulated disposal facilities would be used: The Anderson County Sanitary Landfill? The Roane County Sanitary Landfill? How much garbage and what type would be generated at plant site? What type waste would be generated from transmission line construction? Stumps?

(d) If local jurisdiction "regulated disposal facilities" are expected to be utilized, what effect would there be on the current estimated useful life of the landfill site and equipment used thereon? Who would bear the cost of an earlier than expected requirement for locating, purchasing and developing a new landfill? Equipment replacement?

Roane is further concerned about the impact of increased solid wast generated by both temporary construction workers and their families and new "permanent" settlers off the project site. How many new local government employees will be needed to pick up the additional solid waste? How many pieces of new collection and pick-up equipment will be needed? What further effect will those increases in solid waste have on the current useful life for the landfill sites and equipment used thereon?

What will be the increase in local jurisdiction cost from all of the above in this area of concern? Who will bear the cost?

4. Impacts on land use at plant site are discussed in 4.2. Roane is concerned about impacts on land use in areas beyond the plant site, especially in construction worker housing areas. What local efforts would applicants or NRC staff suggest be made to mitigate deleterious or blighting effects that temporary housing may have on our countryside?

5. Roane submits that it is reasonable to conclude that a full-time qualified and experienced planner and/or co-ordinator should be employed by Roane to consider immediate questions of local resource impact and all other long-range questions raised by this document and DES. What local cost could be expected for such an effort? Who would pay this cost on an immediate basis so that local efforts of mitigation can be taken in co-ordination with applicants' fulfilling the two requested conditions? Could it not be reasonably concluded that such a local employment of a planner is a justifiable and reasonable cost of the project itself? To date, Roane has been handed several documents and/or studies upon which to make comment. Roane has attempted to make such comments. It clearly appears to Roane that the several documents and/or studies have been prepared/performed for the most part in a vacuum by applicants or their selected sub-contractors. While local involvement in such activities is much discussed, it has been little practiced by applicants to date. Further, the comments are requested from a local governmental staff already pressed for time and resource availability. When local comments are prepared and distributed it has appeared to Roane that applicants' response is to undertake still further costly studies/reports through sub-contractors working in isolation from local staff for the local staff to again comment upon. Such a seemingly endless cycle appears to Roane to be both needlessly costly to applicants and counterproductive to both applicants and Roane in terms of calming Roane's concerns over possible impacts of CRBRP and reaching an accord of what steps should be taken by applicants and Roane to mitigate the undeniable impact upon Roane and its cities of CRBRP. See section 4.5.1. for DES verification of that impact.

Roane respectfully submits that applicants' commitments should be expanded to provide an immediate and reasonable money grant to Roane for employment by Roane of a planner and/or co-ordinator to develop a more complete local assessment of CRBRP impact and to provide more adequate local planning and co-ordinating ability with respect to mitigating that impact; said grant to be a reasonable and justifiable project cost, mutually beneficial to Roane and applicants in terms of both time and money.

6. Roane has mixed response in its further comment to 4.5.1. on social impact. The DES clearly states that the communities of Harriman and Kingston, with no firm zoning regulations and with public services of modest size, are not prepared to handle a large influx of people. The DES clearly states that Roane is particularly vulnerable to unregulated growth which could strain schools and other community services, already stretched to the limit. Roane is pleased to see such a clearly stated recognition of its current situation. Roane's concern is, however, that the DES does not adequately assess impact on local schools and mitigating steps that should be required of applicants to enable Roane to handle the overcrowding in schools that will result from CRBRP impact. The DES states "any additional students would result in overcrowding". How many additional students will there be? The DES takes as a basic assumption the presence of a local labor market, especially in Knox County, that would seem to diminish estimates of imported labor numbers or "movers" to Roane. Roane has substantial and justifiable reason to believe that the above assumption is totally incorrect. A precise survey of labor unions in Knox County should be made to clearly quantify the presence or absence of a local labor market of the skills required by the project, with the FES to clearly set out results of that survey and clearly make necessary adjustments in the foregoing assumption. That assumption

has a direct bearing on school population increase. Realistic considerations of site proximity, tax rate comparisons, and available housing and land indicate Roane as the site for living quarters of workers in numbers far beyond current estimates. T.V.A. experience figures are not appropriate or applicable to Roane to the degree relied upon by applicants, due to the nature of those realistic considerations coupled with the probable non-existence of the currently estimated available Knox County labor market.

7. The DES in 4.5.2. on economic impact contains a staff conclusion that the portions of taxes such as state sales tax, gas tax, cigarette taxes, and liquor taxes, for example that are returned to the communities would not in themselves be equal to the cost of the public services which must be provided by the communities. It further states that such taxes are relatively small compared to the receipts communities get from personal property.

Parenthetically, it is to be noted that on pages three and four of applicants' amended answer to Oak Ridge amendment to petition for leave to intervene, applicants state that "The Constitution establishes a broad immunity for the United States and its property from taxation by the States or their local governments... Absent specific congressional exception or waiver of this immunity, the CRBR cannot be subjected to taxation by a state or local government". The DES on the other hand in 1.2 states that the CRBRP is a cooperative effort of industry and government. Is the private industry involvement to be afforded the same immunity from state and local taxation as that claimed by the federal government? Assuming for argument that McCullock vs Maryland, 17 U.S. (4 Wheat) 316 (1819), does afford such immunity to the federal government, can the reasoning of that 1819 case be so stretched to preclude local and state taxation of private industrial involvement in a "cooperative effort of industry and government"? Roane takes exception to such a conclusion and submits that further discussion of local ad valorem taxation should be made in FES with staff conclusions made on the subject. Local ad valorem taxation of private interests in the project would assist in mitigating the CRBRP impact on Roane.

4.5.2. further states that the degree is unknown to which such public sector money would be available to provide for the cost of public services. Roane submits that [illegible] above stated "unknown" should be made a "known" by efforts of app[illegible]nts satisfactory to the affected local jurisdictions. The DES sets out the applicants' efforts to identify and quantify the rabbits, foxes, birds, deer, fish species, ichthyoplankton, reptiles, algae, zooplankton, rotifers, arthropods, amphibians, squirrels, skunks, opossum, muskrat, etc., that are found in the environs of the plant site. DES sets out applicants' efforts to locate and preserve the integrity of human burial grounds on the site. DES sets out applicants' efforts to identify plant species on the site

DES set out applicants' efforts to take steps to prevent pollution of the Clinch River and surrounding atmosphere from radionuclides. Extraordinary precautions are set forth in applicants' commitments to minimize the impact on the ecological balance of the site and its environs. Can it be any less important for applicant to be required by NRC to quantify to local satisfaction the social and economic impacts on the communities directly affected by the CRBRP? The DES states in 2.8 that many county residents hold the opinion that current payments in lieu of taxes are considerably below tax revenues that would accrue from the same facilities on private land. Why should applicants not be required to make the same extraordinary, meticulous efforts in quantifying local governmental impacts and to establish in the licensing process clearly defined methods of mitigation, as applicants are required to take in protecting the integrity of the physical environment?

While county and city governments are not fish, birds, mammals, trees, zooplankton or algae, they are as surely affected by non-mitigated impact as are wildlife and water and air. In some respects, local governments, because of their conservative nature and modest size, are as helpless as are wildlife and water and air when it comes to mitigating the effects of a multibillion-dollar project of major national significance supported by both a national taxation base and a varied private industrial revenue base upon a mini-million (or mini-thousand in case of cities) local government supported chiefly by ad valorem taxes on mortgaged homes and small business establishments.

Roane respectfully submits that NRC staff evaluation set forth in 4.6.2. (e.) that "Local costs for additional public services...should be assessed by the applicants to determine the need for offsetting in-lieu of tax payments" should be strengthened by staff to the level of adding the two conditions upon applicants requested by Roane in this document before license is issued by NRC. Roane will make a corresponding co-ordinating effort to facilitate applicants' compliance with those conditions.

8. The following questions should be further addressed and specifically answered in the FES:

   (a) Is that portion of the plant valuation that may be attributed to private industrial investment subject to local ad valorem property taxation?

   (b) Is sales and use tax applicable to materials and equipment used to construct the plant?

   (c) Is constructio[illegible]ment located long on the site subject to [illegible] property taxation?

   (d) Are power sales by T.V.A. to P.M.C. subject to sales and use tax?

   (e) Are future power sales that may be made after experimental stage is completed subject to sales and use tax?

   (f) What mitigation procedures and plans for monitoring local impacts during post licensing period need to be established in pre-licensing period as a condition of license issuance to insure that burdens are not placed on local jurisdictions that would prevent those local governments from achieving the break even point?

(g) Who will the license be issued to: ERDA, PMC or TVA?

(h) With whom would local communities negotiate for impact mitigation and under what conditions and/or restraints would those negotiations be conducted during plant construction phase?

(i) Since secondary private sector employment benefits have been included in the DES, what are anticipated secondary private sector costs to local communities?

(j) What increases in numbers of personnel in Roane and its cities in areas of ambulance service, solid waste and sewage attendants, police protection, fire protection, health protection and general services will be required by CRBRP impact? What total capital costs on Roane and its cities are anticipated as a result of CRBRP impact? What may be anticipated debt service increases on Roane and its cities as a result of CRBRP impact? Administrative personnel increases should also be identified and quantified, those persons being independable to efficient governmental operations.

(k) What specific and definite assignments of areas of responsibilities for emergency plans need to be made? Who will bear the cost of meeting of those responsibilities?

With respect to Roane, one means of increased cost impact mitigation is suggested as an additional increment to revenue from ad valorem taxation of private investment interests in the CRBRP. Recent amendment to 1955 Atomic Energy Communities Act affords Roane and ERDA opportunity for negotiated contractual just and reasonable annual assistance payments through 1986 for CRBRP impacts; provided those impacts upon Roane discussed herein and yet to be satisfactorily quantified are considered in addition to impacts of existing plants in reaching a total annual assistance payment figure to Roane.

Respectfully submitted this 29th day of March, 1976.

ROANE COUNTY TENNESSEE

By [signature]
S. Wallace Brewer, County Judge

SWB/pb

OAK RIDGE
OR
TENNESSEE
MUNICIPAL BUILDING
37830 TELEPHONE 483-5671

RECEIVED APR 1 1976

March 29, 1976

CERTIFIED MAIL NO. 659200

50-537

Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Sir:

Enclosed please find Comments on the Draft Environmental Impact Statement filed in behalf of the City of Oak Ridge, Tennessee.

Sincerely yours,

[signature: Luther M. Reed]
Luther M. Reed
City Attorney

lm

Enclosures

3299

VISIT THE MUSEUM OF ATOMIC ENERGY

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of — Docket No. 50-537

PROJECT MANAGEMENT CORPORATION

TENNESSEE VALLEY AUTHORITY

(CLINCH RIVER BREEDER REACTOR PLANT)

CITY OF OAK RIDGE
COMMENTS ON THE
DRAFT ENVIRONMENTAL IMPACT STATEMENT
RELATED TO THE CONSTRUCTION OF THE
CLINCH RIVER BREEDER REACTOR PLANT

Luther M. Reed
William E. Lantrip

A. Socioeconomic Impacts

The DES is to be commended because it (1) utilizes the current techniques to estimate socioeconomic impacts; (2) recognizes that public facilities like schools are fully utilized even though they may not have a population equal to nominal capacity; (3) recognizes that the public sector costs are likely to exceed benefits in the case of a tax exempt facility; (4) recognizes that each member of an in-moving population induces public sector costs for every type of public service; and (5) recognizes that the local economy does not benefit economically to the full extent of the worker payroll.

However, there are several deficiencies in the DES in the area of socioeconomic impacts. The following are comments, indications of need for additional information, and recommendations concerning socioeconomic impacts of the CRBRP.

1. The DES recognizes the potential problem of traffic congestion but fails to provide an adequate discussion of the potential problem and its solutions. The following questions should be answered:

a. What are the current traffic capacities on the travel routes leading to the CRBRP site (see Fig. 8.1.2) and current road use (vehicles per hour at peak traffic times)?

b. What are the expected traffic increases and times of day of increased traffic flow during construction of CRBRP?

c. What coordinated activities will be taken to assure staggered work shifts during construction of CRBRP?

d. What alternative actions in addition to staggered shifts can be taken to prevent or lessen traffic impacts during CRBRP construction and who would be responsible for implementing these alternatives?

e. What future plans have been made by ERDA, the counties, and the State for the roads in the area? Will any of these plans need to be implemented to minimize traffic impacts from CRBRP construction?

2. The DES does not provide an adequate discussion of the potential sources of tax revenue to local communities. The DES indicates that the project will not contribute to tax revenues in any direct way. The local community would benefit if it knew whether this opinion reflects the opinion of the NRC staff attorneys as well as the attorneys of the applicant. There are several reasons which indicate that some form of taxation may be possible.

First, over $200 million is being contributed to the CRBRP by private utilities. Logically, this significant private part-interest in the CRBRP can be subject to property tax even though the Federal Government's share cannot be taxed in the same manner. (See for example, a report in The Oak Ridger of April 9, 1974, wherein Peter Van Nort, general manager of PMC, indicated that PMC is in the legal position to pay taxes if the PMC board deems that taxes should be paid. The Environmental Statement should contain a discussion of this possibility and a recommendation making this a requirement for licensing.)

Second, construction equipment long-on-the-site and any leased plant equipment are taxable.

Third, it is not entirely clear whether Tennessee's sales and use tax will apply to materials and equipment of which the plant is constructed. Power-producing machinery is excluded, but, since during the 5-year experimental period the plant will not be included in TVA's power-producing capacity because of the experimental nature of the enterprise, all the machinery may be subject to the use tax.

Finally, a more complete discussion of the payments in-lieu-of taxes should be included in the Environmental Statement. Prior to licensing, in-lieu-of tax payments to Oak Ridge should be negotiated to take into consideration the realities of the value of the property and its use by and to promote activities in the private sector.

The following specific questions should be answered:

a. How much will the in-lieu-of tax payments be and to whom? Will the NRC require in-lieu-of tax negotiations as a condition to licensing the CRBRP?

b. How much revenue can be received through taxation of that portion of the CRBRP owned by private interests (over $200 million)?

c. Does Tennessee's sales and use tax apply to materials and equipment used to construct the plant?

d. How much revenue can be received through taxation of construction equipment long-on-the-site?

e. Will the presence of the CRBRP workers and their families act in any way to reduce in-lieu-of tax payments to the City of Oak Ridge by ERDA under the existing financial assistance agreement? For example, will payments under PL 874 for children of CRBRP construction workers reduce ERDA payments?

3. Mitigation procedures and plans for monitoring impacts during the post-licensing period need to be established to insure that inequities or unfair burdens which are a consequence of the construction and operation of the plant do not fall on local community institutions or local citizens. During construction, efforts should be undertaken to minimize impacts on local communities, such as (1) intensifying efforts to recruit locally, (2) intensifying efforts to train local workers, and (3) providing financial assistance and expertise to local communities to assist them in managing impact. If unexpected harmful effects are

detected during facility construction, the applicant should be required to provide an acceptable analysis of the problem to the local community involved and to provide a plan of action to eliminate or significantly reduce these harmful effects.

The following specific questions should be answered:

a. Who are the applicants and who could be held responsible for mitigating impacts during construction and operation of the CRBRP?

b. With whom would the local community negotiate for mitigation of impacts and under what conditions during the construction and operation of the plant?

c. Since ERDA will regain control of 100 acres of CRBRP land (see p. al-274c, Amendment 5, to the Environmental Report) and manage operation of the plant, why is ERDA not an applicant for the construction permit?

d. What are the planned procedures for the mitigation of impacts?

e. What are the applicant's plans for monitoring impacts on the community?

f. Provide a table similar to Table 5.9 for construction impacts.

4. The DES should have given consideration to the effects of other planned construction projects in the area on the impact of the construction and operation of the CRBRP. In a worst case situation, all the proposed energy-related projects for the Oak Ridge vicinity will be built with work schedules that peak and taper off at the same time. In such a case, worker in-migration may be substantial, followed by an economic letdown after completion of the projects. The applicants should be required to cooperate with other major construction projects in the area and local governments to minimize the cumulative or interactive effects of the several construction projects on local communities.

5. Secondary employment benefits have been included in the DES; therefore, associated secondary costs should also be included.

Such questions that should be answered include:

a. What are the costs to employers not directly associated with the applicants that result from a loss of their trained personnel to the CRBRP project?

b. What will be the capital costs associated with secondary employment opportunities?

B. Land Use Impacts

Section 10.2.3.1 of the DES indicates that the land comprising the CRBRP site is presently idle, unsettled, and uncleared. This is somewhat misleading since this 1,364-acre CRBRP site ~~was once~~ part of a 1,480-acre tract established by AEC, TVA, and the City of Oak Ridge for the purpose of industrial development to enable Oak Ridge to experience normal industrial growth. It was the intent of the agreement that, as industrial developers requested sites, TVA would sell the land to the City, which would in turn sell it to the interested industrial developer. Thus, although the land was transferred from AEC to TVA, it was transferred with the intent that it would be made available to the City for industrial development. Of the remaining 113 acres of this tract, which was designated as the Clinch River Industrial Park, one industry is currently located on a 33-acre site; a second 5-acre tract has been sold, and 15 acres is owned by Oak Ridge. The City has provided water, sewer lines, and electrical power connections to this park. Thus, of an original site which was tacitly understood by AEC, TVA, and Oak Ridge to be utilized for industrial expansion of Oak Ridge, 92% has now been set aside for the CRBRP. This 92% is, therefore, not subject to local taxation in the normal manner. The DES should assess the loss of taxes to the City as a result of the site being developed as the CRBRP site, as compared to expected revenues if it would have been developed as originally planned.

Another question arises with regard to efficient land use since the reactor site itself will only require a small fraction of the land. The DES should address this in terms of the minimum exclusion radius requirements and the possibility of making the rest available for industrial development as originally planned. TVA should be asked questions regarding its intended use of the major portion of the site not used for the CRBRP (e.g., are there plans to construct a coal-fired, steam-electric generating plant at this location?).

A final question arises with regard to the restricted area, which includes the full width of the Clinch River around the peninsula on which the site is located. What are the implications of this "restricted area" in terms of commercial and recreational use of the river?

C. Accidents

1. Since the CRBRP is a new technology and may harbor unexpected vulnerabilities such as those demonstrated by the Brown's Ferry fire, the applicants should be required to cooperate with State and local civil defense and public health officials in the preparation of contingency evacuation plans for the nearby population. Some assurance should be provided that specified State and local officials be notified promptly if an emergency develops at the plant which has the potential for offsite contamination. There should be provision for periodic (at least annual) exercise of the communications channels between the CRBRP and local civil defense and public health officials. The Environmental Statement should summarize the applicant's plans with regard to meeting emergency preparedness requirements.

2. A severe accident that occurs at CRBRP while a southerly wind was blowing could result in significant damage to an area including Oak Ridge. Would the Price-Anderson Act apply to an accident at the CRBRP? Since the Price-Anderson limit of liability is $500 million, if the TVA and/or ERDA were liable, considering that both TVA and ERDA are governmental agencies, how would the excess above the Price-Anderson limit be distributed? What would be the liability of the other participants in the CRBRP project? Would TVA and/or ERDA be exempt from claims from events at CRBRP which affected persons and property offsite? What assurance is there that those affected by a CRBRP incident would receive prompt settlement of their claims?

3. Paragraph 5 of Section 7.2 indicates that a severe fire involving a loaded spent fuel cask would reduce the dose estimate by five orders of magnitude. This appears to be in error and should be corrected in the FES. Considering the release of cesium, which was the basis for Table 7.4 of the DES, a fire reduces the indivdual dose commitment by about four orders of magnitude, but in the case of the overall population, the dose estimate actually increases somewhat as a result of a fire (see Table 4.5-35 in WASH 1535).

D. The following section includes items in the DES which appear to be in error but are of lesser significance to the overall assessment than those reported immediately above.

1. In the Summary and Conclusions section, it is mentioned at the end of the demonstration period (1988), TVA would have the option of purchasing the plant for its own use. It should be made clear what will happen to the CRBRP if TVA does not exercise this option.

2. Condition (c) on page iii should be clarified to indicate whether the doses mentioned are to an individual or to a certain population.

3. Section 1.4 indicates that WASH-1535 and ERDA-1535 were major documents used in the preparation of the DES. Therefore, these documents should be included as part of the docket file in the local public libraries.

4. Paragraph 2 of Section 1.4 indicates that part of the DES's conclusions were based on visits by the NRC staff to the site and surrounding areas in January and November of 1975. Paragraph 5 of the Foreword indicates that such visits may include meetings with State and local officials who are charged with protecting State and local interests. In view of the significant impact of the construction and operation of the CRBRP on the surrounding communities, the extent to which the staff contacted local (city and county) officials should be discussed and those officials with whom meetings were held should be identified, along with their positions of responsibility.

5. Paragraph 5 of Section 1.4 indicates that since the plant would be titled in the United States and built on federal land, the project is not required to obtain licenses and permits from State and local authorities. Since the original contracts among the participating organizations indicated that TVA would hold title to the CRBRP plant, and since there has been significant litigation in a neighboring state as to whether TVA plants require local permits governing air pollution requirements, then an explanation should be included in this section indicating whether the conclusions expressed in this paragraph is the opinion (legal?) of the NRC staff or of the applicant and to what extent the litigation mentioned above affects this conclusion.

6. Paragraph 5 of Section 1.4 indicates that licenses and permits from State and local authorities will not be required. Since one of the purposes of construction and operation of the CRBRP is to "demonstrate the licensability of LMFBRs" (Section 8.2), to what extent will this purported demonstration of licensability be negated by the lack of requirement of State and local permits?

7. The second sentence in Section 2.1 (1st paragraph) and Fig. 2.1 (as well as Figs. 2.2 and 6.2) are very confusing, and in error, about the relationship of the CRBRP location to the City of Oak Ridge. The implication is that the CRBRP is outside the City limits of Oak Ridge, which is not true since the corporate City limits are approximately coextensive with the ERDA boundary shown on Fig. 2.2. Further, the maps indicate that residential Oak Ridge is completely within Anderson County, whereas, in fact, residential

Oak Ridge extends several miles farther west than shown on these figures, is well within Roane County, and development is continuing in this direction. The text of Section 2.1 states that Oak Ridge is 9 miles northeast of the CRBRP site; a more accurate statement would be that the site is within Oak Ridge, with residential areas of the City extending to within approximately five miles of the site. Text and figures should be changed to reflect existing conditions. The applicant's Environmental Report is similarly misleading.

8. Include a political jurisdictional map, i.e., showing boundaries of the authority of planning commissions, fire districts, water districts, etc.

9. Section 2.2 and Fig. 2.6 may be misleading. Growth within a five-mile radius was projected in the applicant's Environmental Report since it contains a large percentage of the potential locations for trailer parks for construction workers, whereas, the DES projects no growth within this five-mile radial area. Also, long-range growth of residential Oak Ridge includes areas within five miles of the site. Moreover, depending on what portion of the site one takes as the center of the circle of radius of five miles, there may be no residences to the north, but there are always people to the north at the ORGDP and the Clinch River Industrial Park. Any discussion of population concentrations should take into consideration day and night time variations related to community activities.

10. One of the historical sites is the former County Courthouse in Kingston (Section 2.3). The "X-10 Reactor" is actually the X-10 Graphite Reactor, a national historic monument.

11. In paragraph 1 of Section 2.5.1, the width of the Clinch River is mentioned as 612 ft. in the winter, with an average summer width of 657 ft. Are those widths for a particular location (e.g., at a particular river mile)? If so, this location should be specified.

12. Paragraph 2 of Section 2.5.1 quotes the applicant as promising to control dam releases in the future to meet the needs of the CRBRP. This is plausible so long as TVA is prominent among the applicants. If the applicant should change its identify pursuant to recent legislation, then specific commitments should be required with regard to flow maintenance if river flow is a significant variable. With regard to zero flow conditions at Melton Hill Dam, were these historically to refill the reservoir or to control the milfoil? How will milfoil in Melton Hill Lake be controlled in the future (e.g., by significant use of 2,4-D?)?

13. Figure 2.9 should be labeled such that it is apparent whether the wind roses indicate the direction from which the wind is blowing or to which the wind blows.

14. Section 2.6 should have mentioned specifically the tornado that passed near the CRBRP site area at 3:30 a.m. on May 2, 1953.

15. Since the applicant's Environmental Report was heavily relied upon in the preparation of the DES, there needs to be clarification of some materials contained in the Environmental Report with regard to meteorology. Tables 2.6-21 through 2.6-27 of the Environmental Report set out the annual joint frequency of wind direction and wind speed for the seven stability classes, based on data taken at the 75-ft. level at the CRBRP site. Table 2.6-44 contains calculations of the annual average Chi/Q values using the wind direction and wind speed at the 75-ft. level. Using the data in Tables 2.6-21 through 2.6-27 together with the calculational methods outlined on page 2.6-28 of the Environmental Report, Chi/Q values higher by a factor of about 20 than those reported in Table 2.6-44 are obtained. Therefore, additional details of the Chi/Q calculation should be provided in order to establish that the applicant's calculational procedures were correct.

16. Paragraph 2 of Section 2.6 indicates that heavy fog occurs at the weather office location only about three days annually. Considering the proximity of the Clinch River to the site as compared to its proximity to the weather office location, heavy fog would be expected to occur much more frequently at the site. This should be investigated.

17. The second paragraph of Section 2.8 puts the Oak Ridge Operations Office of ERDA somewhere near Gum Hollow Road and the wrong county. It is actually in the middle portion of residential Oak Ridge, immediately south of the Oak Ridge Turnpike.

18. At the beginning of paragraph 3 of Section 2.8, it should be made clear that ". . . construction employees have usually resided outside of Oak Ridge . . ." refers to recent times, or since incorporation of the City. As to mobile homes, the present ordinance prohibiting them is currently under study by the City.

19. The fourth paragraph of Section 2.8 indicates that Oak Ridge schools are uncrowded. Later in the DES they are indicated to be fully utilized, using a criterion more realistic than that presented in the applicant's Environmental Report. Note that portable classrooms are presently in use in Oak Ridge.

20. Paragraph 4 of Section 2.8 (and also the last paragraph of Section 4.5.2) refers to "personal property tax" when "property tax" or "ad valorem" tax is intended. In Tennessee, the term "personal property tax" has a narrower meaning under the law. A good reference on tax problems in Roane and Anderson counties can be found in the May 9, 1975, hearing record on S 1378 and HR 5698 before the Joint Committee on Atomic Energy.

21. Paragraph 2 of Section 3.6.2 indicates plans to inject hypochlorite into the intake at the river water pumphouse, but that the necessity for this and the time required have not yet been established. Section 9.3.5 indicates that the applicant proposes to inject chlorine continuously at this point at the level of 1 ppm. This inconsistency should be examined.

22. Section 3.7.2 indicates that some solid wastes from the plant would be disposed of offsite by a licensed contractor. In view of the closing of the City's landfill in the near future, it would be of interest to know where and how the proposed contractor would dispose of these materials.

23. The last paragraph of Section 4.1 indicates that the Exxon Nuclear Fuel Plant is currently under construction in the area. While plans must be made for the possibility of this plant, so far there has been no public indication of a definite decision to build it.

24. Table 4.1 indicates zero construction employment for 1976 and 1977. Since paragraph 1 of Section 4.1 indicates construction start in December of 1976, an inconsistency arises.

25. Paragraph 2 of Section 4.5.3 indicates that the most noticeable visual feature of the CRBRP would be the reactor containment building. However, the most noticeable feature of the operating plant would be the cooling tower plume, which ordinarily would extend for about 1.5 miles and sometimes would extend for 6 miles (Section 5.3.3) and would be visible from much greater distances. This effect should also be mentioned in Section 5.1.

26. The 60-cycle hum from the station's switchyard should be included in the estimates of noise levels due to station operation, and discussed in Section 5.

27. The effects of chlorine in the drift from cooling towers should be discussed, since chlorine in the drift would be expected to be present to the same extent as it is in the circulating water (up to 3 mg/l, Section 3.6.2).

28. The effects of long-term deposition of trace contaminants contained in cooling tower drift and the ultimate accumulation of these contaminants in the biological components of the surrounding environment should be discussed in more detail in the DES.

29. Sport fishing activity is much greater at times than indicated in the DES (Section 5.2). Sport fishing activity is greatest during runs of white bass in the river, usually from November through March.

30. Although the design of the water intake system is basically satisfactory, lengthening each intake section to 8 or 9 feet and maintaining the original open area (thereby giving a greater distance between holes) would decrease the chances of fish impingement upon the intake.

31. Although the discharge of cooling tower blowdown into the Clinch River presents no great problem, the alternate multi-port discharge structure design could provide considerable insurance against high blowdown temperatures and at a low cost (DES, Table 9.7).

32. The cooling tower design drift rate is given as 0.05% and 0.005% in different parts of the DES. This should be reconciled.

33. The DES refers to interaction between the CRBRP cooling tower plume and the ORGDP cooling tower plumes "only with a constant wind from the northern sector" (DES, Section 5.3.3). Why would not a southerly wind cause a similar interaction?

34. While the effect of fogging at ORNL is considered, no predications are specified for either Tennessee Highway 95 west of and closer to the CRBRP than ORNL, or for the Bear Creek Road near the CRBRP. Both of these roads carry a significant traffic load during the hours of probable fogging, and effects of fogging on these highways should be considered. Additionally, instead of a linear array of the ten cooling tower cells, two parallel banks of five cells each could enhance plume rise and reduce fogging probabilities, with little or no additional cost.

35. The following comments pertain to Section 7.2, Transportation Accidents.

a. With regard to historical accidents involving release of radioactivity during transportation of radioactive materials, how many packages of the size and weight comparable to the casks containing CRBRP spent fuel have been transported? Indicate

the number of shipments and vehicle miles. Please reference the value of 3,600 for the number of packages of irradiated fuel that has been shipped to date (February 1976).

b. Paragraph 2 of this section relies heavily on WASH 1238 to define severe and extremely severe accident categories and Category 5 accidents. A better explanation of these categories is needed here. It should be pointed out that the dose estimates from the releases discussed in subsequent paragraphs result from a specific accident category (Category 5).

c. Paragraph 2 mentions 100 shipments per year at 750 miles per shipment for a total of 75,000 miles. Elsewhere in this paragraph the figure 100,000 miles is assumed. The calculations in subsequent paragraphs seem to be based on 75,000 miles. This point should be clarified.

d. To what destination is the spent fuel expected to be shipped? Will the shipments be routed through Oak Ridge? Are spent fuel casks to be shipped via rail only?

e. To what destination is the beta-gamma waste expected to be shipped. Will these shipments be routed through Oak Ridge? Will these shipments be via rail or by truck?

f. Paragraph 4 discusses doses to an adult standing 50 meters from the accident. Would doses be higher (and by how much) for an adult within 3 meters or a child within 3 or 50 meters? What population has been assumed for the region within 50 miles of the accident?

g. The background radiation referred to in paragraph 6 should be given either in the text or in Table 7.4 for comparative purposes.

h. Paragraph 7 indicates that the risk in shipping fresh fuel to the reactor is not considered to be serious. While this is true, the paragraph distinguishes between risk and accidents. This difference is lost on many people and consequently the paragraph appears to say that accidents are not considered very seriously. In point of fact, criticality is seriously considered and packages must be designed to preclude that possibility. In addition, while the CRBRP fresh fuel containers may look like LWR fresh fuel casks, there is likely to be additional neutron and gamma shielding due to the high burnup plutonium which will be associated with the CRBRP fuel. This was not mentioned in the DES.

36. Table 9.2 indicates a distance from Oak Ridge to the site of ten miles. This is, of course, in error as was mentioned earlier (see also comment 7 above).

37. Table 9.3 refers to the ORNL "Graphic" Reactor. It should be "Graphite" Reactor.

East Tennessee
Development District
1810 Lake Avenue Knoxville Tennessee 37916 615-974-2385

April 28, 1976

ANDERSON COUNTY
Clinton
Lake City
Norris
Oak Ridge
Oliver Springs

Mr. Paul H. Leach
NRC Environmental Project Manager
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC

Dear Mr. Leach:

SUBJECT: Result of Regional Review
Docket Environmental Statement on Clinch River Breeder
Reactor Plant, Docket No. 50-537

The U.S. Nuclear Regulatory Commission's draft environmental statement related to construction of the Clinch River Breeder Reactor Plant has been reviewed by the East Tennessee Development District. This review was conducted under provisions of Office of Management and Budget Circular A-95 and as a result of the Governor's designation of the East Tennessee Development District as a regional clearinghouse to review federally-assisted projects.

After ETDD received the draft statement on February 20, 1976, letters notifying other agencies and governmental units of the proposal were sent to the following:

Judge C. Howard Bozeman, Knox County
Mr. Albert B. Slusher, County Administrator, Anderson County
Judge William Russell, Loudon County
Judge S. Wallace Brewer, Roane County
Mayor Randy Tyree, Knoxville
Mayor A. K. Bissell, Oak Ridge
Mayor Joe D. Grayson, Lenoir City
Mayor Morgan Collins, Harriman
Mayor James Henry, Kingston
Mr. Jack Rains, Anderson County Planning Commission
Mr. Lynn Noey, Oak Ridge Planning Commission
Mr. Ben Gaylon, Loudon County Planning Commission
Mr. Lee Thompson, Lenoir City Planning Commission

4371

Mr. Walter Russell, Roane County Planning Commission
Mr. Robert Kyker, Harriman Planning Commission
Mr. Maitland H. Baker, Kingston Planning Commission

A copy of an eight-page letter from Roane County Judge Brewer raising a number of objections, sent to your agency, also was sent to us. We are attaching the letter as part of ETDD's comments. *

The East Tennessee Development District will focus its comments primarily on the socio-economic impacts on communities as a result of the Clinch River Breeder Reactor Plant (CRBRP). These comments are tentative, pending the outcome of meetings in the next few weeks with public officials, and in no way are to be taken as an endorsement of the project.

The projection of virtually no growth within a five-mile radius of the site, while generally correct, is doubtful in the case of the area along Gallaher Road in Roane County. We anticipate some growth in this vicinity (p. 2-6).

The environmental impact statement says that Harriman and Kingston have no firm zoning regulations (p. 4-5) but we disagree. The problem is one of enforcement. It is not as good as it might be although we think Kingston and Harriman are above average in zoning administration. Perhaps the cities change the zoning ordinances from time to time with less deliberations than might be desirable - but this is a criticism and problem with zoning everywhere, from the smallest town to the largest city.

In discussing the numbers of persons to be employed in connection with the project (p. 5-15), the EIS estimates an average work force of 275 employees during the demonstration stage, 205 new employees in support of the CRBRP work force, 360 spouses and 360 children, or a total of 1,200 persons. Then the statement says this is an increase in permanent population. Is it not possible that some of the 480 workers, especially many of the 205 support employees, will be people already in the area who are unemployed, underemployed or who are employed there now but would be replaced? In connection with the population, the statement does not discuss the impact on schools of the 1,230 construction workers who are projected to move into the area. This impact is likely to be much more burdensome on the communities than the estimated 290 "permanent" new school-age children.

The other comment we have relates to a failure to recognize the impact of CRBRP on Morgan County. Morgan County is strongly linked economically to both Roane and Anderson Counties. A great deal of commuting is done from Morgan into Roane and Anderson, especially into Roane. In 1970,

* See Roane County's comments - page A-31, this Appendix.

1,015 workers commuted into Anderson and Roane, about 31 percent of the Morgan County labor force; 680 workers went into Roane, or 21 percent, and 335 workers into Anderson, or 10 percent. The commuting time from southern Morgan County will not be much different than the commuting time from Loudon or Knox Counties. Any project which has a strong impact on Roane will impact Morgan.

In addition, the lack of land use controls, cited as one reason why the impact on Roane County is likely to be large, also applies to Morgan. Morgan County is so small that even a minimal impact from the project could be major for the county.

The East Tennessee Development District is scheduling a meeting with public officials in Roane, Anderson, Loudon, Knox and Morgan Counties in the next few weeks to discuss the socio-economic impact, especially on the schools and in the housing market. We will have additional comments following the conclusion of these meetings.

In addition, we have just received an amendment on the socio-economic impact from Project Management Corporation and need to review it.

Sincerely,

John W. Anderson, Jr.
Executive Director

JWA/GV/tg

cc Judge C. Howard Bozeman, Knox County
Mr. Albert B. Slusher, County Administrator, Anderson County
Judge William Russell, Loudon County
Judge S. Wallace Brewer, Roane County
Mayor Randy Tyree, Knoxville
Mayor A. K. Bissell, Oak Ridge
Mayor Joe D. Grayson, Lenoir City
Mayor Morgan Collins, Harriman
Mayor James Henry, Kingston
Mr. Jack Rains, Anderson County Planning Commission
Mr. Lynn Noey, Oak Ridge Planning Commission
Mr. Ben Gaylon, Loudon County Planning Commission
Mr. Lee Thompson, Lenoir City Planning Commission
Mr. Walter Russell, Roane County Planning Commission
Mr. Robert Kyker, Harriman Planning Commission
Mr. Maitland H. Baker, Kingston Planning Commission
Mr. George Brummett, Office of Urban and Federal Affairs

Mr. E. W. Christopherson, Batelle Pacific N.W. Labs
Mr. E. H. Lesesne, Director of Water Management Planning, Tennessee Valley Authority
Mr. Mike Butler, Project Management Corporation
Mr. Leslie Cavada, Tennessee State Planning Office

CONCERNED CALIFORNIANS
ACTIVE NATIONALLY
SECRETARY - 2912 BAYWATER AVENUE - SAN PEDRO - CA 90731
PHONE - (213) 664-2074

February 26, 1976

Docket No. 50-537

Mr. B. J. Youngblood, Chief
Environmental Projects Branch 2
Division of Site Safety and Environmental Analysis
United States Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

Because the LMFBR program is of nation-wide significance, we (non-nuclear engineers) appreciate this opportunity to offer the following comments on the Draft Environmental Statement related to construction of the Clinch River Breeder Reactor Plant.

(1) Initially, it is regretable that the contracts authorizing ERDA to become a co-applicant, to acquire site custody and to assume overall management responsibility, had not been completed prior to the preparation of the DES. Implementation of these contracts would seem to be a necessary pre-requisite to preparation of the Final Environmental Statement with ERDA's participation.

(2) While it has become customary to refer to the Clinch River Breeder Reactor Plant as a demonstration unit, obviously it is in fact an EXPERIMENTAL facility. This is borne out by Dr. Seamans' statement in his "Findings on the LMFBR Program Final Environmental Statement" (December 31, 1975). Quoting: "As the LMFBR program and its supporting programs continue to evolve and new information is generated, ERDA may decide to reorient the structure or pace of the LMFBR program or even terminate it altogether".

The CRBR's experimental role is further emphasized by the proposed involvment of the nuclear industry and at least 700 utility entities in its development processes.

Within this concept, it becomes necessary to consider also - (a) The tremendously volatile properties of sodium in its role as coolant and its still incompletely known behavior; (b) The presence of cumulative quantities of deadly plutonium: plus (c) the still unsolved problems associated with nuclear fission reactors in general.

And - This is the burden of hazard being imposed upon a populace which is being given virtually no opportunity to participate in the siting decisions on this plant.

Thus it seems unreasonable to ignore the potential impact of accidental occurrences which could adversely affect environment and populace over an area far beyond the confines of the plant site.

Yet all this has been given very scant cognizance in the DES. (Actually, the aquatic populace has been given more attention than the human!)

Therefore, we strongly urge that the Final Environmental Statement be amplified to encompass the following objectives:

(A) Complete removal from all public use of the entire land and water area within a 5-mile radius of the plant (except for controlled, "in motion" traffic on highways and railroad). A portion of this zone, of course, will be on terrain already federally controlled.

(B) Creation of a secondary "zone of special protection" extending over a radius of 50 miles from the plant and bending outward as necessary to include sizeable communities close to the circumferance.

(C) For all residents and workers within the "zone of special protection", provision of a rigidly organized emergency and evacuation program - federally operated, with the federal government assuming full responsibility (since the CRBR is essentially a federally instigated project) - and implemented by federal personnel in close and constant associaiton with state and local authorities.

(D) Distribution to <u>all</u> residents and workers within the "zone of special protection" of basic emergency/evacuation instructions.

(E) Provision for all residents, workers and landowners within the "special protection zone" of full liability insurance protection against effects of accidents occurring at the CRBR plant.

This to be achieved either by special amendment to the Price-Anderson Act or by special Congressional legislation.

That this program will be costly is very obvious - but the cost will be negligible in comparison to the impact upon the entire nation, both social and economic, of a serious accident at the CRBR plant without these basic protective measures.

Thank you -
CONCERNED CALIFORNIANS
By G. M. Millar
G. M. Millar
Researcher

Mk

CC - Senators
Proxmire
Tunney
Cranston
Pastore

ENVIRONMENTAL COALITION ON NUCLEAR POWER

Philadelphia Office: A400 Benson East, Jenkintown, Pa. 19046 ... -884-6262
Executive Directors: George Boomsma—R.D. #1, Peach Bottom, Pa. 17563 717-548-2836 Judith Johnsrud—433 Orlando Avenue, State College, Pa. 16801 814-237-3900

RECEIVED 4-5-76 U.S. NUCLEAR REGULATORY COMMISSION Mail Section

March 28, 1976

50-537

Director
Office of Nuclear Regulation
Nuclear Regulatory Commission
Washington, D.C. 20545

Dear Sir/Madam:

One does not have to read many Draft or Final Environmental Statements to realize that such documents are used to justify many useless projects and that the cost-benefit analyses can always be adjusted to demonstrate the "need" of any project. The recently published Clinch River Breeder Reactor Plant Draft is just such an example. Benefits are maximized and costs to the public (local and national), to the world economy, and to the environment are minimized and ignored. Monopoly power is increased, politically and economically. Individual power and opportunities for self sufficiency are decreased. Hazards are also minimized or ignored. Examples of these problems are detailed below.

1. In Sec. 2.8, some social problems of the area surrounding the plant are detailed. Local counties have 15 to 18% of their families living at the poverty level. No comment is made, however, about the impact of the construction force on these people. They face higher costs for everything, higher taxes, rents, and so on, and higher risks. Yet they accrue no tangible benefits from this project, be it the CRBRP or the entire LMFBR program. Certainly electricity is not such a benefit, because nuclear electricity cannot compete in the cost market with the cheap hydroelectric power of TVA. And the electric utilities, themselves monopolies, by their own decisions, force the poor to pay the highest rates for electricity. No breeder reactor will modify this injustice.

2. Section 3 contains no worthwhile information on the design and operation parameters of CRBRP. For instance, there is no description or diagram of the reactor, even to show whether it is a "pot" or "loop" type. Nor is there a diagram/description of the fuel and blanket distribution in the core. There is no detailed mention of the composition of the core-initial and equilibrium. There are no descriptions/diagrams of the reactor vessel, containment structure, accident prevention or mitigation device, turbine, steam generator, or control-room placement, and so on. Yet four pages are devoted to describing the water intake/discharge apparatus!

3. Section 6 briefly describes the environmental monitoring program. Yet, maintaining the traditional attitude of the old AEC toward humans, far more attention is paid to the non-human environment prior to and subsequent to operation than to humans. This is evidenced by the fact that the AEC/NRC has never conducted a thorough health survey

3334

in the vicinity of its licensed and unlicensed facilities to see if there are indeed health effects. Without such before hand base data, there is nothing to compare any afterward data with. Such a system allows for simple refutation of charges by critics of damage to humans by radiation. Such refutations, however, do not mean damages, including severe ones, have not occurred. The NRC appears to be continuing this public-be-damned operation. Around the CRBRP there is no radiation monitoring to determine real doses to any real people. Nor has there been or is there being conducted a thorough survey of the health of those who might possibly be affected by the normal and abnormal radioactive releases from CRBRP.

4. It is no surprise that there is no mention of manufacturing economics in the brief reference to quality assurance programs on page 7-1. To what extent is the effectiveness of quality assurance programs reduced or even nullified by manufacturing economics?

5. Again, on page 7-1, paragraph 5. It is not particularly comforting to read that "rigorous design codes and standards" for LWRs will be applied to CRBRP. The generally low capacity factors of the U.S. LWRs (58.0% in 1975) does not speak well for such codes. Nor do incidents like the Browns Ferry fire. It is more disturbing to suspect that the same lack of codes and standards for other components will also apply. To what extent is independent testing of components done to assure compliance with codes?

6. Reference is made on page 7-2 to various assumptions by the Applicant of low probabilities of various kinds of largely unspecified accidents. Yet no mention is made of the basis for such assumptions, or who made them. Are they based on yet more unverified (perhaps, unverifiable?) computer calculations?

7. Table 7.1 details brief descriptions of Class 1 through Class 8 accidents, but gets very vague for Class 9 accidents. Is this to avoid public scrutiny and discussion? Or will it be NRC policy that Class 9 accidents cannot happen?

8. Why is it that a safety device as important as a core-catcher is afforded only a brief mention in a foot-note on page 7-8, with no description or diagram? No mention is made of the design capabilities for containing core explosions in terms of TNT equivalents.

9. Sec 8.2 describes the principal objectives of the CRBRP. Of these, (a) has not yet been done with LWRs. As mentioned earlier, the lack of health baseline data denies any "demonstration" of safe or clean operations. While high availability factors are nice, high capacity factors are what count. Of the 15 countries operating nuclear power plants, nine had better average capacity factors than the U.S. in 1975. (Source: Nucleonics Week, Jan. 29, 1976, pages 11 and 12). For (c), an attempt was made at this almost 20 years ago, with the now mercifully defunct Enrico Fermi LMFBR. The major progress seems to have been in the devising of methods of shifting the major costs and cost overruns onto the U.S. taxpayers. Again, for (d), the "licensability of LMFBRs" was demonstrated years ago with the Fermi plant, which only proved that any plant built would be licensed. Nothing in the CRBRP Draft suggests otherwise. Of course, no mention is made of the inherent conflict of interest in the NRC trying to critically review the Applicant's submitted materials, while its purpose is to license the plant. It is inconceivable that an objective

review could take place in such an atmosphere.

10. The specific purposes of CRBRP, as outlined on page 8-3, are amplifications of the principles on the previous page. Again, no reference is made to the last attempt in this field-the Enrico Fermi. No mention is made of any progress-in 19 years-in improving on the Fermi design or in resolving the problems that plagued Fermi.

11. On page E-17, reference is made to plutonium accountability. It is difficult to conceive of how safeguards can be effective if measurement uncertainty can be as high as 1% for any plant process. Perhaps some discussion of how past performances in this field have worked out would be in order.

Yours sincerely,

Chauncey Kepford

Dr. Chauncey Kepford
Executive Board Member
Environmental Coalition on
Nuclear Power

Geothermal Energy Institute

1000 NORTHPOINT, #1704 · SAN FRANCISCO, CA 94109

DONALD F. X. FINN
MANAGING DIRECTOR

50-537

March 8, 1976

U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

RECEIVED MAR 12 1976 U.S. NUCLEAR REGULATORY COMMISSION Mail Section

RE: Clinch River Breeder Reactor Plant
975 MW thermal, 380 MW electrical
(1121 MWt, 439 MWe)
Roane County, Tennessee
NUREG-0024, February 1976

Gentlemen:

Pursuant to your March 4, 1976 request for comments on your Staff's Environmental Statement we submit the following for your consideration:

1. In our opinion the statutory requirements of NEPA and the Commission's own regulatory requriements have not been complied with insofar as the Staff's two sentence dismissal of alternative energy sources is concerned. (p. 9-1). The incorporation by reference to WASH-1535 is not a permitted procedure; that incorporation does not address itself to our comments which were not made part of that FES, and which were arbitrarily assigned as merely part of the LMFBR Hearing Record. This resulted in the failure to address our comments as NEPA and the Commission's Rules require.

2. Chapter 8 of The DES, therefore, is essentially based on a 1974 analysis, which may not be applicable as of 1976.

3. The alternative energy sources analysis simply does not address itself to the rock-bottom alternative posed by the policy question as to whether the money to be budgeted to the CRBRP facility ($1.736 Billion for the first five years) could not more wisely and profitably be invested, all or in part, in more productive alternative energy sources. This, then, raises an even more fundamental question as to the direction and scope of alternative energy source R & D, and the necessity to re-evaluate such programs as the 1974

2520

CRBRP program in view of the intensive and developing re-examination of energy needs and goals that is occuring on many levels in the United States today, particularly on the State and Local level.

4. We believe there are a number of alternative programs, as well as a suitable mix of alternative programs, that may be better suited to our energy needs, than the CRBRP program as presently formulated. We note, by way of example, the re-evaluation made by the U. S. Geological Survey since 1974, of geothermal and geopressured-geopressured resources as presented in USGS Circular 726 and USGS Open-file-Reports, as well as by independent and ERDA supported studies.

5. The nuclear option, in all it's facets, is an option open to our Nation, as well it should be. But the DES of your Staff simply does not adequately consider all the alternatives to that option in a reasonable and open-minded way. The DES, in our mind, is argumentative and self-serving, and is not a well-rounded analysis of alternatives as NEPA requires.

Sincerely yours,

Donald F.X. Finn

Donald F.X. Finn

ROISMAN, KESSLER AND CASHDAN
1712 N STREET, NORTHWEST
WASHINGTON, D. C. 20036
(202) 833-9070

ANTHONY Z. ROISMAN
GLADYS KESSLER
DAVID R. CASHDAN
KARIN P. SHELDON
CLIFTON E. CURTIS
DAVID S. FLEISCHAKER
MERIDETH WRIGHT (ADM. FLORIDA)

PHYLLIS L. QUANDER
ADMINISTRATIVE SECRETARY

March 13, 1976

Director
Division of Site Safety and
Environmental Analysis
Office of Nuclear Reactor
Regulation
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Re: Draft Environmental Impact Statement for the Clinch River Breeder Reactor, NUREG-0024, (February 1976)

Gentleperson:

Enclosed are the comments of the Natural Resources Defense Council, *et al.*, on the above-referenced draft environmental statement (DES). These comments and this letter are a formal request to the Nuclear Regulatory Commission to treat this February, 1976, document as a pre-draft version of the CRBR DES and to issue the actual DES at some point, hopefully in the near future, when the NRC Staff is prepared to address meaningfully the critically important issues presented by the CRBR. We urge that this redraft incorporate the modifications in scope and depth suggested in our comments and that it be recirculated for public review. For the reasons set forth in our comments, we believe the February, 1976, draft to be completely inadequate under applicable National Environmental Policy Act standards and so deficient that it does not permit the full depth and breadth of federal and state agency and public comment on it. We consider this DES one of the worst we have ever reviewed.

Sincerely,

Anthony Z. Roisman /crt

Anthony Z. Roisman
Counsel for NRDC, *et al.*

Enclosure

2735

Natural Resources Defense Council, Inc.
917 15TH STREET, N.W.
WASHINGTON, D.C. 20005
202 737-5000

Western Office
664 HAMILTON AVENUE
PALO ALTO, CALIF. 94301
415 327-1080

New York Office
15 WEST 44TH STREET
NEW YORK, N.Y. 10036
212 869-0150

NRDC COMMENTS ON THE

DRAFT ENVIRONMENTAL IMPACT STATEMENT

RELATED TO THE CONSTRUCTION OF THE

CLINCH RIVER BREEDER REACTOR PLANT

(NUREG-0024)
(Docket No. 50-537)

Thomas B. Cochran
Arthur R. Tamplin

INTRODUCTION

In its Guidelines for Preparation of Environmental Impact Statements the Council on Environmental Quality describes the nature and purpose of the draft EIS (40 CFR §1500.7(a)):

> . . . *The draft statement must fulfill and satisfy to the fullest extent possible at the time the draft is prepared the requirements established for final statements by section 102(2)(C)* . . .
>
> . . . *In particular, agencies should keep in mind that such statements are to serve as the means of assessing the environmental impact of proposed agency actions, rather than as a justification for decisions already made. This means that draft statements on administrative actions should be prepared and circulated for comment prior to the first significant point of decision in the agency review process. For major categories of agency action* . . .

The CEQ also states (40 CFR §1500.7(c)):

> *Where an agency relies on an applicant to submit initial environmental information, the agency should assist the applicant by outlining the types of infor-*

2735

> *mation required. It all cases, the agency should make its own evaluation of the environmental issues and take responsibility for the scope and content of draft and final environmental statements.*

Judged by these explicit CEQ standards the draft statement for the CRBR is woefully inadequate. The detailed deficiencies in the draft are discussed below. The most glaring defects are that 1) the draft is clearly premature being issued before the Staff has completed sufficient safety analyses to even bound the potential adverse consequences and 2) the draft accepts uncritically the conclusions by the Applicant (ERDA) that it is beneficial to build and operate the CRBR as a part of the LMFBR program.

In prematurely issuing the draft before completing the CRBR safety review the Staff is depriving those who want to, or by law are required to, comment on it, of the fundamental factual basis for evaluating the conclusions reached. Except for an apparent obsession with fulfilling the commitment to produce the draft on or about February 1, there is no possible explanation for the Staff decision to publish this document at this time. The CEQ admonition to make the draft fulfill the requirements of §102(2)(C) of NEPA to the "fullest extent possible" has not been heeded.

Similarly the draft disregards the requirement that an independent evaluation of the analyses of an Applicant must be performed. *Greene County Planning Board v FPC*, 455 F.2d 412 (2nd Cir., 1972); CEQ Guidelines, 10 CFR §1500.7(c). Attempting to restrict the NRC's NEPA review by assuming that its real benefit is furtherance of the LMFBR program but refusing to independently evaluate the validity of that conclusion is not only blatantly

illegal but severely hampers fulfillment of the NEPA objective of a systematic and interdisplinary approach to decisionmaking. NEPA §102(2)(A); *Hanley v Kleindienst*, 471 F.2d 823, 835 (2nd Cir., 1972); *Environmental Defense Fund v Corps*, 348 F. Supp. 917, 927-28 (N.D. Miss., 1972). The CRBR licensing action is the only opportunity to evaluate the full spectrum of environmental costs and benefits of the CRBR. For instance in depth consideration of the safety problems of the CRBR may result in imposition of such substantial additional costs that when viewed as part of the total LMFBR program the CRBR is not justified. Such a balancing did not and could not have occurred in the LMFBR program EIS and now the Staff proposes to prevent it from occurring here.

Even assuming, as the Staff apparently does, that the principal objective is to complete the NEPA review on schedule and not to do a thorough analysis of the CRBR, the publication of this draft is counter-productive. Ultimately the validity of this draft will be tested in the CRBR licensing proceeding when the Staff attempts to offer the FES in evidence. At that time the Licensing Board will have to decide if the FES is legally sufficient which will depend upon whether the draft was legally sufficient. If, as we believe is likely, the Board concludes that the draft was illegal, then a very substantial licensing delay will occur. If, however, the Staff chooses not to run that risk and withdraws and reissues the draft with a fuller analysis of the CRBR the delay now will not be on the critical path -- at least not as much as would occur if the Board subsequently declares the draft and final EIS illegal. The Staff should seriously consider whether it is worth the risk to its scheduling objective to pursue its present course of action.

I. General Comments

The DRAFT Environmental Statement related to construction of the Clinch River Breeder Reactor (CRBR) Plant (hereafter referred to as the DRAFT) should be withdrawn because the application for a Construction Permit and Limited Work Authorization is illegal for reasons set forth in Contention 1 of the Affidavit of Thomas B. Cochran in NRDC, *et al.'s*, Petition for Leave to Intervene,[1/] and briefed in *Natural Resources Defense Council, Sierra Club and East Tennessee Energy Group Response to Applicant's Amended Answer To Petition to Intervene,* (Docket No.50-537, December 31, 1975) and *Response to Staff Position On Amended Answer* (February 3, 1976). The Contention and the Briefs are incorporated herein by reference.

We submit also that the DRAFT is in violation of NEPA in that it does not discuss responsible opposing views. The authors of the DRAFT appear to have made a concentrated effort not to discuss the issues raised in the Contentions of NRDC, *et al.*, which were submitted on July 18, 1975. The DRAFT fails to mention the NRC Staff has not completed its safety review of the CRBR, has not resolved the problems associated with the radiological toxicity of plutonium, has underway an extensive study of the nature and implication of an adequate system of safeguards, and has under consideration a petition related to occupational exposure limits. The DRAFT also fails to mention that the important NRC decision relative to the advisability of Pu-recycle is in abeyance. All of this is in clear violation of NEPA, and, as a consequence, the DRAFT should be withdrawn and rewritten in such a fashion as to discuss these issues in an unbiased and unprejudiced manner.

1/ Natural Resources Defense Council, Inc., Sierra Club and East Tennessee Energy Group Petition for Leave to Intervene, Docket No. 50-537, July 17, 1975, and Affidavit of Dr. Thomas B. Cochran Identifying Specific Contentions and Bases, filed with Petition.

Aside from the above, it is premature for the Nuclear Regulatory Commission (NRC) Staff to prepare a DRAFT EIS on the CRBR for the following reasons: the Staff has not completed its review of the CRBR Preliminary Safety Analysis Report (PSAR). The Staff has not resolved whether two categories of accidents with potentially severe consequences are sufficiently likely that additional provisions should be included in the design to mitigate the consequences of these types of accidents. These two categories of accidents are identified as "large rupture of primary piping" and "events leading to core disruption." The Staff has not determined whether the provisions identified by the Applicant to mitigate the consequences of these accidents are effective. Furthermore, the Staff has not made an adequate determination of the health effects of plutonium and other transuranium elements, and therefore is unable to determine the consequences of the two categories of accidents should they occur. Until these determinations are made it is impossible to assess adequately two of the fundamental requirements under Section 102(2)(C) of the National Environmental Policy Act.

(i) the environmental impacts of the proposed action, or
(ii) any adverse environmental effects which cannot be avoided should the proposal be implemented.

Furthermore, since these two requirements cannot be met, it is impossible to adequately compare the proposed action against alternatives -- alternative sites, alternative designs, and alternative LMFBR program structures and schedules. Thus, it is impossible to adequately assess the third fundamental NEPA requirement:

(iii) alternatives to the proposed action, short-term uses of man's environment and the maintenance and enhancement of long-term productivity.

The Staff has made a further mockery of the NEPA requirements by failing to make a benefit-cost comparison of the proposed action with alternatives. The Staff has relied totally and uncritically on the ERDA Staff as to the objectives of the LMFBR program in general and, more specifically, the CRBR. The Staff has relied totally and uncritically on the ERDA Administrator's views as to the benefits of the LMFBR program and his finding of December 31, 1975 regarding the need for and scheduling of the CRBR. There is a summary of benefits and cost of the proposed action (DRAFT, pp.10-6 to 10-10), but no benefit-cost comparison of the proposed action with alternatives, designs, sites, schedules, etc. In the DRAFT the Staff has simply assumed that the Applicant will demonstrate to the satisfaction of the Staff that the CRBR will meet certain criteria, for example:

(c) The applicant shall demonstrate to the satisfaction of the staff that the

realistically analyzed radiological consequences of postulated plant accidents (Table 7.2) will not exceed 15 rem to the bone, 2.5 rem to the whole body and 30 rem to the thyroid. (DRAFT, p.iii.)

and

(Class 8) consequences have been assessed by the Staff by assuming that the special provisions identified by the applicant as being required are included in the design and are effective. [Emphasis supplied.] (DRAFT, p.4-2.)

Regardless of the cost of meeting these criteria, the proposed action by the Staff's logic, is the best alternative because the ERDA Administrator has previously determined it to be so. The Staff fails to make its own determination even though ERDA, for all practical purposes is the Applicant. As the Atomic Safety and Licensing Board (ASLB) has noted:

*The intimate relationship between ERDA and the Applicants reduces to a mere technicality the inference that ERDA is not officially or formally designated as a member Applicant.**/

II. Detailed Comments

1. Introduction

The Staff states (on p.1-2 of the DRAFT) that "approximately 15 months of delay are anticipated and reactor criticality is now

*/ Memorandum and Order Concerning NRDC, *et al.*'s Interrogatories to the Applicant, In The Matter of Project Management Corporation, Tennessee Valley Authority (Clinch River Breeder Reactor Plant), Docket No.50-537, February 11, 1976.

scheduled for 1983." Is this a Staff or Applicant estimate? The Staff should make its own independent estimate of the potential delays and indicate the basis for its estimate. (Page i of the DRAFT should be corrected similarly.) The Staff should also make its own estimate of, and discuss here, the enormous cost overruns of the project and the potential for further cost overruns due to further licensing delays and design changes, *e.g.*, those associated with changing the earthquake design criteria (*see* discussion below), and potential equipment delivery and construction delays. Staff should review the accuracy of cost and schedule estimates for light water reactor and the basis for delays and cost overruns. It is important that the public not be hoodwinked by the Applicant and the Staff as to the true cost and schedule of the CRBR.

2. <u>The Site and Environs</u>

2.4 <u>Geology</u>

The Staff states (on p.2-8) that, "The effects of such earthquakes on the proposed plant will be considered in the staff's Safety Evaluation Report, in accordance with 10 CFR Part 100, Appendix A." The Staff is trying to mask the controversy among the Applicant, Staff, and NRDC, *et al.*, over the size of and horizontal ground acceleration associated with the safe shutdown earthquake. We call the Staff's attention to NRDC, *et al.'s* Contention 15 (Enclosure 1(a)) which presents our position on this issue. The controversy over the appropriate ground acceleration to use as a design basis has reached the popular press (*see* Enclosure

1(b) from *Business Week*, March 15, 1976, p.32). As such, it is all the more appropriate for the Staff to discuss this issue thoroughly in the EIS.

2.6 <u>Meteorology</u>

By not discussing the fact that the CRBR site is in a particularly unfavorable area of the country with respect to dispersion conditions (*e.g.*, frequency of inversion and low wind speeds), the Staff is again masking from the general public a principal environmental concern. We call the Staff's attention to NRDC, *et al.'s* Contention 6(b) which states:

> *6. The site selected does not provide adequate protection for the public health and safety.*
> *(b) The site meteorology is sufficiently unfavorable that an alternative site should be selected.*
> *1. The site meteorology is worse than most sites used for light-water reactors due to wind speed and inversion conditions.*
> *2. Alternate sites with more favorable meteorology have not been adequately identified and analyzed nor has their rejection been justified.*

In responding to the Applicants Interrogatories to NRDC, *et al.*, we pointed out:

> *5(a). The various meteorological parameters are all interrelated. Taken together it is clear that the site is situated in a region of unfavorable dispersion with respect to the frequency of occurrence of high air pollution potential meteorology (PSAR, p.2.3-5). The 95 percent χ/Q value was found to occur in Pasquill stability G (PSAR, p.2.3B-14). These we consider to be sufficiently unfavorable than an alternative site should be selected.**/

*/ Natural Resources Defense Council, *et al.*, Response to Applicants' Interrogatories Dated November 18, 1975, pp.5-6, December 9, 1975.

Also, we call the Staff attention to the Applicant's Environmental Report (ER), which states (ER, p.2.6-8):

> *. . . Holzworth's data*[(23)] *indicates that eastern Tennessee is in a region of unfavorable dispersion with respect to the frequency of occurrence of high air pollution potential meteorology.*

Neither the Staff nor the Applicant objected objected to Contention 6(b) filed by NRDC, *et al.*, in July 1975, all the more reason for the Staff to have recognized this as a viable issue. Failure to discuss this responsible opposing view is irresponsible and a violation of NEPA.

3. Facility Description

The Staff should discuss the two designs, "reference" and "parallel" and the various unresolved design features in this section.

On p.3-2 of the DRAFT, the Staff states:

> *That action, exceeding the consumption of fissile material in the core by approximately 20%, is the breeding object of the LMFBR concept.*

Elsewhere (DRAFT, p.10-6) the Staff states:

> *The principal benefit of the proposed facility would be to demonstrate the liquid metal fast breeder nuclear reactor for commercial use . . .* [Emphasis supplied.]

Nowhere does the Staff provide an analysis much less an independent analysis, of the CRBR's breeding ratio and fuel doubling time (if it is capable of breeding). Will the CRBR breed? According to a recent article in *The Bulletin of the Atomic Scientists:*

> *When questioned by Hanes Alfven, during the 1974 Pugwash Conference in Baden, Austria, the ex-project leader of Kalkar, Wolf Hafele, acknowledged that in fact the SNR-300 cannot breed at all, since the breeding factor is less than 1.* */

We have also heard that the British demonstration plant at Dounreay does not breed. Dr. Seamans and the ERDA Staff testified on March 3, 1976, before the House Committee on Interior, Subcommittee on Energy and the Environment that the French Phenix does not breed. If the CRBR doesn't breed why is it called a breeder reactor. How can it demonstrate the breeding concept? (*See* our comments on p. 30 for further discussion.) What safety related design changes would be required to obtain a sodium-cooled fast reactor with an adequate breeding ratio (fuel doubling time)? How would these design changes influence safety considerations, *e.g.*, can the breeding ratio be changed without significantly affecting the doppler coefficient?

3.5 Radioactive Waste Systems

The Staff states, "Although the applicant proposed to bottle gases from the noble gas storage vessel for temporary onsite storage and eventual offsite shipment to a licensed burial facility, the staff model assumes that the contents of the storage vessel would be released to the environment." (DRAFT, p.3-16.) We have been told by AEC officials since 1972 that the radioactive noble gases recovered from the primary sodium system cover gas would be bottled for storage and not released to the environment. The 1972

*/ Smith, Philip B., and Ruud Spanhoff, "The Nuclear Energy Debate in The Netherlands," *The Bulletin of the Atomic Scientists*, February, 1976, p.44.

Final EIS for the LMFBR Demonstration Plant (WASH-1509, p.51) states:

> *The xenon-krypton concentrates in the bottom of the distillation column is extracted and bottled for storage in a repository. Thus, the reactor cover gas system will be designed so that there is negligable release of radioactive gases, mainly those which diffuse through or leak by, equipment seals. This will result in an increase in the activity due to radioactive gases at the site boundary of less than one percent of the natural background level.*

The schematic of the radioactive gase processing system in WASH-1509 (p.50), unlike the schematic in Figure 3.16 in the DRAFT (p.3-15), does not show a flow path from the noble gas storage tank to the environment.

We do not object to the Staff assuming the radioactive gases would be released to the environment in the Staff's radiological evaluation model for the radioactive argon processing system (RAPS). However, we strongly object to the Staff using 10 CFR 50, Appendix I for determining whether the system's design releases are as low as practicable (ALAP), thereby leaving the Applicant with the option of not bottling the noble gases. ALAP in the case of the CRBR means bottling the noble gases -- nothing less. If the Applicant cannot accomplish this rather unsophisticated engineering task, they have no business building something as complicated as an LMFBR steam supply system. In this regard, we call the Staff's attention to NRDC, *et al.*'s Contention 8:

> *Applicants have not demonstrated that the plant is designed to limit the public health risk from all radiation exposure to as low as practicable.* [Emphasis supplied.]

3.5.3 Solid Waste

With regard to the discussion here we call the Staff's attention to the EPA's current position with respect to solid wastes stored or buried at commercial (NRC licensed) burial grounds; namely, that disposition in this manner should be treated as delayed releases of radioactivity. This EPA position was taken as a consequence of the discovery of offsite transport of radioactive materials (including plutonium) from Maxey Flats and other commercial burial sites. The Staff should analyze the health consequences due to the delayed releases of the solid radioactive waste from the CRBR and its supporting fuel cycle.

5. Environmental Impacts of Plant Operation

5.7 Radiological Impact on Biota Other than Man

The Staff states (DRAFT, p.5-16):

> *. . . the limits established for humans generally are agreed to be conservative for other species (Auerbach, 1971).*

We simply note that "general agreement" should not substitute for "established fact." We note that numerous attempts have been made to substitute "general agreement", "sound engineering judgment", "established engineering practice," etc. for established facts in what are purported to be conservative analyses of the environmental (including health and safety) consequences of the CRBR operations.

5.7.2 Radiological Impact on Man

5.7.2.5 Occupational Radiation Exposure

The DRAFT makes no mention of the admonition in 10 CFR 20 that the exposure should be kept as far below the limits as is practicable (ALAP). Furthermore, it is not demonstrated that the plant design will lead to exposure ALAP.

On September 26, 1975, NRDC submitted to NRC a petition to amend 10 CFR 20.101. This petition and its supporting document requested a factor of 10 reduction in the exposure standards for younger workers and a somewhat smaller reduction for older workers. The supporting document demonstrated that such changes were required to bring the risk associated with occupational radiation exposure more in line with the risks associated with other occupations, to reduce the risk of exposure to the fetus of pregnant employees, and to account for the societal implications of the genetic damage induced in workers. It was also shown that nuclear industry could accomodate to these amendments. The petition is still pending before the NRC. We also call the Staff's attention to NRDC, *et al.*'s Contention 8(a) which raises the same issues.

Here the Staff has, as it has with many other issues in the DRAFT, chosen not to present or comment upon the issues raised in NRDC's pending petitions before the NRC or our Contentions related to the CRBR. This is a clear violation of NEPA.

5.7.2.6 Transportation of Radioactive Material, and
5.7.2.8 Fuel Cycle Impacts

Our comments relative to these sections are contained in our Comments on Appendix D (*see* pages 31 - 33.)

5.7.2.8 Summary of Annual Radiation Doses

The discussion in this section is totally inadequate in the following regards:

1) the cumulative dose estimate due to radiological releases from the plant are limited to a 50-mile radius;

2) the Staff does not calculate the total integrated dose over all future time;

3) the Staff fails to carry the analysis to its logical conclusion by calculating the health effects, *e.g.*, cancers and severe genetic effects, associated with the cumulative dose commitment, and in this regard the Staff fails to include the public health consequences due to the genetically significant occupational dose commitment resulting from exposure to the CRBR and the supporting fuel cycle work force;

4) the doses associated with the supporting Fuel Cycle (Table 5.13) are unsupported by analysis generally and are in some cases erroneous (*see* our Comments on Appendix D); and

5) the Staff has failed to adequately document the references, methodology and assumptions necessary to make a critical evaluation of the data that are presented.

6. Environmental Measurement and Monitoring Program

The Staff indicates it has reviewed the Applicant's monitoring program and "considers the proposed program adequate" (DRAFT, p.6-1).

There is no discussion of NRC and EPA's enforcement programs to insure the Applicants' program will be adequate. Enclosure 2 provides a discussion of inadequacies in reactor environmental monitoring programs in the recent past and a need for a strong enforcement program.

7. Environmental Impacts of Postulated Accidents

It is clear from the discussion here that the plant design has not been determined nor have the design basis accidents (DBAs) been determined. Furthermore, the Staff hasn't identified those structures, systems or components of the facility which require research and development to confirm the adequacy of the design, or the research and development program necessary to resolve safety questions associated with such structures, systems or components, much less determined a schedule of the R&D program. Instead, the Staff simply states:

> *If any aspect of the design of the plant is considered to be inadequate in this regard, the Staff will require the applicant to make appropriate modifications as a condition of licensing.* (DRAFT, p.7-1.)

and

> *Accidents having greater consequences must be shown to be of acceptably low probability or the Staff will require such features as are necessary to further reduce the probabilities and consequences.* [Emphasis supplied.] (DRAFT, p.7-1.)

and

> *The procedures employed in the design and review of the CRBR will be comparable to those employed for LWRs.* [Emphasis supplied.] (DRAFT, p.7-1.)

and

> *. . . design basis accidents will be established and their consequences be required to be safely mitigated.* (DRAFT, p.7-1.)

and

> *The postulated occurrences in Class 9 involve sequences of successive failures that are considered to be less likely than those required to be considered in the design bases of protection systems and engineered safety features. Their consequences could be severe. However, as with LWRs, the probability of their occurrence will be made so small that their environmental impact will be acceptably low. This can be accomplished by means of defense in depth (multiple physical barriers), quality assurance for design, manufacture and operation, continued surveillance and testing, and conservative design.* (DRAFT, p.7-2.)

and

> *The applicant has provided information to support his view that such events are very unlikely and need not be considered in establishing the plant design bases. Recognizing the possibility that this view may not be sustained, the applicant has identified special provisions in the design which would be included to accomodate either or both types of events, should there be a requirement to do so.* (DRAFT, p.7-2.)

We note here in passing that one of these provisions is the so-called "ex-vessel core catcher." The efficacy of this core-catcher is highly speculative. With reference to the core-catcher, the Applicant in the PSAR states:

> *If the experimental data indicate that molten fuel behavior in a sacrificial bed is not as predicted, the first fallback position will be to redesign the sacrificial bed using a different sacrificial material. If an acceptable material is not available, the EVCC concept will require substantial modification, possibly toward a crucible design with active cooling system (Reference 10).* (PSAR, p.1.5-28b.)

Additional evidence that the CRBR design and safety review is far from complete is found in the Staff's statement:

> *As more detailed design information becomes available and the results of R&D programs are obtained, a better understanding will be gained of the likelihood and effects of core disruptive accidents and their associated radioactive releases. Thus, the risk perspective relative to Class 9 events which are presented below will be further developed as an ongoing effort by the applicant as the design is completed and the facility constructed.* (DRAFT, p.7-2.)

The Staff has requested an extension of time to respond to to our Interrogatories related to the safety issues discussed above. In their request, the Staff indicated that it could not respond because it had not completed its safety review. As an example, Enclosure 3 is the Staff's assessment concerning when they will be in a position to respond to our questions concerning the models and computer codes that are being used in the safety analysis. Obviously, the safety analysis in this section is premature, and consequently so is the DRAFT.

Not deterred by the lack of a decision and the determination of the DBAs, without completing the safety review and without determining the R&D required to clarify the possibility of resolving the safety issues, the Staff proceeds with a presentation of consequences of postulated accidents. As noted previously, this presentation assumes with respect to the severe accident categories, "large rupture of primary piping" and "events leading to core disruption," that:

> *special provisions* [as the ex-vessel core catcher] *identified by the applicant as being required are included in the design and are effective.* [Emphasis supplied.] (DRAFT, p.7-2.)

Thus it is clear that the Staff's preliminary conclusion that "the accident risks can be made acceptably low,"*/ depends critically not only on the unsupported assumption that certain undermined design features are in place and are effective, but also on unsupported assumptions that certain radiological criteria related to the consequences of postulated accidents are adequate and that the Applicant will be able to and will satisfy these criteria. The criteria are that:

> *The Staff will require that the conservatively calculated consequences of this* [Class 8] *event to be used for the safety review of the parallel design case not exceed 150 rem to the bone, 25 rem to the whole body and 300 rem to the thyroid, and that realistically analyzed consequences be at least a factor of 10 below these mentioned values.* (DRAFT, p.7-6.)

(The last sentence in the above quote leads to the criterion cited on pages 6-7, above).

On February 24, 1975, NRDC petitioned the NRC to reduce the existing radiation protection standards for exposure to insoluble alpha-emitting hot particles.**/ The petition included a request for modification of 10 CFR §100.11(a)(1) to include a lung particle burden criterion. The NRC has yet to act on this petition. The Staff radiological criteria quoted above do not contain a lung particle

*/ DRAFT, p.7-2.

**/ NRDC Supplemental Submission to the Environmental Protection Agency Public Hearings on Plutonium and the Transuranium Elements, Arthur R. Tamplin and Thomas B. Cochran, February 24, 1975; Tamplin and Cochran, "Radiation Standards for Hot Particles," February 14, 1974; and Tamplin and Cochran, "The Hot Particle Issue: A Critique of WASH-1320 as it Relates to the Hot Particle Hypothesis," NRDC, November 1974.

burden criterion. Moreover, nowhere in the DRAFT is there a discussion of the health implications of insoluble alpha-emitting hot particles with respect to the CRBR and related facilities.

The Staff also does not discuss the method that would be utilized to calculate the rem value to bone in the above quoted criteria. Recent data relative to this have been reviewed by Dr. Karl Z. Morgan and he concludes that the present approach may underestimate the bone dose in rem that would result from plutonium by a factor of 250.*/ This suggests that the bone dose in Table 7.1 for Class 8.4 accidents should have been determined to be an order of magnitude higher than the criterion.

The ERDA Internal Review Board reviewing the PFES on the LMFBR program recognized plutonium toxicity as an outstanding unresolved issue. Under "Health Effects," the Board stated:

> *The outstanding issue is whether the hot particle hypothesis should be assumed as an additional degree of conservatism in projecting health effects of plutonium.***/

The ERDA Administrator in his December 31, 1971 Findings also recognized this as an unresolved issue -- one that would not be resolved before 1986. The Administrator stated:

> *4. The FES shows that the major areas of uncertainty lie in plant operation, fuel cycle performance, reactor safety, safeguards, health effects, waste management, and uranium resource availability.* [Emphasis supplied.]

and later on,

> *10. On the basis of the material set forth in the FES, I find that if the reference plan and its supporting programmatic efforts vigorously pursued,*

*/ Morgan, Karl Z., "Suggested Reduction of Permissible Exposure to Plutonium and Other Transuranium Elements," *Journal of American Industrial Hygiene* (August 1975).

**/ PFES, LMFBR Program, P.IV.B-19.

> *sufficient information would be available as early as 1986 to resolve the major uncertainties affecting widespread LMFBR technology development . . . .* [Emphasis supplied.]

Even the Staff recognized the significance of the plutonium toxicity issue in the CRBR licensing proceeding stating:

> *We are aware of the NRDC 'hot particle' petition which is under advisement by the NRC. The forthcoming NRC decision on this petition will be considered by the Staff in its review of CRBRP and may affect our responses.**/

The plutonium toxicity issue is yet another example of the Staff going out of its way to avoid addressing outstanding unresolved issues -- issues we have raised as contentions in the CRBR licensing proceedings.

Until the plutonium toxicity issues raised in the hot particle petition of NRDC and the report of Dr. Morgan are resolved, the Staff radiological criteria cited on page 19 above, are indeterminate with respect to safety and ambiguous relative to design objectives or acceptability.

Clearly, what we have here is not a draft EIS assessing the environmental impact of a reactor of a specified design at a specified site, rather it is an environmental assessment of a reactor type of undetermined design that is assumed to be effective and capable of meeting specified criteria. This DRAFT can only be considered as an instrument for the licensing of criteria, certainly not a reactor. But worse still, the adequacy of the criteria is not even addressed in the DRAFT.

*/ NRC Staff's Response To Natural Resources Defense Council Interrogatory Number Nine of First Set, Docket No. 50-537, February 24, 1976, p.3. We also refer the Staff to Issue No.5 in the NRC Memorandum from Stephen H. Hanauer to Commissioner Gilinsky, March 13, 1975 (Enclosure 4).

Before leaving this section, one final gross error is worth noting. The Staff states:

> *The Commission's regulations require that an applicant design manufacture and operate the plant to minimize the likelihood of postulated accidents.* DRAFT, p.7-1.)

This is patently absurd. Were it true, the reactor design would include more than two independent and redundant scram systems. Also, the "reference design" would not even exist since the additional provisions of the "parallel design" (*e.g.*, the core catcher) would have to be included to minimize the likelihood.

7.3 Safeguards Considerations

The safeguards discussion represents one of the most irresponsible sections of the DRAFT. Nowhere is it mentioned that safeguards are presently under intensive study by the NRC and that the eventual use of plutonium as a fuel hinges upon the outcome of these ongoing studies. NRC Special Safeguards Study is designed:

1. To determine safeguard objectives.

2. To determine the nature and size of the threat.

3. To determine the nature of the safeguards system required to reduce the risk to the level of the objectives.

4. To determine the monetary cost of an adequate safeguards system.

5. To determine the societal cost of such a system in terms of civil liberties and institutional changes.

The DRAFT does not even mention the civil liberties and institutional changes associated with safeguards and yet, these are central items in the current debate over the virtue of utilizing plutonium as a fuel. To ignore this issue is an outright violation of NEPA wherein responsible opposing views are to be presented.

To ignore the fact that GESMO and the decision on plutonium recycle is in abeyance pending completion of the study of safeguards is inexcuseable and irresponsible. Obviously the decision on Pu-recycle is central to the LMFBR and this should have been fully discussed in this DRAFT. If for no other reason (and there are many) this DRAFT should be withdrawn and rewritten.

We would like to incorporate by reference here all of the safeguard related comments submitted by ourselves and others with respect to the Draft EIS on the LMFBR Program (WASH-1535) and with respect to the Draft GESMO (WASH-1327). These should be considered as an integral part of our comments on the DRAFT, and we request that the Staff give the same consideration to these as it gives to the comments herein.

The DRAFT (pages 7-13, 7-14, and Appendix E) makes reference to existing safeguards regulation. We are convinced that these regulations are totally inadequate and wish to incorporate by reference our petition to NRC requesting the agency to undertake emergency measures to upgrade the existing safeguards.*/

Our views on the inadequacies of the domestic safeguards program are summarized in our recent testimony before the House Committee on Interior, Subcommittee on Energy and the Environment of the Committee on Interior and Insular Affairs (Enclosure 5).

8. Need for the Proposed Facility

It is clear from the discussion here that the NRC Staff has not made an independent assessment of the wisdom of the proposed

*/ Natural Resources Defense Council Petition For Adoption of Emergency Safeguard Measures or, Alternatively, for Revocation of Licenses, February 2, 1976.

action, instead relying uncritically on ERDA's Proposed Final and Final Environmental Statements (PFES and FES) on the LMFBR Program, and the ERDA Administrator's Findings of June 30, 1975 and December 31, 1975. After quoting liberally from these sources the Staff concludes:

> *The overall objective of the LMFBR program is to 'establish a broad technical and engineering base sufficient to permit industrial involvement required for a commercial breeder industry.' ERDA identified the CRBRP as an important element in attaining this objective (ERDA-1535, Section I.B.1). The ERDA Administrator's Findings of December 31, 1975 support this statement and specifically reject those options involving rapid acceleration of the program because of the 'lack of any demonstration plant or large plant experience . . .'. Similarly, delays or omission of the CRBRP from the program are stated to be unacceptable (ERDA-1535). The staff concludes that the applicant's discussions of the need for the CRBRP are consistent with existing and prior determinations by ERDA (AEC) arising from the NEPA review of the LMFBR Program. If realized, the benefits deriving from the Program would be of major national significance. The CRBRP, as a key element in the program, can therefore provide a benefit significantly greater than that which might be attributed to the generation of electricity in a generating station of its size.* [Emphasis supplied.] (DRAFT, p.8-4.)

What the Staff has done here is to uncritically accept the Applicant's justification for the CRBR. To argue that ERDA is not the Applicant is absurd considering the footnote on page 1-1 of the DRAFT:

> *Legislation was enacted in January 1976 by the Congress which authorizes reassignment of the overall management responsibility to ERDA; however, the necessary contracts among the parties have not yet been revised. PMC would continue to administer the financial interests of the utility industry and arrange for participation of utility personnel.*

This absurdity has also been pointed out, as we indicated previously, by the ASLB when they stated:

> *The intimate relationship between ERDA and the Applicants reduces to a mere technicality the inference that ERDA is not officially or formally designated as a member Applicant.* */

NEPA requires an independent benefit-cost analysis of the CRBR by NRC. The Staff has chosen to independently assess only the costs and to uncritically accept the Applicant's assessment of the benefits. Clearly this is in violation of NEPA and the DRAFT should be withdrawn and rewritten.

9. Alternatives

In this section the Staff purports to analyze alternatives to the proposed action. As noted previously, the Staff has relied uncritically on the Applicant's (the ERDA Administrator's) view that the presently proposed CRBR Program as scheduled, "should provide sufficient experience in design, procurement, component fabrication and testing, licensing and plant construction and operation . . ." Since the Staff erroneously believes it has no legal obligation to critically review the Applicant's (the ERDA Administrator's) Findings, it has excluded any discussion of alternatives to the CRBR Program, and has excluded any discussion of alternative CRBR schedules. Furthermore, the Staff's analysis of alternative CRBR sites is limited to sites within the TVA System.

*/ Ibid.

One of NRDC *et al.'s* Contentions in our Petition for Leave to Intervene is that the Applicant has not included an adequate analysis of the alternatives to the CRBR, including:

> a) A full range of LMFBR program structures and schedules is not presented. Consequently, the timing and even the need for the CRBR has not been demonstrated;
> b) The alternative of stretching out the LMFBR development and postponing the CRBR is not analyzed;
> c) Alternative designs to meet the objections expressed by the Panel on Advanced Nuclear Power of the "Cornell Workshop on Major Issues of a National Research and Development Program" are not analyzed;
> d) Alternative concepts for testing the safety and economic viability of the breeder concept are not analyzed;
> e) Alternative methods of ownership and control of the CRBR are not analyzed;
> f) Alternative methods for funding the CRBR are not analyzed;
> g) Alternative sites with more favorable environmental and safety features are not analyzed;
> h) Underground siting is not analyzed;
> i) CRBR siting alternatives consistent with the objective of restricting LMFBRs to nuclear parks is not analyzed. Co-locating the CRBR in a nuclear park with CRBR fuel cycle facilities is not discussed.

These same deficiencies are noted in the DRAFT.

Asked by the Applicant to identify and describe each specific alternative:

> 1) method of control and ownership; 2) method of funding; 3) and site, the analysis of which you consider to be necessary for an adequate analysis of alternatives to the CRBR

NRDC responded:

1) Alternative methods of control and ownership:

i) complete control and ownership by private industry;

ii) complete control and ownership by the Federal government - ERDA.

2) Alternative methods of funding:

i) complete funding by the utilities;

ii) complete funding by the Federal government - ERDA;

iii) the present arrangement except private industry (*e.g.*, utilities) assuming the open-ended risk;

iv) same as (iii) except private industry and government sharing the risk, *e.g.*, each sharing 50 percent of the cost overruns.

3) Alternative sites:

i) in an area having more favorable meteorology in terms of the site χ/Q values;

ii) the Hanford Reservation;

iii) the NRTS Idaho Reservation;

iv) the Nevada Test Site;

v) co-located with an LMFBR fuel reprocessing plant (*e.g.*, the hot pilot plant) and an LMFBR fuel fabrication plant (as mentioned in our Contention 10(i));

vi) underground sites (as mentioned in our Contention 10(h)).

Alternative site (i) was chosen for reasons identified in our Comments on Section 2.6 Meteorology.

As Alvin M. Weinberg, former Director of the Oak Ridge National Laboratory (ORNL), noted in a February 13, 1975 letter to Mr. Anders, Chairman of the NRC (Enclosure 6), one of the reasons the present CRBR site was selected was because it was adjacent to ORNL, thereby preserving the option of co-locating all breeders in nuclear parks (Alternative (v) above). The alternative TVA sites discussed by the Staff appear to be contrived sites, chosen after the original site was selected. As we have noted in our Contentions, other ERDA owned facilities (Alternatives (ii) through (iv) above that preserved the nuclear park option (Alternative (v)) should have been among the alternative sites considered by the Staff. These were surely considered in the original site selection.

As noted by Steven Hanauer in Issue 6(c) of Enclosure 4, underground siting (Alternative (vi) above), an alternative favored by Dr. Edward Teller, is presently being considered by the Staff. Hanauer notes that underground siting may offer substantial safety improvements.

Finally, we want to call the Staff's attention to NRDC, *et al.'s* Contention 6(c):

> *c) The close proximity of a gaseous diffusion plant and the Oak Ridge National Laboratory to the site and the possible long term evacuation of those facilities as the result of a CRBR accident involves unacceptable risks to the national security and the national energy supply.*

A related issue is raised by Hanauer (Enclosure 4, Issue 6(b)) where he states:

> *A related problem is our present total lack of control over what goes in near the plant after the site is approved. We have some vague words about the licensee's responsibility to stay informed about subdivisions, ammunition plants, LNG terminals and other post construction materialization of things that would have made the site unacceptable if known before licensing. Someday some operating reactor is going to have a new neighbor of a really abominable kind and we are going to have trouble coping with it.*

None of these alternatives are discussed in the DRAFT.

It might seen repetitious to again state this, but the Staff discussion in this Alternative section is yet another example of the Staff failing to discuss issues raised in our contentions, another violation of NEPA and another reason for withdrawing the DRAFT.

10. <u>Evaluation of the Proposed Action</u>

In the discussion of "Unavoidable Adverse Environmental Impact" under "Radiological Effects" the Staff dismisses accident radiation exposure, one of the most important issues, with the one sentence:

> *The risk associated with accidental radiation exposure would be very low (Chapter 7).*

As we noted in our review of Chapter 7, this is an unsupportable conclusion since it depends on the unsupported assumptions that certain undetermined design features will be put in place and will be effective and that certain radiological criteria related to the consequences of postulated accidents are adequate and that the Applicant will be able to and will satisfy these criteria. What a joke!

Furthermore, as we noted in our discussion of section 5.7.2.8 above, while there is a discussion of the man-rem commitment (limited to 50-mi radius) there is no discussion of the health consequences (*e.g.*, the number of cancers and severe genetic effects) caused by this man-rem commitment. The Staff compares the dose to natural background, evidently believing cost should be weighed against costs (of an unrelated phenomena) instead of weighing the costs against the benefits of the proposed action and the net benefits of the proposed action against the net benefits of alternatives.

The discussion of decommissioning is inadequate for reasons we have outlined in NRDC *et al.*'s Contention 14 (Enclosure 7).

The Benefit-Cost analysis (Section 10.4) makes a mockery of NEPA in its failure to compare the proposed action against the alternatives identified in our Contentions. (*See* discussion of Section 9 of the DRAFT).

In the Benefit-Cost Summary the Staff notes that it:

> *. . . reviewed the applicant's proposed plant (Chapter 3) and made an independent evaluation of the environmental effects of construction and operation (Chapters 4 and 5) at the proposed site (Chapter 2).* [Emphasis supplied.] (DRAFT, p.10-10.)

As noted previously, the Staff takes the position that it is not legally required to make an independent evaluation of the benefits of the proposed action. Instead the Staff simply concluded:

> *The principal benefits of the proposed facility would be to demonstrate the liquid metal fast breeder nuclear reactor concept for commercial use in generating electrical power.* (DRAFT, p.10-6.)

Precisely, how will the CRBR demonstrate each of its major objectives (DRAFT, p.1-1):

1) the technical performance;
2) reliability;
3) maintainability;
4) safety;
5) environmental acceptability; and
6) economic feasibility

of an LMFBR central station electric power plant, and how will it confirm the value of this concept for conserving natural resources? What criteria does the Staff believe must be met in order to conclude that each of the above objectives will be met? What are the implications of not meeting one or more of the objectives? Instead of making an independent analysis of the benefits of the CRBR, the

Staff concludes in the last line of its Benefit-Cost Summary, that ". . . the CRBRP, as a demonstration plant, <u>is a key element</u> in the evaluation and development of the LMFBR concept." (DRAFT, p.10-10.) Its hugh, $2 billion cost (and probably much more) makes it a "key element." This doesn't demonstrate the benefits outweigh the costs, or that this is the preferred alternative.

Appendix D - <u>Environmental Effects of the CRBR</u>

<u>Fuel Cycle and Transportation of Radioactive Materials</u>

2. <u>Environmental Considerations</u>

a. <u>Fuel Cycle Impacts</u>

The Staff has indicated that Table 2 is prepared utilizing information and data presented in five references, and "Where necessary, the values reported for the generic model LMFBR [discussed in the latter references] were scaled to the CRBR requirements . . ." (DRAFT, p.D-3). It is impossible to provide specific comments on the values in Table 2, since the Staff does not provide any further information on how the estimates were made. We cannot tell which entries were scaled from data in which references, the page or pages where the data are presented in the references, etc. The same holds for the data presented in Tables 3 through 7. (DRAFT, pp.D-8 through D-14.)

We call the Staff attention to NRDC *et al.'s* Contention 9:

> *9. The ER does not include an adequate analysis of the environmental impact of the fuel cycle associated with the CRBR.*
> *a) The impact of reprocesisng of spent fuel and plutonium separation required for the CRBR is not included.*
> *b) The impact of transportation of plutonium required for the CRBR is not included.*
> *c) The impact of disposal of wastes from the CRBR spent fuel is not included.*
> *d) The impact of an act of sabotage, terrorism or theft directed against the plutonium in the CRBR fuel cycle, including the plant, is not included nor is the impact of various measures intended to be used to prevent sabotage, theft or diversion.*

The Contention applies equally to the DRAFT. Again, the Staff appears to have gone out of its way to ignore the issues raised in our Contentions in its preparation of the DRAFT.

Until the Staff identifies more precisely how it arrived at the values in Tables 2 through 7 in Appendix D and Table 7.4 on p.7-12, we can only provide the following general comments.

We incorporate by reference NRDC's comments on the DRAFT and Proposed Final EIS on the LMFBR Program (WASH-1535) and DRAFT GESMO (WASH-1327) related to the LMFBR fuel cycle and transportation. To the extent that data in Table 2 through 7 were drawn from WASH-1535 and WASH-1327, the Staff should check our comments for applicability. For example, Table 7.4 (DRAFT, p.7-12) provides an estimate of the dose resulting from a Category 5 accident that is totally inconsistent with the ORNL Staff analysis, "An Evaluation of the Shipment of Nuclear Materials through the Year 2000,"*/

*/ PFES, Liquid Metal Fast Breeder Reactor Program, Volume VI, December 1974, U.S. Atomic Energy Commission, WASH-1535, p.IV.38-69.

reviewed in NRDC's Comments on WASH-1535.*/

Our comments relative to Sections 5.7.1.5, 5.7.1.8 and those related to plutonium toxicity in Section 7 apply equally to the fuel cycle impacts radiological evaluation.

*/ PFES, Liquid Metal Fast Breeder Reactor Program, Volume VI, December 1974, U.S. Atomic Energy Commission, WASH-1535, pp.VI.38-69, to VI.38-74.

ENCLOSURE 1a

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of)
PROJECT MANAGEMENT CORPORATION)
TENNESSEE VALLEY AUTHORITY) Docket No. 50-537
(Clinch River Breeder Reactor Plant))

CONTENTION NO. 15

The Applicant has failed to comply with the requirements of 10 C.F.R. Part 100 (Appendix A) in designating the quantitative vibratory ground motion design basis for the facility.

Basis

The Applicant has designated the Safe Shutdown Earthquake as a VII-VIII or "weak" VIII; it has designated a ground acceleration for the facility of .18g.

A. The Safe Shutdown Earthquake

As a starting point in establishing the Safe Shutdown Earthquake, Appendix A requires a determination of the largest historical event in the tectonic province in which the facility is to be located. 10 C.F.R. Part 100 (Appendix A (V)(a)).1/ In this case, the maximum historical event in the Southern Appalachian Tectonic Province is the Giles County, Virginia earthquake which occurred on May 31, 1897. The National Oceanographic and Atmospheric Administration officially classifies this event as a MMI VIII.2/

1/ Under certain circumstances Appendix A requires designation of a Safe Shutdown Earthquake greater than the maximum historical event. 10 C.F.R. Part 100 (Appendix A §§II and V(a).

2/ Coffman and Von Hake, Earthquake History of the United States (1973), the official publication of NOAA lists the event as an MMI VII. This is apparently a typographical error.

The United States Geological Survey is in accord with this classification. Dr. Gilbert Bollinger, in a recent examination of the event concluded that a MMI VIII is a proper assignment. Bull. Seism. Soc. Amer. 61, pp. 1033-1039 (1971). See also, Eppley, Earthquake History of the United States (1965) which classifies the event as an MMI VIII.

Intervenors submit that proper designation of the Safe Shutdown Earthquake is at least a MMI VIII.

B. Maximum Vibratory Acceleration

Appendix A requires determination of the maximum vibratory acceleration associated with the Safe Shutdown Earthquake (10 C.F.R. Part 100 (Appendix A (V)(a))). A recent re-evaluation of the empirical relationship between intensity and acceleration has been conducted by Trifunac and Brady. Trifunac, M.D. and A.G. Brady, On the Correlation of Seismic Intensity Scales with the Peaks of Recorded Strong Ground Motion, Bull. Seism. Soc. Amer. 65, pp. 139-162 (1975).3/ This study is based on a comprehensive data set and, in fact, has been cited by the NRC Staff in support of their conclusions regarding intensity vs. acceleration values.4/

3/ See also, Trifunac, M.D., and A.G. Brady, On the Correlation of Peak Accelerations of Strong Motion with Earthquake Magnitude, Epicentral Distance and Site Conditions, Pros. U.S. National Conf. on Earthquakes Eng., Ann, Michigan 43-52 (1975); Trifunac, M.D., Preliminary Analysis of the Peaks of Strong Earthquake Ground Motion -- Dependence of Peaks on Earthquake Site Conditions, Bull. Seism. Soc. Amer. 66 (1976).

4/ In the Matter of CONSOLIDATED EDISON COMPANY OF NEW YORK, INC. (Indian Point, Unit Nos. 1, 2 & 3) Docket Nos. 50-3, 247 & 286; NRC STAFF ANSWERS TO CCPE INTERROGATORIES, See Answer, Q-21.

At a recent hearing [5/] Dr. Trifunac postulated the following as the appropriate values for intensity vs. reasonable estimate of upperbound peak accelerations:

MM Intensity	Peak Acceleration
VII	.2g
VIII	.4g
IX	.75g

Thus, intervenor submits that pursuant to the requirements of Appendix A the ground acceleration value for the facility should be designated as .4g.

5/ In the Matter of PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE, et al. (Seabrook Station, Units 1 & 2), Docket Nos. 50-443, 444; Direct Testimony of M.D. Trifunac.

feated at the meeting, as expected, but they received surprising support. One proposal, calling for a study of how much the anti-union fight has cost Stevens over the years, drew 9% of the 8.6 million shares voted, partly because of the backing of large institutional investors such as Carnegie Corp. of New York. This indicates that a loose alliance already formed by the TWU and nonunion, dissident shareholders—with church and student groups waiting in the wings—could put considerable pressure on Stevens.

As a result of its fight against the TWU, Stevens has been found guilty of labor law violations 13 times by the NLRB; board rulings against the company have been upheld eight times by federal appeals courts and three times by the Supreme Court. "This is not a matter of hidden crime," said dissident shareholder Bob Hall of Chapel Hill, N. C., at the Stevens meeting. "This is a record of open lawlessness." Hall, editor of a magazine named *Southern Exposure*, proposed the two labor resolutions, and the Securities & Exchange Commission ruled over Stevens objections that they had to be considered.

Although the TWU had no part in organizing the shareholder fight, union officials also appeared at the annual meeting—the TWU owns 11 shares of Stevens stock—to criticize Stevens' "adamant position against unionism." They charged that Stevens has refused to negotiate a contract at Roanoke Rapids, N. C., where the TWU has its lone unit. Warned TWU's organizing director, Paul Swaity: "A confrontation is building up between J. P. Stevens and organized labor that may very well cost shareholders millions and millions of dollars."

Support. James D. Finley, Stevens chairman, called the meeting protest "a charade" and indicated that Stevens did not intend to relent in its fight against unionization. Because the TWU represents only 3,600 Stevens' workers, Finley said, "93% of our people don't want unions." He added: "As far as I'm concerned we're going to protect their rights."

But the anti-Stevens battle is clearly gaining support. A number of contempt proceedings against Stevens are pending in federal appeals courts. Two weeks ago, the AFL-CIO executive council named a five-man committee of top union leaders to devise an "action program" against Stevens.

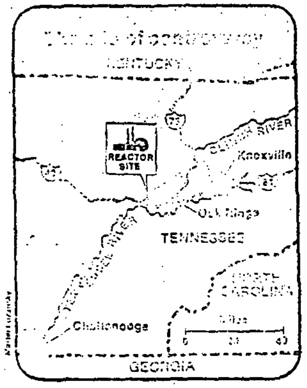
Moreover, the TWU is expected to merge in June with the Amalgamated Clothing Workers, which has conducted many successful boycotts, including the big campaign against Farah Mfg. Co. in the early 1970s. A Stevens boycott will not occur until after the merger, but "it is a foregone conclusion," says a TWU official. ■

REGULATORS

The earthquake risk for a fast breeder

The Administration's plan to build a fast-breeder reactor demonstration plant near Oak Ridge, Tenn., has had its share of critics who have assailed the project as too costly and possibly unsafe. All this appeared swept aside last year, however, when the project's management was overhauled and Congress approved more funds. But now the project has run afoul of the Nuclear Regulatory Commission, which last June toughened its formula for calculating earthquake resistance. Now, says the NRC, the plant's design is not up to the hazards of the site.

The Energy Research & Development Administration, which will build the plant along with several private utilities, countered by asking the U. S. Geological Survey to put the project's site in a gentler earthquake category.



The USGS stoutly refused. "Obviously," says Henry W. Coulter, the survey's director for environmental conservation, "ERDA realizes that the cheapest thing to do is to reduce the size of the quake rather than redesign the plant."

Based on an earthquake that hit Giles County, Va., in 1897, the USGS says the reactor should be built to withstand a quake of an intensity of 8 on a scale of 12. ERDA has asked for a classification of 7.5.

A final decision is due next week, but it is unlikely that the NRC will back down. ERDA simply miscalculated the "ground acceleration"—the lateral forces—of a postulated earthquake at the plant site, according to Richard P. Denise, assistant director for special projects at the commission. The plant, he says, is now designed to withstand a ground acceleration force of 18% of gravity, while it should be designed to cope with a force of 25% of gravity.

The cost. Estimates of the cost of redesigning the plant run as high as $100-million. Officials of Project Management Corp., which is running the job for ERDA and its utilities partners, say such a figure is too high. They insist they can stay within their $2 billion budget. But with the work scheduled to begin this fall, ERDA is clearly worried. It is picking up 85% of the bill, and each month of delay, according to PMC's general manager, Peter Van Nort, could add $12 million to the cost.

If cost overruns do result, it will be NRC's fault, Van Nort declares. When the company applied for an operating license in 1974, he notes, the standard called for an intensity 8 quake with a given formula for calculating the ground acceleration. But last June the NRC tightened the formula.

The USGS is also being overly strict, he says, in its interpretation of the Giles County quake. An intensity 8 earthquake would cause factory stacks to fall and water levels to change in wells. "They [the USGS] were asking 90-year-old people to remember if the water level changed in their wells during the quake," Van Nort says.

Nevertheless, PMC and ERDA are preparing for an adverse decision. Seymour Baron, senior vice-president of Burns & Roe Inc., architect-engineers for the breeder, concedes that "we will have to go back and look at all the structures within the plant." But he hopes that any overhaul will not run into really big money. "We may be able to get by," he says, "without major additions of concrete and steel." ■

Congress may let clear-cutting live

When a U. S. Appeals Court last August barred the Forest Service from permitting clear-cutting in national forests in four Southern states, the timber industry and the Forest Service feared that the ban could spread nationwide and cripple U. S. timber production. Now Congress is stepping into the fight. The Forest Service is likely to emerge with its control of timber practices—including clear-cutting—intact, although subject to new guidelines that sponsors say will balance environmental and timber considerations.

The outlines of a possible solution

ENCLOSURE 2

Reactor Environmental Monitoring

Reactor environmental monitoring programs are inadequate to determine whether routine releases from a licensed reactor meet design objectives.

Documented evidence of this is with respect to the Shippingport Atomic Power Station operated by Duquesne Light Company. The Shippingport incident began in 1971. Details of the controversy are provided in an article from the *Beaver County* (Pa.) *Times*, written by Joel Griffiths, June 7, 1974.

According to the *Times*, 1971 Shippingport's own monitoring program was reporting the lowest radioactive releases of any commercial reactor in the country. At about the same time, a private firm, NUS, was asked by Duquesne Light to conduct environmental monitoring in connection with the proposed construction of a second nuclear plant on the Shippingport site. Dr. Sternglass, reviewing NUS monitoring reports, discovered abnormally high radiation levels measured by NUS and reported this in January 1973. NUS attempted to absolve itself of the blame by attributing the high levels to fallout. The AEC accused NUS (which had performed similar environmental monitoring surveys and safety studies for some 34 other nuclear power plants) of bungling the job. Dr. John Harley, Director of AEC's Health and Safety Laboratory is quoted as saying "This (NUS) draft proves to my satisfaction that the work of this organization is incompetent." Pennsylvania Governor Milton J. Shapp appointed a commission to investigate. The Shapp Commission's report had not been released as of June 1974 (the date of the *Times* article) although originally promised in October 1973. Reportedly,

this was because some of the commissioners did not agree with "final drafts" of the report reflecting the view that there were no serious problems connected with Shippingport itself. The *Times* interviewed four of the five scientific members of the commission. While there was disagreement among the commissioners, some of the responses to questions put to the commissioners are enlightening. For example:

> *Was Shippingport's radiation monitoring program satisfactory?*
>
> *ALL: No.*
>
> *What were the shortcomings that most concerned you? Dr. Degrott: First, because of the inadequacy of the monitoring program, it was impossible to determine how much radiation exposure the people in the surrounding area had been receiving from Shippingport.*
>
> *Second, and perhaps more essinrk, aas e fac a e ir (sic) radioactivity levels measures in 1971 by NUS were ignored by the Duquesne Light Company, the AEC and the relevant health agencies until Dr. Sternglass blew the whistle. There was dereliction of duty, I think.*
>
> *Dr. Morgan: The shippingport monitoring program was worse than none at all in my opinion. In a nuclear plant there are many ways that radioactivity can escape into the environment without always being detected by the monitoring instruments at the plant itself, even with a good monitoring system.*
>
> *So unless you have a thoroughgoing monitoring program in the environment beyond the plant site, you're not going to measure all the radioactivity that gets out. But Shippingport's environmental monitoring program was almost nonexistent.*
>
> *Then, when they did get some detailed environmental data from NUS showing high levels, they sat on it. It's just unthinkable to me that something damning like that would be in the records without some explanation or action by their health physics personnel.*

A second example of inadequate environmental monitoring is with respect to Consumers Power Company's Palisades Nuclear Plant near South Haven, Michigan. Consumers Power was fined $19,000 by the AEC for a series of violations including failure to control radioactive releases, failure to correct chronic operating problems in a timely fashion (inability of waste gas decay system to provide seven day holdup for potentially high-radioactivity gaseous waste); failure of management to perform its safety review function; and failure to report occurrences as required. (AEC News Releases, August 14, 1974, p.4 and September 18, 1974, p.1). Consumers Power was accused of knowingly operating the Palisades plant when their radioactive gas holdup system was not functioning and not reporting this to the AEC.

A third example is with respect to Commonwealth Edison Company's Dresden Nuclear Power Plant in Morris, Illinois. The AEC has proposed fining Commonwealth Edison $25,000 for 18 apparent violations occurring between June and September of this year (AEC News Releases, December 18, 1764, p.6). According to the AEC:

> *The apparent violations involved management of the plant's radioactive waste (radwaste) system, an unplanned and uncontrolled release of radioactivity from Dresden Unit 1 and implementation of the facility's security plan. None of the violations involved an immediate threat to public health and safety.*
>
> *The release of radioactivity occurred on August 15 when 1,130 gallons of water from the unit's laundry tank were pumped inadvertently into the Illinois River through a valve that should have been closed. The radioactivity was undetectable above natural background levels and posed no public health or safety hazard.*

> *Director of Regulatory Operations, Dr. Donald F. Knuth, in a letter to the Company, said the incident was the latest example of failure to properly manage radioactive waste operations.*
>
> *Other apparent violations involving the radwaste system include the Company's failure to exercise control over the use of valves through which radioactive liquids can be discharged, to conduct required analyses for radioactive isotopes and the calibrate monitoring instrumentation. The systems are designed to keep the routine release of radioactivity from nuclear plants as low as practicable.*

Aside from the 18 violations, the fact that "radioactivity was undetectable above natural background levels" following the release of 1,130 gallons of water from the laundry tank brings into question the effectiveness of the environmental monitoring program.

Other notable examples of failures in nuclear industry environmental monitoring programs (although not directly associated with commercial nuclear power plants) include:

1. The loss at the AEC's Hanford Reservation of 115,000 gallons of high level radioactive waste over a 51 day period during which no one monitored the tank (*Nucleonics Week*, July 26, 1973).
2. The discovery that tritium was leaking offsite from the AEC's Rocky Flats plutonium facility only after the tritium turned up in the drinking water in Broomfield, Colorado.
3. The discovery by the EPA that cattle grazing in the Rocky Flats area (offsite) showed a high degree of plutonium in their lungs (*The Washington Post*, December 6, 1974, p.3).
4. The discovery of plutonium in the sediment of the Erie Canal next to the Mound Laboratory.

This 1974 Survey is by no means an exhaustive list of the kinds of inadequacies experienced in nuclear facility environmental monitoring programs, rather it represents the numerous examples that would be uncovered by a more extensive literature search.

ENCLOSURE 3

	1 early March	2 early May	3 late May
SAS3A	20%	60%	20%
SASBLOK			
VENUS	40%	60%	
PLUTO	75%	25%	
FX2VARI	0	100%	
REXCO-HEP	100%		
transition phase	20%	40%	40%
hydrodynamic disassembly	20%	40%	40%
CDA energetics	20%	40%	40%
HAA-3	75%	25%	
CONTRADEX	20%	80%	
source term	?		

INTERROGATORY RESPONSE SCHEDULE NRC

ENCLOSURE 4

March 13, 1975

Commissioner Gilinsky

Thru: Acting Executive Director for Operations /s/ LVG

TECHNICAL ISSUES

Attached you will find, in accordance with your oral request, discussion of some technical issues I believe to be important subjects for Commission consideration, although not necessarily in the immediate future. The list is confined to reactor safety topics.

I have also appended a list of some reactor safety policy issues that have come to my attention in technical reviews.

These enclosures represent my personal views and have not been staffed out with the organizations normally concerned with such matters.

Original Signed by
Stephen H. Hanauer

Stephen H. Hanauer
Technical Advisor

Encls
1. Technical Issues
2. Policy Issues

cc: w/encl
Chairman Anders
Commissioner Kennedy
Commissioner Mason
Commissioner Rowden
L.V. Gossick
E. Case
H. Kouts
F. Schroeder
A. Giambusso
R. Minogue

OFFICE ▶	TA					
SURNAME ▶	SHHANAUER:pg					
DATE ▶						

AEC-318 (Rev. 9-53) AECM 0240 — U. S. GOVERNMENT PRINTING OFFICE: 1974-526-166

IMPORTANT TECHNICAL REACTOR SAFETY ISSUES FACING THE COMMISSION NOW OR IN THE NEAR FUTURE

1. Design Objectives and Safety Design Basis for Water Reactors

Although your mother-in-law and your Congressman will tell you that the safety goal is zero risk, we know that this is unattainable and that some non-zero risk must be accepted in all activities. The social question involving cost/risk/benefit comparisons of the various alternatives that are realistically available needs to be established. The Rasmussen Study made an important first step in quantitative risk evaluation but the technology is not yet available to resolve this question in a completely quantitative way. The study has pointed out a disparity between (a) our present "design basis" safety approach in which all potential accidents are either put into the design basis for complete mitigation or remain outside the design basis and have no safeguards compared to (b) the more realistic viewpoint of a spectrum of accidents each with probability and consequences of its own. Serious consideration should be given to modifying the present all-or-nothing approach in the light of reality.

2. Design Objectives and Safety Design Basis for Non-Water Reactors

For non-water reactors, we have neither the operating experience nor the Safety Study to guide us in developing criteria. The situation is reasonably well in hand for HTGRs, but the potential for autocatalytic positive feedback leading to core nuclear explosions in LMFBRs is creating great uncertainty regarding their design requirements. Calculations of such violent events are increasing in scope and sophistication. However, the results presently depend to a considerable extent on the phenomena postulated to occur. For the near term, the staff has already decided that a core disassembly accident must be part of the licensing design basis. This decision is subject to future revision based on further research that ERDA is convinced will show that such events are so improbable they need not be considered.

Adequate safety must be provided. Too much safety - added safety equipment not actually needed to provide adequate safety - wastes scarce and valuable resources. Attention to improbable severe postulated events tends to short-change more probable but less severe accidents that should be considered.

An important corollary issue is whether the planned LMFBR safety research programs meet the totality of NRC needs.

3. Reliability and the Single Failure Criteria

NRC has not established quantitative reliability criteria for safety-related systems. The operating plants are one of our chief sources of information but we do not know whether the rate of abnormal occurrences now being experienced is a satisfactory one or not. We do know that nuclear unit availabilities and capacities are not satisfactory. We need to find out whether safety system availability is satisfactory and to improve whatever aspects of reliability need improving.

4. Human Performance

Present designs do not make adequate provision for the limitations of people. Means must be found to improve the performance of the people on whom we depend and to improve the design of equipment so that it is less independent on human performance.

The potential for internal and external sabotage constituting a public safety hazard, and the degree to which design and operation needs to take sabotage into account, need to be delineated. Studies now underway should help, but some of the issues are non-technical. In spite of this difficulty, technical criteria are needed.

The relative roles of human operation and automation (both with and without on-line computers) should be clarified. Criteria are needed regarding allowable computerized safety-related functions and computer hardware and software requirements for safety-related applications.

5. Plutonium Dose Criteria

Present accident dose guidelines values are given only for whole-body and thyroid doses. Other dose components (lung, GI tract, bone) should be covered by similar guidelines. A number (or numbers) for plutonium is particularly badly needed and will be particularly hard to establish.

6. Siting

Present criteria for siting are in need of improvement in the following areas:

a. The design basis external events now in use for licensing are founded on various schemes for estimating a "probable maximum" event. We do not have any good way of estimating the return interval or the frequency of the earthquake or flood calculated in this way. Furthermore we are not likely to develop good methods for doing so in the near future because of the short history (a few hundred years at best) and the long recurrence interval desired (sometimes we talk about a million years). Various developmental methods for estimating frequencies of design basis events, chosen as we choose them, give recurrence intervals substantially shorter than a million years. The lack of knowledge and the desire to be conservative is going to make resolution of this problem very difficult.

b. Our population siting criteria are indefinite at best. The applicant is required to study population distributions around a site and to project them for the life of the plant which, of course, he can do only very crudely, but our criterion for population distribution surrounding the plant are very vague. Recent attempts to be more quantitative in this area met with great resistance from the industry and from the old AEC. They tend to be over-simplified, but I believe we could do better than has been done. A related problem is our present total lack of control over what goes in near the plant after the site is approved. We have some vague words about the licensee's responsibility to stay informed about subdivisions, ammunition plants, LNG terminals and other post construction materialization of things that would have made the site unacceptable if known before licensing. Someday some operating reactor is going to have a new neighbor of a really abominable kind and we are going to have trouble coping with it.

c. I believe we are not being serious enough about siting alternatives that may offer substantial safety improvements. An obvious example is underground siting about which we are just starting a study in RES.

7. Degree of Detail and Realism in Safety Evaluations

The great improvement in computer codes available for use in analyzing the course and consequences of postulated accidents has rather naturally led to a corresponding increase in the depth and detail of Regulatory review of these accidents. On the face of it this is a good thing. It leads to better technical understanding and increased realism in evaluations. But is overall safety review enhanced by such detailed examination of certain design basis accidents? It is at least arguable that a broad brush treatment, with plenty of arbitrary conservatisms, gives at least as much safety with a lot less work on everybody's part. A recent and obvious example is the new ECCS regulation, which specifies in gory detail exactly how these calculations are to be made. There are many arguments for and against use of such details and the subject is about right for reopening, in my opinion.

A related subject is the very large increase in the capability of the NRC staff to make independent calculations in many accident areas. This has proved to be invaluable in increasing the staff's technical understanding and should be continued even if some of the details are recognized as too detailed for licensing.

8. Fuel Performance

The performance of light water reactor fuel in normal service has been disappointing to say the least. One would have thought that by this time fuel technology would be well developed. The appearance of such difficulties as densification, hydriding, hot pellets, and the recent incident at Dresden where a transient, well within all limits, resulted in unexpected fuel failures - all tell us that fuel technology is not in as good a state as we thought. The related technology of establishing fuel damage limits under accident conditions is even less well established, principally because PBF is so many years late.

9. Pu Recycle

This is not primarily a reactor problem. The reactor aspects seem to me to be adequately in hand.

REACTOR SAFETY POLICY ISSUES

1. Internal Quality Assurance

We are not taking our own medicine with regard to a quality assurance program in Reg. We do not have a quality assurance organization, independent of the line, reporting to higher management and we have very little auditing and QA in the line. If 10 CFR 50, Appendix B, is good stuff, then it should be applied to the NRC organization. This must be applied to the quality of our product - safety decisions - as well as the quantity and timeliness of our output.

2. Making Better, Faster and More Generic Decisions

Our recent record is mixed. A good example is ATWS and a bad example is turbine missiles, about which we seem not to be able to make up our minds. Future technical safety review should not be endless and mindless repetition of what we have been doing for the past couple of years but rather consolidation into general decisions and general principles, better identification of what is truly important (risk evaluation?), and increasing automation of routine evaluations.

3. Stabilization of Regulation Requirements and Standardization of Designs

Our recent reviews of the standardized designs that have been submitted and recent discussions on standardization (and piggy-back) show the following:

a. The standardization designs submitted are not consolidations of previous experience. The proposed standard designs include a large number of "improvements" not yet actually designed. So, these first standard CPs will be based on a bunch of promises, even more than recent custom CPs.

b. New information from design and operating experience and safety research programs, and new insights as a result of this experience and research have pointed the way to improvements in safety that seem worthwhile and in some cases necessary. The pace and guidelines of the standard reviews has not permitted implementation of these, so they are hanging over our heads as a serious threat to standardization.

c. As a result of a. and b. and of the long time lag between today's bunch of promises and construction and operation of standard plants, more attention needs to be paid to the execution of standardization over the next several years and stabilization of Reg requirements.

4. Too Many Surprises

This is closely related to Item 3. In the past couple of years surprises have come both from operating experience and from improved understanding by both Reg and the industry of safety problems we thought were put to bed. An obvious example is all the trouble we had with ECCS evaluation models. Innovation by applicants will continue to generate surprises. We must develop methods for dealing with these surprises, in cases and generically, without having a fire drill each time.

ENCLOSURE 5

Natural Resources Defense Council, Inc.

917 15TH STREET, N.W.
WASHINGTON, D.C. 20005
202 737-5000

New York Office
15 WEST 44TH STREET
NEW YORK, N.Y. 10036
212 869-0150

Western Office
664 HAMILTON AVENUE
PALO ALTO, CALIF. 94301
415 327-1080

NRDC STATEMENT
BEFORE THE
SUBCOMMITTEE ON ENERGY AND THE ENVIRONMENT
OF THE
COMMITTEE ON INTERIOR AND INSULAR AFFAIRS
U.S. HOUSE OF REPRESENTATIVES
FEBRUARY 27, 1976

ARTHUR R. TAMPLIN
THOMAS B. COCHRAN

WITNESSES:

Dr. Arthur Tamplin is a bio-physicist formerly with the AEC's Lawrence Radiation Laboratory and co-author of Poisoned Power: The Case Against Nuclear Power Plants.

Dr. Thomas Cochran is a nuclear physicist and the author of The Liquid Metal Fast Breeder Reactor: An Environmental and Economic Critique.

Both are members of the staff of the Washington, D.C. office of the Natural Resources Defense Council.

NRDC STATEMENT
BEFORE THE
SUBCOMMITTEE ON ENERGY AND THE ENVIRONMENT
OF THE
COMMITTEE ON INTERIOR AND INSULAR AFFAIRS
U.S. HOUSE OF REPRESENTATIVES

February 27, 1976

Arthur R. Tamplin
Thomas B. Cochran

We were requested to present an overview of safeguards as applied to the domestic nuclear industry. We shall make two points in this presentation:

1. Existing domestic safeguards are totally inadequate. We believe that the situation existing today is critical and have petitioned the NRC to take far-reaching action immediately.

2. The development of an adequate system of domestic safeguards for a large civilian plutonium industry will most likely prove to be an impossibility. Moreover, in trying to develop and sustain such a safeguards system we will be forced to accept major alterations in our open society and its institutions. We have grave doubt that a plutonium fueled economy is compatible with civil liberties as we know them today.

During 1973 and 1974 a number of reports were published that were highly critical of existing domestic safeguards. Prominent among these were two GAO reports, the report of the Ford Energy Policy Project by Willrich and Taylor, and the AEC's Special Safeguards Study known as the Rosenbaum Report.1-4/

Prodded by these reports the AEC modified its safeguard regulations in 1974. However, the Rosenbaum Report, published after the regulations were changed, concluded with the following:

> "Even though safeguard regulations have just been revised and strengthened, we feel that [the] new regulations are inadequate and that immediate steps should be taken to greatly strengthen the protection of special nuclear materials. We hope that this paper will contribute in a positive way to the speedy implementation of such steps."

In an expression of its concern, the U.S. Congress, in the Energy Reorganization Act of 1974, mandated that the newly created Nuclear Regulatory Commission undertake a one year study of safeguards. This study, called the Security Agency Study, is nearing completion.

1/ U.S. General Accounting Office, Improvements Needed in the Program for the Protection of Special Nuclear Material (November 7, 1973)

2/ U.S. General Accounting Office, Protecting Special Nuclear Material in Transit: Improvements Made and Existing Problems (April 12, 1974)

3/ Willrich and Taylor, Nuclear Theft: Risks and Safeguards (1974)

4/ U.S. Atomic Energy Commission, Special Safeguards Study ("Rosenbaum Report") (April 29, 1974)

Late last year, after undergoing classification review, the reports of numerous NRC safeguards consultants were made public. These reports were critical of existing domestic safeguards and have served to heighten our concern over existing domestic safeguards. These reports and other information have convinced us that the possibility that plutonium or other similar materials now held by companies under NRC licenses might be stolen and fabricated into a nuclear bomb is real. Terrorist activity and other forms of anti-social violence are an almost daily occurrence. In an age of organized crime, of terrorists bombings, the risks of nuclear theft, blackmail and terrorism cannot be dismissed. From 1969 through 1975 there were 99 reported threats and acts of violence directed against licensed nuclear facilities in the U.S., 5/ 76 threats and acts of violence directed against unlicensed nuclear facilities, and 28 threats and acts of violence involving nuclear materials. 6/

The present situation is dangerous and requires urgent action by the Commission. Numerous private facilities around the country

---

5/ Letter to James M. Cubie, Public Citizen, dated January 19, 1976, from John G. Davis, U.S. Nuclear Regulatory Commission.

6/ Letter to James M. Cubie, Public Citizen, dated January 26, from H.E. Lyon, U.S. Energy Research and Development Administration.

are licensed to, and do, possess and ship plutonium and other nuclear bomb materials. This material can be stolen and fabricated into a nuclear weapon with skills and equipment which can be bought. And the incentive to resort to nuclear violence appears to exist.

In late January of this year, we obtained two internal NRC documents. The material in these documents precipitated our decision to petition the NRC for emergency safeguards action. One document is a memorandum which reveals that at least some members of the NRC staff are deeply concerned that nuclear bomb materials now held by private companies under NRC licenses may not be adequately protected from theft. A second document, a preliminary version of the Executive Summary of the NRC's Security Agency Study, suggests additional reasons for concern that plutonium and highly enriched uranium in circulation today might be stolen. We would like to submit both of these documents for the record.

In the memorandum, dated January 19, 1976, Carl H. Builder, Director of the NRC's Division of Dafeguards, concedes that he is "not in a position to judge current safeguards [against nuclear theft] as adequate or inadequate." The Builder memorandum goes much further, however. It states:

> "I am concerned that some or even many of our currently licensed facilities may not have safeguards which are adequate against the lowest levels of design threat we are considering in GESMO" (which are "for an internal [employee] threat, one person and, for an external threat, three persons").

In short, the head of the NRC's safeguards program is stating that he doubts that the safeguards employed at some or even many licensed facilities are adequate to prevent plutonium or similar materials from being stolen even when only small efforts are involved, such as a theft attempt by one employee or three armed intruders. This small threat of 1 to 3 individuals must be compared with the credible threat or more prudently the maximum credible threat. These threats are discussed in the other NRC document, the Draft Executive Summary of the Security Agency Study:

> "Congressional concern for adequate safeguards was heightened as a result of a special safeguards study done for the Atomic Energy Commission in 1974. That study, by David Rosenbaum and others, ... expressed concern about the adequacy of protection afforded SNM by the private industrial security systems of licensees. One aspect of concern was the level of threat to facilities and SNM. The authors postulated a maximum credible threat consisting of 15 highly trained men, three of whom might be "insiders", employed by the licensee target firm.
>
> * * *
>
> "To estimate the credible threat, the office of Nuclear Materials Safety and Safeguards researched 19 relevant studies and conducted 9 interviews with

individuals and groups of professional analysts from the FBI, the intelligence community, the Department of Defense and State and local law enforcement agencies.

"What emerged from this was a consensus estimate that an external threat group will probably number about 6-8 persons and very likely not exceed 12 persons. . . .

"[A] credible internal threat, for safeguards purposes, is estimated to consist of 2-3 persons in collusion."

Given threats of this size, it must be seriously questioned whether any of the facilities which are licensed to possess and transport plutonium and highly enriched uranium are adequately safeguarded. Present regulations require two guards armed with pistols. These two guards could be confronted by 6 to 15 commandoes armed with automatic weapons, grenades and bazookas. Moreover, one or both of the guards could be part of the attacking force.

Besides inadequate numbers of guards relative to the threat, the Executive Summary of the Security Agency Study and the various consultant reports point out other serious problems. For example, one of the consultant reports, that of the U.S. Marshals Service, begins with this statement: 7/

"'The image of security is all that's wanted.' This quotation from a study entitled Private Security and the Public Interest effectively illustrates one problem with guard forces employed by the private sector of the nuclear industry throughout the United States: too often the image has little substance behind it."

7/ U.S. Marshals Service, Security of Special Nuclear Materials (October, 1975).

We conclude that this is no idle statement, because the Marshals' report also states:

"[T]he writers of this report have only considered private guards in nuclear facilities. The generalizations are based upon research, extensive discussions with private security executives, and actual on-site observation of guards at selected nuclear facilities."

Another consultant, Mr. Charles Brennan, former Assistant Director of the FBI for Domestic Intelligence, recently stated: 8/

"The safeguards are a joke. The companies involved are interested mostly in saving money. They're doing only the bare minimum of security required by the Nuclear Regulatory Commission."

These conclusions by Brennan and the U.S. Marshals are borne out by the revelation this week 9/ that the workers handling bomb-grade uranium in a plant in Erwin, Tennessee, worked under an "honor system", and were not searched when leaving the working areas where the uranium was kept.

8/ U.S. News and World Report, February 16, 1976, p. 50.

9/ John F. Fialka, Washington Star, February 24, 1976, p. 1. Based on a report by Barbara Newman, National Public Radio.

Among other problems identified in the Executive Summary and consultant reports are the following:

1. recruiting, clearing, training and equipping sufficient guard personnel;

2. acquiring the necessary legal authority to permit guards to obtain the necessary weapons and to transport them across state lines;

3. acquiring the necessary legal authority to permit guards to use force or deadly force in their duties (such authority could be justified only if guards were well-qualified and trained);

4. establishing adequate communications and other protective systems during the phase of transportation of special nuclear materials; and

5. establishing reaction forces capable of responding quickly with adequate assistance during an attempted theft.

Obviously, these and other problems cannot be solved either quickly or easily. And this is why we have urged the NRC to consider such measures as making the security of the nuclear bomb material in presently licensed facilities the responsibility of the U.S. Marshals Service and halting all transportation of this material except that essential for national defense.

Subsequent to filing our petition, we requested and were granted on February 13 a meeting with the NRC safeguards staff. This meeting was open to the public. Shortly thereafter we were

requested by the NRC staff not to release the transcripts of that meeting because the staff felt that a discussion of evaluation criteria, used by the staff to determine whether safeguards were adequate, should not be made public. However, before we had an opportunity to make a response to the request, the Commission determined, independently, that NRC would release the transcripts. These transcripts reveal that the situation is actually worse then the Builder memorandum suggested. We would like to submit pages ~~48-50 and 61-64~~ 48-64 of this transcript for the record.

The transcript, on pages 48-50, discloses, contrary to the consultants' opinions, that the NRC staff considers two guards armed with pistols and shotguns are adequate. They indicated that they felt these two guards could effectively overcome two agressors and withstand up to ten agressors long enough for assistance to arrive. Furthermore, they indicated that they felt the agressors would only be armed with small weapons (e.g., pistols). We were asked if we had evidence that they would be armed otherwise. Dr. Cochran indicated that Patty Hearst was certainly much better armed.

On pages 61-64 of the transcript, it is demonstrated that the situation is even worse relative to the transportation phase.

This was also a conclusion of the various consultant reports. A Mr. Page of the NRC staff suggested with regard to the transportation sector that the easily jammed citizen band radio provided a very effective communication system for safeguards purposes in areas of the country where radio-telephone communication with the police is impossible.

We submit that anyone who reads the total transcript of that meeting will end up with a well-chilled spine. The meeting only confirmed and reinforced our conclusion that the existing safeguards system is totally inadequate and the situation is critical and immediate remedial actions are necessary.

However, we hasten to add that while requesting these emergency actions to rectify the critical extant situation, we do not mean to imply that an adequate and socially acceptable system of safeguards is possible for the proposed plutonium economy of the future. We doubt that such a safeguards system is possible and believe that the spread of nuclear technology throughout the world will lead to the steady spread of nuclear arms first to nation-states but then to subnational groups such as separatist factions, terrorist organizations, blackmailers and even fanatical individuals. This process is already underway. One only needs to cite India's recent joining of the club of nuclear nations.

Israel is known to possess some 50 kg of plutonium extracted from a nuclear reactor. South Korea has announced that it would build atomic bombs if necessary, and we are uneasy about the nuclear technology being acquired by Brazil. International safeguards are nothing more than a paper deterrent. No sanctions have been imposed on India. We have supplied enriched uranium to France so that France could use its small indigenous enrichment capability for the construction of nuclear weapons.

But, as you know, the plans are to extract plutonium from the spent reactor fuel and use the plutonium as fuel. The plutonium presently in the civilian sector of society is for research and development of the plutonium economy of the future. If the proposed plans materialize, there will be thousands of tons of plutonium in the private sectors of society and hundreds of tons in the transportation networks of the world. When this happens plutonium will be stolen or diverted for direct use in atomic bombs or for sale in a black market. We shall then move into an era where it will be next to impossible to prevent terrorists and other subnational groups from becoming armed with atomic bombs. It is important to recognize that nuclear reactors and fuel cycle facilities can also represent attractive targets for sabotage. The results of such terrorism or sabotage could be disastrous --

an atomic bomb explosion in a major metropolitan center or a major accident in a nuclear reactor.

At a very minimum to provide adequate safeguards the facilities and the transportation sector that handle strategic quantities of special nuclear materials should be secure against the maximum credible threat. To provide the necessary level of protection these facilities would have to be turned into armed camps and transport would be by armed convoy. We do not believe the trivial economic advantage of plutonium recycle, if an advantage exists at all, is worth turning our utilities and their support facilities into a series of armed camps.

But more importantly, the proposed response by the industry and the NRC to the threat of nuclear terrorism goes far beyond simply providing more physical security. The nature of the proposed safeguards is a drastic increase in police powers and a concomitant decrease in civil liberties and personal privacy. We have brought a paper with us that discusses the expanded police powers and their civil liberties implications. We would like to submit it for the record. It is:

> Russel W. Ayres, "Policing Plutonium: The Civil Liberties Fallout," Harvard Civil Liberties Law Review, Vol. 10, 1975, pp. 369-443.

We would like to highlight just a few of the civil liberty, privacy and right-to-work issues that are covered in this paper. First, the safeguards program contemplates security clearances for the employees of the nuclear industry. At best, such clearances infringe upon the privacy of the individual being cleared and his family and friends; at worse they are instruments of suppression and reprisal. In addition to these security clearances, it is also proposed that the employees be given yearly psychological profile tests. Such tests are as insidious as security clearances and a recent report of the Congressional Committee on Government Operations recommended: 10/

> "It is the recommendation of the committee that the use of polygraphs and similar devices be discontinued by all Government agencies for all purposes.
>
> Even if the committee adopted the position of some agencies that the polygraph is useful solely as a secondary investigative technique and that the results of a polygraph examination alone are never considered conclusive, the committee finds that the inherent chilling affect upon individuals subjected to such examinations clearly outweighs any purported benefit to the investigative function of the agency."

The safeguards plans also call for intelligence gathering to determine potential terrorists and terrorist groups and it

10/ Committee on Government Operations, "The Use of Polygraphs and Similar Devices by Federal Agencies," House Report No. 94-795, January 28, 1976, p. 46.

was reported that the Texas State Police were collecting dossiers on anti-nuclear individuals and groups in that state, supposedly for this reason. Such intimidation has a stifling effect on dissent and debate which are essential in a free society. How much governmental investigation into the private lives of its citizens can a free society tolerate? The actions of the Texas State Police and the recent congressional investigations concerning Watergate and the CIA, FBI, and IRS demonstrate that, even at their present level, these investigative powers are abused.

Because of the threat posed by stolen plutonium, recovery operations can be expected to be severe and involve no-knock search, search without warrant, area search, and detention and interrogation without warrant. In the presence of a nuclear blackmail threat, martial law seems likely.

All of this must inevitably be put under the direction and control of a central agency which would maintain close liaison with State and local law enforcement agencies and those of foreign nations. The FBI has just suspended its plans for a regional computer center whose purpose was to expedite the exchange of information among state and local law enforcement agencies. The reason given was that this would be close to the creation of a federal police force. This central agency would be a federal police force and one with expanded powers.

While today we can contemplate putting checks and restraints on federal investigative agencies, banning polygraphs and holding firm against a federal police force, it is important to realize that in the presence of nuclear blackmail and terrorism these restraints would have to be removed and these breaches of our civil liberties would become essential.

In summary, our reservations regarding the effectiveness of future safeguards stem from the unprecedented and ultimately unworkable demands that will be placed on any future safeguards system and the people working within it. This system would have to operate on a vast, worldwide basis, yet there is no reason to believe that international cooperation on the scale required is possible. It would have to protect against both theft and sabotage both at fixed sites and in interstate and international transportation. It would have to be essentially infallible, maintaining what Alvin Weinberg, former director of the Oak Ridge Laboratory, has called "unaccustomed vigilance" and "meticulous attention to detail." And it would have to do so for long periods and in the face of -- not a machine -- but a determined, intelligent and well-financed opposition. Yet we know that our human institutions and those who act within them are far from infallible.

Moreover, it should be noted here that those who claim that safeguards can be devised which will keep the risk acceptibly low never tell us how large a risk they think is acceptible. They concede that the risk cannot be reduced to zero but do not tell us to what it can be reduced. We urge you to ask these people, the NRC among them, how many successful nuclear thefts, how many credible nuclear blackmail threats, how large a plutonium black market, and how many illicit nuclear explosions per decade are acceptible.

ENCLOSURE 6

INSTITUTE FOR ENERGY ANALYSIS

P. O. Box 117 / Oak Ridge, Tennessee 37830 / (615) 483-8411

Office of the Director

February 13, 1976

Mr. William A. Anders
Chairman
Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Bill:

I was pleased to receive a copy of the Nuclear Centers report from Dr. Smiley of your staff. I think the report contributes significantly to our understanding of the pros and cons of energy centers, although I don't agree with what I take to be NRC's position — that NEC's are acceptable but not particularly desirable.

It seems to me that the primary long-range question is not so much what should be done about siting LWR's and their supporting facilities, but much more the country's policy with respect to the breeder. You may recall that one reason both FFTF and LMFBR are on Government reservations was because the issue of ultimate siting policy had not been resolved: by confining the first two large fast reactors to Oak Ridge and Hanford, one retained options as to future siting of breeders.

If the breeder is successful, it is not unlikely that it could become the backbone of our electrical energy system for a very long time — much longer than the 30 years we now allot to LWR's. I would therefore categorize siting policy for the LMFBR as one of the most important long-range questions that faces our country. My main purpose in writing is to call to your attention the implications of this aspect of siting policy; I hope that NRC will respond to this issue with appropriate vigor. I'm enclosing a copy of a letter to Bob Seamans in which I raise some of these points.

Sincerely,

Alvin

Alvin M. Weinberg

AMW:bc
cc: S. H. Smiley, NRC
C. G. Kirkbride, ERDA
R. W. A. Legassie, ERDA

INSTITUTE FOR ENERGY ANALYSIS
P. O. Box 117 / Oak Ridge, Tennessee 37830 / (615) 483-8411

Office of the Director

February 13, 1976

Dr. Robert C. Seamans, Jr.
Administrator
Energy Research & Development Administration
20 Massachusetts Avenue, N. W.
Washington, D. C. 20001

Dear Bob:

I am writing to call to your attention what I believe is one of the most important questions relating to the development of our nuclear energy system: the siting policy — particularly the siting of breeder reactors. Our country has, rather by default, adopted "scatter" siting for the current generation of reactors. The Nuclear Regulatory Commission has recently completed a Congressionally-mandated study of nuclear power parks, i.e., cluster siting, and has drawn the conclusion (as far as I can judge) that parks are acceptable, but not really needed.

I do not agree with this assessment of the desirability of parks, but I am not prepared to argue the matter very strongly with respect to LWR's since LWR's are expected to be replaced in the long run by breeders. The really fundamental question is whether or not our country is going to confine breeders and their chemical plants to parks, or whether breeders will be sited as are LWR's — separate from the chemical reprocessing and fuel fabrication.

The arguments favoring collocation of breeders and their supporting reprocessing plants seem compelling to me: they are well summarized in the enclosed letter in *NUCLEAR NEWS* written by Professor H. G. MacPherson of the University of Tennessee. MacPherson argues that nuclear parks greatly simplify guarding against diversion. One point that perhaps should be stressed even more is the great logistic strength that could be mobilized in a park. After all, our primary assurance of safety in reactors lies in the skill of the people who design, build and operate them.

As I understand it, the Congressionally-mandated study of nuclear parks by NRC has now been completed, and NRC has no further plans to pursue the matter. I would think it extremely important for ERDA to pick up the ball and launch studies that would:

(1) Clarify the issues related to LMFBR siting so that, say 5 years from now, we can explicitly enunciate a national policy with respect to LMFBR siting that will be based on serious studies.

(2) Continue the survey of possible nuclear park sites that until this year had been conducted by ERDA/FEA.

ERDA has a great opportunity to help clarify one of the trickiest questions in the nuclear thicket: the long-term policy for siting of reactors. I hope ERDA takes full advantage of this opportunity by continuing its sponsorship of studies aimed at clarifying this issue.

Sincerely,

Alvin

Alvin M. Weinberg

AMW:bc
Enclosure: As stated

cc: William A. Anders, Nuclear Regulatory Commission
Chalmer G. Kirkbride, Energy Research & Development Administration
Roger W. A. Legassie, Energy Research & Development Administration

letters

Review reviewed

In reference to the review [by Albert Gunby*] of my novel *Paradigm Red* in the November issue of NUCLEAR NEWS, I feel I must respond to the assessment of the book's intent.

"The intent of *Paradigm* is clear: to leave the reader with the image of nuclear reactors as dangerous, vulnerable machines, ultimately controlled by untrustworthy people (or computers)."

Permit me to clarify. I try not to suggest that the nuclear reactor, of itself, is dangerous or even that a computer can take on evil personifications. What concerns me most—and is the underlying premise of the work—is that men can be so unyielding in their views that they cannot see past their convictions objectively. It worries me that both sides of the nuclear power controversy wage war on one another with such tenacity that neither is likely to compromise for the sake of the question. How is it to be resolved? I do not count myself among those who see catastrophe every time an electric company announces plans to build a reactor plant, but I do believe some of their concerns merit more than a disgusted shrug of the head.

I believe that the nuclear power industry can prevent an accidental disaster, and [that is] precisely why I chose not to allow one in the conclusion of the novel. Sabotage, however, is an entirely different matter. The saboteur in *Paradigm* did not fail for want of trying. [The reviewer asks] for a realistic story about a saboteur who fails "because of the thorough design in a nuclear plant . . . far more honest." Is it truly? Certainly there is no guarantee. As recently as late November the government released a study undertaken by MITRE Corp. (contracted for by the newly established NRC) which warns of the danger—"the constant danger"—of nuclear sabotage by foreign governments. In these times of terrorist groups of every persuasion, sabotage is not only a viable threat, but a "realistic" possibility.

As for the technical shortcomings of the novel, I defer to [the reviewer's] expertise in the field. I spent nearly a year to research the book; read technical journals and manuals, interviewed experts in the industry (whose words [were] faulted in the review), corresponded with government agencies and scoured through everything I could put my hands on from both sides of the nuclear controversy to learn as much as a layman can that I might present as realistic as possible a credible situation for the novel.

If I have illustrated an incomplete knowledge of nuclear reactor systems in specific instances, it should not be terribly surprising. My intent was not to offer a detailed guidebook on the subject to would-be saboteurs. . . .

On the whole I found the review to be fair and necessarily critical over particular points. For whatever purpose, we've each tried to be honest in our separate approaches to the novel. I think that is a good sign.

Harold King
Bossier City, La.

*The name of Mr. Gunby, a nuclear engineer, San Jose, Calif., was incorrectly given in our November issue as Grundy.—*Ed.*

Reply

Dear Mr. King:

My applause to you for desiring dialogue. The nuclear power community and the community-at-large *together* must consider the role of nuclear electricity, with all the attendant questions—sabotage included. Indeed, the NRC-sponsored studies by the MITRE and BDM corporations strongly indicate that these concerns are being seriously evaluated and not given a "disgusted shrug of the head."

A word on sabotage is appropriate here. A dedicated terrorist is likely to choose an easier, more dramatic, and more certain method of affecting society than attempting to cause a reactor meltdown. How about blowing up a dam, poisoning a water supply, or crashing an explosive-laden plane into a full football stadium? The saboteur would have more control over the results. He wouldn't have to worry about being foiled by conservative core design, high plate-out of fission products, or fickle weather. In the world of fiction, a good recent example of this genre is *Black Sunday*, in which 80,000 people at the Super Bowl are nearly wiped out by 1,200 pounds of plastic explosive and shrapnel.

My basic comment in the review, however, relates to images. If dialogue over real concerns is our goal, it is not served by either secretive attitudes in the nuclear community or emotional responses of the public triggered by disaster scenarios. In another time, *Paradigm Red* would be a "good read," to be considered on literary merits alone. Unfortunately, today's climate of debate inhibits that approach. Does *Paradigm*, then, add anything of value to the current dialogue? I think not . . . but it is an interesting novel.

Albert L. Gunby

Crater credence

Thank you for an even-handed treatment of the Russian crater story [*NN*, December 1975, p. 67].

I regret, though, that the story did not contain one of the more decisive elements in my conversation with Joe Fouchard, assistant director of public affairs for the U.S. Nuclear Regulatory Commission.

At one point in that discussion, I said:

"Joe, if you have any reason to believe there's nothing to this report, tell me and I'll forget about it."

Joe answered:

"I can't say that."

Perhaps it is in the light of hindsight that the NRC wishes to disavow giving any credence to the crater report. I wish it had been as emphatic from the start.

Casey Bukro
Environment editor
Chicago Tribune
Chicago, Ill.

Reply

I don't believe I have anything to add to what I told Dave Walker [*NN* staffer who wrote the Bukro-Comey-crater story] earlier. Your December story quotes me accurately, except that Mr. Comey's call was to Edson Case, deputy director of reactor regulation, not to me. I would observe that two other reporters called NRC the same day as Mr. Bukro, were given the same information, and did *not* go with a story.

Joseph J. Fouchard
Assistant Director
Office of Public Affairs
U.S. Nuclear Regulatory Commission
Washington, D.C.

Preventing diversion

Of the three major substantive issues raised by the anti-nuclear forces, I imagine that most readers of NUCLEAR NEWS would agree that the problems of reactor safety and waste disposal can be handled adequately by technical and administrative means already at our disposal. Speaking personally, my only concern about reactor safety is that, in defending ourselves from the critics, we might develop an unwarranted bravado. As for waste disposal, a line of reasoning suggested by Bernard Cohen convinced me that permanent disposal of wastes deep in the earth poses so little hazard to future generations that there will be little real need for long-term surveillance.

With respect to the possibility of diversion of nuclear materials for weapons use, I feel much less assured. I agree that so long as there is little traffic in plutonium or in highly enriched U-235 or U-233, a combination of physical and administrative security can probably prevent all but the most determined of unauthorized persons from coming into possession of weapons materials. In the longer run, however, when there are many thousands of power reactors distributed among several times the 20 countries that now possess them, the accounting for all of the fissile material will be very difficult. I cannot see how there can be the desired high certainty of safeguards if plutonium and other easily separated bomb-making materials are in daily shipments all over the world.

I suggest that there is a very simple way of adding to the security against the diversion of possible weapon-making materials. This is to ban the shipment of plutonium from power reactors and to ban the shipment of U-235 and of U-233 when they are not diluted with at least 80 percent U-238.

Taking such a step would require a restructuring of the way nuclear power is presently expected to develop. It would require that any reactors using recycled plutonium be located at the same sites as the processing facilities that separate it from spent fuels. HTGR's either would be located at uranium isotope separation plant sites or else use a fuel diluted with U-238. I don't believe that the latter would be much of an economic disadvantage, because studies made several years ago showed that HTGR's could compete about as well using a low-enrichment uranium fuel as with the presently proposed mixed uranium-thorium cycle. The presently sited light-water reactors would probably not be placed at too much of a disadvantage because recent indications of high costs for processing plants make it doubtful if plutonium recycle will reduce the fuel cycle costs appreciably, at least in the near future. Some recycle of plutonium in light-water reactors is probably desirable to extend our supplies of relatively low-cost uranium, and this could be accomplished by locating some light-water reactors along with fuel processing facilities. Fast breeder reactors would, of course, have to be located at the same sites as fuel processing and fabrication facilities.

In my opinion, these restrictions would provide a net benefit for they would force the establishment of nuclear energy centers: conglomerate sites in which many gigawatts of electricity would be generated, locations at which a large force of nuclear experts could ensure that the reactors and processing plants were operated in the most sophisticated manner. Nuclear energy centers have been under study by various groups for some time, and, on the whole, the balance seems to be in favor of their establishment. There are savings in capital cost to be achieved by the orderly construction of a number of power plants at the same site, especially if it is done serially over quite a long time so that the construction force can be stable, gathering experience along the way. Other advantages and disadvantages can be cited, but the added control of fissile material that they would provide seems to me to be the overriding public issue. Studies made for the National Science Foundation and the Nuclear Regulatory Commission are indicating that nuclear energy centers are economically and technically feasible, but for the establishment of such centers to become national policy will require a political force generated by the rather simple consideration of whether the world will be rendered safer by having this additional control on the movement of materials from which bombs can rather readily be made.

I would welcome receiving critical comments on the proposed ban on the shipment of plutonium and enriched uranium.

H. G. MacPherson
102 Orchard Circle
Oak Ridge, Tenn. 37830

Protection or discrimination?

Well, sir, they are after my job again, and it is only a matter of time before they zero in on some of the guys, too. I had thought the Regulatory Guide 8.13 would bury the "woman=baby machine" philosophy, but do-gooders still insist the possibility of a child must be protected from the possibility of danger due to our feeblemindedness. They are still trying to force the limit for fetuses on all women, single, married, or whatever.

How could this possibly affect men? After they get rid of us (women), one of them will realize that men have something to do with pregnancy too. Then watch out, fellows, they will want to protect you too. (Ref. NUCLEAR NEWS, May 1975, pp. 59, 60) With all the males and females under 45 out of radiation fields, how long do you think the nuclear industry can last?

No, I do not think it will go that far. You will fight for your jobs, but will you help me? Will you fight for mine, too?

Mary S. Wegner
Decatur, Ala.

Socioeconomics: Slighted area

Given your interest in nuclear power, I would like to call your attention to a rapidly emerging problem relating to power plant siting. Specifically, there are major difficulties with the manner in which most socioeconomic impact statements are being prepared. While the new stress on socioeconomic effects is encouraging, the manner in which the majority of impact statements are being handled will very likely lead to severe difficulties for the nuclear industry in future years. After an extensive review of the literature, I have concluded that socioeconomic projections are typically made by consultants who have either (a) little or no training in social research methods or (b) little or no experience in studying the effects of industrial development. To document my argument, let me present some examples:

(1) A major consulting firm recently contracted with a federal agency to study the potential socioeconomic effects of nuclear centers. All of the study sites were in non-metropolitan areas. Yet the firm's final report ignored virtually all the research on industrial growth in small towns and rural areas. This incomplete literature review led to very questionable conclusions in the areas of population size, public service demands and housing needs.

(2) Another large consulting firm contracted with a group of four power companies to study the feasibility of energy parks. The consultants projected a new population of 20,335 of which 5,970 would be school children. When a trained demographer made predictions for the same size park, he projected a new population of only 6,843 with 1,505 school children. One reason for this great discrepancy was that the consultants, untrained in demographic research, had used 1954 birth rates to project to the 1980's!

(3) Environmental sociology seems to be fair game for so-called experts. Due to the money flowing into socioeconomic impact statements, the strangest variety of people are now claiming expertise in "environmental sociology." These often are people with degrees in chemistry, physics, or engineering and virtually no work in the social sciences. A good attorney for an intervenor could devastate the credentials of such a person.

(4) Some consulting firms now have computer-simulated models of the socioeconomic effects of power plants. Generally speaking, these models have rigid assumptions and are based on very limited empirical data. It is essential to recognize that modeling is *not* a well developed technique in the social sciences. Consultants who say they have a predictive model of socioeconomic effects should be taken with a grain of salt.

Normally, I would be inclined to take a *caveat emptor* approach to the problem. In other words, if power companies or government agencies do not demand high-quality reports from consultants, then they deserve the inferior work they receive. In the case of nuclear power, however, the potential negative consequences of poor socioeconomic projections can be quite harmful for the nation as well as for the nuclear industry. As you know, nuclear power is under very strong attack in the U.S. as well as in other countries. Many critics of nuclear plants have focused on safety issues and physical environment effects, but an increasing number of intervenors are now zeroing in on socioeconomic effects. This new line of attack makes it absolutely critical that proponents of nuclear plants obtain the best possible socioeconomic projects and thereby reduce their vulnerability to intervenor suits. Unless power plant proponents improve their procedure for obtaining social impacts statements, one of the major rallying points for anti-nuclear critics will soon be on socioeconomic grounds.

I urge the industry to do what it can to improve the quality of socioeconomic projects of nuclear siting. The critical first step is to insure that projections are made by researchers trained in both social science methods and in studying the effects of industrial development. It would be a sad day if the nuclear industry survived its critics on safety and the physical environment only to fall prey to critics on socioeconomic effects. Steps should be taken immediately to prevent social, demographic, and economic projections from being the Achilles heel of the nuclear movement.

Frank Clemente, PhD
Director of Graduate Studies
in Sociology
The Pennsylvania State University
University Park, Pa.

Enclosure 7

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of)
)
PROJECT MANAGEMENT CORPORATION) Docket No. 50-537
TENNESSEE VALLEY AUTHORITY)
)
(Clinch River Breeder Reactor Plant))

NATURAL RESOURCES DEFENSE COUNCIL,
SIERRA CLUB AND
EAST TENNESSEE ENERGY GROUP
AMENDED PETITION FOR LEAVE TO INTERVENE

Contention 14

The unavoidable adverse environmental effects associated with the decommissioning of the CRBR have not been adequately analyzed, and the costs (both internalized economic costs and external social costs) associated with the decommissioned CRBR are not adequately assessed in the NEPA benefit-cost balancing of the CRBR.

a) There is no analysis of decommissioning in the Applicants' Environmental Report;

b) Environmental Impact Statement (EIS) related to LWRs prepared by NRC have been inadequate due in part to recently discovered omissions (see below), and there is no reason to believe the EIS for the CRBR will be any different;

c) A recent report "Decommissioning Nuclear Reactors" by S. Harwood, May, K., Resnikoff, M., Schlenger, B., and Tames, P. (New York Public Interest Research Group (N.Y. PIRG), unpublished, January,

1976) indicates that (with the exception of the Elk River reactor) the isolation period following decommissioning of power reactors has been based on the time required for Co-60 to decay to safe levels. Harwood, et al. (p.2) believe the previous analyses are in error because they have underestimated the significance of radionuclide, Ni-59. The time period for Ni-59 to decay to safe levels is estimated by Harwood, et al. (p.2) for LWR to be at least 1.5 million years. The economic and societal implications of this 1.5 million year decay period are at present unknown.

d) Petitioner believes the NRC must systematically analyze all neutron activation products that may be produced in the proposed CRBR to determine the potential isolation period, following decommissioning, and then provide a comprehensive analysis of the costs (both economic and societal) of decommissioning.

Washington, D. C., ss:

I, Thomas Cochran, affirm that the above contention and bases are true and correct to the best of my personal knowledge.

Thomas Cochran

SUBSCRIBED AND SWORN to before me this 9 day of February, 197

Notary Public

2 April 1976

50-537

RECEIVED APR 6 1976

Paul Leech
Environmental Project Manager
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Leech:

I have completed review of the Clinch River Breeded Reactor Draft Environmental Statement and have enclosed comments and some additional information for your consideration of the final.

In the main, my objections to the draft are based on the premise that an insufficient amount of material is presented in the document to adequately charactorize the project area. An effective public evaluation of impacts based on such sparse information is not possible, especially for anyone who is not familiar with the region. For the most part, the applicant's Environmental Report seemed sufficient in this respect. The addition of some of this material into the final would substantially assist in correcting this deficiency.

I am sure the condensation of such a voluminous document as the ER into a draft statement is quite difficult. However, in view of the constantly increasing public participation in the environmental impact statement process, as well as the significant controversity over LMFBR's, it would seem that a much more comprehensive document is necessary.

It is my opinion that this statement should be comprehensive enough in scope that substantial reference material is not necessary to both quantitatively and qualitatively define the project area and thus have an effective grasp on potential impacts.

Therefore, I would like to request that NRC review the draft (especially sections 2,4, and 5) to ensure that sufficient information is presented for the public to assess this project and its associated impacts without undue relience on other documents.

Finally, I wish to thank both you and your staff for the effort expended in supplying the additional material requested and the generous extension of the comment period. Your quick response and cooperation on these matters are a credit to NRC and are sincerely appreciated.

Yours truly,

Enclosures

3436

Section 2 comments:

2.1 → A list of abbreviations used (throughout the text) would be helpful

What does industrial 2 mean?

Need a more detailed discussion of site topography

Need regional land use data

Data on CR withdrawls & discharges

More information on the recreational use of CR-- locking-through data for recreational craft are misleading -- few pleasure boaters travel through locks.

More information as to the number of barges and cargoes carried should be helpful

A map of regional and site Transportation is needed, as is information on capacity, present use, projected use, ect

2.2 Why is population related to ag. production?

2.3 A brief discussion of regional and site history is needed, as is a discussion of archaelogical findings.

Figure 2.7 should indicate construction areas.

2.4 → This section needs a regional map; a regional discussion of geology, physiography and geography; a table of ~~earthquag~~ earthquakes and intensities;

a discussion of economic geology

information on soil types

A much more comprehensive discription of site geology, including significant karst features.

2.5.1 → A regional discussion of surface water and a map

A discussion of milfoil problems

detailed description of water quality at the site, with appropriate conclusions drawn for the layman.

2.5.2 Information on groundwater quality and the effects on groundwater from a karst topography should be discussed.

2-6 Needs information on air quality, local point sources of pollutants, ect.

Have any tornadoes occurred at the site?

2.7 The term "ecology" deals with "the inter-relationships between living organisms and their environment." This term is often misused for "biology" in this document.

2.7.1 Inadequate! Each community type should be qualitatively described and flora-fauna relationships discussed. There is no discussion of edge effects or the amount of ecotone on the site.

The term "natural area" should be defined further and special attention should be paid these areas in the discussion of ecology.

An ~~areas~~ area which has been substantially undisturbed for 30 years implies a degree of uniqueness which needs to be discussed.

A discussion of the ~~caverns~~ cave environment should be added, since these phenomena apparently exist on the site.

Conclusions as to relative importance of each habitat type should be made for the lay reader.

2.7.1.1 What species are expected for "land undergoing secondary succession in Eastern Tennessee?" An appendix listing flora present (by range) with those species noted which were identified in the field, should be included.

2.7.1.2.1 A list of mammals by range is needed.

Any unusual occurances should be noted.

Notes on relative abundance, habitat preference, and other such data is needed

The discussion of "threatened species" is not adequate and is out of date. This section should be based on occurance by range and the latest USDI list (enclosed).* Some additional data on the Myotis sodalis is also enclosed.** It was noted that the ER was remiss in this area as well. A cave search in August is certainly ill-timed and inconclusive.

2.7.1.2.2. A list of bird species by range is needed.

Some conclusions as to habitat quality need to be drawn

There is no discussion of water-oriented game birds and no discussion of flyways, etc.

The rare, threatened, etc. list needs to be updated and the discussion of ~~of~~ available habitat is needed.

Any unusual occurances should be noted.

* 40 FR 44418, September 26, 1975.

** Bulletin of the National Speleological Society, April 1972.

2.7.1.2.3 A list of herps is needed, as is a discussion of habitat requirements which the site provides, unusual occurances noted, and conclusions as to the quality of the site need to be drawn.

2.7.2 Conclusions should be drawn regarding the data presented and its significance discussed.

Again, lists of aquatic species would be helpful.

Discussion of rare species should be by range!

2.8 Little information on land use, agriculture, general population characteristics, social characteristics (education, average income, race, workforce, etc), and economic and industrial development. Needs considerable expansion.

Other comments -

No discussion of noise levels

No discussion of site aesthetics

No discussion of terrestrial invertebrates or vector problems

No discussion of karst resources -- geological, biological, recreational or historical.

In general, section 2 is extremely inadequate. Enough discussion, tables, and appendices should be added to the final to ensure that an ample amount of information is present to adequately characterize the present project setting.

Section 4 and 5

Impacts are, of necessity, linked to the existing setting. As that section was inadequate, it thus follows that 4 and 5 are not adequate. Discussion of impacts are too limited in scope and treatment. Not enough information is present to support the "staff opinion." Secondary impacts are not properly discussed. For instance, the operation of Melton Hill Dam to meet the requirements of the CRBR are not discussed.

Terrestrial biology recieved particularly poor treatment. The tables of present flora and fauna, mentioned in my previous comments, could also include a column of "project impacts" based on habitat destruct.

As the project is located in karst ~~terrain~~ topography, impacts on cave-related species should be discussed. Some recent studies (Eric Morgan, Dept of Biology, Tennessee Tech University) indicate some cave fauna are extremely sensitive to dissolved solids and chlorine residuals. As there are few "surface streams" on the site, cooling tower drift could easily enter the cave environment.

In all, sections 4 & 5 require a great deal of expansion in detail and scope.

If you need an clarification of these comments, or if I can assist you ~~so~~ in any manner, please do not hesitate to contact me at:

Brad Neff (ORLPD-R)

scattered brushy areas provide excellent habitat for the striped skunk (Mephitis mephitis), red fox, Virginia opossum (Didelphis virginianus), and the coyote (Canis latrans).

5.92 The nongame mammals of the study area are comprised of six insectivores (moles and shrews); eight bats, excluding the Indiana myotis (Myotis sodalis); and 13 rodents. These species are economically important in a number of ways. Mice, rats, and shrews are utilized as prey by raptors and several other mammals. Some bats are known to carry rabies and, hence, are dangerous to livestock and humans. From a beneficial standpoint, however, bats consume large numbers of noxious insects. The old world rats and mice, represented in the study area by the Norway rat (Rattus norvegicus) and the house mouse (Mus musculus), are considered economically harmful, since they damage or destroy large quantities of crops and stored grains, and carry diseases to which man is susceptible. During the field surveys, nine white-footed mice (Peromyscus leucopus) and two short-tailed shrews (Blarina brevicauda) were trapped in a river-edge habitat. In addition, an eastern chipmunk (Tamias striatus) was sighted on a natural ridge in the floodplain, and one 13-lined ground squirrel (Spermophilus tridecemlineatus) was sighted on a bluff at the edge of the floodplain. no info

IN-HOUSE REVIEW DOCUMENT SUBJECT TO CHANGE

5.93 The Indiana myotis (Myotis sodalis), which appears on the United States List of Endangered Fauna (Fish and Wildlife Service, 1974), is the only endangered mammal possibly occurring in the study area. This medium-sized myotis, belonging to the family Vespertilionidae (plainnose bats), closely resembles the little brown bat (Myotis lucifugus) but differs in coloration. Its fur is a dull grayish chestnut rather than bronze and the basal portion of the hairs is a dull lead color. The morphological similarity of these species and the frequency of which they are found together often make field identification rather difficult.

5.94 The distribution of the Indiana bat is confined to the midwestern and eastern United States from the western edge of the Ozark Region in Oklahoma to central Vermont and southern Missouri, and as far south as northern Florida ("Threatened Wildlife of the United States," 1973). With the absence of caves in the study area, the distribution of this species is probably restricted to spring and summer populations associated with migration and breeding activities. Generally, any small drainage in the midwest that contains some riparian habitat is conducive to the support of good Indiana bat populations (pers. comm., Stephen Humphrey, University of Florida, Gainesville, 1975). The Big Blue River and the numerous smaller drainages associated with it afford excellent foraging and roosting areas for this species. There is no evidence, however, that the Indiana bat utilized larger bodies of water like reservoirs, large rivers, or lakes (pers. comm., Stephen Humphrey, University of Florida, Gainesville, 1975).

note: this is extracted from a contractor's assessment for the Louisville District and furnished for information purposes only.

5.95 Although the Indiana bat forms small nursery colonies in hollows of dead trees and under loose bark during the summer, it is then far less vulnerable to catastrophic threats than when it congregates in caves during hibernation. When weather conditions are favorable, it uses alternate roosting trees before and after lactation. If the nursery tree is destroyed, it occupies another suitable tree nearby, thus retaining essentially the same foraging area. Roosting sites like tree crevices and wood protect these bats from extreme ambient temperatures, which is of metabolic advantage. However, since the roost temperatures conform to mean seasonal temperatures, the thermal advantage of the roost is slight in spring and autumn (Humphrey, 1974). a

5.96 Foraging is restricted to areas near the foliage of riparian vegetation (mainly sycamores and cottonwoods), over water, and a few isolated trees (oaks, walnuts, etc.) in pastures in creek floodplains. During the cooler part of early summer, which coincides with pregnancy and the presence of transients, foraging takes place almost exclusively over water. During warmer weather and following parturition (usually one young per season in late June), the foraging habitat is expanded to include riparian habitat and areas within the floodplain. The total foraging range of the Indiana bat is about one-half mile, while the estimated population density of the species along a linear half mile of creek is about 50 bats (pers. comm., Stephen Humphrey, University of Florida, Gainesville, 1975). Stream impoundment and channelization are believed to be the greatest threats to foraging habitat and, consequently, to the survival of spring and summer populations of the Indiana bat (Humphrey, 1974).

5.97 In the December 16, 1975, issue of the Federal Register, the Director of the U.S. Fish and Wildlife Service issued a proposed rule for determining critical habitat for six endangered species, which included the Indiana bat. Big Wyandotte Cave in Crawford County and Ray's Cave in Greene County were the only wintering areas in Indiana declared critical habitat. The Indiana bats are entirely dependent on the shelter provided by these and other caves during hibernation. Approximately 94 percent of the known Indiana bat population hibernates at these sites and in other caves located in Illinois, Kentucky, Missouri, Tennessee, and West Virginia. Their loss or subjection to excessive disturbance or modification would lead to the near or total extinction of the species. The wintering areas mentioned earlier do not necessarily include the entire critical habitat of the Indiana bat, as modifications to critical habitat descriptions may be proposed in the future. Riparian habitat is also believed to be essential to the Indiana bat for feeding and reproduction. These habitats are currently being evaluated and may be proposed in the future as critical habitats.

THE UNIVERSITY OF ALABAMA
NEW COLLEGE
POST OFFICE BOX 6211
UNIVERSITY, ALABAMA 35486

March 24, 1976

RECEIVED
MAR 30 1976
U.S. NUCLEAR REGULATORY COMMISSION
Mail Section

Mr. B. J. Youngblood
Environmental Projects Branch 2
Division of Site Safety and Environmental Analysis
United States Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Youngblood:

The following major deficiencies in the Draft Environmental Statement for the Clinch River Breeder Reactor (Docket #50-537) should be noted:

1. The cost estimate of 1.7 billion dollars is grossly inadequate, even for a small (350 NET M.W.e.) LMFBR. Further, the cost of larger or next-generation breeders should be accounted for. The cost of a 1000 M.W.e. LWR is presently about 1 billion dollars. What is the projected cost of a comparable (1000 M.W.e.) LMFBR?

2. The payroll is estimated for the construction phase (1976-1983) and the demonstration phase (1983-1988) but <u>no</u> estimate is made for the <u>majority of the lifetime</u> of the plant (10.4.1.5). What is the payroll beyond 1988? An answer such as "substantially the same as during the demonstration phase" is <u>not</u> adequate. An analysis should be performed and a figure derived and published.

3. Section 9.1 is totally invalid. Unless whole-system alternatives, such as energy conservation, are considered, the Draft Environmental Statement becomes a mockery of its intended purpose.

4. The plant has an <u>un</u>favorable Benefit Cost Ratio. This fact alone should serve to cancel plans for the plant. The use of in-lieu-of-tax-payments (10.4.3) utterly subverts the intent of Benefit-Cost analysis.

In summary, I am appalled at the obvious build-it-at-any-cost attitude displayed in the Draft Environmental Statement (Docket 50-537). I have not seen such a blatant disregard for economics in any other nuclear plant environmental statement. The Clinch River Breeder Reactor Plant statement hits a new low in economic analysis.

Sincerely,

Edward Passerini

Edward Passerini (Dr.)
Associate Professor of Environmental Studies

3203

by the Project. It is recognized that the staff DES evaluation has been limited in several aspects to a conservative scoping type evaluation in order to ascertain the need for further analyses and to identify potential problem areas. The Project has consequently extended the assessments previously reported in ER Amendment V to include a dynamic simulation, utilizing up-to-date computer methods, in order to more precisely determine the scope and nature of potential socio-economic impacts to the local communities. This study is reported in ER Amendment VI. Furthermore, in response to the staff's concerns on the fiscal impacts to the local communities, the Project has further examined this area in Amendment VI. Finally, in response to the staff concern on the availability of off-setting in-lieu-of-tax payments, the Project reaffirms the availability of ERDA payments to local communities in accordance with the provisions as set forth by Congress. Additional detailed comments are given below.

A. Pp. 2-17, Section 2.8, paragraph 3.

The description of strain on local services should be clarified to indicate an historical observation rather than infer a present condition.

B. Pp. 4-1, Section 4.1.

1. Table 4.1 and the text should be updated to reflect current workforce estimates (Amendment VI to the Environmental Report).

2. The Project has further evaluated use of indirect employment multipliers and the percentage of workers who will likely immigrate to the local area for ER Amendment VI. It is concluded that secondary employment multipliers should be applied to the more permanent type work force (Operations and Project Office employees) rather than for temporary construction workers. (See Enclosure 4.) Also with regard to workforce immigration rates, the ER in Amendment VI has been expanded to include a range of mover rates. For nominal type competition for construction workers a 27% mover rate is expected, whereas, a 40% mover rate is considered more appropriate for the area in the event other major construction activities in the area coincide with the CRBRP construction schedule.

3. The last paragraph in this section should be modified to reflect the actual status of the cited projects.

C. Pp. 4-4 to 4-7, Section 4.5.1.

The analysis of schools should consider the fact that projected educational impact will be concentrated and not be a system-wide phenomenon. Moreover, the DES analysis is "static" and does not appear to account for indigenous population and enrollment changes. Such dynamics need to be considered since excess capacity in 1975 has only limited bearing on the problem. In the ER, school data are presented only for those schools most likely to be impacted by the Project. This was based on an assessment of housing choice, housing availability, and location patterns of new employees. Looking at whole school systems as NRC did can mask some problems or magnify others so that accurate assessment in the DES

of impacts is more difficult. Also, school-age children associated with construction workers and those associated with more permanent employees should be differentiated as done in the ER. This distinction is important in that NRC states that school systems try to allow 10 percent excess capacity as a contingency factor. It seems most appropriate to consider the temporary influx of construction-related students as a contingency for which excess capacity is maintained. The remaining permanent students would be diffused throughout the schools and have little measurable impact.

D. P. 4-7, Section 4.5.2.

ER Amendment VI (Appendix C to Chapter 8.0) provides results of a further study by the Project of sources of revenue that will be available to the local communities to mitagate increased social needs due to construction and operation of CRBRP. Property taxes will be a significant revenue source which the DES has not accounted for.

E. P. 5-15, Section 5.6.

1. Table 5.9. A source should be provided for each of the standards listed. Many of them do not reflect planning standards specified by the State of Tennessee. (A teacher-pupil ratio of 1/25 for kindergarten, 1/30 for grades 1 through 6, and 1/35 for grades 7 through 12.) Also a factor of 1 acre/100 persons for parks and playgrounds appears somewhat high as a "level of required services." A more realistic requirement is provided by the National Recreation and Park Association which has published standards indicating a need of only 2.5 to 5 acres/1,000 persons for such facilities. (National Recreation and Park Association, <u>National Park, Recreation, and Open Space Standards</u>, n.d., p. 12.) Also it should be noted that extensive recreational areas presently exist for the local area.
2. The DES estimate for population increase during plant operations of 1200 people is considered excessive. ER Amendment VI provides analyses which show that the population increases stabilizes to about 700 people by 1989. An important consideration in the analysis is the fact that only a fraction of the induced employment should be considered as new residents to the area.

F. Pp. 5-16,17, Section 5.6.1.

1. Income from personal property taxes should also be included in this section as a source of revenue.

2. The DES incorrectly presumes that the TVA act authorizes TVA to make in-lieu-of tax payments to local governments in the vicinity of the Project (see enclosure 5). ER Amendment VI provides a further evaluation by the Project on potential fiscal impacts due to CRBRP construction and operation. It should be noted that means presently exist to Roane and Anderson counties as well as Oak Ridge for financial assistance from ERDA through the Congressionally-funded Community Act. Enclosure 3 provides further clarification to the staff on the nature and scope of this financial assistance program.

4. The Project notes that in several areas of the DES the NRC staff has made more conservative estimates for both normal operational and accident releases of radioactivity than presented in the Environmental Report. Although consequences are still judged by NRC to be environmentally acceptable, the Project believes that the Environmental Report analyses appropriately considers a realistic assessment at these events.

1. The footnote on page i of the DES requires some clarification. The referenced legislation authorized ERDA to acquire custody of the site needed for the CRBRP, but the legislation is silent on the question of whether ERDA will become an applicant. The legislative authorization contemplated revised Project arrangements in which the responsibilities of the respective parties would be realigned with ERDA in a lead role. In addition to custody of the site, the legislation also authorizes ERDA to acquire ownership and custody of the CRBRP.

2. Archaeological field studies at the CRBRP have been completed although laboratory analysis is still in progress. The current status of this activity should be reflected in the DES by replacing the top paragraph on page 2.8 with the following:

   Archaeological field studies have been completed for six sites, 40RE104, -105, -106, -108, and -124. Removal of nearly all sediments down to the premound surface of 40RE124 indicated interment of more than 36 individuals. Laboratory analyses and final report preparation are continuing.

3. The CRBRP Baseline Terrestrial Survey program has identified the unusual or rare community types and plant species of special importance on the CRBRP site (Environmental Report Sections 2.7.1.3.3 and 2.7.1.3.4). DES Section 2.7.1.1 should be modified to reflect the final results of the baseline terrestrial survey. Maps showing the exact location of these communities or plant species have been generated. An examination of these locations in comparison with site construction plans have shown none of these areas will be disturbed.

4. The results for the complete one year Aquatic Baseline Survey are contained in Environmental Report, Amendment VI. To be entirely consistent with the complete year of data, DES Section 2.7.2 and other sections using the baseline aquatic data (i.e., Section 5.3) would need minor revisions of numbers. The final year's results confirm and further verify the conclusions, trends, and patterns of the aquatic ecology of the Clinch River site which were observed from the first 6 months of data.

5. Procurement of the turbine generator for the CRBRP has resulted in revisions to the design parameters for the heat dissipation system (DES, Section 3.4) and plant water requirements (DES, Section 3.3). A listing of the new parameters appears below:

Number of Cooling Towers	2
Number of Cells Per Cooling Tower	14
Cooling Tower Dimensions	250' x 70' x 60'
Cooling Tower Design Heat Load	2.17×10^9 BTU/hr.
Approach	11°F
Range	20°F
Maximum Outfall Temperature	90.5°F
Minimum Outfall Temperature	61.5°F
Condenser Cooling Water Flowrate	185,200 gpm
Temperature Rise Through Condenser	22°F
Auxiliary Cooling Water Flowrate	24,000 gpm
Make-up Water*	13.0 cfs (5835 gpm)
Blowdown*	4.9 cfs (2210 gpm)
Evaporation*	7.7 cfs (3475 gpm)
Consumption*	8.1 cfs (3785 gpm)
Drift*	105 gpm

*Annual Average at 100% Load Factor

The overall assessment of the environmental impacts in the DES would not require revision because of the above changes. No environmental impact is significantly altered; in fact, the effects of thermal and chemical discharge and cooling tower drift and fogging are actually decreased.

6. Regarding Section 3.5.1.4 of the DES, the Project recommends that the staff further consider the fact that drains being processed by the Low Activity System (LAS) would contain sodium that has decayed for a minimum of 10 days before being introduced or utilized in areas of the plant which potentially feed into the drain system. Therefore, taking such factors into account, an assumption of 10-day decay time for sodium processed by the LAS is more appropriate than the 2-day decay time sited in the DES.

7. Some revisions are needed in DES Table 3.5 for three separate reasons. First, the design annual average blowdown has decreased slightly to 2210 gpm (see comment 5, enclosure 2). Second, some minor changes to ambient river conditions have occurred based on the full one-year Aquatic Baseline Survey data (March 1974 through May 1975). Finally, the chlorine residual values obtained during the baseline survey were below the detectable limits reported by the orthotolidine colorimetric field methods. Since chlorine residual is neither a stable or a natural occurring water quality parameter and since there are no major chlorinated discharges in the vicinity of the site, the ambient chlorine residual for the plant discharge

analysis have been assumed to be zero. All three corrections have been made in the corresponding Environmental Report Table 3.6-1 in Amendment VI. These small revisions to the chemical nature of the CRBRP discharges will not alter any environmental impact conclusions in the DES.

8. With respect to DES Section 5.4.1 and Table 3.5 , the analysis of downstream concentrations at 30 and 200 ft. of copper (Cu), iron (Fe), and total suspended solids (TSS) require slight corrections. The 30 and 200 ft. downstream concentrations should correspond to the chemical isopleths equivalent to the 4.5 and 2.0° winter worst case isotherms. Therefore, the values given in Table 3.5 for the concentrations at 30 and 200 feet below the discharge should have used a dilution factor of 10.4 and 23.4, respectively, as opposed to the 6.8 and 17.9 factors that were apparently used. With these corrections, the levels of Cu, Fe, and TSS would be:

	Portion of River Affected	
	30 ft. Downstream (4.5 F° Isotherm)	200 ft. Downstream (2 F° Isotherm)
Copper, mg/l	0.10 (0.15)	0.049 (0.061)
Total Iron, mg/l	0.78 (0.83)	0.72 (0.74)
Total Suspended Solids, mg/l	52.63 (56.35)	48.95 (49.86)

Note: Values in parentheses are those given in DES Table 3.5.

9. Clarification is needed in the description of the chlorination program in DES Sections 3.6, 5.4, and elsewhere. An accurate description of the program is that periodic chlorination of the circulating water system to prevent biological buildup in the heat rejection system will be conducted by injection of hypochlorite equivalent to 2-5 mg/l chlorine for a 20-30 minute period 3 to 4 times a day. Release of chlorine via the cooling tower blowdown will be controlled by an automatic blowdown shutoff valve. This valve will preclude the release of an excessive chlorine concentration. Excessive chlorine concentration is defined as the free available concentration that would cause a daily maximum concentration to exceed 0.5 mg/l or a monthly average concentration to exceed 0.2 mg/l (40 CFR 423). In addition, blowdown will be stopped during chlorine injection.

10. The provisions for a filter in the cooling tower blowdown shown in DES Figure 3.17 were initially included since they may have been required to comply with proposed suspended solids guidelines. The filter has now been deleted from the CRBRP design as it is not required per 40 CFR 423.

11. The discussion in DES Section 3.6.7 on polychlorinated biphenyls (PCB) should be expanded to say that PCB, if used, will be within the plant (indoors) and surrounded by dikes which drain into a special sump. If a spill occurs, the PCB will be collected and either reused or returned to the manufacturer for reprocessing or disposal.

12. The initial paragraph, second and third sentence, in DES Section 4.1 requires some clarification. Excavation will actually start shortly after clearing and grubbing (several weeks), and both will continue through site preparation. Some excavation and clearing and grubbing will also be performed during the construction stage.

13. The DES in Section 4.2.1 (third paragraph, third sentence) has accurately stated the present plans to remove all trash off-site during construction. However, it may be feasible to open a sanitary fill on-site in the vicinity of the borrow pit at considerable cost savings. If this option is elected, all applicable requirements for such a landfill would be met.

14. The source and amount of water estimated to be needed during construction for concrete mixing, sanitary facilities, drinking water, and other uses has been revised from that indicated in the DES. The water now estimated as a maximum of 150,000 gpd will be piped from the nearby Bear Creek Filtration Plant along existing roads to the CRBRP site.

15. In reference to statements in the DES concerning suspended solids limitations on discharged water from settling basins during construction (i.e., Section 4.3, second paragraph, second sentence), thermal discharge criteria (i.e., Section 5.3.2.1, page 5-8, third paragraph), and technical specifications for monitoring certain chemical discharges (i.e., Section 5.4.1, fifth paragraph, last sentence) the Project will meet the requirements as established by EPA in the National Pollutant Discharge Elimination System (NPDES) permits.

16. An updated description of excavation and other activities required in or along the banks of the Clinch River during construction of the CRBRP was contained in the Project application for an Army Corps of Engineering permit submitted on February 13, 1975. Estimate excavation quantities are

given below:

Barge Unloading Facility	15,000m^3
Other Facilities	
Access Road and Railroad Fills	968m^3
River Water Intake	585m^3
Plant Discharge	9m^3
	1,562m^3

The needed excavation is less than the quantities now given in the DES (Primarily Section 4.4.2, but quoted throughout), consequently reducing even further this minor environmental impact. In addition, the Corps application describes the proposed location for disposal of excavated material in a minor depression near the barge unloading facility and indicates measures such as dikes which will be used as required to control turbidity and prevent excavated material from returning to the river.

17. Item 4 from DES Section 4.6.1.1 should be changed to indicate reclamation would consist of grading, returning topsoil and seeding native grasses and forbs.

18. Item 9 from DES Section 4.6.1.1 should be revised to clarify the storm drainage system in connection with the transmission facilities. Temporary drainage ditches to direct rain water off the access roadways, the use of terracing, and ground cover will be provided along the transmission line rights of way as needed to prevent excessive soil erosion.

19. Although herbicides will not be used in initial clearing operations, they may be used on a small scale for the maintenance of the transmission line right-of-way. Plans call for use of hand carried chemical dispensers if necessary. Item 13 from DES Section 4.6.1.1 should reflect this.

20. In the DES Section 4.6.1.1, item 14 should be clarified to state grading the right-of-way will be done where necessary followed by discing, fertilizing, and seeding as quickly as practicable.

21. The statement in DES Section 5.3.1 (page 5-2, last paragraph) discussing the expected frequency for back flushing the perforated pipe intake should be changed to indicate the intake pipe will be monitored and back flushing will be done as required since it is difficult to predict in advance to what extent back flushing will be needed.

22. DES Section 6.0 should be revised to consider the recently installed (February 11, 1976) instrumentation and equipment at the on-site meteorological tower and refinements and better definition of the preoperational (excluding the completed aquatic and terrestrial baseline surveys) and operation monitoring programs (radiological, aquatic, and chemical and physical). These modifications (Amendment VI to the Environmental Report will fully cover the above revisions to the monitoring program) provide further information on the environmental monitoring programs and as such should not effect any conclusions in the DES concerning CRBRP environmental monitoring.

23. The Project has the following comments on DES Section 7.1:

A. Table 7.1

1. The examples of Class 4 accidents identified for the CRBRP are not appropriate since none of these would result in release of radioactivity into the primary system. The Project would suggest the example of off-design transients that induce fuel failures above those expected (Environmental Report 7.1.2.5.1).

2. The Project believes a leak in a core component pot to be a Class 8 (Extremely Unlikely Event) rather than a Class 6 as stated in Table 7.1.

B. Table 7.2

For event 3.3 the Project believes that processing by CAPS of the release from the surge vessel as analysed in Environmental Report Section 7.1.2.3.3 should be included in the assessment of the postulated event.

C. Table 7.3

1. Under "Reactivity Transients", item 1 would not result in core melting or disruption and should not be included in the list. The condition described would result in stable operation at about 15% overpower and fuel failures would not even be predicted for a number of hours. We suggest deletion of item 1 of entry A.

2. Under "Single Unlikely Faults", the third event (better titled "Assembly-to-Assembly Fuel Failure Propagation, no RT") should be deleted since it is not a single unlikely fault. No single fault has been identified that could result in gross failure of one fuel assembly and subsequent propagation to other fuel assemblies (Environmental Report Amendment II, response to NRC question 000.14).

3. Under "Single Unlikely Faults", the primary pipe rupture sub-items C.1, C.3, and C.4 should be deleted because rupture plus Plant Protection System failure (i.e., no RT or no PT) is not a single unlikely fault. It is recommended that these sub-items should not be included in the Table since they involve doubly hypothetical conditions.

4. No mechanism for introducing large gas bubbles or significant quantities of moderator into the coolant have been identified by the Project.

5. An external event beyond the design basis is clearly in Class 9 and should be excluded from this Table.

D. Page 7-7, paragraph 3.

It should be pointed out that the CRBRP decay heat removal system includes reliability and diversity (e.g., turbine driven auxiliary feedwater pumps) not addressed in this paragraph. The features can be expected to provide additional assurance of the essential cooling function such that the overall unreliability of the system will be much lower than the text indicates.

E. Page 7-7, paragraph 4.

The Project recommends further amplification of this paragraph in order to clarify the point that loss of offsite power does not of itself cause failure of the reactor shutdown system. To the contrary, loss of offsite power removes the holding voltage to the primary rod drive mechanism coils, causing the rods to be inserted into the core, even if the plant protection system is postulated to fail.

24. For reasons discussed in Environmental Report Section 10.1 and confirmed in DES Sections 9.3 and 9.4, the CRBRP has selected a mechanical draft wet cooling tower design. However, the Project is further evaluating whether to use the linear or circular cell array option of the mechanical draft wet cooling tower. (See Amendment VI of the Environmental Report, revised Section 10.1.) The environmental impacts of both options are essentially identical, with the circular array having a marginal environmental advantage in duration of close-in fogging (less than 1/10 mile) and drift deposition (see Environmental Report Tables 10.1-2 and 10.1-4). Therefore, the final decision on a circular or linear array will be based primarily on cost. Since both the Environmental Report and DES have analysed a linear array and found its impact to be minor aesthetic and nuisance factors, the uncertainty in the final selection of linear versus circular mechanical draft wet cooling towers is of little environmental concern.

25. Because of the newly revised Project cost estimate now totaling $1.950 billion, the figures in DES Table 10-5 and Section 10.4.2.2, including the revenue for electricity used by TVA ($71.8 million), will need to be revised.

26. The DES analysis in Appendix D when treating the environmental effects of transportation of radioactive fuel material assumes for irradiated fuel assemblies a storage time of approximately 360 days and 25.5 railroad shipments per year. The evaluation in the CRBRP Environmental Report states that our present design is capable of having a storage time of approximately 100 days and with 9 assemblies per spent fuel cask would require only 12 shipments per year during the initial pre-equilibrium fuel cycle and eight during the equilibrium phase. Also recent revision indicate that 20 and 25 radial blanket assemblies will be replaced annually during the pre-equilibrium and equilibrium fuel cycle, respectively. Overall these changes would reduce the estimated transportation doses to transportation workers and the general population along the transportation routes.

ERDA IN-LIEU-OF-TAX PAYMENTS

The Atomic Energy Community Act of 1955 provides for annual assistance payments to the City of Oak Ridge in recognition of the special circumstances which attend the tax-exempt status of Federal installations located within that locality and the need to maintain an appropriate level of local government services. In 1975 this Act was amended to authorize annual assistance payments to Roane and Anderson Counties in recognition of the "peculiar fiscal problems by reason of the [ERDA] operations and their employees within their boundaries." The CRBRP will be located in Roane County and Oak Ridge, while the CRBRP Project Office is located in Anderson County and Oak Ridge. Should conduct of CRBRP activities within these localities give rise to peculiar fiscal problems, which might be analogized to cumulative impacts upon those localities, the Community Act would provide a mechanism by which ERDA may recognize those impacts which are unique to the localities in which CRBRP activities are conducted. ERDA will undertake discussions with Roane and Anderson counties concerning the need for assistance payments to those localities. ERDA will consider all ERDA activities, including CRBRP, in these discussions, and its ultimate determination will provide such mitigation as falls within the criteria of the Community Act. In the case of the City of Oak Ridge, ERDA's existing contract with Oak Ridge for assistance payments will provide a basis for mitigation of any special impacts which may arise as a result of ERDA activities, including CRBRP. */ The existing contract provides a mechanism for increasing assistance payments if actual impacts from ERDA activities should cause fiscal impacts upon the City which necessitate an increase in real property ad valorem tax rates. In that event, the contract formula operates such that ERDA would bear a proportionate share of the fiscal burden resulting in the tax rate increase through increased assistance payments. In addition, the amount of assistance may be further adjusted when, in its discretion, ERDA determines that additional assistance is required to enable the City to maintain school and other municipal services at a level which will not impede the recruitment or retention of personnel essential to the atomic energy program. Finally, in making its recommendations to Congress as to the need for assistance payments to the City beyond the statutory expiration date in 1979, ERDA will consider and take all ERDA activities, including CRBRP, into account.

*/ See S. 1378 and H.R.5698: Assistance Payments to Anderson County and Roane County, Tennessee, Hearing before the Subcommittee on Communities, Joint Committee on Atomic Energy, 94 Cong., 1st Sess. May 9, 1975, pp. 398-400.

SECONDARY EMPLOYMENT CONSIDERATIONS

The Project's analysis of secondary employment generated by construction workers concludes that there will be no measurable secondary employment generated. This conclusion is based on an analysis of the existing trade sector. It shows that the existing trade sector of the impact area can adequately absorb the volume of trade resulting from expenditures of inmoving construction workers without increasing employment levels.

This analysis is based on examination of existing seasonal variation in sales in each of the impact counties and the relative size of the increase caused by inmoving construction workers as shown in the following tables. The basic tenet is that the monthly variations occur without similar fluctuations in employment. Thus, a small increase in the existing variation would have no effect on secondary employment during the period of construction.

	Description
Table 1	Retail trade volume in 1974 in the impact counties and the associated total monthly variations in sales.
Table 2	The estimated monthly expenditures of inmoving construction workers in the impact counties.
Table 3	The relationship between peak monthly expenditures of workers and normal variations of sales in each of the impact counties.

The results of this analysis lead to the conclusion that no secondary employment will occur due to the construction force because their temporary impact on the trade sector is well within the variation now being experienced.

Enclosure 4

TABLE 1

RETAIL SALES AND ESTIMATED MONTHLY VARIATION

IN ANDERSON, KNOX, LOUDON, AND ROANE COUNTIES, TENNESSEE 1974

		Estimated Monthly Retail Sales Volume			
County	Retail Sales 1974	Monthly Average	Low Month	High Month	Seasonal Variation (High to Low)
Anderson	$ 146,206,000	$ 12,183,833	$10,234,420	$ 16,082,660	$ 5,848,240
Knox	972,514,000	81,042,833	68,075,980	106,976,540	38,900,560
Loudon	40,752,000	3,396,000	2,852,640	4,482,720	1,630,080
Roane	77,751,000	6,479,250	5,442,570	8,552,610	3,110,040
Total	$1,237,223,000	$103,101,916	$86,605,610	$136,094,530	$49,488,920

Enclosure 4

Table 2

ESTIMATED RETAIL SALES AND MONTHLY VARIATION

IN ANDERSON, KNOX, LOUDON AND ROANE COUNTIES, TENNESSEE

ASSOCIATED WITH INMOVING CONSTRUCTION WORKERS*

AT CRBRP IN PEAK CONSTRUCTION YEAR

County	Average	Estimated Monthly Retail Sales Low Month	High Month
Anderson	$207,167	$174,020	$273,460
Knox	672,000	564,480	887,040
Loudon	159,600	134,064	210,672
Roane	361,200	303,408	476,784

*Based on estimated annual payroll of $16,800,000 to inmoving workers in the peak year.

Table 3

COMPARISON OF ESTIMATED MONTHLY EXPENDITURES OF WORKERS

TO TRADE SECTOR VARIATION IN CRBRP IMPACT COUNTIES

Counties	Seasonal Variation In Retail Sales (From Table 1)	Peak Month Retail Expenditures Of Inmoving Workers (From Table 2)	Peak Month Expenditure As a Percent Of Seasonal Variation
Anderson	$ 5,848,240	$ 273,460	4.7%
Knox	38,900,560	887,040	2.3
Loudon	1,630,080	210,672	12.9
Roane	3,110,040	476,784	15.3

Enclosure 5

TVA IN-LIEU-OF-TAX PAYMENTS

The DES makes several incorrect statements and inferences regarding TVA's in-lieu-of-tax payments. The third full paragraph on page 5-16 incorrectly presumes that the TVA Act authorizes TVA to make in-lieu-of-tax payments to certain of the local governments in the vicinity of the Project.

While Section 13 of the TVA Act does provide for payments in lieu of taxes to be made directly to states and counties, it also describes the basis for making such payments. Section 13 does not provide for payments to be made to any local governments other than counties, and it only authorizes TVA to make tax replacement payments to counties on (a) power property acquired by TVA (and taxed as such prior to the time of acquisition) and operated by TVA, and (b) the portion of reservoir lands allocated by TVA to power operations. Since the Clinch River site does not fall within either of those categories, there is no basis for TVA to make in-lieu-of-tax payments to Roane County, the proposed location of the plant. However, Section 13 does authorize TVA to make in-lieu-of-tax payments to states in which the power operations of the Corporation are carried on. The payments to each state are based on (1) the gross proceeds from TVA's power sales within the state, and (2) the book value of TVA's power property within the state. Thus, if at some time in the future TVA should purchase the CRBRP as power property, then the State of Tennessee's share of TVA's in-lieu-of-tax payments may be increased by virtue of a resultant increase in the book value of power property in Tennessee.

The DES makes the statement on page 5-16 that:

> Presumably, one or both of those agencies (ERDA or TVA) could make some form of in-lieu-of-tax payment to the local area as compensation for burdens imposed over benefits received by the area from this Project.

As indicated above, there is no basis for TVA to make such in-lieu-of-tax payments to the local area, since the TVA Act explicitly provides for the in-lieu-of-tax payments that are to be made, and it does not authorize TVA at its discretion to make any other payments of this type.

50-537

After reviewing the Environmental Statement concerning the Clinch River Breeder Reactor Plant, I wish to express my concern about its construction. In reviewing the power plant's mechanisms, many of its actions such as waste production (section 3-11) and emergency systems (section 7-1), specifically, are designed and explained by the same principles as the light water reactor. However, because of the constant production of energy by the breeder reactor, the above mentioned mechanisms must be different. The wastes from the breeder reactor, such as tritium and argon, are unique to that type of power plant. Thus, waste disposal and treatment must change as waste production does. In addition, because of the extreme amount of fuel that is in constant production, heat is also continually produced. The emergency system must be prepared to deal with the excess energy in the event of an accident. The energy mechanisms must

5356

also be different. Thus, in considering the plant's construction, closer examination of its differences from the presently used light water reactors should be made.

The breeder reactor's effects on the environment must also be thoroughly examined. The waste products (heated water and radioactive materials) all have the possibility of disturbing food chains, changing geological and meteorological aspects of the surrounding area, and killing wildlife. In examining the affects of the reactor, more than single tests (sections 4-4 and 5-12) on plant and animal, particularly the human, species must be made. Many of the conclusions in the Environmental statement are not supported by experimental nor field data. The nuclear plant cannot be built upon assumptions. Concrete evidence for its safety and need must first be made.

Comments from:

Deborah J. Hurwitt ECOS Inc. Chapel Hill, N.C. 27514

TENNESSEE
STATE PLANNING OFFICE

RAY BLANTON
Governor

NILES SCHOENING
Director

660 CAPITOL HILL BUILDING
301 SEVENTH AVENUE, NORTH
NASHVILLE, TENNESSEE 37219
615-741-1676

June 11, 1976

RECEIVED JUN 14 1976 U.S. NUCLEAR REGULATORY COMMISSION Mail Section

50-537

Mr. Bernard Rusche, Director
Division of Reactor Licensing
P-722, NRC
Washington, D. C. 20555

SUBJECT: Draft Environmental Statement
Clinch River Breeder Reactor Plant

Dear Mr. Rusche:

Enclosed are comments on the subject document from the Tennessee Department of Conservation transmitted for your information.

Sincerely,

Stephen H. Norris/mn

Stephen H. Norris
Grant Review Coordinator

SHN:mn

Enclosure

6062

RRC 6-4-76

Tennessee Department of
Conservation Division of Planning & Development
RAY BLANTON · GOVERNOR
B.R.ALLISON · COMMISSIONER
2611 West End Ave. Nashville, Tennessee 37203 (615)741-1061
WALTER L. CRILEY · DIRECTOR

June 1, 1976

Mr. Stephen H. Norris
Grant Review Coordinator
Office of Urban & Federal Affairs
Tennessee State Clearinghouse
660 Capitol Hill Building
Nashville, Tennessee 37219

RE: Clinch River Breeder
Reactor

Dear Mr. Norris:

In cooperation with the Tennessee Department of Conservation, the Tennessee Heritage Program reviewed the Clinch River Breeder Reactor Plant - Draft Environmental Statement and noted some errors in reference to the identification of certain "rare plant species".

"Citticifuga rubifolia (Black Snakeroot)" is incorrectly spelled and should read Cimicifuga rubifolia Kearney, a member of the Ranunculaceae family that apparently is an endemic to Tennessee.

Also "Saxifiaga carayana (Carey's Saxifrage)" is misspelled and should read Saxifraga careyana Gray, a member of the Saxifragaceae family that has been reported to be restricted in range to the mountains of Virginia and North Carolina.

The status of these two plant species should be clarified as both of these plant species are currently listed as threatened species on the Smithsonian Institution Report for endangered and threatened plant species of the United States. This is not discernable from the draft statement.

Mr. Stephen H. Norris
Page 2
June 1, 1976

Although the proposed construction will apparently avoid the locations of these threatened plant populations of which we are aware, we feel that the presence of these significant populations should be noted and measures taken to further assure their protection.

Sincerely,

Walter L. Criley

Walter L. Criley

WLC/dh

cc: Mike Countess
Rex Bomar

East Tennessee Development District

1810 Lake Avenue Knoxville Tennessee 37916 615-974-2385

50-537

June 16, 1976

RECEIVED JUN 29 1976 U.S. NUCLEAR REGULATORY COMMISSION Mail Section

ANDERSON COUNTY Clinton Lake City Norris Oak Ridge Oliver Springs
BLOUNT COUNTY Alcoa Friendsville Maryville Rockford Townsend
CAMPBELL COUNTY Caryville Jacksboro Jellico LaFollette
CLAIBORNE COUNTY Cumberland Gap New Tazewell Tazewell
COCKE COUNTY Newport Parrottsville
GRAINGER COUNTY Rutledge
HAMBLEN COUNTY Morristown
JEFFERSON COUNTY Dandridge Jefferson City White Pine
KNOX COUNTY Knoxville
LOUDON COUNTY Greenback Lenoir City Loudon Philadelphia
MONROE COUNTY Madisonville Sweetwater Tellico Plains Vonore
MORGAN COUNTY Oakdale Wartburg
ROANE COUNTY Harriman Kingston Rockwood
SCOTT COUNTY Huntsville Oneida
SEVIER COUNTY Gatlinburg Pigeon Forge Pittman Center Sevierville
UNION COUNTY Luttrell Maynardville

Mr. Paul H. Leach
NRC Environmental Project Manager
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC

Dear Mr. Leach:

SUBJECT: Clinch River Breeder Reactor Plant, Docket No. 50-537

When the East Tennessee Development District submitted comments earlier on the U.S. Nuclear Regulatory Commission's draft environmental statement related to constructing the Clinch River Breeder Reactor, we indicated we would be having meetings with public officials to discuss the project further.

These meetings now have been held. There have been meetings too between ETDD and CRBRP staffs and the ETDD staff has reviewed "Amendment 6" from Project Management Corporation. Our focus is and has been solely on the socio-economic impact of the breeder.

The following summarizes the major views presented by local officials and others:

The overriding concern of the local officials from the counties expected to feel the impact is the matter of financing the services anticipated for handling the needs of an additional 3000 persons during the peak of construction, both capital as well as operating costs. We feel a closer look should be taken at the financial burdens to be faced by local governments as a result of the project.

During a meeting with project officials, Ross McCauley, assistant manager for administration for ERDA-OR Operations, said ERDA would be willing to review and comment upon applications and project proposals from local governments for services being constructed, added to or improved upon, in which the breeder was a major factor and, if necessary, provide a supportive statement. We urge that this commitment, which was made verbally, be put in writing.

8517

ETDD and individual jurisdictions within the District also are concerned with the impact of large numbers of construction workers living in mobile homes near the CRBRP site. As I am sure you are aware, mobile home residents do not pay taxes as home owners do: the mobile homes are taxed as vehicles. Therefore, the burden for new classrooms--mobile or otherwise--and the costs of education, which is largely supported by the property tax, will have little effect in offsetting those costs. Also, although mobile homes are being used more often to meet the housing needs of District families they have not been used in large concentrations. The City of Oak Ridge excludes them altogether. To house this segment of the construction force effectively and with minimum adverse impact will require one or more large scale, well-developed mobile home "parks" with all the support services, a difficult accomplishment in counties that have strenuously resisted any form of zoning or other land use controls. The problems of initial capitalization of such a development and amortization of the investment in a short period of time is one that may preclude development by private enterprise of a quality necessary to assure long-term benefits to the community. We would like to see consideration given to the development of such sites by either local governments or local non-profit housing organizations, possibly on land now owned by TVA or ERDA.

We look to ERDA as the agency responsible for the breeder to develop alternatives that will ensure that their workers and those of the contractors are well housed while they are here and that the District is not left with major scars, physically or economically.

We also encourage all CRBRP agencies to participate in plans for the dispersal of CRBRP construction employees in apartments and houses throughout the area. We must work together to avoid major concentrations that may result in mass abandonment or undue concentrations of vacancies at the end of the construction period.

ETDD is concerned as we have said that an estimated 40 percent of the temporary work force will be inmigrants, in light of the 16 to 18 plus percent unemployment rates prevailing in Anderson and adjoining counties (outside of Oak Ridge). ETDD staff has requested of ERDA that far more than ordinary efforts be made to recruit, train, and hire persons in the region now unemployed. This request, I think, is strengthened by the existence of Training and Technology (TAT) in Oak Ridge which has provided highly specialized industrial training even though providing a significantly increased opportunity for out-migration of those trained has a significant and beneficial impact on the local economy. We realize that initiating and carrying through such a training/employment program is a difficult task at best, involving early and intensive coordination with trades and crafts unions and governmental agencies at all levels as well as a vigorous outreach program in the communities. ETDD and its

resources, ARC and others will be glad to work with ERDA, PMC and others in the development of such a program. I am sure that the East Tennessee Human Resource Agency (which would be the most likely and most intensively involved) would agree also.

The East Tennessee Development District also believes detailed information, relating to the socio-economic figures projected in Amendment 6, should be provided to the District and other similar agencies such as the East Tennessee Human Resource Agency upon request. We believe the guarantee that this will be done should be made in writing. The information is needed to do local and regional planning so that, indeed, there is the maximum, beneficial impact on the area that all of us would like to see occur.

The District also has received a letter from Phillip Ray Duncan, mayor of Lake City, outlining reasons why he feels the CRBRP will affect the Town of Lake City, which is located in Anderson County. (Lake City has been omitted from the study area.) Spencer D. Ralston, executive director of the East Tennessee Health Improvement Council, also has written that he feels additional medical services, that have not been taken into consideration, will be needed. Their letters are attached.

We also are attaching staff memoranda summarizing issues discussed at the public meetings.

Sincerely,

John W. Anderson, Jr.
Executive Director

JWA/GV/tg

cc Judge C. Howard Bozeman, Knox County
Mr. Albert B. Slusher, County Administrator, Anderson County
Judge William Russell, Loudon County
Judge S. Wallace Brewer, Roane County
Judge J. D. McCartt, Morgan County
Mayor Randy Tyree, Knoxville
Mayor Byron Hale, Clinton
Mayor Phillip Ray Duncan, Lake City
Mayor Douglas Boardman, Norris
Mayor A. K. Bissell, Oak Ridge
Mayor Pete Johnson, Oliver Springs
Mayor Tom Peeler, Greenback

Mayor Joe D. Grayson, Lenoir City
Mayor Eugene Lambert, Loudon
Mayor Roy Bledsoe, Philadelphia
Mayor Mickey Bingham, Oakdale
Mayor Roy McNeal, Wartburg
Mayor Morgan Collins, Harriman
Mayor James Henry, Kingston
Mayor Paul E. Layne, Rockwood
Mr. Jack Rains, Anderson County Regional Planning Commission
Mr. J. Leo Waters, Clinton Regional Planning Commission
Mr. Harry L. Watts, Lake City Municipal Planning Commission
Mr. Richard Sowell, Norris Regional Planning Commission
Mr. Lynn Noey, Oak Ridge Regional Planning Commission
Mr. Don Gilson, Metropolitan Planning Commission, Knoxville
Mr. Lee Thompson, Lenoir City Regional Planning Commission
Mr. Henry Mitchell, Loudon Regional Planning Commission
Mr. Ben Gaylon, Loudon County Regional Planning Commission
Mr. Floyd E. Freytag, Morgan County Regional Planning Commission
Mr. Robert Kyker, Harriman Regional Planning Commission
Mr. Maitland H. Baker, Kingston Regional Planning Commission
Mr. Walter Russell, Roane County Regional Planning Commission
Mr. Arvel McNelly, Rockwood Regional Planning Commission
Mr. George Brummett, Tennessee State Clearinghouse
Mr. E. W. Christopherson, Batelle Pacific N.W. Labs
Mr. E. H. Lesesne, Director of Water Management Planning, Tennessee Valley Authority
Mr. Mike Butler, Project Management Corporation
Mr. John Mayes, Tennessee State Planning Office
Mr. Gordon Acuff, East Tennessee Human Resource Agency
Mr. Spencer D. Ralston, East Tennessee Health Improvement Council

TOWN OF LAKE CITY

LAKE CITY, TENNESSEE
37769

JUN 14 1976

June 7, 1976

Ms. Georgiana Vines
Project Review Director
East Tennessee Development District
1810 Lake Avenue
Knoxville, Tennessee 37916

Dear Ms. Vines:

The Town of Lake City, Tennessee, with this letter, wishes to file a formal complaint against the Clinch River Breeder Reactor Plant's Environmental Report and Nuclear Regulatory Commission's Draft Environmental Statement.

The Town of Lake City is nine miles North of Clinton and has one of the busiest interchanges from I-75. Our Town is located on U.S. 25-W route which is a direct route to Clinton and Hwy 61 to Oak Ridge, over which workers from adjoining counties; Scott, Campbell, and Claiborne use to commute to and from Oak Ridge.

The Town of Lake City feels that a portion of the temporary workers expected to move into the County will find houses and trailer spaces in our area due to the opening of the new Norris Dam State Park. The Park has many facility advantages such as fishing, boating, and camping.

The Town of Lake City feels that having a dentist and the second of only two hospitals in the county, with three doctors and a complete staff of trained qualified personnel, this will intice workers to locate in our area.

We have the third largest high school in the county and this too will have a bearing on workers concerned with the education of their children.

Our Town has three full-time firemen, two fire trucks, six full-time policemen, two patrol cars, complete water and sewer facilities, four full-time garbage employees with once a week pick up, five full-time street employees, and two recreation parks. We feel we will be able to furnish necessary needs for permanent or temporary workers.

In addition to the above-mentioned, and in summary, we feel we will be able to furnish the needs and availability for roads, housing, schools, public safety, water and sewer, and health to provide living conditions in our area.

I feel and urge strong reconciliation in that our area be included in the CRBRP Environmental Impact Statement.

Yours truly,

Phillip Ray Duncan
Mayor

PRD/fh

sixteen counties in partnership for health
EAST TENNESSEE HEALTH PLANNING COUNCIL INC.
2016 Lake Ave. Knoxville, TN. 37916 Phone 615-974-2443

June 4, 1976

Mr. John Anderson
Executive Director
East Tennessee Development District
1810 Lake Avenue
Knoxville, TN 37916

Dear ~~Mr. Anderson:~~

Subject: Clinch River Breeder Reactor Project

The staff of the East Tennessee Health Improvement Council, Inc. has reviewed the health-related portions of the subject project. It appears from the large number of new employees and their families that will be moving into the area especially between the years 1978 to 1983 that additional medical services will be needed in the area at least on a temporary basis. Therefore, it appears that the project will have a definite impact on the medical services of the area. The local communities involved will have to plan for the services and will have the financial burden of providing these services.

The Oak Ridge Hospital of the United Methodist Church is presently adding 27 beds just to meet the current demands of the area. By 1980 the additional citizens of the area will put an increasing demand both on inpatient beds and on outpatient services.

It is the opinion of the East Tennessee Health Improvement Council, Inc. that the Clinch River Breeder Reactor Project should take into account the above problems of the local community.

Please contact me or John Schliesser of our staff if you have any questions in regard to our comments.

Sincerely,

Spencer D. Ralston
Executive Director

SDR/dn

cc: Dorothy Williams
Georgianna Vines

AREA WIDE COMPREHENSIVE HEALTH PLANNING

anderson campbell cocke hamblen knox monroe roane sevier
blount claiborne grainger jefferson loudon morgan scott union

APPENDIX B

TENNESSEE WILDLIFE RESOURCES COMMISSION
PROCLAMATION
ENDANGERED OR THREATENED SPECIES

APPENDIX B

TENNESSEE WILDLIFE RESOURCES COMMISSION
PROCLAMATION
ENDANGERED OR THREATENED SPECIES

Pursuant to the authority granted by Tennessee Code Annotated, Sections 51-905 and 51-907, the Tennessee Wildlife Resources Commission does hereby declare the following species to be endangered or threatened species subject to the regulations as herein provided. Said regulations shall become effective sixty days from this date.

SECTION I. ENDANGERED OR THREATENED SPECIES

FISH

ENDANGERED

Lake Sturgeon	*Acipenser fulvescens*
Ohio River Muskellunge (in Morgan, Cumberland, Fentress & Scott Counties)	*Esox masquinongy ohioensis*
Barren's Topminnow	*Fundulus sp. (cf. F. albolineatus)*
Spotfin Chub	*Hybopsis monacha*
Yellowfin Madtom	*Noturus flavipinnis*
Snail Darter	*Percina (Imostoma) sp.*

THREATENED

Silverjaw Minnow	*Ericymba bucatta*
Slender Chub	*Hybopsis cahni*
Blue Sucker	*Cycleptus elongatus*
______ Madtom	*Noturus sp. (cf. N. hildebrandi)*
Frecklebelly Madtom	*N. munitus*
Slackwater Darter	*Etheostoma boschungi*
Coldwater Darter	*E. ditrema*
Trispot Darter	*E. trisella*
Duskytail Darter	*E. (Catonotus) sp.*
Coppercheek Darter	*E. sp. (cf. E. maculatum)*
Longhead Darter	*Percina macrocephala*
Amber Darter	*P. (Imostoma) sp.*
Reticulate Logperch	*P. sp. (cf. P. caprodes)*

AMPHIBIANS

THREATENED

Tennessee Cave Salamander	*Gyrinophilus palleucus*

SECTION I. ENDANGERED OR THREATENED SPECIES (Continued)

REPTILES

THREATENED

Northern Pine Snake	*Pituophis m. melanoleucus*
Western Pigmy Rattlesnake	*Sistrurus miliarius streckeri*

BIRDS

ENDANGERED

Mississippi Kite	*Ictinea misisippiensis*
Golden Eagle	*Aquila chrysaetos*
Bald Eagle	*Haliaeetus leucocephalus*
Osprey	*Pandion haliaetus*
Duck Hawk	*Falco peregrinus*
Red-cockaded Woodpecker	*Dendrocopos borealis*
Raven	*Corvus corax*
Bachman's Sparrow	*Aimophila aestivalis bachmanii*

THREATENED

Sharp-shinned Hawk	*Accipiter striatus*
Cooper's Hawk	*A. cooperi*
Marsh Hawk	*Circus cyaneus hudsonius*
Bewick's Wren	*Thyromanes bewickii*
Grasshopper Sparrow	*Ammodramus savannarum*

MAMMALS

ENDANGERED

Indiana Myotis	*Myotis sodalis*
Gray Myotis	*Myotis grisescens*

THREATENED

River Otter	*Lutra canadensis*

SECTION II. REGULATIONS

Except as provided for in Tennessee Code Annotated, Section 51-906 (d) and (e), it shall be unlawful for any person to take, harass, or destroy wildlife listed as threatened or endangered or otherwise to violate terms of Section 51-905 (c) or to destroy knowingly the habitat of such species without due consideration of alternatives for the welfare of the species listed in (1) of this proclamation, or (2) the United States list of Endangered fauna.

TENNESSEE WILDLIFE RESOURCES COMMISSION

Dr. P. H. Clay [illegible]

Chairman

I certify that this is an accurate and complete copy of rules lawfully promulgated and adopted by the Tennessee Wildlife Resources Commission on the 12th day of June, 1975.

Harvey Bray

Secretary

Subscribed and sworn to before me this the 18th day of June, 1975.

Bobby L. [illegible]

Notary Public

My commission expires on the 18th day of December, 1976.

OAK RIDGE NATIONAL LABORATORY
OPERATED BY
UNION CARBIDE CORPORATION
NUCLEAR DIVISION

POST OFFICE BOX X
OAK RIDGE, TENNESSEE 37830

February 20, 1975

Ms. Betty Keppler
Ecosystems Department
Battelle-Northwest Labs.
Richland, WA 99352

Dear Betty:

Here are the acreages for the whole Reservation:

	Acres	% of Total
Hardwood	10,876	37
Pine Plantation	5,002	17
Natural Pine	4,888	16
Cedar & Pine	478	2
Hardwood-Cedar	1,660	5
Hardwood-Pine	5,959	20
Hardwood-Cedar-Pine	589	3
	29,443	100

Tom Kitchings
Tom Kitchings
Environmental Sciences Division
Building 3017

TK/clh

APPENDIX C

LETTERS FROM STATE OF TENNESSEE
REGARDING
ARCHEOLOGICAL AND HISTORIC RESOURCES

APPENDIX C

FROM, ER, AM I, PART II, G2

GOVERNOR
GRANVILLE HINTON
COMMISSIONER
PENN S. FOREMAN
ASSISTANT COMMISSIONER
TONY KOELLA
ASSISTANT COMMISSIONER

TENNESSEE DEPARTMENT OF Conservation
Division of Archaeology
5103 EDMONDSON PIKE • NASHIVLLE, TENNESSEE 37211

March 12, 1975

Mr. E. H. Lesesne
Director, Water Control Planning Division
Tennessee Valley Authority
448 Evans Building
Knoxville, TN 37902

Dear Mr. Lesesne:

I have reviewed the report submitted by Dr. Gerald F. Schroedl relating to the archaeological work done in the area of the Clinch River Liquid Metal Fast Breeder Reactor Facility and consider this work to be of excellent quality.

Dr. Schroedl's survey, judging by his report, was very through and brought to light many interesting archaeological and historic sites. His proposal to test the village area near the mound and the shell midden should provide valuable information on the Woodland and Archaic culture periods in the Clinch River area.

The Tennessee Valley Authority is to be commended for its interest and excellent support of the above archaeological research.

T.V.A. has properly considered all archaeological resources and has in my estimation asserted the proper mitigation. The results of the report and studies have shown that there are no sites worthy for nomination to the National Registry.

If you should have further questions or would like additional comments, please do not hesitate to call me.

Sincerely yours,

Joseph L. Benthall

Joseph L. Benthall
Director and State
Archaeologist

STATE OF TENNESSEE
TENNESSEE HISTORICAL COMMISSION
170 SECOND AVENUE, NORTH
NASHVILLE, TENNESSEE 37201
TELEPHONE (615) 741-2371

LAWRENCE C. HENRY, Executive Director
State Historic Preservation Officer

May 1, 1975

Mr. Edward H. Lesesne
Director of Water Control Planning
Tennessee Valley Authority
448 Evans Building
Knoxville, Tennessee 37902

Dear Mr. Lesesne:

This will acknowledge receipt of the report submitted by Dr. Gerald F. Schroedl on Historic Sites Reconnaissance in the Clinch River Breeder Reactor Plant Area.

We have reviewed this report and based on the information contained therein conclude that no structures of historical significance remain in the area. It is obvious that exhaustive efforts were put forth to make the report as complete as possible, and the results reveal that no properties eligible for entry in the National Register of Historic Places exist.

If I can be of further help, please let me know.

Sincerely,

Lawrence C. Henry

LCH/HLH/11

APPENDIX D

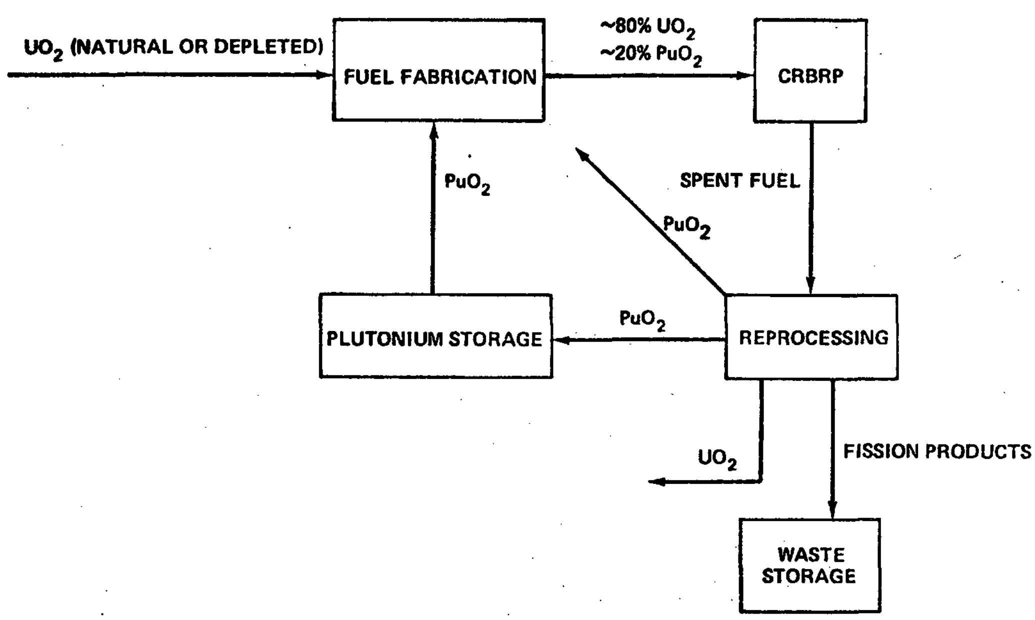
ENVIRONMENTAL EFFECTS OF THE CRBRP FUEL CYCLE AND TRANSPORTATION OF RADIOACTIVE MATERIALS

1. INTRODUCTION

In contrast to light water reactors (LWRs), a fast breeder reactor produces fissile fuel from fertile fuel at a rate higher than the original fissile fuel is expended in the production of thermal energy. The fissile fuel thus produced can be used in a reactor after it is separated from the discharged spent fuel and appropriately processed. The various fuel cycle steps involved are described in detail for a generic LMFBR in the Proposed Final Environmental Statement on the LMFBR Program.[1] A simplified schematic diagram of the fuel cycle for the proposed LMFBR demonstration plant is shown in Figure 1.

The initial feed materials would consist of plutonium (obtained from the reprocessing of light water reactor fuels) and depleted uranium (which is a by-product from the enrichment of the U-235 content of natural uranium). The plutonium would be converted to an oxide (PuO_2) at a reprocessing plant while the uranium, as the hexafluoride (UF_6), would be converted to an oxide (UO_2) at a fuel fabrication plant. Subsequently, at the fuel fabrication plant, plutonium dioxide and uranium dioxide would be combined and fabricated into fast breeder mixed-oxide fuel for seed assembly core components and uranium dioxide would be fabricated into assemblies for axial and radial blanket components of the reactor.

After exposure in the reactor, the irradiated fuel and blanket components would be stored at the reactor for a specified time. This permits decay of the shorter-lived fission products and reduces the component's decay-heat generation rates. Subsequently, they would be shipped in shielded casks to a reprocessing plant where the plutonium, uranium and



fission products would be chemically separated. The separated fission products would be shipped to a Federal waste-storage facility, and the plutonium recycled as fuel. The recovered uranium would either be stored or recycled into the mixed oxide or blanket UO_2. Depleted uranium from enrichment facilities would be used as make-up for the uranium that is either converted to plutonium in the reactor, lost as scrap in the fuel cycle process steps, or stored for later disposition.

An analysis of the predicted environmental impact from the fuel cycle associated with the CRBRP and the transport of radioactive materials between the supporting facilities is provided in the following discussion. This analysis is based on the quantities of materials required in a fuel cycle to maintain the CRBRP's operation.

The initial core loading will consist of approximately 6.5 metric tons (MT) of uranium and plutonium in the form of sintered mixed-oxide pellets of PuO_2 and UO_2 encapsulated in sealed stainless steel tubing (rods) which are formed into assemblies. Each of the 198 fuel subassemblies in the reactor core (108 inner core zone assemblies and 90 outer core zone assemblies) will contain 217 fuel rods. Plutonium enrichment will be 18.7 weight percent in the inner core zone and 27.1 weight percent in the outer zone of the first core. In future cores, the plutonium enrichment will be 22 weight percent in the inner core zone and 32 weight percent in the outer zones. With equilibrium loading, the reactor core would contain 1.7 MT of plutonium, and 4.8 MT of uranium.

An additional 21.7 MT of depleted uranium will be committed in the radial and axial blankets. The radial blankets, consisting of 150 assemblies each containing 61 rods, will contain 16.3 MT of depleted uranium. The two axial blankets, which are an integral part of the fuel core, will each contain 2.7 MT of depleted uranium.

During operation of the reactor, the irradiated fuel will become poisoned with fission products and fresh (unirradiated) fuel will be required. An estimated 2,300 fuel assemblies and 850 radial blanket assemblies would be used during the 30-year life of the plant. The total requirements of the plant during its life could be as high as 20 MT of plutonium and 210 MT of uranium.

The applicant stated in the Environmental Report (ER Sect. 3.8) that the first five years of plant operation would be carried out in a pre-equilibrium mode, while the balance of the plant operating life (25 years) would be carried out in an equilibrium mode. Notable differences between the two operational modes are indicated in Table 1. The quantities of materials and the material shipments for the CRBRP fuel cycle would be maximal during pre-equilibrium operation; however, the burnup of assemblies will be substantially less during the pre-equilibrium mode. The staff has therefore based its evaluation on the equilibrium mode with burnups of 100,000 megawatt-days per tonne except for transportation evaluation which is based on the pre-equilibrium mode with its greater transport requirements. The higher burnup equilibrium mode was selected for the balance of the evaluation because it is expected to have a greater radiological impact.

TABLE 1

NOTABLE DIFFERENCES BETWEEN CRBRP OPERATIONAL MODES

	Pre-equilibrium (5 years)	Equilibrium (25 years)
New Fuel Assemblies replaced/yr	102	66
Weight of Assemblies (tons)	26.3	17.0
Number of Fuel Assembly Shipments/yr	51	33
Number of Spent Fuel Assembly Shipments/yr	25.5	8
Number of Radial Blanket Assembly Shipments/yr	1.4	3

Mining and milling operations for the CRBRP fuel cycle are unnecessary since the feed materials employed would be by-products of the existing LWR fuel cycle. Otherwise, the related transportation steps are similar to those encountered in the LWR fuel cycle.[2] These include shipments of fuel feed materials (such as UF_6 and UO_2) and irradiated material (such as spent fuel, PuO_2 recovered in reprocessing spent fuel, and wastes from fuel fabrication, the reactor and reprocessing plants). Such shipments will normally be made by truck with appropriate restrictions regarding shipping conditions.[3] Where heavy packages are involved (e.g., a spent fuel cask weighing about 75 tons), shipments will be made by rail or truck. Since transportation has no intrinsic capacity factor in the same sense as a fixed facility, the transportation requirements in support of the CRBRP fuel cycle are discussed in terms of the annual pre-equilibrium fuel requirements.

2. ENVIRONMENTAL CONSIDERATIONS

a. Fuel Cycle Impacts

The environmental impact from the fuel cycle facilities supporting the CRBRP was established by utilizing information and data on fuel cycle impacts presented in references 1 through 7. References 8 and 9 were used for estimating reprocessing and waste radioactive source terms. A general analysis of the predicted environmental impacts resulting from the utilization and related shipments of materials in an annual fuel cycle for one 1000-MWe LMFBR is discussed in reference 1. This analysis is based on the quantities of materials required to maintain the CRBRP in operation annually, as reported in the ER. Although the staff used the LMFBR general analysis for overall guidance, specific reliance was placed on the staff's own analyses as found in references 2, 3, 4, and 7. Reference 5 was used only in the sense that, excepting safeguards review, the staff has completed its environmental impact analysis of the Recycle Fuels Plant which was used as a model for estimating impacts from mixed oxide fuel fabrication for the CRBRP. These impacts are summarized in Table 2.

The staff is aware that ERDA is planning a hot pilot plant at ORNL to be operational about 1986, with capability for reprocessing both FFTF and CRBRP fuel.[10] Besides being able to reprocess this fast reactor fuel, the plant would demonstrate the technology to be used in future production facilities for the same type of fuel. Some of the fuel cycle impacts, such as those from transportation, would thereby be reduced. Our estimates for releases have been conservatively based on expected operation of the hot pilot plant with partially reduced effectiveness of the equipment being demonstrated rather than its expected, later improved performance in a production facility.

The amount of land and water utilized by the supporting fuel cycle facilities is inconsequential when compared to the requirements of the power plant. The 18.3 acres of land committed for the fuel cycle facilities are less than 2% of the land committed for the power plant. The daily water discharge of 10^4 gallons via the air and 8.8×10^4 gallons to water bodies for the fuel cycle amount to approximately 0.2% of the water released from the power plant heat dissipation systems.

Fossil fuel requirements, in the form of electrical energy or equivalent coal in support of the CRBRP fuel cycle would be 3.97×10^3 MW-hr/yr or 1.44×10^3 MT/yr, respectively. These values are equivalent to 0.2% of the CRBRP output or to the use of 0.7 MWe by a coal-fired power plant.

Liquid and airborne non-radiological chemical effluent releases from the discharge systems during routine operation of the fuel cycle facilities should result in concentrations that are only a fraction of the state and Federal standards.

The annual estimated doses from ionizing radiation resulting from normal operation of the CRBRP fuel cycle facilities supporting the plant are given in Tables 3 and 4. Average doses from natural background radiation, fallout from weapons testing (based on 1970 data), and medical uses (based on average 1970 diagnostic use) are included for perspective. The data show that yearly population doses due to operation of these facilities would add very little to the impact of existing natural background and medical doses. Based on these data, the staff concludes that the resulting doses from the radiation fields due to fuel cycle facilities supporting the CRBRP would be well below maximum permissible concentrations (MPC's) as set forth in 10 CFR Part 20, Appendix B, well within Federal Radiation Council guidelines, and not significant.

TABLE 2

SUMMARY OF ENVIRONMENTAL CONSIDERATIONS FOR THE CRBRP FUEL CYCLE

	Fuel Fabrication					
Natural Resource Use	Mixed Oxide (Core Fuel)	Uranium Dioxide (Blanket)	Reprocessing	Waste Management	Transportation	Total
Land (acres)						
Temporarily Committed	3.3	5.8	8.3	--	--	17.4
Undisturbed Area	3.0	5.3	7.4	--	--	15.7
Disturbed Area	0.3	0.5	0.9	--	--	1.7
Permanently Committed	--	--	0.4	0.5	--	0.9
Total Land	3.3	5.8	8.7	0.5	--	18.3
Water (gallons/day)						
Discharged to air	4.0×10^2	8.8×10^2	8.7×10^3	390	--	1.0×10^4
Discharged to water bodies	2.3×10^2	1.47×10^3	8.6×10^4	52	--	8.8×10^4
Discharged to ground	--	--	--	980	--	980
Total Water	6.3×10^2	2.35×10^3	63.9×10^3	1420	--	6.7×10^4
Fossil Fuel						
Electrical Energy (MW-hr/yr)	1.50×10^2	8.15×10^2	3.0×10^3	230	---	4.2×10^3
Equivalent Coal (MT/yr)	5.4×10^1	2.95×10^2	1.1×10^3	82	--	1.5×10^3
Effluents						
Effluents-Chemicals						
Atmospheric* (MT/yr)						
SO_x	--	2.9	1.0	0.006	--	3.9
NO_x	2.6×10^{-3}	0.8	4.4	0.006	--	5.2
Hydrocarbons	--	7.6×10^{-3}	3.6×10^{-3}	0.004	--	1.5×10^{-2}
CO	--	2×10^{-2}	0.31	0.001	--	0.33
Particulates	--	0.86	0.35	0.004	--	1.2
HF	1.5×10^{-6}	7.2×10^{-4}	--	--	--	7.2×10^{-4}
NH_3	3.6×10^{-4}	1.4	--	--	--	1.4

TABLE 2 (Continued)

SUMMARY OF ENVIRONMENTAL CONSIDERATIONS FOR THE CRBRP FUEL CYCLE

Effluents (Continued)	Fuel Fabrication: Mixed Oxide (Core Fuel)	Fuel Fabrication: Uranium Dioxide (Blanket)	Reprocessing	Waste Management	Transportation	Total
Liquid (kilograms/yr)						
SO_4	0.6	--	87	--	--	87
NO_3	38	430	200	--	--	668
Cl	0.17	--	40	--	--	40
Na	43	--	59	--	--	102
NH_4	--	1400	--	--	--	1400
F	--	580	--	--	--	580
CaF_2	--	3700	--	--	--	3700
PO_4	8.0	16	1.35	--	--	26
Radiological (Curies/yr)						
Atmospheric						
Pu-236	4.2×10^{-10}	--	6.20×10^{-9}	--	--	7.40×10^{-6}
Pu-238	4.2×10^{-6}	--	7.4×10^{-5}	8×10^{-7}	--	7.2×10^{-5}
Pu-239	1.7×10^{-6}	--	2.8×10^{-5}	6.5×10^{-7}	--	1.5×10^{-5}
Pu-240	2.6×10^{-6}	--	4.2×10^{-5}	1.9×10^{-6}	--	2.0×10^{-5}
Pu-241	1.9×10^{-4}	--	3.2×10^{-3}	1.3×10^{-6}	--	2.2×10^{-3}
Pu-242	5.0×10^{-9}	--	8.2×10^{-8}	--	--	6.4×10^{-7}
Am-241	1.0×10^{-5}	--	1.6×10^{-5}	4.9×10^{-4}	--	5.2×10^{-4}
H-3	--	--	4.2×10^{2}	--	--	4.2×10^{2}
C-14	--	--	5.3×10^{-3}	--	--	5.3×10^{-3}
Kr-85	--	--	1.7×10^{4}	--	--	1.7×10^{4}
I-129	--	--	0.004	--	--	0.004
I-131	--	--	0.0064	--	--	0.0064
Ru-103	--	--	0.0035	$<10^{-5}$	--	0.0035
Ru-106	--	--	0.014	$<10^{-5}$	--	0.014
Particulate fission products	--	--	0.044	2×10^{-5}	--	0.044

TABLE 2 (Continued)

SUMMARY OF ENVIRONMENTAL CONSIDERATIONS FOR THE CRBRP FUEL CYCLE

	Fuel Fabrication					
Effluents (Continued)	Mixed Oxide (Core Fuel)	Uranium Dioxide (Blanket)	Reprocessing	Waste Management	Transportation	Total
Radiological (curies/yr)						
Liquid						
Pu-236	8.1×10^{-10}	--	--	--	--	8.1×10^{-10}
Pu-238	2.6×10^{-5}	--	--	--	--	2.6×10^{-5}
Pu-239	1.0×10^{-5}	--	--	--	--	1.0×10^{-5}
Pu-240	1.6×10^{-5}	--	--	--	--	1.6×10^{-5}
Pu-241	1.2×10^{-3}	--	--	--	--	1.2×10^{-3}
Pu-242	2.9×10^{-8}	--	--	--	--	2.9×10^{-8}
U-234	5.2×10^{-11}	2.1×10^{-4}	--	--	--	2.1×10^{-4}
U-235	--	2.5×10^{-5}	--	--	--	2.5×10^{-5}
U-236	--	3.2×10^{-5}	--	--	--	3.2×10^{-5}
U-238	5.8×10^{-11}	1.9×10^{-3}	--	--	--	1.9×10^{-3}
Th-231	--	2.5×10^{-5}	--	--	--	2.5×10^{-5}
Th-234	--	1.9×10^{-3}	--	--	--	1.9×10^{-3}
Am-241	4.2×10^{-6}	--	--	--	--	4.2×10^{-6}
Pa-234	--	1.9×10^{-3}	--	--	--	1.9×10^{-3}
Thermal (Btu/yr)	2.2×10^{7}	4.6×10^{7}	2.1×10^{10}	3.3×10^{10}	5.0×10^{6}	5.4×10^{10}

*Based upon combustion of equivalent coal for power generation.

TABLE 3

COMPARISON OF MAXIMUM INDIVIDUAL DOSES DUE TO NORMAL EFFLUENTS FROM THE CRBRP SUPPORTING FUEL CYCLE WITH OTHER SOURCES(6,11)

Radiation Source	Dose (millirems/year)[a]
Fuel Fabrication Plant	0.17[b]
Fuel Reprocessing Plant	0.04[c]
Transportation (other than to and from the CRBRP)	10[d]
Storage of Radioactive Waste	negligible
<u>Other Sources of Radiation</u>	
Natural Background	100[e]
Fallout	4[f]
Medical Use (diagnostic only)	72[f]
Television	0.1[f]

a. Normalized for the CRBRP supporting fuel cycle facilities for one year.
b. Bone dose.
c. G.I. tract dose.
d. Total-body dose; value assumes exposure for 12 minutes @ 50 mrem/hr.
e. External natural background for Eastern Tennessee.
f. 1970 average doses from reference 12.

TABLE 4

ANNUAL POPULATION DOSES DUE TO THE NORMAL EFFLUENTS FROM THE CRBRP SUPPORTING FUEL CYCLE.[6,11]

Radiation Source	Annual Dose (man-rems)[a,c]
Fuel Fabrication Plant	0.7
Fuel Reprocessing Plant	15
Transportation (other than to and from the CRBRP)	0.5
Storage of Radioactive Waste	negligible
TOTAL	16
Other Sources of Radiation[b]	
Natural Background	2.1×10^7
Fallout	8.4×10^5
Medical Use (diagnostic only)	1.55×10^7
Television	2.1×10^4

a. Normalized for the CRBRP supporting fuel cycle; includes gaseous and liquid effluents and direct radiation.

b. 1970 average doses taken from reference 12 for a U.S. population of 210,000,000 people.

c. The man-rem population dose is the summation of individual doses among the population and reflects dose impact as a whole. The natural background dose of 21,000,000 man-rem, for example, is accrued by 210,000,000 persons if each receives a background dose of 0.10 rem per year.

b. Transportation of Radioactive Materials in the Fuel Cycle

An analysis of the quantities of radioactive material and their transport requirements to maintain the CRBRP during operation in the pre-equilibrium period was performed by the staff. The materials considered in this analysis were divided into three categories: unirradiated fuel, materials and assemblies; irradiated fuel; and irradiated waste. Table 5 summarizes the estimated material quantities that would be generated and the number of shipments made in the operation of the CRBRP fuel cycle.

Shipments of incoming and outgoing radioactive materials to and from the CRBRP will be carried out by commercial trucks and railroads. As shown in Table 6, the staff estimates that approximately 58 incoming shipments and 46 outgoing shipments would be made annually during pre-equilibrium phase of operation. During equilibrium operation, the estimated number of shipments would decrease to approximately 46 incoming and 35 outgoing shipments annually.

Protection of the public and transport workers from radiation during shipment of radioactive materials is achieved by conforming to standards for package design and lading control. Primary reliance for safety in transport of radioactive material is placed on the packaging.[3,13] The packaging must meet applicable Federal and state regulatory standards which provide that the packaging shall prevent the loss or dispersal of the radioactive contents, retain shielding efficiency, assure nuclear criticality safety and provide adequate heat dissipation under both normal conditions of transport and specified damage test conditions (i.e., the design basis accident). The contents of the package must also be controlled so that the standards for external radiation levels, temperature, pressure and containment are met.[12,14]

c. Environmental Effects of Transportation to and from the CRBRP

1. Heat Load

The heat load per shipping container for all unirradiated materials (Table 5) is expected to have essentially no impact on the environment. The temperature of the outer surfaces of these packages would be no higher than 5°F above the average ambient air temperature.

The design rate of release of heat to the air from casks designed to transport irradiated materials would be about 26 kW, or about 90,000 BTU/hr.[16] This rate can be compared with the rate at which waste heat is released from a 100-hp truck engine operating at full power, about 50 kW or 180,000 BTU/hr.[2] With the cask coolant system operating normally, the temperature of the cask surface would be less than 50°F above ambient temperature; in any case, the temperature of accessible cask surface would not exceed 180°F in accordance with regulations.[15] Because the amount of heat would be small and would be released over the entire transportation route, no appreciable effect on the environment would result.

2. Traffic Density

The projected number of annual shipments of each type of package is tabulated in Table 6. The traffic would be over public roads via truck for unirradiated shipments and the number of these shipments would be very small compared with normally expected traffic density. Irradiated material shipments by rail would require an average of about 33 railroad car shipments per year. The empty casks would be returned to the CRBRP. The weight of the spent fuel in the loaded cask would constitute only about 2% of the total weight of the loaded casks. Because the cask being returned empty weighs almost as much as the cask loaded with irradiated assemblies, the weight and number of shipments of empty casks must be considered in assessing the impact on the environment of the shipping of irradiated fuel. Shipping irradiated assemblies would therefore involve about 66 rail-car shipments, including return shipments of the cask. The total number of shipments would be too small to have any measurable effect on the environment as a result of increase in traffic density.

TABLE 5 - A SUMMARY OF MATERIALS AND QUANTITIES SHIPPED FOR THE CRBRP

Type of Shipment	Mode of Transport	Quantity Shipped Per year[a] (kg)	Quantity Shipped Per Package[a] (kg)	No. of Packages Per Vehicle	Heat Generation Rate Per Package (W)	Est. Activity Per Package (Ci)	Avg. No. of Shipments Per Year	Est. Avg. Shipping Distance[g,h] (miles)	Shipment Destination[i]
				Unirradiated Material					
UF_6	Truck	12,437	8,604	1		3.21	1.45	750	FP
UO_2	Truck	11,514	97	64	2.6×10^{-3}	1.60	1.85	750	FP
PuO_2	Truck	1,250	9	64	81	1.04×10^{5}	2.17	750	FP
Fresh Core Assembly	Truck	20,502	201	2	218	2.8×10^{5}	51	750	PS
Fresh Blanket Assembly	Truck	3,107	239	2	6.3×10^{-3}	3.78	6.5	750	PS
				Irradiated Material					
Spent Core Assembly	Rail	20,502	804	1	24×10^{3}	2.17×10^{6}	25.5	750	RP
Spent Blanket Assembly	Rail	3,107	2,151	1	15.8×10^{3}	6.78×10^{5}	1.44	750	RP
Radial Shield Assembly	Rail	8,160	3,060	1	3.06×10^{3}		2.67	750	RP
Control Rod Assembly	Rail	2,591	864	1			3	750	RP

Type of Shipment	Mode of Transport	Quantity Shipped Per Year (ft3)	Quantity Shipped Per Package (ft3)	No. of Packages Per Year	No. of Packages Per Vehicle	Heat Generation Rate Per Shipment (W)	Est. Activity Per Shipment (Ci)	Avg. No. of Shipments Per Year	Est. Avg. Shipping Distance[g,h] (miles)	Shipment Destination[i]
				Waste From Fuel Preparation and Fabrication Plants						
α Waste	Rail	3,587[b]	c	c	c	22.5	2.79×10^{4}	3.6	1000	FR/BG
Low Level $\beta - \gamma$ Waste	Truck	15,057[b]	7.4	2035	64	2×10^{-3}	0.475	31	500	BG
				Solid Waste From CRBRP						
Low-Level β-γ Waste										
Compactible	Truck	284	7.4	38	64		0.03	0.6	500	BG
Non-Compactible	Truck	1187	7.4	160	64		34	2.5	500	BG
Solidified liq Radwaste	Truck	1000	7.4	135	15		6	9	1000	FR/BG
Metallic Sodium	Truck	42	7	6	15		25	.4	1000	FR/BG
Sodium Bearing Solids	Truck	235	TBD[j]	TBD	TBD		TBD	TBD	1000	FR/BG

(CONTINUED)

TABLE 5 (CONT'D) A SUMMARY OF MATERIALS AND QUANTITIES SHIPPED FOR THE CRBRP

Type of Shipment	Mode of Transport	Quantity Shipped Per Year (ft3)	Quantity Shipped Per Package (ft3)	No. of Packages Per Year	No. of Packages Per Vehicle	Heat Generation Rate Per Shipment (W)	Est. Activity Per Shipment (Ci)	Avg. No. of Shipments Per Year	Est. Avg. Shipping Distance[g,h] (miles)	Shipment Destination[i]
				Solid Waste From Reprocessing Plants						
α Waste	Rail	267[b]	c	c	c	22.5	2.79×10^4	0.27	1000	FR/BG
α-β-γ Waste	Rail	694[b]	25	28	3	1.12	500	10	1000	FR/BG
Low-Level-β -γ Waste	Truck	1041[b]	7.4	141	64	2×10^{-3}	0.475	2.2	500	BG
Cladding Hulls	Rail	58[d]	3.5	17	36	10.3×10^3	1.46×10^6	.47	1000	FR/BG
High-Level Waste	Rail	19	6.28	3.04	12	2.5×10^4	7.8×10^6	.25	1500	RSSF
Noble Gases	Truck	0.6[e]	0.6[f]	1	6	1.47×10^3	9.0×10^5	0.167	1500	NGSF
Iodine	Truck	0.027	0.16	0.17	64	1.0×10^{-3}	1.46	0.0026	1000	FR/BG

[a]All quantities of materials shipped are given in kilograms of heavy metal.

[b]Compacted a factor of 10 from original volume generated.

[c]Alpha waste is packaged in 55-gal (7.4-ft^3) drums and large boxes; each rail car contains 1000 ft^3 of waste.

[d]Hulls compacted to 8.8 ft^3 per ton of fuel.

[e]Compressed gas at 2,200 psi.

[f]Standard gas cylinder.

[g]Estimated distance to one-of-a-kind repository, 1500 mi; between facilities, 750 mi; to multiple burial ground sites, 500 mi.

[h]Distance of 1000 mi is a compromise between 1500 mi to one-of-a-kind repository and 500 mi to multiple burial ground sites.

[i]FP: fabrication plant; PS: power station; RP: reprocessing plant; FR: Federal repository; BG: burial ground; RSSF: retrievable surface storage facility; NGSF: noble gas storage facility.

[j]TBD: To be determined.

TABLE 6 - TRANSPORTATION OF RADIOACTIVE MATERIALS TO AND FROM THE CRBRP

	Number of shipments/yr (first 5 years)	Number of shipments/yr (after 5 years)	Probable mode of transportation
A. Incoming Shipments			
New Fuel Elements			
Core Assemblies	51	33	truck
Radial Blanket Assemblies	6.5	13	truck
TOTAL	57.5	46	
B. Outgoing Shipments			
Irradiated Fuel Elements			
Core Assemblies	25.5	8	rail
Radial Blanket Assemblies	1.44	3	rail
Replacement In-vessel Components			
Control Rod Assemblies & Drive Lines	3	3	rail
Radial Shield Assemblies	2.67	5.5	rail
Solid Radwaste			
Compactible Solids	0.44	0.25	truck
Non-Compactible Solids	2.84	5.5	truck
Solidified Liquid Radwaste	9.7	9.7	truck
Metallic Sodium	0.4	0.4	truck
TOTAL	45.99	35.35	

3. Radiation Exposure

Estimates of the doses to transport workers and the general population from the shipment of incoming and outgoing radioactive material to and from the CRBRP are tentative because the supplier and reprocessor of the assemblies and the burial site(s) for the radioactive waste have not been established. Comparative estimates have been made for a 1000-MWe model LMFBR.[1] Using similar assumptions, based on average, realistic model conditions as to radiation fields outside of packages, shipping distance, exposure times and number of people exposed, the radiological doses from the transportation of radioactive materials for the CRBRP were derived. These are compared with the values for the model LMFBR in Table 7. As noted in the table, the cumulative radiation dose to transport workers and the general population is approximately 17 man-rem per year for the CRBRP and 10 man-rem for the model LMFBR. The difference is attributable to the higher number of shipments performed during the pre-equilibrium operational mode. This dose would be uniformly distributed along the route among approximately 750,000 people.[3] Due to average normal background radiation (about 130 mrem per person per year), these same people receive about 97,500 man-rem per year.

Based on the above analysis, the staff concludes the doses to transport workers and the general population associated with the shipment of radioactive material to and from the CRBRP would be negligible, for they would be indistinguishable from the doses attributable to natural sources.

TABLE 7

ESTIMATED TOTAL-BODY DOSES TO TRANSPORT WORKERS AND THE GENERAL PUBLIC FROM SHIPMENT OF RADIOACTIVE MATERIALS TO AND FROM A 1000-MWe MODEL LMFBR AND THE CRBRP[a]

	MAN-REM RECEIVED PER YEAR			
	1000 MWe Model LMFBR		CRBRP	
	Transport Workers	General Population	Transport Workers	General Population
A. Incoming Shipments				
New Fuel Elements				
Core Assemblies	2.40	0.56	7.1	1.65
Radial Blanket Assemblies	0.038	0.0093	0.084	0.021
B. Outgoing Shipments				
Irradiated Fuel Elements				
Core Assemblies	5.10	0.73	5.7	0.82
Radial Blanket Assemblies	0.92	0.13	0.95	0.13
Solid Radwaste	0.048	0.0117	0.21	0.07
TOTAL	8.45	1.43	14.04	2.69

[a]Packages must meet DOT limits on external dose rates.

REFERENCES

1. Proposed Final Environmental Statement, Liquid Metal Fast Breeder Reactor Program, Volume II, Section 4.5, U.S. Atomic Energy Commission, WASH-1535, December 1974.

2. Environmental Survey of the Uranium Fuel Cycle, Section H, U.S. Atomic Energy Commission, WASH 1248, April 1974.

3. Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants, U.S. Atomic Energy Commission, WASH-1238, December 1972; Docket No. 71-9026, LMFBR Spent Fuel Shipping Cask Model I-(182)-1, Aerojet General Manufacturing Company.

4. Final Generic Environmental Statement on the use of Recycle Plutonium in Mixed Oxide Fuel in Light Water Reactors, NUREG-0002, Volume 3, Chapter IV, U.S. Nuclear Regulatory Commission, WASH-1327, August 1976.

5. "Recycle Fuels Plant Environmental Report," Westinghouse Electric Corporation, July 1973, Docket No. 70-1432.

6. Clinch River Breeder Reactor Environmental Report, Volume 2, Section 5.3, Project Management Corporation, April 7, 1975, Docket No. 50-537.

7. Draft Supplement to the Final Environmental Statement related to the Construction and Operation of Barnwell Nuclear Fuel Plant, Allied-General Nuclear Services, NUREG-0082, Supp. 1 (Draft), June 1976.

8. M. J. Bell, ORIGEN - The ORNL Isotope Generation and Depletion Code, ORNL-4628 (May 1973). Uses LMFBR cross section library.

9. M. E. Meek and B. F. Rider, "Compilation of Fission Product Yields," NEDO-12154-1, Vallecitos Nuclear Center, General Electric Company, January 26, 1974.

10. W. D. Burch, M. J. Feldman, W. E. Unger, and B. L. Vandva, LMFBR Reprocessing Program, Progress Report for Period January 1 to March 31, 1976, ORNL/TM-5463, Oak Ridge National Laboratory.

11. Reference 1, Volume I, Section 1.4.2, Table 1.4-1.

12. The Safety of Nuclear Power Reactors and Related Facilities, U.S. Atomic Energy Commission, WASH-1250, July 1973.

13. 10 CFR Part 71, Packaging of Radioactive Material for Transport and Transportation of Radioactive Material under Certain Conditions.

14. 49 CFR 170-179 (for classification, packaging, labeling and carriage by rail or truck.

15. 49 CFR 173.393(e). Shipping: General Packing Requirements.

16. Flagg, A. H.; "LMFBR Spent Fuel Shipping Cask," Proceeding 4th International Symposium on Packaging and Transportation of Radioactive Materials, CONF-740901-P1, p. 174ff. (Sept. 1976.)

APPENDIX E

SAFEGUARDS REQUIREMENTS FOR SPECIAL NUCLEAR MATERIALS AT FIXED SITES AND IN TRANSIT

INTRODUCTION

Terrorist activities over the past few years have sparked interest and concern at the highest levels of Government for the safety and security of the Nation's critical resources. Where nuclear materials are concerned, the fear of theft is compounded by the possibilities of internal diversion. NRC's safeguards measures, designed to counter such threats, are contained in 10 CFR Part 70 and 10 CFR Part 73, which outline material accountability requirements and physical protection requirements, respectively. The regulations are supplemented by detailed "regulatory guides" that provide licensees with acceptable methods by which requirements may be satisifed. The objectives, simply stated, are to deny access to unauthorized persons and prevent misuse or diversion by those who are authorized access to nuclear materials. The following are highlights of current requirements for protecting special nuclear materials against theft or diversion and for protecting facilities, where special nuclear materials are used or stored, against acts of sabotage which could be inimical to the national security or to the public health and safety.

PHYSICAL PROTECTION OF SPECIAL NUCLEAR MATERIAL AT FIXED LOCATIONS

Each person who is licensed or applies for a license to possess or use at any site or contiguous site uranium-235 (contained in uranium enriched to 20 percent or more in the U-235 isotope), uranium-233, or plutonium alone or in any combination in a quantity of 5,000 grams or more computed by the formula, grams = (grams contained U-235) + 2.5 (grams U-233 + grams plutonium), must comply with established physical protection requirements. A physical protection plan must be submitted to the NRC for approval, and must demonstrate how the licensee will satisfy the following regulatory requirements:

Physical Security Organization

The licensee must maintain a physical security organization, including armed guards, to protect his facility against industrial sabotage and the special nuclear material in his possession against theft. At least one supervisor of the security organization must be onsite at all times. The licensee must establish, maintain, and follow written security procedures which document the structure of the security organization and which detail the duties of guards, watchmen, and other individuals responsible for security. All guards or watchmen must be properly trained, equipped, qualified, and requalified at least annually.

Physical Barriers

All "vital equipment," which is defined as any equipment, system, device, or material whose failure, destruction or release could directly or indirectly endanger public health and safety, must be located within a separate structure or barrier designated as a "vital area." All vital areas and material access areas must be located within a larger protected area which is surrounded by a physical barrier. An isolation zone is required around the outer physical barrier and it must be kept clear of obstructions, illuminated and monitored to detect the presence of individuals or vehicles attempting to gain entry to the protected area, and allow response by armed members of the facility security organization to suspicious activity or to the breaching of any physical barrier. Special nuclear material not in process must be stored in a vault or in a vault-type room equipped with an intrusion alarm. Each vault or vault-type room is to be controlled as a separate material access area. Enriched uranium scrap in the form of chips, small pieces, cuttings, solutions, etc., in 30-gallon or larger containers and with a U-235 content of less than 0.25g/ℓ may be stored within a locked, separately-fenced area located within a protected area and no closer than 25 feet to the perimeter of that protected area. When unoccupied, this storage area must be protected by a guard or watchman who must patrol at intervals not to exceed four hours, or by intrusion alarms.

Access Controls

Personnel and vehicle access into a protected area, material access area, or vital area must be controlled. A picture badge identification system must be used and visitors must be registered and escorted. Individuals and packages entering the protected area are required to be searched. Admittance to a vital area or material access area must be controlled and access limited to those persons who require such access to perform their duties. Methods of observing individuals within a material access area to assure that special nuclear material is not being diverted must be provided and used on a continuing basis. All individuals, packages, or vehicles must be searched for concealed nuclear material before exiting from a material access area. Keys, locks, combinations and related equipment are required to be controlled to minimize the possibility of compromise.

Intrusion Alarms

All emergency exits in the protected area, vital areas and material access areas must be alarmed. Each unoccupied material access area must be locked and alarmed. All alarms must annunciate in a continuously manned central alarm station located within the protected area and in at least one other continuously manned station. All alarms must be self-checking and tamper indicating, and inspected and tested for operability and required functional performance at specified intervals not to exceed 7 days.

Communications

Each guard or watchman on duty must be capable of maintaining continuous communications with an individual in a continuously manned central alarm station within the protected area who must be capable of calling for assistance from other guards and from local law enforcement authorities. To provide the capability of continuous communication with local law enforcement authorities, two-way radio voice communications must be available in addition to conventional telephone service. All communications equipment must remain operable from independent power sources in the event of loss of primary power, and must be tested for operability and performance at least once at the beginning of each security personnel work shift.

Response Capability

Licensees must establish liaison with local law enforcement authorities, and be prepared to take immediate action to neutralize threats to the facility by appropriate direct action, calling for assistance from local law enforcement authorities, or both.

Records

Security records must be maintained of all individuals authorized access to vital and material access areas, including visitors, vendors, and others not employed by the licensee. Routine security tours, and all of the tests, inspections, and maintenance on security related equipment and structures must be documented. A record must be maintained on each alarm, false alarm, alarm check, intrusion indication, or other security incident, including the details of the response by facility guards.

Reports to NRC

Suspected thefts, unlawful diversions, and/or industrial sabotage must be reported immediately to NRC, followed by a written detailed report within 15 days.

PHYSICAL PROTECTION OF SPECIAL NUCLEAR MATERIAL IN TRANSIT

Each licensee who transports or delivers to a carrier for transport uranium-235 (contained in uranium enriched to 20 percent or more in the U-235 isotope), uranium-233, or plutonium alone or in any combination in a quantity of 5,000 grams or more computed by the formula grams = (grams contained U-235) + 2.5 (grams U-233 + grams plutonium) must submit a plan to NRC for review and approval, outlining the methods to be used for the protection of special nuclear material in transit. Following approval, the licensee is not permitted to make any change that would decrease the effectiveness of the plan without the prior approval of the NRC. The plan must demonstrate the means to be used in meeting the following requirements:

General Requirements

If a common or contract carrier is used, the special nuclear material must be transported under the established procedures of the carrier which provide a system for the physical protection of valuable material in transit and require a hand-to-hand receipt at origin and destination and at all points en route where there is a transfer of custody. Transit times of all shipments must be minimized and routes selected to avoid areas of natural disaster or civil disorders. Special nuclear material must be shipped in containers which are sealed by tamper-indicating type seals. The outer container or vehicle is required to be locked and sealed. No container weighing 500 pounds or less may be shipped on open vehicles, such as open truck or railway flatcars.

Road Shipments

All shipments by road must be made without any scheduled intermediate stops to transfer special nuclear material or other cargo between the point of origin and destination. All motor vehicles are required to be equipped with a radio-telephone. Calls must be made at predetermined intervals, normally not to exceed 2 hours, and if calls are not received when planned, the licensee or his agent must immediately notify an appropriate law enforcement authority and the NRC. Shipments by road must be accompanied by at least two people in the transport vehicle. When a specially designed transport vehicle with immobilization and penetration resistant features is used, armed guards are not required. In the absence of immobilization features, armed guards must accompany the shipment. In those instances when the transport vehicle has neither immobilization nor penetration resistant features, at least two armed guards must accompany the shipment in a separate escort vehicle equipped with a radio-telephone.

Air Shipments

Shipments of special nuclear material in quantities exceeding 20 grams or 20 curies, whichever is less, of plutonium or uranium-233 and in excess of 350 grams of uranium-235 (enriched to 20% or more in the U-235 isotope) are prohibited on passenger aircraft. Shipments on cargo aircraft are required to be arranged so as to minimize the number of scheduled transfers. Such transfer, when necessary, must be monitored by armed guards.

Rail Shipments

Rail shipments must be escorted by two armed guards in the shipment car or in an escort car. Continuous on-board radio-telephone communications capability must be provided with conventional telephone backup. Periodic calls to the licensee or his agent are required at the same time intervals as for road shipments.

Sea Shipments

Shipments by sea must be made on vessels making the minimum ports of call. Transfer at domestic ports from other modes of transportation must be monitored by a guard. Shipments must be placed in a secure compartment which is locked and sealed. Export shipments must be escorted by an authorized individual, who may be a crew member from the last port in the U. S., until it is unloaded in a foreign port. Ship-to-shore communications must be made every twenty-four hours to relay position information and the status of the shipment as determined by daily inspections.

Reports on Nuclear Shipments

A licensee who makes a shipment must notify the consignee of the shipment schedule and details, including the estimated time of arrival of the shipment. A licensee who receives a shipment must immediately notify the shipper. Shipments which fail to arrive at the destination on time must be traced.

Reports to NRC

Unaccounted for shipments must be reported immediately to NRC, followed by a detailed written report within 15 days.

SPECIAL NUCLEAR MATERIAL ACCOUNTABILITY

Each person who is licensed or applies for a license to possess at any one time and location more than one effective kilogram* of special nuclear material in unsealed form is required to comply with detailed material accountability requirements as stipulated in his fundamental nuclear material control plan, which he must submit to NRC for approval. The plan must demonstrate compliance with the following:

Facility Organization

Responsibility for the material accountability functions must be assigned to a single individual at an organizational level sufficient to provide independence of action. The SNM custodial, measurement, accounting, and audit functions must be separated in a manner which assures that the activities of one organizational unit or individual serves as control over and checks the activities of another organizational unit or individual.

A manual of approved current material accountability procedures must be maintained and reflected in the facility process specifications, manufacturing instructions and standard operating procedures. A formal program for the training and periodic requalification of personnel assigned to SNM accountability functions must be developed and documented.

Facility Operation

Material Balance Areas (MBAs) or Item Control Areas (ICAs) must be established for physical and administrative control of nuclear material. The custody of all nuclear material within any MBA or ICA must be the responsibility of a single individual. Each MBA must be an identifiable physical area such that material assigned to a given area is kept separate from material assigned to any other area, and such that the quantity of nuclear material moved into or out of an MBA is represented by a measured value.

Item Control Areas (ICAs) may be established according to the same criteria as that used for Material Balance Areas (MBAs) except material is inventoried, and moved into or out of ICAs by item identity and count. The validity of previously measured quantities of SNM must be assured by the application of tamper-indicating seals or devices applied to each item or container.

The number of ICAs and MBAs established at a plant must be sufficient to localize nuclear material inventory discrepancies.

*"Effective kilograms of special nuclear material" means: (1) for plutonium and U-233, their weight in kilograms; (2) for uranium with an enrichment in the isotope U-235 of 0.01 (1%) and above, its element weight in kilograms multiplied by the square of its enrichment expressed as a decimal weight fraction; and (3) for uranium with an enrichment in the isotope U-235 below 0.01(%), its element weight in kilograms multiplied by 0.0001.

Measurement and Statistical Controls

The licensee is required to determine by measurement the nuclear material content of all receipts, shipments, discards, and material on inventory. The identity of the various measurements that are used in nuclear material control, including a description of measurement methods and procedures with statements of measurement uncertainties must be provided. Error models including the basic statistical methodology and techniques are required to demonstrate the licensee's capability of meeting adequate measurement criteria.

A system of control must be established and maintained that will assure that measurement uncertainties during any material balance period does not exceed (i) 200 grams of plutonium or uranium-233, 300 grams of highly enriched uranium or the uranium-235 contained in greater than 20% enriched uranium, (ii) those limits specified in the following table, or (iii) other limits approved by the NRC as discussed below.

Material Type	Measurement Uncertainty on Any Total Plant Inprocess Material Balance (expressed as a percentage of additions to or removals from material in process, whichever is greater)
Plutonium element or uranium-233 in a chemical reprocessing plant	1.0%
Uranium element and fissile isotope in a reprocessing plant	0.7%
Plutonium element, uranium-233, or high enriched uranium element and fissile isotope - all other	0.5%
Low enriched uranium element and fissile isotope - all other	0.5%

The NRC will approve higher limits than specified if an applicant demonstrates that he has made reasonable efforts and cannot meet the prescribed limits and he has or will initiate a program to enable him in time to meet these limits.

Plant operators are required to establish and maintain a measurement control program covering all of the components of measurements used for material accountability purposes. This program must include organizational controls for the management of measurement quality, training and performance qualification requirements, a standards and calibration system, a quality testing system for the determination and the control of systematic and random errors, a records evaluation system for the collection and statistical analysis of data, and a system of management audits and reviews.

Inventories

NRC requires physical inventories of plutonium, uranium-233, and uranium enriched 20% or more in the isotope uranium-235 to be conducted every two months except for material that is in the inaccessible portion of an irradiated-fuel reprocessing plant. Uranium enriched less than 20% in the isotope uranium-235, plutonium-238 and all special nuclear material in the inaccessible portion of irradiated-fuel reprocessing plants must be inventoried every 6 months. (Licensees authorized to possess less than one effective kilogram, but more than 350 grams of special nuclear material, are required to conduct annual physical inventories.)

The principal measure of special nuclear material control is the magnitude of inventory discrepancies. This measure is a calculated value which represents the difference between the amount of material that is supposed to be present according to the accounting records (taking into account measured receipts, transfers, and discards) and the amount of material actually found to be present during a physical inventory. The probability that no inventory discrepancy will exist is very small since the measurements required to establish the amount of material present are subject to error. A knowledge of the magnitude of these measurement errors is necessary for the proper interpretation of an inventory discrepancy.

The Commission is proposing new guidelines to assure that corrective action will be taken when the amount of inventory discrepancy reaches NRC's allowable limits. Under the regulation published for public comment on July 17, 1975, explicit limits are specified for inventory discrepancies. More significantly, the new regulation would require specific actions to be taken such as immediate reinventory, investigation of excessive inventory discrepancies or adoption of new procedures to prevent recurrence. In the case of a reinventory, it may be necessary in some cases to shut down the plant.

Storage and Internal Control

A documented system of control over the nuclear material within a facility must be maintained. All transfers of material between MBAs and ICAs must be documented and validated. A centralized accounting system using double entry bookkeeping with subsidiary accounts for each material balance area and item control area must be established and maintained. Procedures for reconciliation of control and subsidiary accounts with each other and to the results of a physical inventory at the end of each accounting period must be established and followed. Storage and internal handling controls must be established, maintained, and followed to provide information on a timely basis related to the identity, quantity, and location of all SNM within a plant in discrete items or containers. A unique item identification system must be established to ensure that no two items can have the same number. All containers and items of material in the form of unopened receipts, finished products or waste, and scrap awaiting offsite transfer should be stored on the basis of measurements. Records must be maintained which show the identity, source and disposition of all items.

A program must be developed and implemented for the control, processing, and disposition of scrap. The uncertainty of such measurements, if large, could be used to mask a theft. No item of scrap generated in a facility that is measured with an uncertainty of greater than ± 10 percent is permitted to remain on inventory longer than six months when such scrap contains plutonium, U-233, or uranium enriched 20 percent or more in the isotope U-235, or twelve months when such scrap contains uranium enriched to less than 20 percent in the isotope U-235 or plutonium containing 80 percent or more by weight of the isotope Pu-238.

Shipping/Receiving

As a rule, shipments and receipts are required to be independently measured by both the shipper and receiver.

Shipper/receiver differences must be reviewed and evaluated on an individual container or lot basis, on a shipment basis, and on a cumulative basis for shipments of like-type material. Appropriate investigative action must be taken on all shipper-receiver differences greater than 50 grams which are statistically significant at the 95% confidence level to decide whether corrective action is necessary, or more important, whether diversion or theft has occurred. The detection of missing material and, in turn, the discovery of diversion or theft should be timely. Receipts should be piece-counted and item-identified for comparison with the shipment bill of lading as soon as possible. The integrity of the tamper-safing devices should be verified, and receipts should be checked by weighing and, to the extent practical, by nondestructive analyses (NDA) for comparison with the shipper's values. The more accurate and precise receipt measurement must be made as soon as possible. Records of shipper-receiver difference evaluations, investigations, and corrective actions must be maintained on file at the facility for a period of five years.

Management of Material Accountability System

Audits are required of the material accountability programs annually by licensee management not connected with the safeguards program. The results of these reviews must be documented, reported to appropriate plant management, and be kept available at the facility for inspection for a period of five years. Investigation of losses of discrete items or containers must be conducted and the results of the investigation reported to licensee management and to the NRC.

APPENDIX F

LETTER FROM ERDA RE
IN-LIEU-OF-TAX PAYMENTS

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

APR 9 1976

50-537

Dr. Bernard C. Rusche
Director
Office of Nuclear Reactor Regulation
Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Rusche:

We have reviewed the Nuclear Regulatory Commission's (NRC) recently issued Draft Environmental Statement (DES) related to construction of the Clinch River Breeder Reactor Plant (CRBRP). Contained in the DES is an evaluation of the cost and benefits of the CRBRP during construction and operation. One conclusion reached was that the Energy Research and Development Administration (ERDA) should assess and determine the need for payments in lieu of taxes to mitigate any adverse impacts in the local area affected by construction and operation of the CRBRP.

Sec. 168 of the Atomic Energy Act of 1954, as amended, and Sec. 91 of the Atomic Energy Community Act of 1955, as amended, provide a specific statutory mechanism for the evaluation and determination of the need for financial assistance to local entities which may be affected by ERDA activities. The locality in which CRBRP activities will be carried on are within the scope of this statutory authority.

It is our purpose to call to your attention these sections of the Acts which were enacted by the Congress for the express purpose of dealing with such matters and to assure you that ERDA will act in accordance with this statutory authority.

Sincerely,

Richard W. Roberts
Richard W. Roberts
Assistant Administrator
for Nuclear Energy

APPENDIX G

LETTER FROM ERDA RE NEED FOR
SOCIO-ECONOMIC MONITORING PROGRAM

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
CLINCH RIVER BREEDER REACTOR PLANT PROJECT OFFICE
P. O. BOX U
OAK RIDGE, TENNESSEE 37830

Docket No. 50-537 File: 05.10

September 10, 1976

RECEIVED 9-15-76 U.S. NUCLEAR REGULATORY COMMISSION Mail Section

Mr. Roger S. Boyd, Director
Division of Project Management
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Boyd:

CRBRP SOCIO-ECONOMICS

Reference: Letter P. S. Van Nort to R. S. Boyd, "Clinch River Breeder Reactor Plant Project Comments on the Draft Environmental Statement for the CRBRP," dated March 29, 1976.

At the August 18, 1976, meeting with NRC regarding the CRBRP socio-economic analysis, Mr. P. Leech of NRC pointed out the need for the Project to define a socio-economic monitoring program. Since issuance by NRC of the DES for the CRBRP, several important developments have occurred in this area which directly relate to the need and manner for such a monitoring program for the CRBRP Project.

First, as explained in Amendment VI to the ER and in the Project's comments on the DES (Reference), the Atomic Energy Community Act of 1955 has been amended by Congress to include Roane and Anderson Counties as communities with which ERDA has the responsibility and authority to mitigate socio-economic impacts attributable to ERDA facilities, including the CRBRP. Previously, only the City of Oak Ridge was covered by the Act. ERDA-Oak Ridge Operations is the office which is empowered to directly coordinate and work with each of these communities. The Project's response to ER Question F4 fully describes the manner in which this coordination has successfully worked in the past. As described in Enclosure 3 to the Project Comments to the DES (Reference), ERDA intends to extend and to execute its responsibility for community impact mitigation to Roane and Anderson Counties. In fact, discussions have already been initiated between ERDA and responsible county officials. Thus, the Project believes that adequate mechanisms have been established to assure proper monitoring and impact mitigation in the Roane and Anderson Counties as well as the City of Oak Ridge.

Secondly, the Project wishes to advise the NRC that extensive discussions have recently been held with the State of Tennessee Energy Office with respect to mitigation of potential impacts in other communities in the vicinity of the site as well as to the State of Tennessee. The Tennessee Energy Office has actively pursued this issue and has developed proposed

9398

legislation for consideration by Congress. The legislation would authorize ERDA to enter into an agreement with the State of Tennessee to provide financial assistance to the State, and to the counties, municipalities, school districts, and other local governmental entities within the State. The proposed legislation would authorize such financial assistance, including temporary use of Government-owned property, for mitigation of increased needs for Governmental services and facilities attributable directly to personnel employed in connection with construction of the CRBRP.

Discussions are being held with the State Energy Office to develop suitable arrangements which would specify the essential socio-economic factors which need to be monitored during the construction phase of CRBRP and would provide for such monitoring. The Project will keep NRC advised of the progress and results in this area.

Finally, it should be noted that the Project assessments to date have shown that no severe socio-economic impacts are expected to occur during the construction and operation of CRBRP. However, as indicated above, mechanism and legislation are in place for ERDA to work directly with the three local communities (Roane County, Anderson County, City of Oak Ridge) where most of the temporary socio-economic impacts due to construction will occur. For other communities and the State of Tennessee, the Project is directly working with the Tennessee Energy Office in order to resolve their concerns. Therefore, it is the Project position that the above provides or would provide for adequate monitoring of the socio-economic effects of the CRBRP and that no additional monitoring requirements are needed.

Sincerely,

Lochlin W. Caffey

Lochlin W. Caffey, Director
Clinch River Breeder Reactor Plant Project

S:L:1542

cc: E. Spitzer
G. Williams, Jr.
K. Winkleblack
Service List
Standard Distribution

APPENDIX H

DRAFT

Permit No. TN0028801
Application No. TN0028801

AUTHORIZATION TO DISCHARGE UNDER THE
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Federal Water Pollution Control Act, as amended, (33 U.S.C. 1251 et. seq; the "Act"),

U.S. Energy Research and Development Administration
Clinch River Breeder Reactor Plant Project Office
P.O. Box U
Oak Ridge, Tennessee 37830

is authorized to discharge from a facility located at

Clinch River Breeder Reactor Plant
near Oak Ridge, Tennessee

to receiving waters named Clinch River
from discharge points enumerated herein, as serial numbers 001, 002, 003, 004, 005, 006, 007, 008, 009, and 010.

during the effective period of this permit

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

This permit and the authorization to discharge shall expire at midnight, . Permittee shall not discharge after the above date of expiration without prior authorization. In order to receive authorization to discharge beyond the above date of expiration, the permittee shall submit such information, forms, and fees as are required by the Agency authorized to issue NPDES permits no later than 180 days prior to the above date of expiration.

Signed this day of

Jack E. Ravan, Regional Administrator

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on start of discharge and lasting through expiration the permittee is authorized to discharge from outfall(s) serial number(s) 001 - CRBRP Diffuser Discharge

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent characteristic	Discharge Limitations		Monitoring Requirements	
	Daily Average	Daily Maximum	Measurement Frequency	Sample Type
Flow-m^3/Day (MGD)	N/A	N/A	Continuous	Recorder or Calculation
Oil and Grease (mg/l)	5.0	5.0	1/week	Grab
Temperature °C(°F)	N/A	33.3 (92.0) 1/	Continuous	Recorder
Ammonia (mg/l as N)	N/A	N/A	2/month 2/	Grab
Total Chlorine residual	See Below		3/	Multiple grabs

The permittee shall provide a technical study that evaluates actual operations experience with copper/nickel condenser tubes and demonstrates a sufficient low corrosion/erosion rate to assure protection of aquatic organisms or monitor discharge concentrations of total copper at a frequency of 1/month.

Total residual chlorine shall not exceed an average concentration of 0.2 mg/l and a maximum instantaneous concentration of 0.5 mg/l. Neither free available chlorine nor total residual chlorine may be discharged from any unit for more than two hours in any one day. Additionally, a study shall be instituted to evaluate all practicable methods to reduce total residual chlorine levels, including, but not necessarily limited to (1) minimization of chlorine addition commensurate with control requirements, (2) reduction of flow during chlorination, and (3) discontinuation of blowdown during chlorination and subsequent periods of high concentration. Results of this study including facilities and/or methods proposed to reduce total chlorine residuals shall be submitted no later than one year after on-line date. In the event that the unit(s) cannot be operated at or below this level of chlorination, the applicant may submit a demonstration, based on biological toxicity data, that discharge of higher levels of chlorine are consistant with toxicity requirements of the Tennessee Water Quality Standards. Effluent limitations will be modified consistant with an acceptable demonstration.

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored 1/week.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

CONTINUED

DRAFT

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on start of discharge and lasting through expiration the permittee is authorized to discharge from outfall(s) serial number(s) 001 - CRBRP Diffuser Discharge (con't)

1/ The receiving water shall not exceed (1) a maximum water temperature change of 3°C(5.4°F) relative to an upstream control point, (2) a maximum temperature of 30.5°C (86.9°F), and (3) a maximum rate of change of 2°C(3.6°F) per hour outside of a mixing zone which shall not exceed the dimensions of a circle with a maximum diameter of 30.5 meters (200 ft.).

2/ Monitoring for ammonia shall be conducted in a manner representing various operating and river conditions for a period of 6-month duration unless adverse effects from cooling tower concentration are noted.

3/ Analyses shall follow each application of chlorine until sufficient operating experience has been obtained to assure conformance with limitations and then may be reduced to one day per week.

DRAFT

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): plant discharge prior to combination with sewage treatment plant effluent and prior to entry into the Clinch River.

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on start of discharge and lasting through expiration **the permittee is authorized to discharge from outfall(s) serial number(s)** 002 - Construction Sewage Treatment Plant Effluent

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 (mg/l)		Measurement Frequency	Sample Type
	Daily Avg	7-Day Avg.	Daily Avg.	7-Day Avg.		
Flow-m^3/Day (MGD)	N/A	N/A	N/A	N/A	Continuous	Recorder
BOD_5	6.96(15.3)	10.4(23.0)	30	45	3/week 2/	Grab 1/
Total Suspended Solids	6.96(15.3)	10.4(23.0)	30	45	3/week 2/	Grab 1/
Settleable Solids (ml/l)	N/A	N/A	1.0	1.0	5/week	Grab
Dissolved Oxygen (mg/l)	N/A	N/A	N/A	N/A	5/week	Grab
Ammonia (as N)	1.16(2.56)	1.85(4.09)	5.0	8.0	1/week	Grab
Chlorine Residual	N/A	N/A	N/A	N/A	5/week	Grab
Fecal Coliform (organisms/100 ml)	N/A	N/A	200	400	3/week 2/	Grab

Effluent shall be aerobic at all times.

1/ Influent and effluent.
2/ Monitoring frequency may be reduced to one/two weeks during periods when flow is less than 50,000 gpd.

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored 1/week.

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 effluent prior to mixing with any other waste stream.

Note: In the event that the Clinch River Basin Plan, when approved, contains more stringent requirements than contained herein, the permittee shall expeditiously design and construct facilities necessary to conform with the more stringent requirements.

* 61,250 gpd design capacity

DRAFT

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on start of discharge and lasting through expiration the permittee is authorized to discharge from outfall(s) serial number(s) 003, 004, 005, 006 - Point source(s) runoff from construction and concrete batch plant discharges

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations	Monitoring Requirements	
	Instantaneous Maximum	Measurement Frequency 2/	Sample Type
Flow-m^3/Day (MGD)	N/A	1/week	Grab
Total Suspended Solids (mg/l)	1/	1/week	Grab
Settleable Solids (ml/l)	N/A	3/week	Grab

1/ Pending repromulgation of effluent guidelines for this waste category, limitations on total suspended solids shall not be applicable. Within 90 days of repromulgation, permittee shall submit a proposed implementation schedule and shall expeditiously complete necessary facilities, if any, to assure compliance with such repromulgated regulations. In the interim, construction practices and control of site runoff shall be consistent with sound engineering practices such as those contained in "Guidelines for Erosion and Sediment Control Planning and Implementation" EPA-R2-72-015 (August, 1972) or "Processes, Procedures and Methods to Control Pollution Resulting from all Construction Activity", EPA-430/9-73-007 (October, 1973). Where an impoundment is utilized by permittee, it shall be capable of containing a 10-year, 24-hour rainfall event.

2/ Only applicable during periods of actual discharge.

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored 3/week on a 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): point(s) of discharge from treatment system prior to mixing with other waste streams.

DRAFT

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on start of discharge and lasting through expiration the permittee is authorized to discharge from outfall(s) serial number(s) 007 1/ - Surge and Neutralization Tank Waste

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 (mg/1)			
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	N/A	N/A	N/A	N/A	1/week	Measurement or pump logs
Total Suspended Solids	0.28 (0.63)	3.8 (8.4)	15	20	1/week	Grab
Oil and Grease	0.28 (0.63)	3.8 (8.4)	15	20	1/week	Grab

The pH shall not be less than 7.0 standard units nor greater than 9.0 standard units and shall be monitored 1/week on a 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): Surge and neutralization tank filter effluent prior to mixing with any other waste stream.

1/ Serial number assigned for identification and monitoring purposes.

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on start of discharge and lasting through expiration the permittee is authorized to discharge from outfall(s) serial number(s) 008 1/ - Neutralization and Settling Facility

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations kg/day (lbs/day)		Other Units (mg/1)		Monitoring Requirements	
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	N/A	N/A	N/A	N/A	1/week	Measurement or pump logs
Total Suspended Solids	0.36(0.80)	6.0(13.2)	30	50	1/week	Grab
Oil and Grease	0.18(0.40)	2.4(5.3)	15	20	1/week	Grab

DRAFT

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 neutralization and settling facility prior to discharge to cooling tower basin.

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on start of discharge and lasting through expiration the permittee is authorized to discharge from outfall(s) serial number(s) 009 1/ - Sewage Treatment Plant Effluent

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 (mg/1)			
	Daily Avg	7-Day Average	Daily Avg	7-Day Average	Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	N/A	N/A	N/A	N/A	5/week	Grab
BOD 5	0.91(2.00)	1.36(3.00)	30	45	1/month	Grab 2/
Total Suspended Solids	0.91(2.00)	1.36(3.00)	30	45	1/month	Grab 2/
Settleable Solids (ml/1)	N/A	N/A	1.0	1.0	5/week	Grab
Dissolved Oxygen	N/A	N/A	N/A	N/A	5/week	Grab
Ammonia (as N)	0.15(0.33)	0.24(0.53)	5.0	8.0	1/month	
Chlorine Residual	N/A	N/A	N/A	N/A	5/week	Grab
Fecal Coliform (organisms/100 ml)	N/A	N/A	200	400	1/month	Grab

Effluent shall be aerobic at all times.

1/ Serial number assigned for identification and monitoring purposes.
2/ Influent & Effluent.

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored 1/week.

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 effluent prior to mixing with any other waste stream.

Note: In the event that the Clinch River Basin Plan, when approved, contains more stringent requirements than contained herein, the permittee shall expeditiously design and construct facilities necessary to conform with the more stringent requirements.

* 8,000 gpd design capacity

DRAFT

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on start of discharge and lasting through expiration
the permittee is authorized to discharge from outfall(s) serial number(s) 010 1/ - Liquid Radwaste System

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations		Monitoring Requirements	
	Daily Average	Daily Maximum	Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	N/A	N/A	1/batch	Calculation
Total Suspended Solids (mg/1)	15	20	1/batch	Grab

Copies of all environmental monitoring reports submitted to NRC shall be submitted to EPA and the State of Tennessee.

DRAFT

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored 1/batch.

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 radwaste treatment system prior to mixing with any other waste stream.

1/ Serial numbers assigned for identification and monitoring purposes.

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on start of discharge and lasting through expiration
the permittee is authorized to discharge from outfall(s) serial number(s) 011 1/ Plant Intake

Such intake(s) shall be monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations		Monitoring Requirements	
	Daily Average	Daily Maximum	Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	N/A	N/A	Continuous	Pump logs
Temperature			Continuous	Recorder
Ammonia (mg/l as N)	N/A	N/A	2/month 2/	Grab
Total Copper (mg/l)	N/A	N/A	1/month 3/	Grab

1/ Serial number assigned for identification and monitoring purposes.
2/ Monitoring for ammonia shall be conducted in a manner representing various operating and river conditions for a period of 6-month duration unless adverse effects from cooling tower concentration are noted.

3/ The permittee shall provide a technical study that evaluates actual operations experience with copper/nickel condenser tubes and demonstrates a sufficient low corrosion/erosion rate to assure protection of aquatic organisms or monitor discharge concentrations of total copper at a frequency of 1/month.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s):

Plant intake

DRAFT

B. SCHEDULE OF COMPLIANCE

1. The permittee shall achieve compliance with the effluent limitations specified for discharges in accordance with the following schedule:

   a. Blowdown report - during system design stage
   b. Chlorine reduction report - one year after on-line date
   c. Metal cleaning waste disposal report - 180 days prior to any metal cleaning operation
   d. PCB report - 180 days prior to receipt of PCB containing equipment

2. No later than 14 calendar days following a date identified in the above schedule of compliance, the permittee shall submit either a report of progress or, in the case of specific actions being required by identified dates, a written notice of compliance or noncompliance. In the latter case, the notice shall include the cause of noncompliance, any remedial actions taken, and the probability of meeting the next scheduled requirement.

DRAFT

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 . Duplicate signed copies of these, and all other reports required herein, shall be submitted to the Regional Administrator and the State at the following addresses:

Regional Administrator Environmental Protection Agency 345 Courtland Street, N.E. Atlanta, Georgia 30308	AND	Director Division of Water Quality Control Tennessee Dept. of Public Health 621 Cordell Hull Building Nashville, Tennessee 37219

3. *Definitions*

a. The "daily average" concentration means the arithmetic average (weighted by flow) of all the daily determinations of concentration made during a calendar month. Daily determinations of concentration made using a composite sample shall be the concentration of the composite sample. When grab samples are used, the daily determination of concentration shall be the arithmetic average (weighted by flow) of all the samples collected during that calendar day.

b. The "daily maximum" concentration means the daily determination of concentration for any calendar day.

c. "Weighted by flow" means the summation of each sample concentration times its respective flow in convenient units divided by the summation of the flow values.

d. "Nekton" means free swimming aquatic animals whether of freshwater or marine origin.

e. For the purpose of this permit, a calendar day is defined as any continuous 24-hour period.

4. *Test Procedures*

Test procedures for the analysis of pollutants shall conform to regulations published pursuant to Section 304(g) of the Act, under which such procedures may be required.

5. *Recording of Results*

For each measurement or sample taken pursuant to the requirements of this permit, the permittee shall record the following information:

a. The exact place, date, and time of sampling;

b. The dates the analyses were performed;

c. The person(s) who performed the analyses;

d. The analytical techniques or methods used; and

e. The results of all required analyses.

6. *Additional Monitoring by Permittee*

If the permittee monitors any pollutant at the location(s) designated herein more frequently than required by this permit, using approved analytical methods as specified above, the results of such monitoring shall be included in the calculation and reporting of the values required in the 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 Regional Administrator or the State water pollution control agency.

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 Regional Administrator and the State with the following information, in writing, within five (5) days of becoming aware of such condition:

a. A description of the discharge and cause of noncompliance; and

b. The period of noncompliance, including exact dates and times; or, if not corrected, the anticipated time the noncompliance is expected to continue, and steps being taken to reduce, eliminate and prevent recurrence of the noncomplying discharge.

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 to achieve compliance with the terms and conditions of this permit.

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 Regional Administrator and the State 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 Regional Administrator, and/or his 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 Regional Administrator and the State water pollution control agency.

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 State water pollution control agency and the Regional Administrator. As required by the Act, effluent data shall not be considered confidential. Knowingly making any false statement on any such report may result in the imposition of criminal penalties as provided for in Section 309 of the Act.

4. *Permit Modification*

After notice and opportunity for a hearing, this permit may be modified, suspended, or revoked in whole or in part during its term for cause including, but not limited to, the following:

a. Violation of any terms or conditions of this permit;

b. Obtaining this permit by misrepresentation or failure to disclose fully all relevant facts; or

c. A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge.

5. *Toxic Pollutants*

Notwithstanding Part II, B-4 above, if a toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under Section 307(a) of the Act for a toxic pollutant which is present in the discharge and such standard or prohibition is more stringent than any limitation for such pollutant in this permit, this permit shall be revised or modified in accordance with the toxic effluent standard or prohibition and the permittee so notified.

6. *Civil and Criminal Liability*

Except as provided in permit conditions on "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 or regulation under authority preserved by Section 510 of the Act.

9. Property Rights

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor 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 hereby.

DRAFT

PART III

OTHER REQUIREMENTS

A. Metal cleaning wastes including preoperational metal cleaning wastes (including any cleaning compounds, rinse waters, or any other waterborne residues derived from cleaning any metal process equipment, including, but not limited to boiler tube cleaning, boiler fireside cleaning and air preheater cleaning) shall be disposed of off site in an environmentally acceptable manner. Details of such disposal shall be submitted not later than 180 days prior to any cleaning operations.

B. If the permittee, after monitoring for at least 12 months, determines that he is consistently meeting the effluent limits contained herein, the permittee may request of the Regional Administrator that the monitoring requirements be reduced to a lesser frequency or be eliminated.

C. There shall be no discharge of polychlorinated biphenyl compounds such as those commonly used for transformer fluid. Administrative procedures shall be instituted to (1) maintain a detailed inventory of PCB use, (2) assure engineering design and construction to preclude release of PCB's to the environment, and (3) effectively detect the loss of PCB's from equipment. Detail of such procedures shall be submitted no later than 180 days prior to receipt of PCB containing equipment.

D. The permittee shall notify the Regional Administrator 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 or chemical,
2. 96-hour median tolerance limit data for organisms representative of the biota of the waterway into which the discharge shall occur,
3. quantitied to be used,
4. frequencies of use,
5. proposed discharge concentrations, and
6. EPA registration number, if applicable.

E. Discharge of blowdown from the cooling system shall be limited to the minimum discharge of recirculating water necessary for the purpose of discharging materials contained in the process, the further buildup of which would cause concentrations or amounts exceeding limits established by best engineering practice. Discharge temperature shall not exceed the lowest temperature of the recirculating cooling water prior to the addition of make-up. A report showing how conformance with these requirements will be met, including operational procedures, shall be submitted during the system design stage.

F. Blowdown shall contain no detectable amount of materials added for corrosion inhibition including, but not limited to, zinc, chromium and phosphorus.

DRAFT

APPENDIX I

Letter to Mr. Lochlin W. Caffey, Director, Clinch River Breeder Reactor Project Office, from Mr. Richard P. Denise, Assistant Director for Special Projects, Division of Project Management, U. S. Nuclear Regulatory Commission, dated May 6, 1976 pertaining to the CRBR design

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

May 6, 1976

Docket No. 50-537

Mr. Lochlin W. Caffey
Director, Clinch River Breeder
Reactor Project Office
P. O. Box U
Oak Ridge, Tennessee 37830

Dear Mr. Caffey:

Although the detailed evaluation of the Clinch River Breeder Reactor (CRBR) design, including the "reference", "parallel", and "inherent retention" arrangements and features is still underway, we have completed a sufficient level of evaluation to provide major comments and guidance. The purpose of this letter is to transmit our current comments and guidance on the overall approaches being evaluated for CRBR and to obtain your response. The views and positions that follow are intended specifically for the CRBR, and are not intended to establish precedents for future LMFBR license reviews. The requirements and approach identified for CRBR derive in part from the need to include conservatisms where uncertainties are large, because of new elements of technology, and because the aggressive schedule requires information not normally available at this stage of the design effort. For convenience and clarity, we have organized our views and positions by major topics as indicated below; there may be some slight overlapping for clarity.

DESIGN SAFETY APPROACH

Our basic position is that the CRBR should achieve a level of safety comparable to current generation light water reactor (LWR) plants, according to all current criteria for evaluation, and that the design approaches to accomplish the required level of safety be similar or analogous to LWR practice. We recognize, however, that there are reactor concept and experience differences which prevent adherence to precise analogies. As will be evident later in this letter, we have taken some of these differences into account by specifying requirements which are intended to provide assurance that the level of safety achieved for the CRBR will be comparable to that for LWRs.

As is our position on LWRs, the CRBR should be designed according to the three levels of safety approach which reduces the probability and consequences of all design basis accidents to acceptable levels.

This multi-layered safety concept requires that nuclear power plants be designed and constructed to conservative standards and engineering practices so that there is a large tolerance for operator errors, off-normal operation, and component malfunctions, and a high probability that they will operate without failures or malfunctions that could lead to accidents. It is also necessary to anticipate that some incidents or malfunctions will occur during the life of the plant, and to provide measures and features to cope with such events. The third level of safety is based on the conviction that it is prudent to go beyond the first two levels of safety, and requires that additional features and margins be incorporated in the plant design to protect the public from the consequences of certain highly unlikely events. The postulated events in the third level of safety are used to establish a set of design basis accidents, and systems and features are designed to control these accidents so that the consequences of accidents within the design basis envelope are within the radiological dose guidelines of the Commission's siting regulations, 10 CFR 100.

In the implementation of this approach, we require that plant safety features be selected which will produce acceptable performance with substantial margins of safety, that potential departures from normal or design performance be identified and features included to reduce the estimated probability of design basis accidents to the level identified for LWRs, and that engineered safety systems be provided to cope with identified design basis accidents to ensure that off-site doses are less than the 10 CFR 100 guidelines.

We use the further safety objective that there be no greater than one chance in one million per year for potential consequences greater than the 10 CFR 100 dose guidelines for an individual plant, for example, CRBR; this is a design objective rather than a fixed number which must be demonstrated for a given plant. However, we believe that the numerical evaluations of system reliability and accident risks undertaken by the CRBR Project and the ERDA LMFBR Development Program, as well as the systematic and disciplined evaluations of the plant design to identify potential causes and pathways for serious accidents so that any required design accommodation can be effectively implemented, are of significant value in indicating whether the safety objective "aiming point" is being adequately approached; these activities should be continued.

Major attention should be placed on the prevention of accidents leading to core melt and disruption, and loss of containment system integrity, for all identified initiators. In some cases, the possibility of accidents can be adequately dealt with by reducing the probability of the initiators to an acceptable level; in other cases, provisions may be necessary to cope with the initiators in a manner which prevents progression from the initiator to the core melt stage.

Based on our evaluation thus far, we believe that the minimum features and characteristics identified below are necessary for CRBR to accomplish the safety objectives. Any views expressed regarding these features and characteristics as they may now be incorporated in the CRBR design must be considered as preliminary in nature, representing neither approval nor disapproval at this stage of design evaluation.

1. At least two independent, diverse, and functionally redundant reactor shutdown systems should be provided to satisfy the requirement that the reactor power level will be quickly and reliably reduced whenever plant conditions require such action. The current approach on CRBR appears to have the potential to comply with this requirement.

2. At least two independent, diverse, and functionally redundant decay heat removal systems should be provided. Because of the dependence of the proposed plant arrangement on circulation through the main heat transport loops to accomplish decay heat removal, we are not currently convinced that this requirement has been satisfied.

3. Means to detect subassembly faults, to cope with these faults, and to protect against progressive subassembly fault propagation, should be provided. Since individual subassembly instrumentation to detect significant faults and indicate that protective action should be taken, and provisions to cope with subassembly faults which have been thus limited, are not now provided in the design, we are not currently satisfied that this requirement has been met.

4. The heat transport system integrity should be very high, and assured on a continuing basis. The acceptability of systems for leak detection, provisions for pre-service and in-service inspection, and materials monitoring over the long term, have not been sufficiently established. If these aspects are not resolved to the satisfaction of the NRC staff, protective features to cope with pipe failures, in a manner which will prevent core melt and disruption, will be required. In addition, it will be necessary to establish a design basis leak in the heat transport system for the purpose of determining the adequacy of other aspects of the design, for example, cell liners, vent sizes, and cell design pressure.

5. The containment system should be protected from the effects of sodium releases in the equipment cells, particularly those cells containing the main heat transport system equipment. Because dispersed releases of sodium into these cells could result in the cell design pressure being exceeded, increased structural capability may be required. Alternatively, venting of the cells may be an acceptable means to limit the cell pressure, provided such pressure relief venting does not result in other unacceptable conditions, such as the disabling of essential equipment.

Later sections of this letter will address additional design features and characteristics.

SITE SUITABILITY SOURCE TERM

We will require that the containment system design and performance be such that the calculated doses at the exclusion radius and the low population zone radius, following a postulated release of fission products and other material from the core, not exceed the dose guidelines of 10 CFR 100 and the additional guidelines for lung and bone doses from plutonium of 75 and 150 rem, respectively. The exposure durations will be as specified in 10 CFR 100, and calculations will be performed in accordance with our current practices for LWRs. During the construction permit review, guideline exposures of 20 rem whole body, and 150 rem thyroid should be used rather than the values given in 10 CFR 100.11 (see Regulatory Guides 1.3 and 1.4); plutonium doses of 7.5 rem lung and 15 rem bone should be used for reasons stated in paragraph B of Regulatory Guides 1.3 and 1.4.

The source term used to determine the consequence limiting features required to maintain the calculated doses to within the guideline values shall consist of the usual LWR source term specified in TID-14844 plus 1 percent of the plutonium in the core. The source term will therefore consist of 100 percent of the noble gases, 50 percent of the halogens, 1 percent of the solid fission product inventory, and 1 percent of the core plutonium inventory. Although we anticipate that doses from activated sodium will not be a significant contribution to total dose, this should be considered in your analysis. The source term is non-mechanistic, and will be assumed to be released above the operating floor into the main containment volume.

Based on our previous calculations, which have been discussed with your staff and the ACRS, it appears that this source term will require some form of dual containment arrangement, or a containment-confinement arrangement with a filtered exhaust, to reduce calculated off-site doses to an acceptable level. This type of containment system arrangement is not part of any of the designs made available for our review thus far.

CORE DISRUPTIVE ACCIDENTS

In early correspondence and meetings with project personnel we expressed the view that core disruptive accidents (CDAs), or core melt accidents, should be included in the spectrum of design basis accidents. This view was based on the limited information available at the time and the belief that this assumption would be beneficial to the project by ensuring the viability of the appropriate features and causing the least disruption of the design if this accommodation were eventually required for the protection of public health and safety. It is our current position that the probability of core melt and disruptive accidents can and must be reduced to a sufficiently low level to justify their exclusion from the design basis accident spectrum. We will therefore not consider CDAs as design basis accidents.

Nevertheless, because of the difference in the state of technology and experience between LMFBRs and LWRs, the consequent inability to evaluate the safety of the CRBR design as precisely as can be done for LWRs, and the absence of a quantitative risk assessment based on experience and data such as the Reactor Safety Study for LWRs, prudence dictates that additional measures be taken to limit consequences and reduce residual risks from potential CRBR accidents having a lower probability than design basis accidents to ensure that the public health and safety is adequately protected. The basic approach should be to protect the containment system from the unique effects of CRBR core disruptive accidents in order to maintain comparability with LWR safety. This should be done in a manner which incorporates acceptable engineering conservatisms in the design and its evaluation so that there is an extremely low likelihood that CRBR potential accidents could result in early containment system failure.

To this end, we will require that the containment integrity be provided for at least 24 hours following a postulated core disruptive accident. Our current evaluations of the CRBR design indicate that the following CDA consequences should be included in the specification of functional requirements for features to protect containment integrity:

1. A core mechanical work energy release of 1200 MW-sec based on fuel vapor as the working fluid and expansion to 1 atmosphere.

2. A sodium release of 1000 pounds from the reactor head.

3. Vaporization of 10 percent of the core fuel inventory, and direct release of this fraction from the reactor head.

The accident consequences noted above are based on a spectrum of calculations performed by the NRC staff for accident scenarios which included initiators such as reactivity additions ranging from a few cents to a few dollars per second, step reactivity insertions, loss of coolant flow, loss of heat sink, and fuel failure propagation. In these analyses we have included consideration of the phenomena of direct hydrodynamic disassembly, such as may arise from reactivity additions caused by loss of coolant flow, recriticality resulting from material re-entry and meltdown instabilities, and thermal interactions of fuel and other materials with the coolant.

Based on our evaluations of the design, we currently envision that the following features or functional equivalents are necessary to provide the required containment system protection:

1. A head hold down and missile barrier device to provide physical protection of the containment from potential missiles.

2. A sodium and fuel vapor deflector arrangement to localize sodium reactions so the containment system is protected from overpressurization, and to provide assurance that plutonium released to the containment and available for release as an aerosol does not exceed 1 percent of the core inventory.

3. Design features to reduce the possibility and extent of hydrogen-producing reactions (such as sodium-concrete reactions) to an acceptable level, and a recombiner for free hydrogen to reduce the probability of containment system failure due to hydrogen burning or explosion to an acceptable level.

The above measures should be interpreted to include protection against meltdown phenomena and consequences which could lead to loss of containment system integrity within the specified 24 hour period.

As the project proceeds with the evaluation of these accidents, and design of features to cope with their effects, measures which could be reasonably employed to further reduce the residual risk should be considered; one such approach could be to vent the containment atmosphere in a controlled manner through filters at such time, after 24 hours, that the containment system integrity is seriously threatened by overpressurization.

MERGING OF THE DESIGNS

We have frequently discussed with your staff the possibility of merging the various design approaches so that a single design, with a minimum of undecided features and criteria, is defined. We believe that this would be beneficial to your design efforts and to our evaluation of the design. We urge you to proceed in this manner as rapidly as possible to retain the prospect of approaching the review schedule that we have published.

SCHEDULAR EFFECTS

We believe that the responses given above to your design submittals will be beneficial to you in your further efforts. We would be pleased to meet with you at an early date to further discuss and clarify these matters. Please advise us of your intended response schedule or proposed meeting date within two weeks. We will develop a revised schedule for review of the CRBR following your response. We have recently transmitted a letter to you expressing the need for the CRBR Project to respond in a complete and timely manner to our requests for additional information and the consequent effects on the review schedule. We request that you arrange to discuss this entire matter with us at an early date.

Sincerely,

Richard P. Denise

Richard P. Denise, Assistant Director
for Special Projects
Division of Project Management

cc: See next page

cc:

Mr. George L. Edgar
Morgan, Lewis & Bockius
1140 Connecticut Avenue, NW
Suite 1100
Washington, D. C. 20036

Mr. W. B. Behnke
Project Management Corporation
P. O. Box U
Oak Ridge, TN 37830

Mr. W. M. Jacobi, Plant Manager
LMFBR Demonstration Plant
Westinghouse Electric Corp.
CRBR Project Office
P. O. Box U
Oak Ridge, TN 37830

Mr. Richard W. Roberts
US ERDA MS A-436
Washington, DC 20545

Mr. Eric S. Beckjord
US ERDA MS F-309
Washington, DC 20545

Mr. Luther M. Reed
Attorney for the City
of Oak Ridge
253 Main Street, East
Oak Ridge, TN 37830

Mr. James E. Watson
Manager of Power
Tennessee Valley Authority
Room 818, Power Building
Chattanooga, TN 37401

Mr. William H. Young
Project Manager, CRBRP
Burns & Roe, Inc.
700 Kinderkamack Road
Oradell, NJ 07649

Mr. Anthony Roisman
Roisman, Kessler & Cashdan
1712 N Street, NW
Washington, DC 20036

Mr. T. Cochran
Natural Resources Defense
Council, Inc.
917 - 15th Street, NW
8th Floor
Washington, DC 20005

Mr. Peter S. Van Nort (3 cys)
General Manager, Project
Management Corporation
P. O. Box U
Oak Ridge, TN 37830

Mr. William F. Hubbard
Assistant Attorney General
State of Tennessee
Supreme Court Building, Rm. 421
Nashville, TN 37219

Mr. S. Wallace Brewer
County Judge and Attorney
Roane County Courthouse
Kingston, TN 37763

Mr. Herbert S. Sanger, Jr.
General Counsel
Tennessee Valley Authority
Knoxville, TN 37902

BIBLIOGRAPHIC DATA SHEET	1. Report No. NUREG-0139	2.	3. Recipient's Accession No.
4. Title and Subtitle Final Environmental Statement Related to the Construction and Operation of the Clinch River Breeder Reactor Plant			5. Report Date December 1976 6. February 1977
7. Author(s)			8. Performing Organization Rept. No. NUREG-0139
9. Performing Organization Name and Address U. S. Nuclear Regulatory Commission Office of Nuclear Reactor Regulation Washington, D. C. 20555			10. Project/Task/Work Unit No. 11. Contract/Grant No.
12. Sponsoring Organization Name and Address See 9 above			13. Type of Report & Period Covered Final Environmental Statement 14.

15. Supplementary Notes

This report pertains to Docket No. 50-537

16. Abstracts
A Final Environmental Statement for the construction and operation of Project Management Corporation, et al.'s Clinch River Breeder Reactor Plant (Docket No. 50-537) located in Roane County, Tennessee, has been prepared by the Office of Nuclear Reactor Regulation of the Nuclear Regulatory Commission (NRC). This statement provides (1) a summary of environmental impact and adverse effects, and (2) a consideration of principal alternatives. Also included are comments of Federal agencies and other State and local organizations on the Draft Environmental Statement for this plant, and staff responses to those comments. The NRC staff has concluded, based on a weighing of the environmental, economic, technical, and other benefits, against environmental costs and available alternatives, that a construction permit could be granted. This is not a final licensing action. The applicant will be required to assure that adverse environmental impact from construction activities will be kept to a minimum.

17. Key Words and Document Analysis. 17a. Descriptors

17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages
No restrictions on distribution.	20. Security Class (This Page) UNCLASSIFIED	22. Price

FORM NTIS-35 (REV. 10-73) ENDORSED BY ANSI AND UNESCO. THIS FORM MAY BE REPRODUCED USCOMM-DC 8265-P74