NUREG-0139
Supplement No. 1
Draft Report

Draft Supplement to Final Environmental Statement

related to construction and operation of Clinch River Breeder Reactor Plant

Docket No. 50-537

U.S. Department of Energy
Tennessee Valley Authority
Project Management Corporation

U.S. Nuclear Regulatory Commission

Office of Nuclear Reactor Regulation

July 1982

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SUMMARY AND CONCLUSIONS

This Draft Supplement to the Final Environmental Statement (FES) relative to construction and operation of the Clinch River Breeder Reactor Plant 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 U.S. Department of Energy (DOE) 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 (DOE) would also own the plant.* Site preparation is scheduled to begin in May 1983 with completion of construction to be in 1989. Reactor criticality is anticipated in February 1990.

   During the first 5 years of operation (1990-1995), TVA would operate the CRBRP and purchase its electrical output as a demonstration plant under DOE'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. Inplant 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. At full-power operation, the annual average water requirement would be about 13.7 cfs

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*Legislation was enacted by the Congress in January 1976 which authorized the U.S. Energy Research and Development Administration (ERDA) to acquire ownership and custody of the CRBRP and custody of the associated site area. ERDA (now DOE) became a co-applicant on May 6, 1976.

(6145 gpm), of which 5.4 cfs (2412 gpm) would be returned as blowdown to the river and 8.3 cfs (3733 gpm) would be consumed, mainly by evaporation.

3. Updated Summary of Environmental Impacts and Adverse Effects:

(a) Some timber would be harvested and other vegetation and animal life would be destroyed on the 292 acres disturbed for construction of the plant facilities and 58 acres of right-of-way for new transmission lines. All but 113.5 acres would be revegetated after completion of construction (Sections 4.2.1 and 4.4.1). (The land area disturbed for plant construction would be about 50% higher than indicated in the FES; this would still be a small percentage of similar resources on the Oak Ridge Reservation.)

(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). (This item is unchanged from the FES.)

(c) Approximately 63,000 ft^2 of river bank and bottom would be disturbed during construction of cooling water intake and discharge and barge-unloading facilities, improvement of the access road, and construction of the railroad spur; part of these areas would be lost temporarily as benthic habitat (Section 4.4.2). (The area of 63,000 ft^2 replaces the volume of 20,000 m^3 given in the FES.)

(d) Access to Hensley Cemetery onsite would be allowed; historic and archeological resources would not be affected by construction activities (Sections 5.1 and 4.2.1). (Reference in the FES to an Indian mound has been deleted because the remains in the mound have been curated at the University of Tennessee).

(e) Construction noise would be a temporary annoyance to a few residents south of the site (Section 4.5.4). (This item is unchanged from the FES.)

(f) Construction traffic would add to congestion on local roads, particularly State Road 58, during shift changes (Section 4.5.1). (This item is unchanged from the FES.)

(g) Tax receipts would probably compensate for increased public services needed by the additional work force during construction (Section 4.5). (This is a change from the FES, which indicated that tax receipts would not fully compensate for the increased public service.)

(h) Transmission lines 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 6 miles. Fog resulting from the tower operation could be a minor nuisance on nearby roads a few hours per year (Section 5.3.3). (This item is unchanged from the FES.)

(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). (This item is unchanged from the FES.)

(j) Water consumed by the project would be a maximum of 210,00ᶜ gpd during construction and an annual average of 3733 gpm (8.3 cfs) during full-power operation. These figures are 5% and 4% more than in the FES, but the increases are environmentally insignificant. Water use during operation would be less than 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 less than 2 mrems/yr, and the cumulative dose to the estimated year 2010 population within 50 miles would be about 2 person-rems/yr. These doses are less than 2% and about 0.002%, respectively, of those received from natural radiation. The total dose to the general public from operation of supporting CRBR full cycle facilities and transportation of radioactive fuel and wastes from the CRBRP is estimated to be 170 person-rems/yr; this is not significant when compared to the estimated 28 million person-rems/yr received by the U.S. population compared from natural sources (Section 5.7.3). (These figures are higher than those in the FES primarily because of the more conservative assumptions; however, as indicated here, these doses are not significant.)

(l) Risks associated with accidental radiation exposure would be very low (Chapter 7). (This item is unchanged from the FES.)

4. Major alternatives considered were

   ° Sites

   ° Facility systems

   ° Transmission route

   (This item is unchanged from the FES.)

5. The Federal, state, and local agencies that were asked to comment on the DES which was made available in February 1976, and those organizations and individuals that provided such comments will be sent copies of this assessment.

6. The FES was made available to the public, to the Council on Environmental Quality, and to other specified agencies in February 1977. This supplement of updated information is being made available in July 1982.

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 Title 10 of the Code of Federal Regulations Part 51 (10 CFR 51) is the issuance of a construction permit for

the plant subject to the following limitations for the protection of the environment:

(a) The applicants 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 assessment shall be followed.

(c)* The applicants shall demonstrate to the satisfaction of the staff that, at the construction permit stage, the radiological consequences of postulated plant accidents will not exceed 150 rems to bone surfaces, 20 rems to the whole body, 35 rems to the lung, and 150 rems to the thyroid of an individual at the site boundary.

(d) The applicants 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 applicants 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 applicants 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, as updated in 1982, the applicants 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 applicants 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.

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*Limitation (c) in the FES should have stated that "the applicant shall demonstrate to the satisfaction of the staff that the radiological consequences of postulated plant accidents will not exceed 15 rem to the bone, 20 rem to the whole body, 7.5 rem to the lung, or 150 rem to the thyroid of an individual at the site boundary (Appendix I)." In updating the FES, the staff has replaced the bone dose limitation with "150 rems to bone surfaces" and has replaced the 7.5 rem lung dose with "35 rems to the lung." Further discussion of these changes is given in updated Section 11.7.5.

CONTENTS

CONTENTS (Cont'd)

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*New Section

**Indicates change in title from FES.

CONTENTS (Cont'd)

CONTENTS (Cont'd)

***The material in Sections 7.3.1 through 7.3.6 has been revised and now appears under the 7.3 heading.

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PREFACE

In February 1977, the Office of Nuclear Reactor Regulation issued a Final Environmental Statement (FES) (NUREG-0139) related to the construction and operation of the proposed Clinch River Breeder Reactor Plant (CRBRP). That FES was prepared by the Nuclear Regulatory Commission (NRC) staff in cooperation with representatives of the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency.

On the basis of its analyses and evaluation in the FES, the staff concluded that after the environmental, economic, technical, and other benefits of the CRBRP have been weighed against environmental and other costs, and after available alternatives have been considered, the action called for under the National Environmental Policy Act of 1969 (NEPA) and Title 10 of the Code of Federal Regulations Part 51 (10 CFR 51) is the issuance of a construction permit for the plant, subject to certain limitations for the protection of the environment.

Since the FES was issued, additional data relative to the site and its environs have been collected, several modifications have been made to the CRBRP design and its fuel cycle, and the timing of the plant construction and operation has been affected in accordance with deferments under the Liquid Metal Fast Breeder Reactor (LMFBR) program. These changes are summarized and their environmental significance are assessed in this document. The reader should note that this document generally does not repeat the substantial amount of information in the FES which is still current; hence, the FES should be consulted for a comprehensive understanding of the staff's environmental review of the CRBRP project.

The staff has concluded that environmental impacts have changed in some instances from those reported in the FES. However, the staff's overall conclusion remains the same as in the Summary and Conclusions of the FES; that is, the action called for is the issuance of a construction permit for the plant subject to certain limitations for the protection of the environment. Nevertheless, in view of the significance of certain new information assessed in this document relating to the CRBRP, the staff has determined that issuance of this supplement for public comment is appropriate.

FOREWORD

This supplement was prepared by the Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission (NRC, the staff), in accordance with the Commission's regulation Title 10 of the Code of Federal Regulations 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 assessment.

The rest of the FES foreword remains unchanged except as follows:

Mr. Paul H. Leech is the NRC Project Manager for environmental review of this project. Should there be questions regarding the content of this statement, Mr. Leech may be contacted by telephoning 301/492-4503 or by writing to the following address:

Clinch River Breeder Reactor Program Office
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Copies of this statement may be obtained as indicated on the inside front cover. Copies are also available for inspection at the NRC Public Document Room, 1717 H St., NW., Washington, DC; the Oak Ridge Public Library, Civic Center, Oak Ridge, TN; and the Lawson McGhee Public Library, 500 W. Church St., Knoxville, TN.

1 INTRODUCTION

1.1 The Proposed Project

The Clinch River Breeder Reactor Plant (CRBRP) is the demonstration plant proposed by the U.S. Department of Energy (DOE) under its Liquid Metal Fast Breeder Reactor (LMFBR) Program.

1.2 The Project Participants

The project participants remain as stated in the Final Environmental Statement (FES), except that DOE has succeeded the U.S. Energy Research and Development Administration (ERDA) as the responsible Federal agency and lead agency. The applicants (sometimes identified as DOE in this document) also include the Project Management Corporation (PMC) and the Tennessee Valley Authority (TVA).

1.3 Status of the Project

Completion of construction was scheduled for late 1981 and initial operation in 1982. However, President Carter decided in April 1977 to defer any U.S. commitment to advanced nuclear technologies that were based on plutonium. In keeping with that decision, the applicants requested the NRC Atomic Safety and Licensing Board (ASLB) to suspend the CRBRP licensing proceedings, which it did in May 1977.

On October 8, 1981, President Reagan announced that he was lifting the suspension on commercial reprocessing and he directed government agencies to proceed with the demonstration of breeder reactor technology, including completion of the CRBRP. Accordingly, at DOE's request, the ASLB conducted a prenearing conference on February 9 and 10, 1982, for the purpose of resuming the licensing proceedings.

By letter dated November 30, 1981, the applicants requested the Commission to authorize, under Title 10 of the Code of Federal Regulations Part 50 Paragraph 12 (10 CFR 50.12), the conduct of site preparation activities beginnning in March 1982. That request was denied by the Commission's Order Number CLI-82-4 dated March 16, 1982. On May 16, 1982, DOE requested the Commission to reconsider its Order, but the Commission, in an Order dated May 18, 1982, declined to do so.

By letter dated July 1, 1982, the applicants again requested the Commission to authorize the conduct of site preparation activities beginning in August 1982. That request is currently pending before the Commission.

Based on NRC's current projection that a limited work authorization could be issued for nonsafety-related site preparation activities in May 1983, the applicants now plan to complete the construction of CRBRP in 1989. Initial reactor criticality is scheduled for February 1990; thus, the 5-year demonstration period will cover the years 1990 through 1994.

1.4 Status of Reviews and Approvals

The listing of the major documents used in the preparation of this assessment has been expanded to include the Supplement to ERDA-1535, issued as DOE/EIS-0085-FS in May 1982. Additional information was gained from site visits in January and November 1975, October 1981, and February 1982.

In ER Section 12, the applicants provided an extensive listing of licenses and permits applicable to CRBRP. That list has been revised to include:

Permits and Licenses	Issuing Agencies
15. Clean Water Act 401 certification	State of Tennessee
16. Permits relative to air quality	State of Tennessee

In addition, item (8) was revised as follows:

8. License for radio transmitters and associated towers	National Telecommunications and Information Administration

EPA issued a Public Notice of Proposed Issuance of an NPDES Permit and Consideration of State Certification of the NPDES Permit on or about June 24, 1982. (The draft NPDES Permit is included as Appendix H to this assessment.)

2 THE SITE AND ENVIRONS

2.1 General Description

In the first paragraph, the second sentence has been corrected to read as follows:

> Nearby cities are Kingston, 7 miles west, and Harriman, 10 miles west-northwest. The residential sections of Oak Ridge are 9 miles to the northeast (FES Fig. 2.2).

As shown in FES Figure 2.3, the plant would cover 292 acres, about one-fifth of the 1364-acre site. This is an increase of about 50% over the 195 acres indicated in the FES and is considered in Section 4.2.1. One small industrial plant, which manufactures neutron absorbers, is now located on a 33-acre parcel of land in the Clinch River Industrial Park adjacent to the north plant site boundary. The rest of the 112-acre industrial park is undeveloped. As indicated in the FES, the principal industrial installations in the area are DOE's Oak Ridge Gaseous Diffusion Plant (ORGDP or K-25), DOE's Oak Ridge National Laboratory (ORNL) research and development facilities, the Y-12 area which provides research and production facilities for DOE's military program, and TVA's Melton Hill Dam (FES Fig. 2.2).

While the area has no major sports facility, over 60 recreational sites had, in all, about 10,000 people present during the peak hour in 1980; over 15,000 are anticipated in the year 2030 (ER Table 2.2-8). There are four recreational areas within 3 miles of the proposed site, including a small commercial campground located about 1.5 miles south-southeast. A public access area, which accommodates approximately 400 people per day, is also located about 1.5 miles from the site. The other two recreational areas, a visitor outlook and an incidental use area, accommodate about 100 people per day each; they are located about 2.5 miles from the site. A waterfowl refuge is 8 miles southwest on the Tennessee River, a wildlife preserve is at Kingston, and part of the Paint Rock Wildlife Management Area is also about 8 miles southwest.

The number of schools within 10 miles of the site decreased from 22 to 21 by 1981, while the total enrollment increased to 8870 students from nearly 8000 in 1973. A total of four hospitals, located at Oak Ridge, Harriman, and Loudon, are within 15 miles.

The Norfolk-Southern Railroad serves the ORGDP by way of a branch from the line about 2 miles northwest of the site (rather than 4 miles as stated in the FES).

Within a 20-mile radius of the site, 12 public water systems and 15 industrial systems draw from surface water, including the Clinch River and the Emory River. The closest such withdrawal is by DOE, 1.6 miles downstream, for ORGDP and the Clinch River Industrial Park. Groundwater supplies 13 public systems and many residences within the 20-mile 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 12,000 tons in 1980. For the same years, the numbers of recreational craft dropped from 1200 to 284 (ER Sec 2.2).

Section 2.8 below further describes social and community characteristics of the area.

2.2 Regional Demography

Within a 50-mile radius from the plant, Knoxville and Oak Ridge are the largest urban centers, with 1980 populations of 183,139 and 27,662 respectively; 16 other centers have populations between 2500 and 15,000 (ER Table 2.2-1). In 1980 the 10-mile radial area had a resident population of 52,040, and the 50-mile area, 830,840. The corresponding estimates for 2030 are 67,580 and 933,280. Figure A2.1 shows population distributions for 1980 and 2030, from 0 to 10 miles and from 10 to 50 miles from the site.

The resident population within 10 miles of the site is increased by transients using roads, employees travelling into the area, and visitors to local parks or recreation areas. The 1980 resident equivalent population within 10 miles was 19,640; this population is expected to grow to about 30,738 by 2030 (ER Sec 6.1.4.2.1). Employment at the ORGDP, ORNL, and Y-12 facilities is discussed in Section 5.8.

2.3 Historic and Archeological Sites and Natural Landmarks

The National Register of Historic Places through March 1982 shows five sites within 10 miles of the proposed CRBRP site: the Lenoir Cotton Mill (9.5 miles), the Harriman City Hall (10 miles), the Roane County Court House at Kingston (8 miles), the Southwest Point on the Tennessee River southwest of Kingston (8.5 miles), and the X-10 Graphite Reactor at ORNL (4 miles).

In October 1972 and January 1973, the applicants had the University of Tennessee conduct a historical reconnaissance site survey and a reevaluation of six archeological sites that were originally identified in a 1941 survey. The historical survey resulted in the identification of four farmsteads--recorded as 40RE120, 40RE121, 40RE122, and 40RE123--and the Hensley Cemetery (40RE119) within the site boundaries (FES Fig. 2.7). The structure 40RE123 was destroyed before detailed drawings and photographs of the farmsteads were completed. None of the sites and structures qualified for inclusion in the National Register of Historic Places. The State Historic Preservation Officer agreed with this conclusion after review of the report (Schroedl, 1972 and Thomas, 1973) submitted by Dr. Gerald F. Schroedl (FES App C).

Test pits were excavated at six archeological sites identified as 40RE104, 40RE105, 40RE106, 40RE107, 40RE108, and 40RE124. The tests indicated that 40RE107, 40RE108, and 40RE124 required further study, and the University of Tennessee contracted to do the additional work. Salvage work was completed in 1975 on the three sites. Site 40RE124 was the most important of these and indicated interment of more than 36 individuals. The materials from the sites were curated at the University of Tennessee. The results of the investigation have shown that no remaining sites were worthy of nomination for inclusion in the National Register (see the State Archeologist's letter in FES App C).

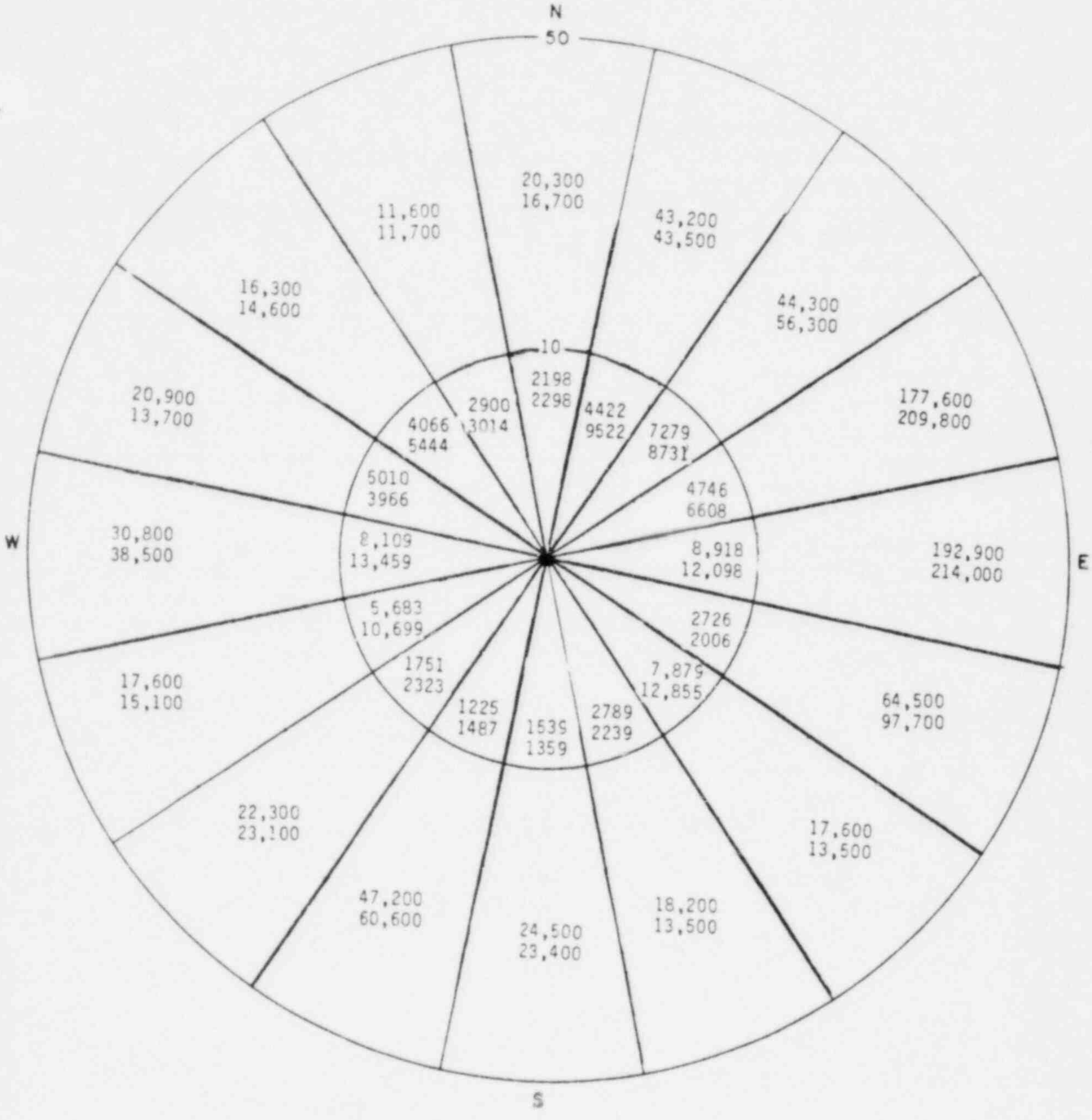


Figure A2.1 Population distributions within 10 and 50 miles of the proposed CRBRP site. The top number in each sector is the total for 1980; the bottom number is the estimate for 2030. The totals within a 10-mile radius include resident and transient population. (Replaces FES Fig. 2.6.)

An additional cultural resources study of unsurveyed portions of the project area was conducted in the winter of 1981-1982. The survey revealed no historic structures that would be directly impacted by the project (ER Am XIII, p. 2.3-4). Seventeen archeological sites and two loci were identified, all of which would be avoided by the construction and operation of the plant. Five of the sites (SS-2, SS-3, SS-5, T-17, and T-23) were thought to be potentially significant. If present plans should change and ground disturbance of the five site areas is anticipated, the applicants should contact the State Historic Preservation Office and the NRC before proceeding. (See Appendix C of this assessment for State Historic Preservation Office agreement with such conditions.) No natural landmarks are present on the plant site or in the vicinity.

The additional information above does not change the assessment in the FES that construction of the CRBRP is unlikely to impact cultural resources on site or in the vicinity (Sec 4.2.1 and 5.1).

2.4 Geology

This section of the FES has been rewritten for clarification but no significant changes have been made in the data presented.

The proposed CRBRP site lies in the Valley and Ridge Physiographic Province. The region is 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 1200 ft. The ground surface of 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. The proposed site is on a broad but small peninsula formed by the meanders of the Clinch River. Within the site boundaries, Chestnut Ridge is comprised of two northeast-trending subordinate ridges, which reach a maximum elevation of about 900 ft. In the valley formed by these subridges, a topographic saddle rises to about 800 ft. The valley slopes from this saddle in both the northeast and southwest directions down to the Clinch River (normal summer pool elevation is 741 ft). Surface drainage of the site occurs along these slopes. Subsurface drainage takes place along solution-enlarged joints in areas directly underlain by limestone and dolomite.

The proposed site is the Southern Valley and Ridge Tectonic Province near the western border of the Appalachian geosyncline, which was formed during the Paleozoic Era (570 million years before present (mybp) to 225 mybp). The sedimentary rocks within the Appalachian geosyncline were folded and faulted during the Paleozoic Era and are now tilted to the southeast at an angle of about 30°. Since the Paleozoic Era, the dominant geologic processes at the site, besides the general uplift of the region, have been weathering and erosion, with sediment accumulation restricted to terrace and floodplain deposits of the Clinch River.

The proposed site is between two major regional thrust faults, the Copper Creek fault, about 3000 ft southeast of the site, and the Whiteoak Mountain fault, 1.7 miles northwest of the site. No evidence of any post-Paleozoic activity associated with these faults has been found. The applicants performed radiometric dating (potassium argon) analyses of the faults and found them to be at least 285 million years old. This finding is consistent with other age dating of thrust faults in the Valley and Ridge.

The proposed site is underlain by siltstones, limestones, and dolomites of Ordovician Age (500 mybp to 430 mybp). The rock in the vicinity of the proposed Category I structures is overlain by 1 ft to about 60 ft of clay residual soil.

Several minor faults and folds were found during site investigations. Displacements on the faults range from a few inches to several feet. Minor folds were also identified which had wavelengths and amplitudes of several feet. All of these structures are interpreted to have formed during late Paleozoic at the same time as the regional faults.

Four sets of joints were mapped at the site. The first two sets have strikes similar to that of the bedding (N52°E) and dip 37° southeast and 58° northwest, respectively. The third and fourth set of joints have strikes perpendicular to the bedding and dip 80° southwest and 75° northeast, respectively. The joints are spaced about 1 to 6 ft apart. Most of the joints are hairline fractures with surfaces that are stained by weathering. The most pronounced weathering and solution activity have been identified within outcrop bands of limestone and dolomite. Weathering and solutioning have advanced from these outcrops downward along steeply inclined joints and bedding planes, developing soil seams and cavities. It was found during investigations that, where unweathered siltstones overlay limestones and dolomites, weathering was minimal and there were no solution features. The plant is to be founded on that type of rock.

2.5 Hydrology

2.5.1 Surface Water

Data regarding the Melton Hill Dam have been revised. Based on 1963-1979 discharge records for the dam, the average flow of the river is about 5380 cfs at the site. The maximum hourly average release was 54,960 cfs, and the maximum daily average release was 34,966 cfs (ER Sec 2.5.1.2 and PSAR Sec 2.4.1.2.4). These figures are 11 to 30% higher than reported in the FES, but they do not significantly affect the impact assessments in FES Chapters 4 and 5. In addition to the influence of the Melton Hill, Watts Bar, and Fort Loudon Dams discussed in the FES, river flow now also is influenced by the newly constructed Tellico Dam. 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 and Tellico Dams. The 1963-1979 flow data for Melton Hill Dam show that nearly all monthly averages exceeded 1000 cfs, except for periods of no flow (ER Table 2.5-2). No extended periods of zero flow are anticipated in the future; however, the applicants state: "Should the need arise for any regulation at Melton Hill Dam which would result in extended periods of zero release, the operations would be coordinated to meet flow requirements at the CRBRP site" (ER Sec 2.5.1.3).

Water temperatures were measured at Clinch River Mile (CRM) 21.6 between May 1963 and August 1979. The maximum temperature observed during this period of record was 78°F, and the minimum, 33°F. Table A2.1 shows the average daily maximum, minimum, and mean river temperatures for each month from 1963 to 1979.

These figures are revised slightly from those in the FES (ER Table 2.5-7), but the changes are not significant.

Table A2.1 Average daily maximum, minimum, and mean river temperatures for each month, 1963-1979*

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	44	44	50	56	62	65	66	67	69	66	58	50
Minimum	42	42	44	54	60	63	64	65	66	64	56	47
Mean	43	43	48	55	61	64	65	66	67	65	57	48

*CRM 21.6; temperatures in °F.

2.5.2 Groundwater

No change is necessary in this section of the FES.

2.5.3 Floodplain Effects

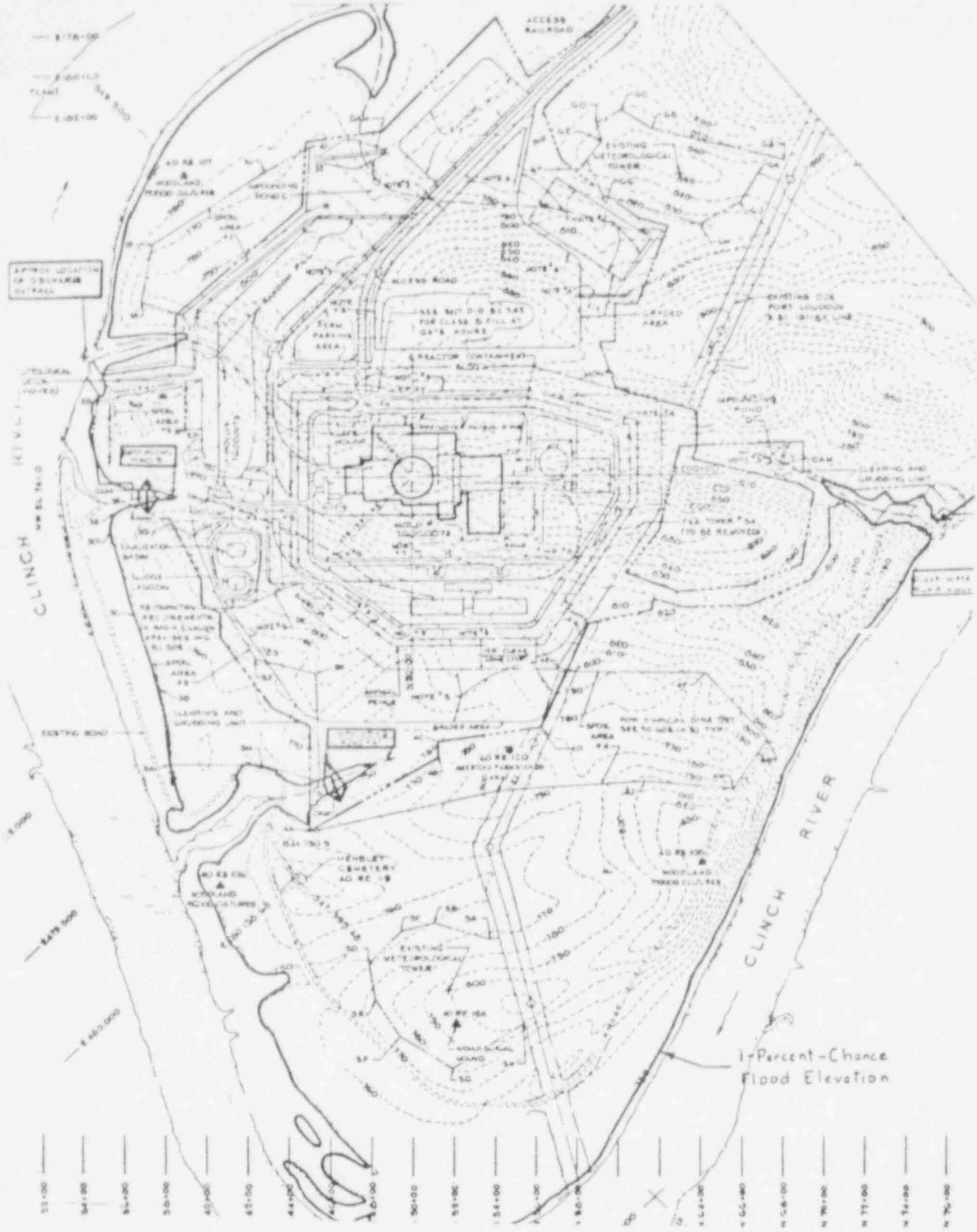
Executive Order 11988, signed in May 1977, requires that there should be no construction in the base floodplain unless there is no clear alternative. The necessary construction in the floodplain should be analyzed to determine its environmental effects and the potential for altered flood flows and levels. The base floodplain for the purposes of this study is defined as the lowland and relatively flat area adjoining the Clinch River that is subject to a 1% or greater chance of flooding in any given year (100-year floodplain).

Clinch River, Grassy Creek, and several intermittent creeks flow through the site. The 100-year floodplain on the Clinch River and Grassy Creek is shown in Figures A2.2 and A2.3. Construction activities proposed in the 100-year floodplain include a limited amount of clearing and grubbing, and activities related to the construction of the runoff treatment ponds, the intake and pumphouse, the barge-unloading ramp and the discharge structure. There would also be some spoil areas in the floodplain.

Plant features located in the 100-year floodplain would be the treatment ponds, river intake and pumphouse, barge ramp, and the intake and discharge structure. The treatment ponds may be removed after completion of construction. This determination is pending the outcome of negotiations between the state and the applicants (NPDES Permit, Part III.C).

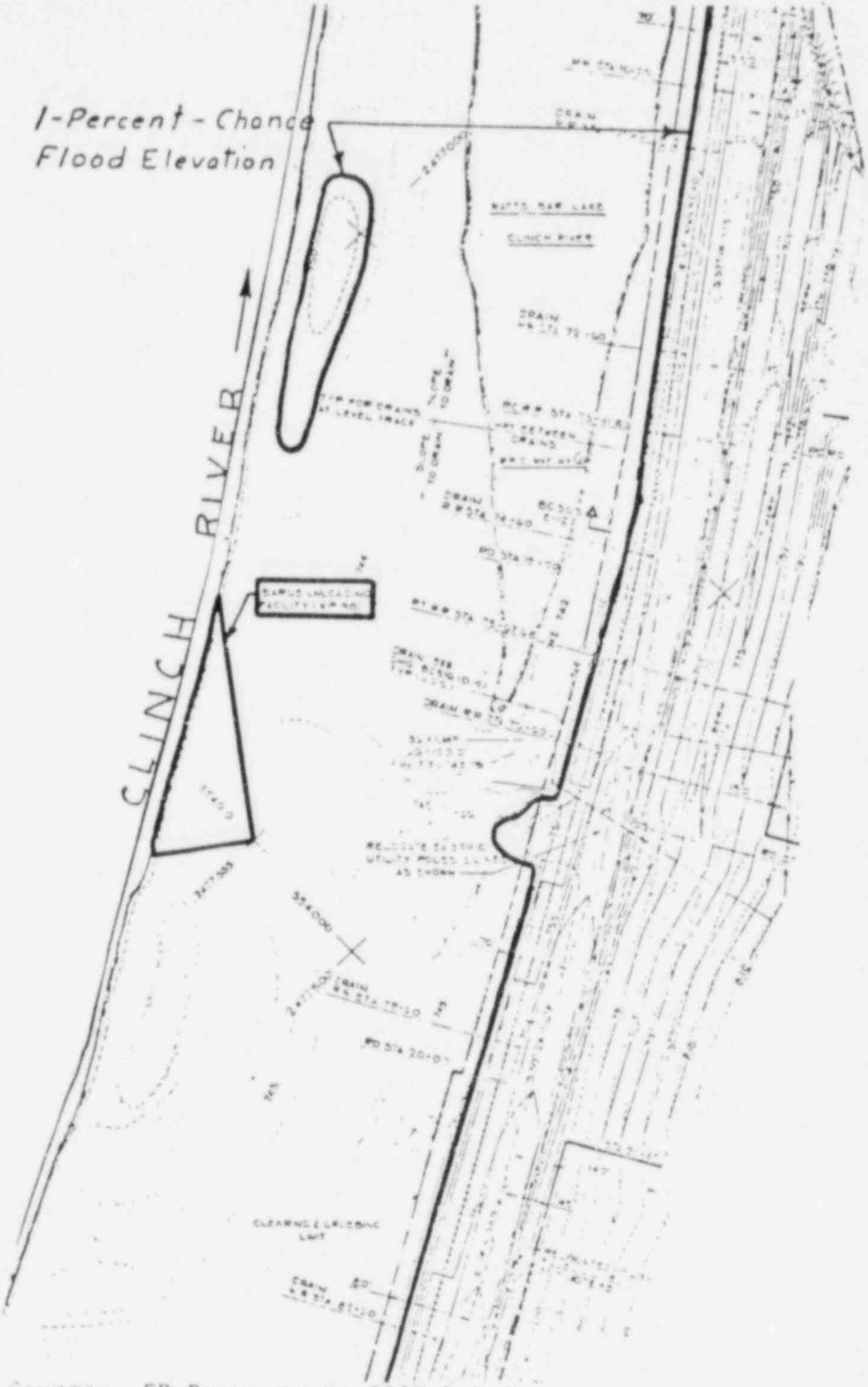
In addition, the plant access road and railspur would cross a portion of the 100-year floodplain. A temporary storage area would be built downstream from the site at about Clinch River Mile 13.8, and it would occupy a portion of the 100-year floodplain. This area has been used previously for construction storage, and it has already been largely graded and stabilized, so there would be a minimum of disturbance to the floodplain.

Construction of the plant would neither increase runoff to nor constrict flow in the Clinch River significantly. None of the plant features located in the



Source: Q240.1R-6

Figure A2.2 Proposed CRBRP site, 100-year floodplain



Source: ER Response to Q240.1-R-6

Figure A2.3 Proposed CRBRP barge-unloading facility, 100-year floodplain

floodplain would increase floodflows or change the flood level measurably. Furthermore, there do not appear to be reasonable alternatives to these features which, by necessity, must be located adjacent to or in the Clinch River.

The staff therefore concludes that the plant construction in the floodplain will not have a significant adverse effect on the river and is consistent with the guidance of Executive Order 11988.

Additionally, safety-related components of the plant are designed to withstand the effects of the probable maximum flood (PMF), a flood considerably more severe than that addressed by the Executive Order.

2.6 Meteorology

Meteorological data regarding the site have been updated.

On 30 to 46 days annually, temperatures may be expected to reach 90°F or higher.

A 24-hr total of 7.75 in. of precipitation was recorded at the X-10 station site (ER Sec 2.6.2.4), and a maximum 24-hr snowfall total of 12 in. was recorded at Oak Ridge. Data indicate that heavy fog (visibility 0.25 mile or less) occurs on about 34 days annually at the weather office location. Such occurrences may be more frequent at the proposed plant site, which is nearer the river. Wind speed and direction distributions (wind roses), based on February 17, 1977 to February 17, 1978 data collected on site at the 33- and 200-ft above-ground levels, are presented in Figure A2.4 (ER Figs. 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 February 17, 1977 to February 17, 1978 (Section 6.1.3). These new data are considered to be cumulative and do not deviate markedly from earlier data.

Footnote (a) of Table 2.3 in the FES should now read "Source: ER, Tables 2.6-4 and 2.6-24."

2.7 Ecology

2.7.1 Terrestrial Ecology

2.7.1.1 Flora

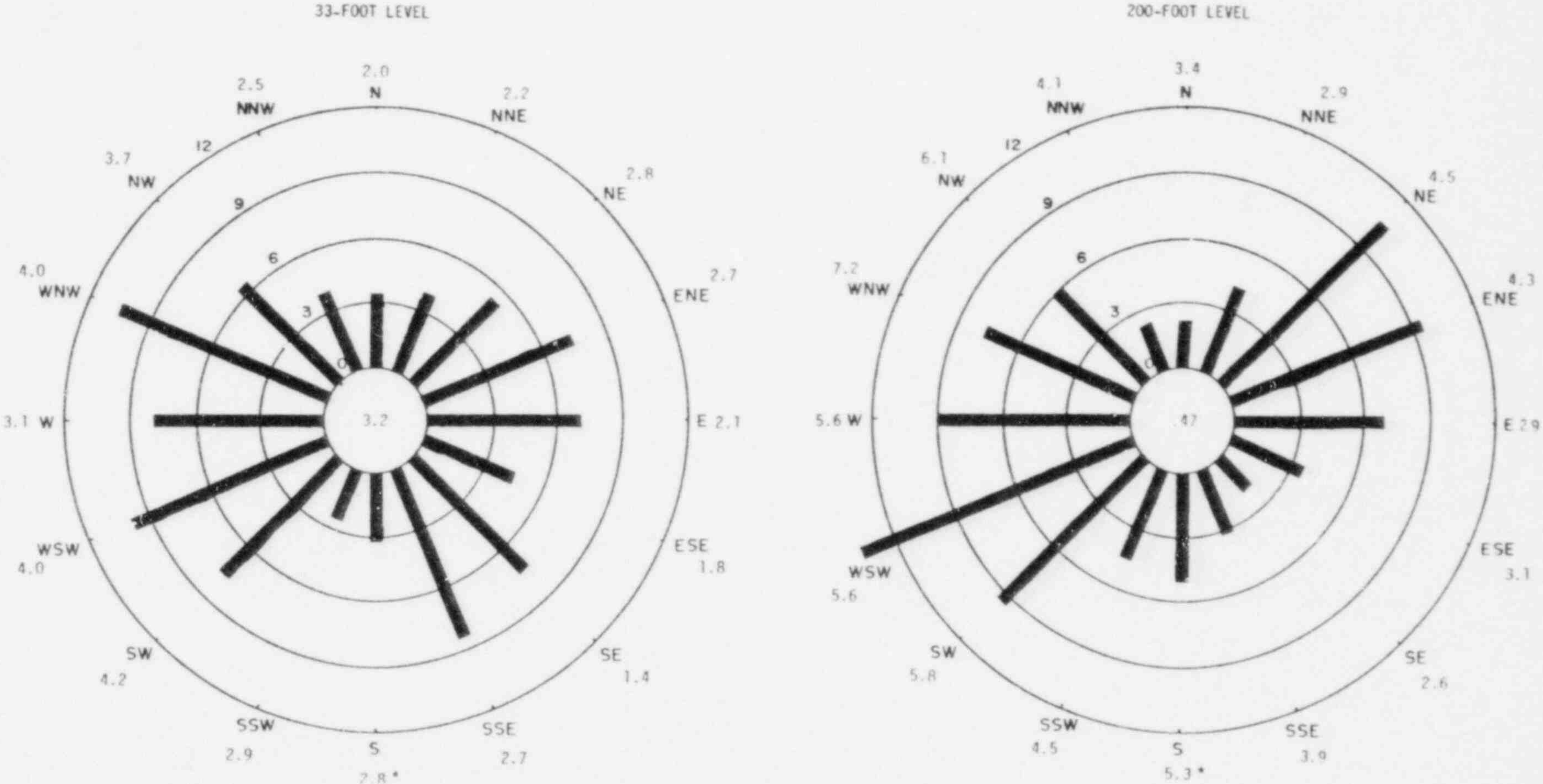
Cimicifuga rubifolia and Saxifraga careyana are the only plant species known to be on the proposed CRBRP site that may at some time in the future be listed as threatened or endangered, according to the U.S. Fish and Wildlife Service (see Appendix B; see also Section 4.4 for a discussion of impacts).

2.7.1.2 Fauna

2.7.1.2.1 Mammals

(2) Furbearers

In addition to those mammals discussed in the FES, bobcats have been observed several times on the Oak Ridge reservation.



*Value denotes average wind speed for each sector (miles per hour).

Figure A2.4 Annual wind roses from CRBRP permanent meteorological tower data for February 17, 1977 through February 17, 1978 (replaces FES Fig. 3.9)

(3) Threatened Species

The only mammal now listed as endangered that might occur on the proposed site is the gray bat (Myotis grisencens; see Appendix B), but to date feeding individuals have not been found on the site nor on the Oak Ridge reservation (ER Sec 2.7.1.4.1). Caves currently utilized by the grey bat for hibernating and for maternity are within 1 week's travel time of the site. Therefore, the grey bat could, on occasion, utilize the Clinch River in the vicinity of the site as feeding habitat. However, the staff concludes that construction and operation activities at Clinch River would not result in significant deterioration of potential feeding habitat (i.e., insects) along the Clinch River and, therefore, construction and operation activities would not affect the grey bat.

2.7.1.2.2 Birds

Of the 125 bird species observed on the site, only the bald eagle (Haliaeetus leucocephalus) is on the Federal list of endangered species and considered endangered by the State of Tennessee (see Appendix B). In addition, four other bird species considered by the state to be threatened and/or endangered have been observed: the sharp-shinned hawk (Accipter striatus), Cooper's hawk (Accipter cooperii), marsh hawk (Circus cyaneus), and the American osprey. All five rare species are on the Oak Ridge Reservation (ER Table 2.7-15). No nesting activities of these five species have been observed on the CRBRP site.

2.7.2 Aquatic Ecology

This material has been rewritten to aid reader understanding and to provide updated information.

Water quality is similar to that of southeastern U.S. rivers (Geraghty et al., 1973). Total and fecal coliform counts taken in the tailraces of Norris and Melton Hill Dams in 1967 (Section 2.5) are below the maximum allowable limit of 5000/100 ml MPN (most probable number) for any one water sample required by the State of Tennessee (TWQCB, 1973) for the protection of fish and aquatic life. Surface water samples in the vicinity of the proposed site were collected at three locations in the Clinch River nine times during 1974-75. The water samples were analyzed for standard plate, total coliform, fecal coliform, and fecal streptococcus. Maximum values for all counts were observed during March; this was probably attributable to bacterial runoff from land as a result of heavy rain just before the sampling. Fecal coliform and total coliform MPN/100 ml ranged from <4 to 1000 and <5 to 2300, respectively.

The phytoplankton community was sampled for the CRBRP from March 1974 through April 1975 and is represented by 157 species. The diatoms (Chrysophyta) were the most numerous taxon from March through May; the percent abundance decreased in June and July and increased during August and September. The blue-green algae (Cyanophyta) were present in May; the percent abundance increased in June and July, when it became the most dominant taxon, and decreased in August and September. The green algae (Chlorophyta) was a small percentage of the total number of organisms 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 May to January all five phytoplankton divisions were present. Phytoplankton densities ranged from 190 to 2940 cells/ml 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 (ibid). A mean ratio of 1.4 to 1 was determined for the pheophytin a content of 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 the pigment extract. A ratio of 1.0 to 1 indicates the presence of only pheophytin a, whereas a ratio of 1.7 to 1 indicates that the samples are free of pheophytin a (EPA, 1973). Because a mean ratio of 1.35 to 1 is midway between 1.0 and 1.7, the phytoplankton population can be considered to consist of both decaying and nondecaying individuals.

The 1975 study conducted by Exxon Nuclear Company (Exxon, 1976) just downstream of the proposed CRBRP site revealed a dominance of Chrysophytes during the growing season from April through October. Both the CRBRP study and the Exxon Nuclear study described a single midsummer peak in abundance of phytoplankton. An Oak Ridge study (Loar and Burkhart, 1981), also downstream of the site, conducted in 1977-78, observed two pulses or peaks in phytoplankton abundance, one in late spring and one in early fall. Differences in sampling frequency, collection methodology, preservation, and analysis make detailed comparisons of the three studies impossible; however, it can be concluded that the phytoplankton community--its abundance and its annual succession--is typical of a Tennessee riverine situation.

A total of 81 zooplankton species were identified from the Clinch River at the site 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/liter to 206/liter. 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 occurs among the arthropod species. In September and November rotifers were up to three times more abundant in the surface samples than in the bottom samples.

Between 1973 and 1978 three additional surveys on zooplankton were conducted on the Clinch River in the vicinity of the proposed site; they are summarized in Loar and Burkhart (1981). Considerable variability between studies in zooplankton abundance was reported; it is possibly the result of differences in sampling methodology, discharge regime, or natural variability.

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 blue-green algae, green algae, dinoflagellates, and euglenoids 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 typical for these organisms. Diatoms had high densities in spring and lower densities in October. During the fall and winter blue-green algae decreased as expected. Diatoms were the numerically dominant form in the winter months, with blue-greens and greens present in lesser amounts. 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.

Both the Exxon Nuclear study (Exxon, 1976) and the Oak Ridge study (Loar and Burkhart, 1981) reported similar successional patterns of abundance and dominance consisting of diatom-dominated communities during the winter and spring and a shift towards dominance by green and blue-green algae in summer and early fall.

Few aquatic macrophytes were found in the vicinity of the site during the baseline survey. A few strands of Eurasian water milfoil were collected, but their origin could not be identified. Also occasional growths of bryophytes and liverworts were encountered in the late spring and summer. The sparse growth of macrophytes is attributed to limited light penetration in the water, steep shorelines, fluctuating river water levels, and changing current velocities (ER Sec 2.7.2.4.6). In August 1980, macrophyte growth was observed to be more extensive than during the baseline period (ER Sec 2.7.2.5). During the Oak Ridge Survey in 1977-78, several small beds of Potamogeton were observed along the banks of the river at CRM 15.

Benthic macroinvertebrates (benthos) collected by dredging during the baseline study included the mollusks, annelids, flatworms, and insects. Insects, primarily midge larvae (Chironomide), were the dominant group in terms of total number of species collected, while mollusks--almost exclusively the Asiatic clam (Corbicula sp.)--were the dominant group in terms of total numbers of organisms and biomass.

Approximately 80 taxa were collected from the Clinch River between March 1974 through May 1975. Densities of benthic organisms ranged from 75 organisms/m^2 in March 1974 to 784 in April 1975. Diversity indices reflected the low diversity of benthic macroinvertebrates in the vicinity of the site. Several collections consisted entirely of Corbicula sp. 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 sediments, with the mollusk Corbicula sp. and the coelenterate hydra dominant in the coarse sand and gravel, respectively. Biomass, expressed as composite biomass and ash-free dry weight, was estimated for samples with clams (shell included) and samples without clams. Biomass of the samples ranged from 2 to 11,400 mg/m^2 with the clams and 0 to 165 mg/m^2 without the clams.

Although the most abundant benthic macroinvertebrate collected during the survey was Corbicula sp., with densities ranging from about 20 to 500 organisms/m^2, such densities are low in comparison with other stretches of the Tennessee system and elsewhere where densities as high as 65,000/m^2 have been reported (Sinclair, 1970). The relatively low density of Corbicula sp. in the vicinity of the site is primarily the result of the hardpan substrate, deep water, and cold release from Melton Hill Dam. Higher densities are known to occur in the overbank area upstream of the site (Copeland, 1981) and are expected to produce large numbers of larvae in the vicinity of the site.

Artificial substrates were also used to assess the macroinvertebrates. Chironomid larvae represented more than 50 percent of the 67 species identified. Biomass values ranged from 39 to 1260 mg/m^2. Mean biomass increased throughout the summer to September, decreased to a low in January, and then increased in the spring. The Asiatic clam was the dominant macroinvertebrate collected in terms of biomass. (For more detailed biomass values, lengths, and life history of this taxon, refer to ER Sec 2.7.2.4.5.)

Morton (1978), under contract with Exxon Nuclear, reported on the results of a benthic macroinvertebrate study just downstream of the proposed CRBRP site. He found a similar distribution and abundance of organisms, with the most frequent numerically dominant organism being Corbicula sp. and the greatest number of taxa in the Chironomidae. Morton concluded that benthic macroinvertebrates are limited in this region principally by the rapid fluctuation in the flow volume as a result of the operation of Melton Hill reservoir and the attendant decrease in habitable area.

Benthic macroinvertebrate communities in the Clinch River, in the vicinity of the Oak Ridge Gaseous Diffusion Plant, were sampled during 1977-78 between CRM 10.5 and 15 (Sasson, 1981). Fewer taxa were taken during the course of this study than reported by Morton (1978) and the applicants (ER Sec 2.7.2.4.5). Distribution and abundance of the dominant species, however, were similar to the earlier two studies.

Fletcher (1977) provided a check list of 76 species of fish known from the Clinch River in the vicinity of the site. The applicants reported (ER Sec 2.7.2.4.7) 34 species of fish collected from the Clinch River by electroshocking and gill netting from March 1974 through January 1975. Fletcher, using the same gear in monthly sampling from May 1975 through April 1976, reported 50 species of fish collected from the Clinch River below Melton Hill Dam. Loar et al. (1981) and Loar (1981), also using the same gear in 1977-80, reported 29 species from the Clinch River above and below the proposed CRBRP site. A composite list of species from these studies is presented in Table A2.2.

Sampling conducted by the applicants in 1974-75 revealed that gizzard and c/o threadfin shad were the numerically dominant species and accounted for 45% of the total catch. The skipjack herring comprised 15% of the weight of the total catch and represented the greatest biomass of any species. The same dominance in number of specimens taken was found by Fletcher (1977); however, sauger, carp, and skipjack herring were the most dominant based on biomass. each comprising approximately 20% of the total catch. Loar (1981) found in the 1977-80 Oak Ridge studies a high relative abundance of game fish that, in part, can be accounted for by the relatively low abundance of forage fishes.

The applicants found in the 1974-75 study that approximately the same number of fish were collected from stations on opposite sides of the river, except at sampling transects in the vicinity of Poplar Springs Creek and Caney Creek, where approximately twice as many fish were collected near the mouth of the creeks. The applicants categorized the species of fish collected into one of three categories: rough, forage, and game fishes. The rough fish (so-called commercial fish) comprised about 21% of the catch by numbers of specimens and 61% of the catch by weight. Forage fish accounted for 63% numerically and 22% by weight of the total catch, and game species 16 and 17%, respectively.

Table A2.2 Fish species taken from the Clinch River below Melton Hill Dam in the vicinity of the proposed CRBRP Site

Scientific name	Common name
Family - Polyodontidae	
Polyodon spathula	Paddlefish
Family - Lepisosteidae	
Lepisosteus oculatus	Spotted gar
Lepisosteus osseus	Longnose gar
Family - Clupeidae	
Alosa chrysochloris	Skipjack herring
Dorosoma cepedianum	Gizzard shad
Dorosoma petenense	Threadfin shad
Family - Hiodontidae	
Hiodon tergisus	Mooneye
Family - Cyprinidae	
Cyprinus carpio	Carp
Hybopsis storeriana	Silver chub
Notemigonus crysoleucas	Golden shiner
Notropis ardens	Rosefin shiner
Notropis atherinoides	Emerald shiner
Notropis spilopterus	Spotfin shiner
Pimephales notatus	Bluntnose minnow
Pimephales vigilax	Bullhead minnow
Family - Catostomidae	
Carpiodes carpio	River carpsucker
Carpiodes cyprinus	Quillback carpsucker
Catostomus commersoni	White sucker
Hypentelium nigricans	Northern hog sucker
Ictiobus bubalus	Smallmouth buffalo
Ictiobus cyprinellus	Bigmouth buffalo
Ictiobus niger	Black buffalo
Minytrema melanops	Spotted sucker
Moxostoma anisurum	Silver redhorse
Moxostoma carinatum	River redhorse
Moxostoma duquesnei	Black redhorse
Moxostoma erythrurum	Golden redhorse
Family - Ictaluridae	
Ictalurus punctatus	Channel catfish
Pylodictis olivaris	Flathead catfish

Table A2.2 (Continued)

Scientific name	Common name
Family - Poeciliidae	
Gambusia affinis	Mosquitofish
Family - Percichthyidae	
Morone chrysops	White bass
Morone mississippiensis	Yellow bass
Morone saxatilis	Striped bass
Family - Atherinidae	
Labidesthes sicculus	Brook silverside
Family - Centrarchidae	
Ambloplites rupestris	Rock bass
Lepomis auritus	Redbreast sunfish
Lepomis gulosus	Warmouth
Lepomis macrochirus	Bluegill
Lepomis megalotis	Longear sunfish
Lepomis microlophus	Redear sunfish
Micropterus dolomieui	Smallmouth bass
Micropterus punctulatus	Spotted bass
Micropterus salmoides	Largemouth bass
Pomoxis annularis	White crappie
Pomoxis nigromaculatus	Black crappie
Family - Percidae	
Etheostoma blennioides	Greenside darter
Etheostoma simoterum	Tennessee snubnose darter
Perca flavescens	Yellow perch
Percina caprodes	Logperch
Stizostedion canadense	Sauger
Stizostedion vitreum vitreum	Walleye
Family - Sciaenidae	
Aplodinotus grunniens	Freshwater drum
Family - Cottidae	
Cottus carolinae	Banded sculpin

Sources: ER Section 2.7.2.4.7; Fletcher, 1977; Loar, 1981; and Loar et al., 1981.

The 1978 commercial fish catch in Watts Bar Reservoir for all species was about 389,000 lbs, with a commercial value of about $116,700. Additionally 1000 lbs of paddlefish roe were taken, worth approximately $24,000 (Tomljanovic, 1981). After 1978, Watts Bar Lake was closed to gill and trammel nets by the Tennessee Wildlife Resources Agency (TWRA), primarily to protect the striped bass sports fishery. As a result, the commercial buffalo fishery declined. The 1980 commercial harvest estimate for all species was 260,000 lbs, valued at $78,000, and 1000 lbs of paddlefish roe, valued at $35,000. Less than 1% of the total catch for Watts Bar Reservoir was harvested within a 10-mile radius of the site.

Based on creel censuses conducted by TWRA, the 1979-80 recreational harvest from Watts Bar Reservoir was estimated at about 280,000 fish and 200,000 lbs. Information on the sport fishing around the site is limited. It is primarily a sauger fishery in the winter, with white bass, crappie, and Micropterus sp. sought after in the spring. Some fishing for striped bass occurs in late summer (Masnik, 1982a). During the baseline monitoring program, approximately 280 hours were spent on the Clinch River near the proposed site collecting samples, and fewer 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 by the applicants in 1974. Approximately 300 unidentified fish eggs were collected, with 93% of the eggs collected on May 16 and June 23, 1974. Fourteen larvae were also collected and identified as to family (1 Percidae and 13 Clupedae). Fletcher (1977) collected larval fish at CRM 12, 14.4, and 15 in 1975. A total of 2328 larvae were taken. Clupeidae were the dominant taxon, comprising 90% of the total number and 76% of the total weight. White crappie larvae represented 9% of the total number and 18% of the total weight and were the second most abundant larval fish. Other species of larvae taken during this study were carp, shiner, bluntnose minnows, Moxostoma sp., channel catfish, brook silverside, Lepomis sp., and Micropterus sp. Cada and Loar (1981) collected 4198 fish eggs and 38,443 larvae in 1978 from Poplar Creek and the Clinch River just downstream of the proposed site. Clupeids comprised 92.9% of the total larvae collected, with Morone sp. also relatively common. Loar et al. (1981) reported clupeids as the most abundant ichthyoplankton from CRM 19 and 22, reaching peak densities in June and July.

Sauger may use the region of the river bordering the site for spawning. In April 1976 at CRM 12, 14.4, and 15, Fletcher (1977) found running males and gravid females in gill net samples, indicating possible capture during the act of spawning.

A single Stizostedion sp. larvae was taken at CRM 15-18 on March 28, 1974 (Fletcher, 1977). Two additional Stizostedion sp. larvae were taken near the Kingston Steam Plant in 1975, the first on April 9 and the second on April 23 (TVA, 1976, in Fletcher, 1977). One post-larval Stizostedion sp. was taken on April 9, 1976 at CRM 12 (Fletcher, 1977). In 1979, TVA conducted (Scott, 1980) a study in the Clinch River below Melton Hill Dam to investigate the hypothesis alluded to by Fletcher (1977) that sauger do not utilize the tailwaters of the dam for spawning but rather use the lower reaches of the river. Gill nets were fished for a 7-week period during the spring. Peak spawning activity based on a catch/net-night ratio and the number of flowing females occurred from April 10 to April 25. The results of the study indicate that the area immediately below the dam is not used for sauger spawning but rather that spawning occurs 6 to 8 miles downstream. It appeared that spawning was not localized in a small area because areas with high spawning activity one week did not show the same activity the next. The highest catch rates reported by the study were immediately below the proposed discharge structure in the vicinity of the submerged island. Most fish were taken in the deeper half of the gill net, with many at the end and taken over sand and silt substrate.

Stomach content analysis was performed on the seven most abundant fish species present from March through January 1975. ER Table 2.7-100 classifies the individual fish species whose stomachs contained food groups. The major food items varied with fish species but included fish, zooplankton, benthic invertebrates, aquatic insects, detritus, and bottom material.

In 1964 the Tennessee Wildlife Resources Agency began a yearly stocking program in Watts Bar Lake for striped bass that has been continued to the present. The striped bass is considered a cool water species and water temperature affects its habits and distribution. A substantial striped bass recreational fishery has not developed in Watts Bar Lake, and the adults of this species are thought to be limited by high water temperatures and low dissolved oxygen levels present in the lake during late summer and early fall. Lakes without temperatures below about 22°C in well-oxygenated zones have been found unsuitable for adult striped bass larger than about 5 kg (Coutant, 1982). In Cherokee Reservoir, Tennessee, the higher summer ambient water temperatures and low dissolved oxygen levels limit for striped bass the habitable volume of the reservoir to several small thermal refuges and apparently have contributed to massive die-offs of adults larger than 4-5 kg (8-10 lbs) (ibid).

Maximum water temperatures in Watts Bar Lake during August and September 1980 ranged from 25.5°C at the bottom to 29.5°C at the surface (Cheek, 1982). Cheek found that as the main body of Watts Bar Lake warmed up fish began to move into thermal refuges. No striped bass were found in the main body of the reservoir when water temperatures reached 24° to 25°C. Cheek found three thermal refuges for adult striped bass in Watts Bar Lake: a groundwater source in the Tennessee River arm of the reservoir, the tailwaters of Tellico Dam (no longer a refuge after its closure in September 1979), and the Clinch River below Melton Hill Dam between CRM 13.5 and 22. The discharge for the CRBRP is planned at CRM 16.5.

In the Clinch River, the favored locations of striped bass during late summer and early fall are thought to be the outside of the river bend from approximately CRM 15 to CRM 17 and the western side of the river near Grubb Islands, from approximately CRM 18 to CRM 18.5 (ER Sec 2.7.2.5). Cheek found the fish primarily along the banks in the shallows where the shoreline was steep and exposed to the water current with many overhanging or immersed trees and logs creating slack water and eddies. It is thought that a significant portion, perhaps the major portion, of adult striped bass inhabiting Watts Bar Lake utilize the Clinch River in the vicinity of the proposed CRBRP site during periods of high thermal stress in the main reservoir.

The U.S. Fish and Wildlife Service has notified the NRC (Hickling, 1981) that 11 species of freshwater mussels from the family Unionidae and 1 species of fish from the family Cyprinidae, which are Federally listed as threatened or endangered, may be present at the proposed CRBRP site or vicinity (see Section 5.3.4). Sampling before 1982 conducted or contracted by TVA, PMC, TWRA, Exxon Nuclear, and Oak Ridge National Lab did not reveal the presence of any of these species from the Clinch River in the vicinity of the proposed facility. In April 1982, while sampling for sauger eggs, TVA biologists found a single live specimen of the Federally protected Lampsilis orbiculata orbiculata, the pink mucket pearly mussel. This specimen was collected at CRM 19.1, about 1 mile upstream of the proposed site.

In May 1982, TVA conducted an intensive mussel survey of the Clinch River in the vicinity of the proposed site. Transects every 0.2 mile from CRM 14.0 to CRM 21.0 were established. Teams of divers traversed the transects and collected mussels from the river bottom. Area surveys were also conducted in the vicinity of the barge-unloading facility, intake, and discharge. A total of 189 specimens from 10 species of freshwater mussels were collected. No threatened or endangered species were taken. Although no Federally protected species of freshwater mussels were taken during the survey, the collection of the single specimen in April confirms that the species is present in the Clinch River in the vicinity of the site. Jenkinson (Masnik, 1982b) estimated, based on extrapolation of the mussel survey, that within the 7-mile reach of river the population size of Lampsilis o. orbiculata is likely to be in the range of 1 to 211 individuals.

The Tennessee Wildlife Resources Commission has declared a number of species to be endangered or threatened (TWRC, 1975). The only species on the state list (which includes all the Federally recognized species) that is known to be in the vicinity of the site is the blue sucker, Cycleptus elongtus. It has been taken in Watts Bar Lake on two occasions (ER Sec 2.7.2.4.11). In 1975 one specimen was taken near the mouth of the Clinch River (CRM 0.3), and in 1977 one specimen was collected from the Tennessee River near Loudon. One specimen was taken (Fitz, 1968) during the preimpoundment survey of Melton Hill Reservoir. Although the habitat in the Clinch River in the vicinity of the proposed CRBRP site appears suitable for this species, none have been reported from this stretch of the river (ER Sec 2.7.2.4.11).

The above information is largely new, but much of it is merely cumulative; in either case the staff does not expect that there will be significant new or changed aquatic impacts from the CRBRP (Sections 4.4.2 and 5.3).

2.8 Social and Community Characteristics

Some changes in the social and community characteristics of the area have occurred, as discussed below.

The Oak Ridge Gaseous Diffusion Plant now employs about 5600 people. The Oak Ridge National Laboratory (ORNL) employs about 5100 people, and Y-12 about 6300 (ER, Sec 2.2.2.2).

The four counties (Anderson, Knox, Loudon, and Roane) that are expected to experience the bulk of the impact of constructing and operating the CRBR had a 1980 population 464,018; this population is expected to grow to 523,252 by 1990. Knoxville, with a 1980 population of 183,139, is by far the largest urban center in the four-country region and serves as the region's focal point.

The presence of DOE/contractor operations in Oak Ridge has had a significant impact on present day socioeconomic conditions. For instance, the percentage of professional and technical employees in Anderson and Knox Counties (26% and 16%, respectively) is much higher than in the state overall and reflects Oak

Ridge employment. Increasingly, the residences of Oak Ridge employees are dispersed throughout the region. Approximately 25% of those working at Oak Ridge live in Knoxville. Employment at Oak Ridge has also raised the per capita income averages of Anderson and Knox Counties above those for the state and for Loudon and Roane Counties (ER Sec 8.1.2.2.2).

In the four-county area, more than 20% of the existing housing stock has been constructed since 1970. Despite the rapid expansion of the housing stock, the percentage of vacant units has remained low. For individual counties and municipalities the rates are as low or lower than those recorded in the 1970 U.S. census. With the exception of Roane County, single family units constitute the largest percentage of housing by type added during the 1970-1980 period. In Roane County, 50% of the new units were mobile homes. Mobile homes constituted less than 25% of the units added to the stock in Anderson and Loudon Counties during the 1970s (ER Sec 8.1.3.1).

Eight school systems serve the four-county area and, with the exception of the Knox and Anderson schools, were under capacity during the 1980-1981 school year. The schools in Oak Ridge, Roane, and Harriman have the largest differentials between capacity and current enrollment. As Table A2.3 indicates, the number of school age children is expected to decrease during the 1980-1990 decade, thereby providing additional capability (ER Sec 8.1.3.1; see also Sec 4.5 of this document).

Table A2.3 Current and projected population aged 5 to 19 years

County	1980	1985	1990
Anderson	15,385	13,745	13,550
Knox	72,949	69,264	72,568
Loudon	6,159	5,779	6,050
Roane	10,896	10,004	10,221
Total	105,389	98,792	102,289

Source: State of Tennessee, Department of Public Health

Most of the water supply systems in the four-county area are operating well below treatment capacity. Only two districts are operating at capacity, and both systems are able to purchase water from adjacent districts while additional plant capacity is being constructed (ER Sec 8.1.3.3). All wastewater utility districts are operating below treatment capacity except for the Harriman district. Three districts with the lowest differentials between average daily flow and capacity have indicated plans to increase capacity by 1984 (ER Sec 8.1.3.3.2).

The current data presented above relative to socioeconomic considerations are essentially cumulative and do not deviate markedly from the trends anticipated in the FES (see Sections 4.1, 4.5, and 5.6 below for the staff's present assessments).

3 FACILITY DESCRIPTION

3.1 External Appearance

The concrete, dome-capped, cylindrical shell that encloses the reactor containment building, would rise 179 ft instead of 169 ft above the grade set for principal plant structures. The emergency cooling tower structure would now consist of two mechanical draft wet cooling towers, each about 36 ft high, 37 ft wide, and 88 ft long.

A conceptual architectural rendering of the plant (FES Fig. 3.1) and the building layout (FES Fig. 3.2) have been revised as shown in Figures A3.1 and A3.2.

In addition to previously described features, a 5-ft-high animal fence would be erected about 33 ft from the security fence. The exclusion area would include the full width of the river, touching the site property and the entire 1364-acre site except for the 112 acres in the Clinch River Consolidated Industrial Park (FES Fig. 3.3).

3.2 Reactor and Steam-Electric System

The homogeneous core design has been replaced by the heterogeneous arrangement described below and in ER Section 3.2.2.

The mixed-oxide fuel would be in the form of sintered pellets encapsulated in stainless steel rods. The plutonium enrichment (Pu/Pu + U) in the fuel would be 32-33%. 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 156 fuel assemblies (Figure A3.3) in the reactor core would have 217 of these fuel rods. Surrounding the core would be a radial blanket consisting of 126 assemblies, each with 61 rods containing depleted UO_2 pellets. In addition, 76 blanket assemblies and 6 alternate fuel/blanket assemblies would be arranged within the core boundary. Figure A3.3 shows a partial cross section of the reactor indicating how the fuel assemblies are positioned.

The refueling scheme calls for a complete replacement of all core assemblies every 2 years of operation. Midway in the 2-year cycle, six internal blanket assemblies will be replaced by fresh fuel assemblies to replace burnup. Row 1 of the outer blanket will be replaced by fresh blanket assemblies every 4 years, and Row 2 will be replaced similarly every 5 years.

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. The applicants expect to achieve a breeding ratio of 1.29 to 1 with the initial core, and 1.24 to 1 with the equilibrium core (ER, Table 3.2-2).

The primary sodium coolant outlet temperature was incorrectly given as 999°F in the third paragraph of FES page 3-2; it should be 995°F.

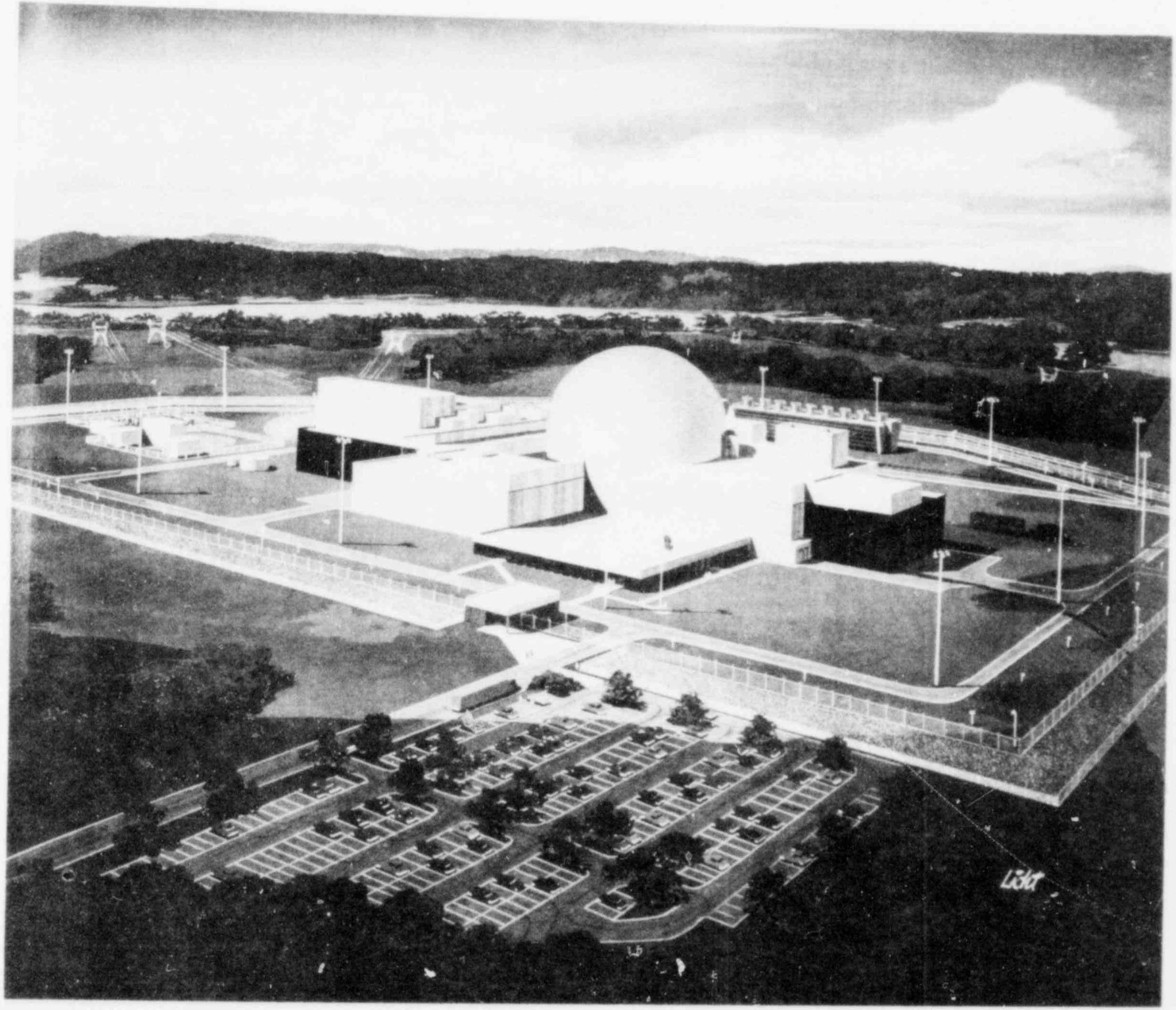


Figure A3.1 A conceptual architectural rendering of the CRBRP

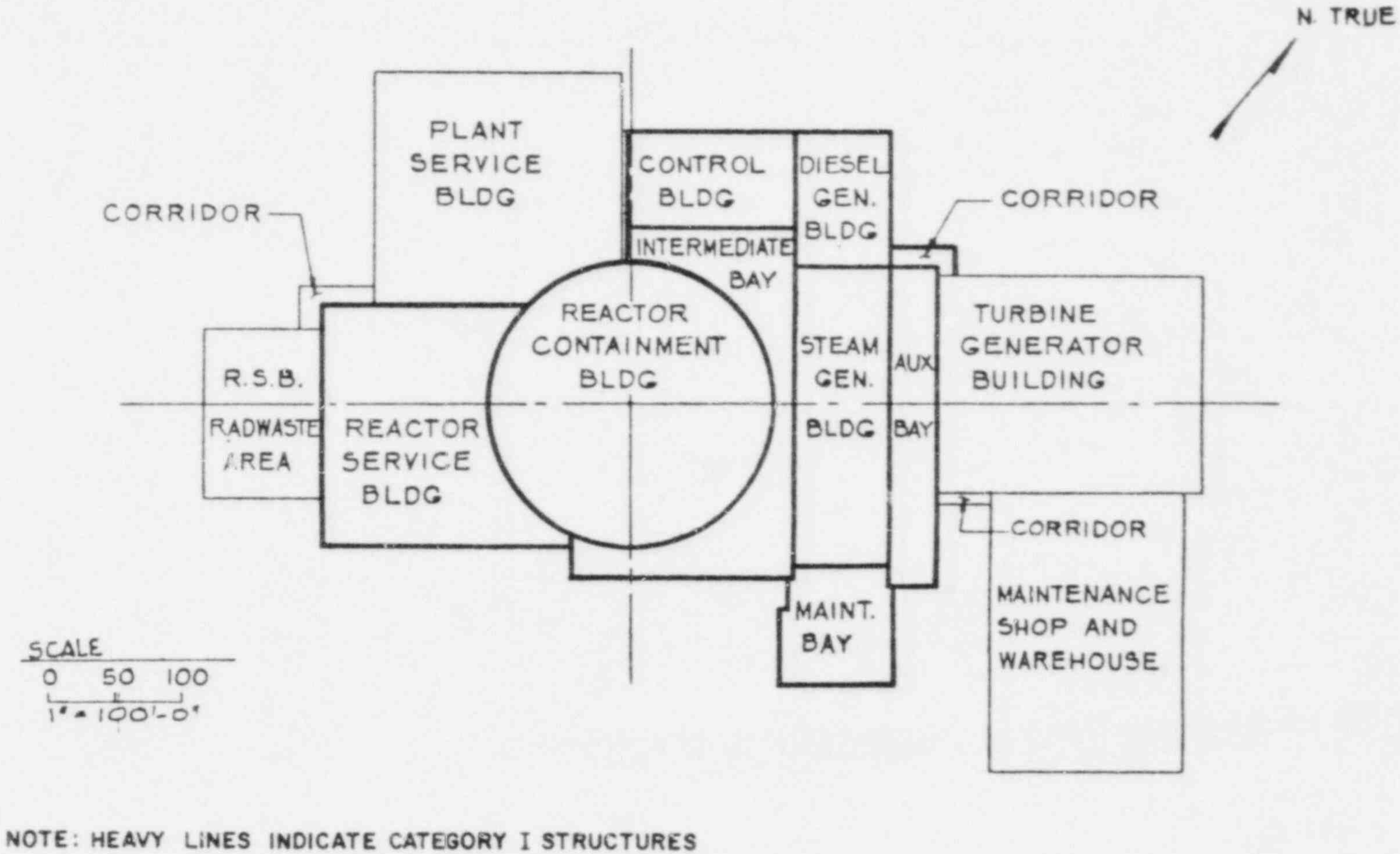


Figure A3.2 Main building layout of CRBRP

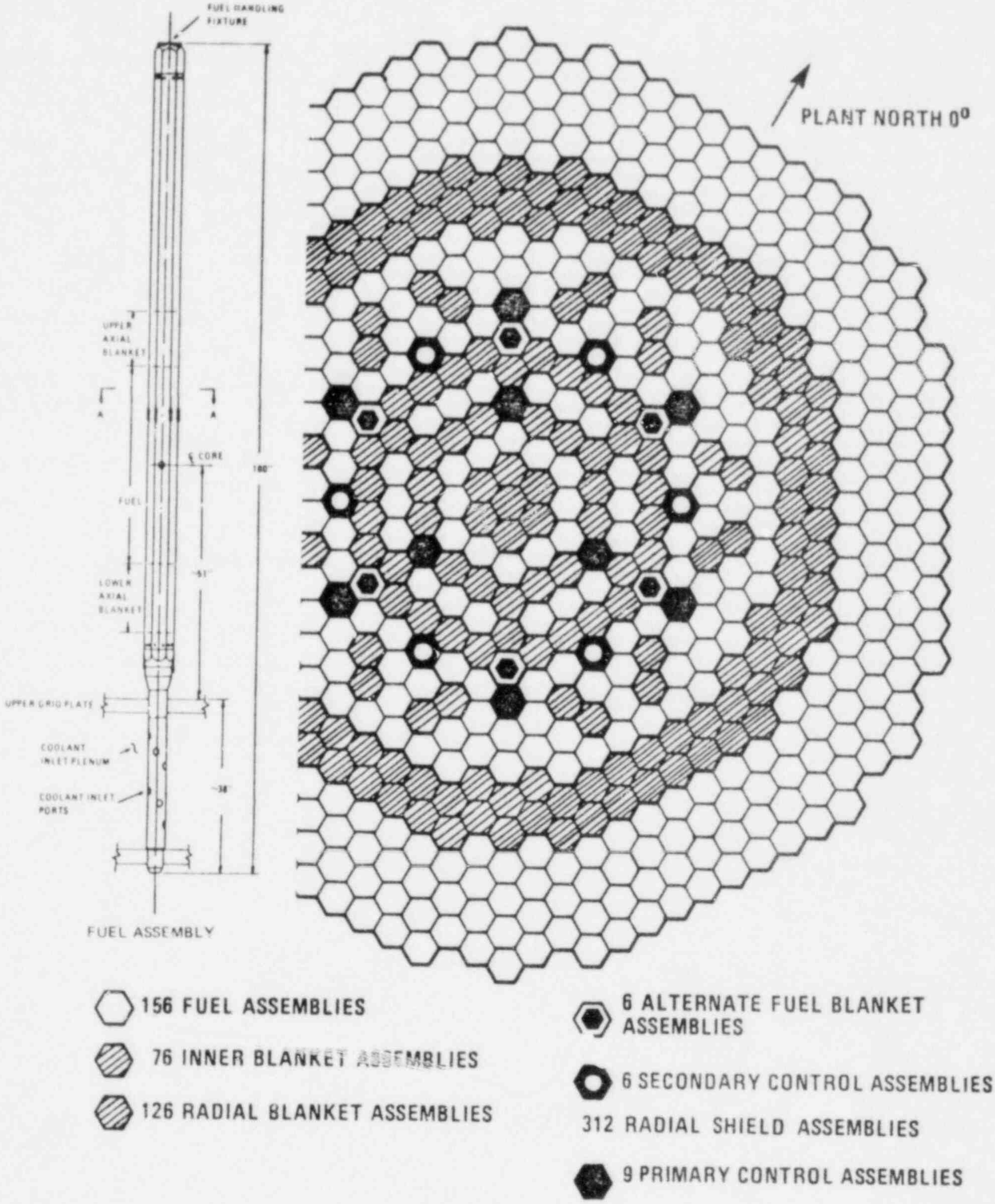


Figure A3.3 CRBRP heterogeneous core design

3.3 Water Requirements

Water use rates have been revised. For maximum power, the anticipated annual average water makeup requirement has increased from 13 cfs (5835 gpm) to 13.7 cfs (6145 gpm), and estimated total consumptive use of river water has increased from 3584 gpm to 3733 gpm. An average of 5.4 cfs (2412 gpm) would be returned to the river as blowdown (2306 gpm) and effluent from other plant systems (106 gpm). Approximately 8.3 cfs (3733 gpm) would be consumed through evaporation, drift, and plant water usage. Figure A3.4 is a water usage flow diagram for the plant. The greatest consumptive water use, representing about 0.15% percent of the river's annual average flow rate, would take place in the heat dissipation system.

3.4 Heat Dissipation System

3.4.1 Cooling System

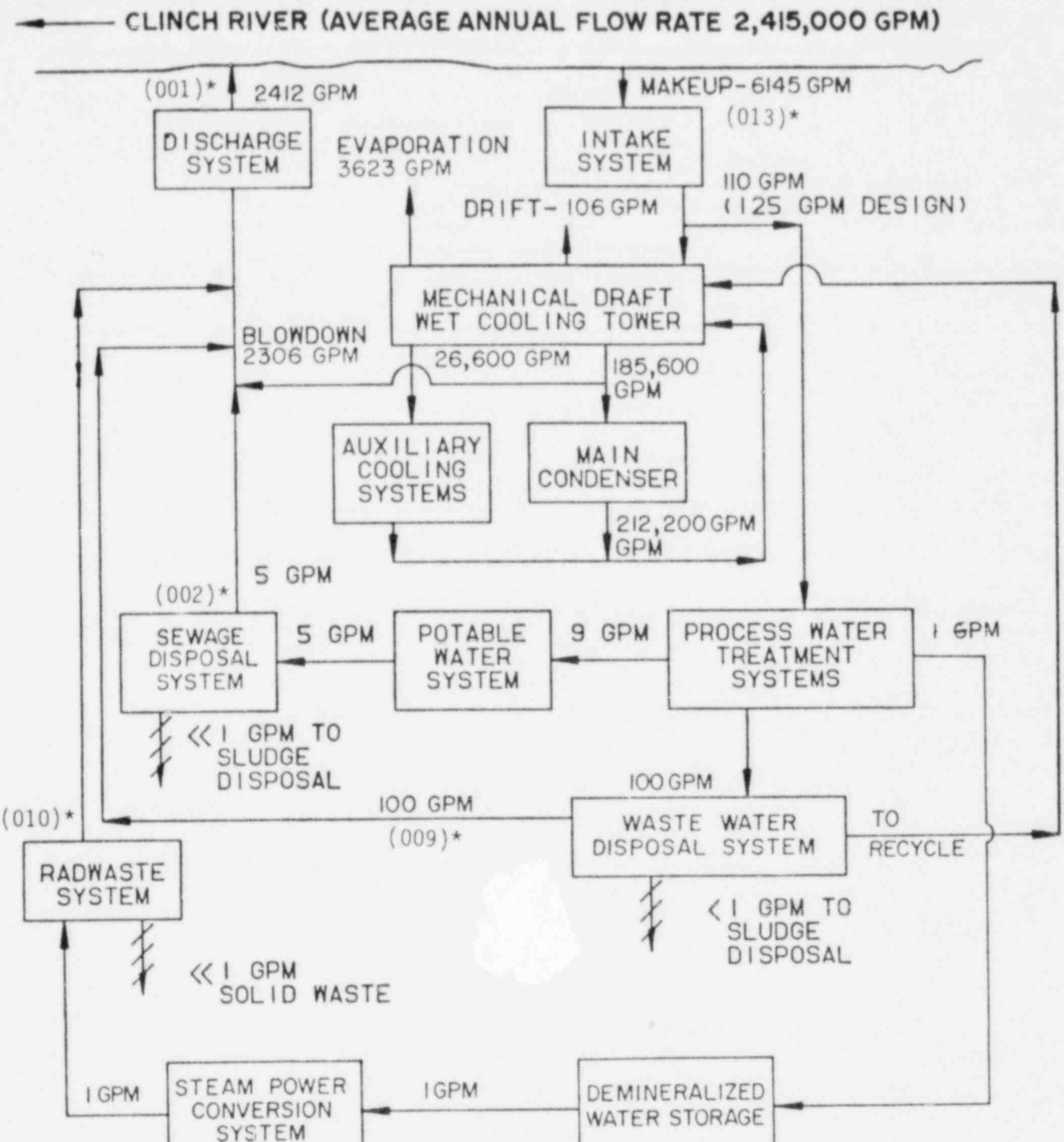
During maximum power operation, the cooling water flow rate to the mechanical draft cooling towers would be 212,200 gpm instead of the 185,200 gpm shown in the FES. The heat rejection from each cooling tower has increased from 2.17×10^9 to 2.26×10^9 Btu/hr.

The expected monthly operating conditions and cooling tower performance characteristics are listed in Table A3.1 (ER Table 3.4-4). The figures for the cooling tower blowdown have been revised from those given in the FES. The daily maximum cooling tower blowdown temperature is limited to 91°F in the NPDES Permit rather than 90.5°F. The minimum expected temperature is now 60.5°F instead of 61.5°F.

Table A3.1 Water temperatures of the Clinch River and the cooling tower blowdown, °F

	River water*			Mechanical wet cooling tower blowdown		
	Avg	Avg max	Avg min	Avg	Daily max	Daily min
Jan	42.7	48.0	37.9	66.3	69.0	60.5
Feb	42.1	48.0	37.6	67.5	69.2	60.5
Mar	47.0	54.9	40.9	70.5	72.0	63.0
Apr	55.1	62.3	48.1	75.0	77.5	66.5
May	60.9	66.4	56.0	79.5	83.0	71.0
Jun	63.5	69.9	58.5	85.0	88.5	75.5
Jul	64.4	69.4	60.3	86.5	91.0	78.0
Aug	65.7	70.1	61.9	86.0	90.0	77.2
Sep	66.9	70.4	63.4	83.0	87.5	73.7
Oct	64.6	68.7	60.2	76.0	81.0	68.5
Nov	57.0	63.4	50.4	70.5	73.0	63.0
Dec	47.7	53.8	43.0	67.0	69.0	60.5

Source: ER Table 3.4-4
*June 1963 to October 1972, Whitewing Bridge Temperature data from TVA.



NOTE: Cooling tower flowrates are annual averages at max power operation

*NPDES serial number

Figure A3.4 Average annual water use rates (replaces FES Fig. 3.6)

Figure A3.5 illustrates the relationship between the wet bulb temperature and the blowdown rate (ER Fig. 3.4-4); it replaces FES Figure 3.7. The auxiliary cooling water systems design has been changed to provide 27,000 gpm instead of 24,000 pgm at 95°F or less.

3.4.2 The Intake (NPDES 013)*

The description of the plant water intake has been modified and expanded. The top of the intake structure now will be 8.5 ft above river bottom rather than 8 ft (see Figure A3.6, which replaces FES Fig. 3.8).

Each of the two intake perforated pipes will be about 24-ft-long and consist of an outer pipe with 3/8-in.-diameter holes covering about 40% of the area and an inner diameter sleeve with larger diameter holes covering significantly less surface area. The outer sleeve is designed to minimize the numbers of fish and the amount of debris entering the system; the inner sleeve is designed to distribute the inflow evenly along the surface of the outer sleeve. Because of the low inlet velocity of 0.2 to 0.4 fps, the applicants anticipate no substantial accumulation of trash on the perforated pipe; therefore, trash racks and screens would not be necessary. Removal of impinged debris from the inlet pipe can be accomplished by flow reversal in the intake piping (ER Am I, Part II, C16).

Two 100% capacity river water pumps would be provided to supply makeup water to the cooling tower basin. The pump design flow rate of 2500 to 10,000 gpm has been changed to 2500 to 9000 gpm.

The above design changes do not result in significant changes in the staff's assessment.

3.4.3 The Discharge (NPDES 001)

A submerged single-port discharge structure as shown in FES Figure 3.12 would be constructed to dispose of the cooling tower blowdown and other plant liquid wastes. The total station discharge rate would be about 2412 gpm.

In FES Figure 3.12, the dimension of 29 ft across the top view should be 39 ft.

3.5 Radioactive Waste Systems

The staff's liquid and gaseous source terms were calculated by the PWR-GALE code, which is described in NUREG-0017, modified to apply to liquid metal fast breeder reactors. (In the FES, this document was identified as Draft Regulatory Guide 1.BB). The principal parameters used in the source term calculations are given in FES Table 3.2. The radioactive argon processing system (RAPS) charcoal adsorber beds dynamic adsorption coefficients shown in the table do not apply because the applicants no longer plan to use those beds. The values for the cell atmosphere processing system (CAPS) charcoal adsorber beds dynamic adsorption coefficients were taken from "Adsorption Bed Performance Equations for Isothermal Steady State Systems" (Atomics International, 1973).

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*NPDES number refers to the outfall serial number in the draft NPDES Permit or to special conditions included in Part III of the draft NPDES Permit (see Appendix H).

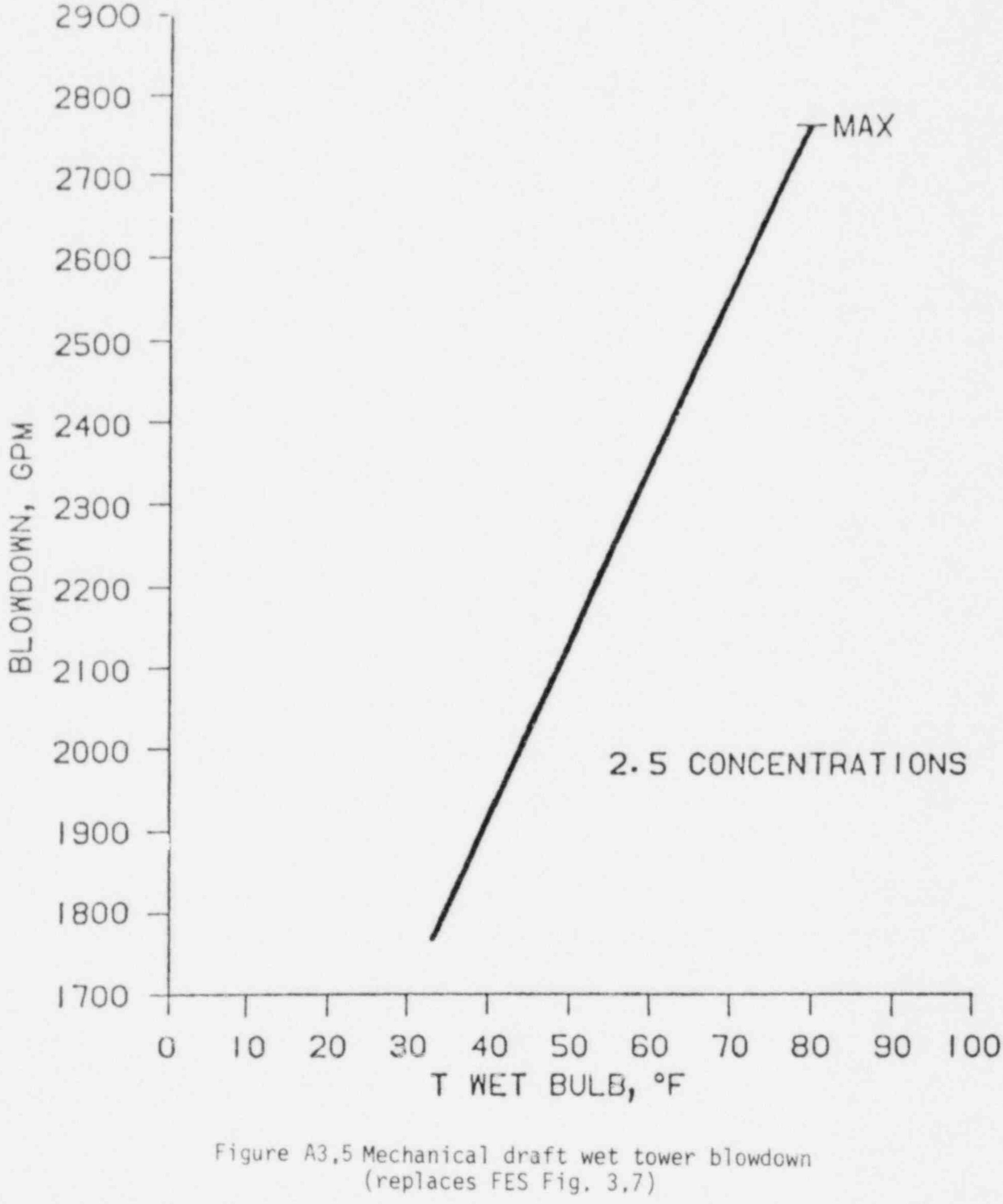

Figure A3.5 Mechanical draft wet tower blowdown
(replaces FES Fig. 3.7)

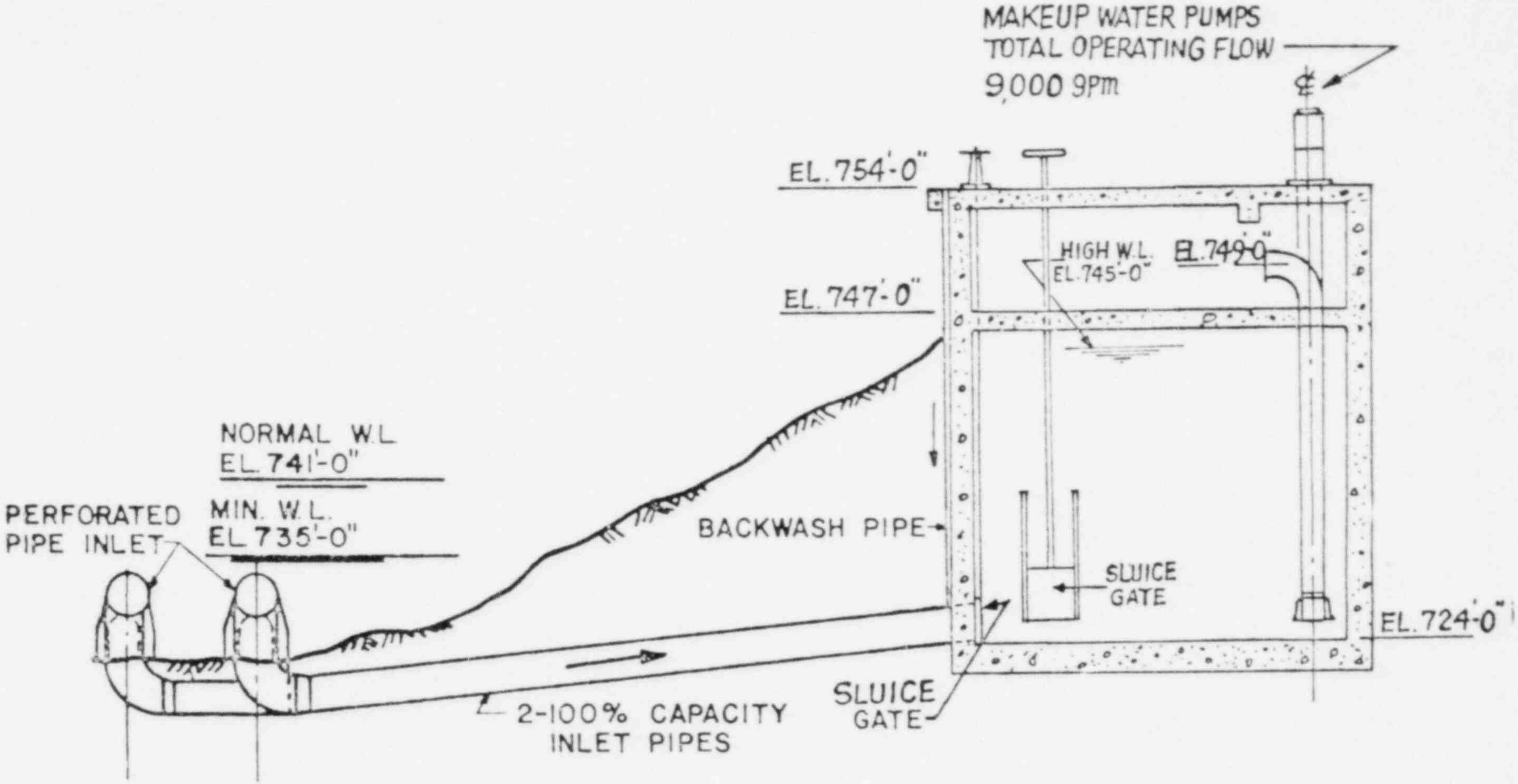

Figure A3.6 Perforated pipe intake system (replaces FES Fig. 3.8)

3.5.1 Liquid Waste (NPDES 010)*

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 vessel (LCCV) and the small component cleaning autoclave (SCA), formerly the intermediate component cleaning cell (ICCC). Based on the applicants' projected component maintenance schedule, the cleaning process now is estimated to produce an average volume of 100,000 gal of aqueous waste per year, an estimate with which the staff concurs.

The input flow rate for the aqueous waste to be collected in the IAS collection tanks (which hold 20,000 gal each) is now estimated to be 340 gpd instead of the 400 gpd indicated in the FES (see Figure A3.7, which replaces FES Fig. 3.15 revised). The staff calculates the collection time to be 59 days. After collection, the waste would be processed, in batches, by filtration, evaporation (10 gpm), and demineralization before it is collected in one of the 20,000-gal monitoring tanks.

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 in the plant and in the reactor service building. After processing, this waste would be collected in one of the two 2400-gal collection tanks at an input rate of 850 gpd (see Figure A3.7). (In FES Fig. 3.15, collection tank capacity was given as 2500 gal.) The staff estimates the collection time will be 2.8 days, slightly more than estimated in the FES. After collection, the waste would be batch processed by filtration, evaporation (10 gpm), and demineralization and then collected in one of the 2400-gal monitoring tanks (also a change from the FES in which tank capacity was given as 2500 gal).

3.5.1.3 Balance of Plant Releases

Tritium buildup in the steam-water system would be controlled by a 1-gpm bleed from the condensate and feedwater system discharged to the environment via the cooling tower blowdown. The applicants now estimate the tritium release to be approximately 2.3 Ci/yr, considerably less than the 330 Ci/yr estimate in the FES. This estimate appears reasonable and the staff agrees with it.

In FES Table 3.3, the values for H-3 and the total should be changed to 2.3 Ci/yr.

3.5.1.4 Liquid Waste Summary

Based on its evaluation of the radioactive liquid waste treatment systems, 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. The applicants now estimate these releases to be 8.7×10^{-4} Ci/yr, excluding tritium

*The nonradioactive components of the liquid waste are regulated by EPA under Clean Water Act (see Appendix H).

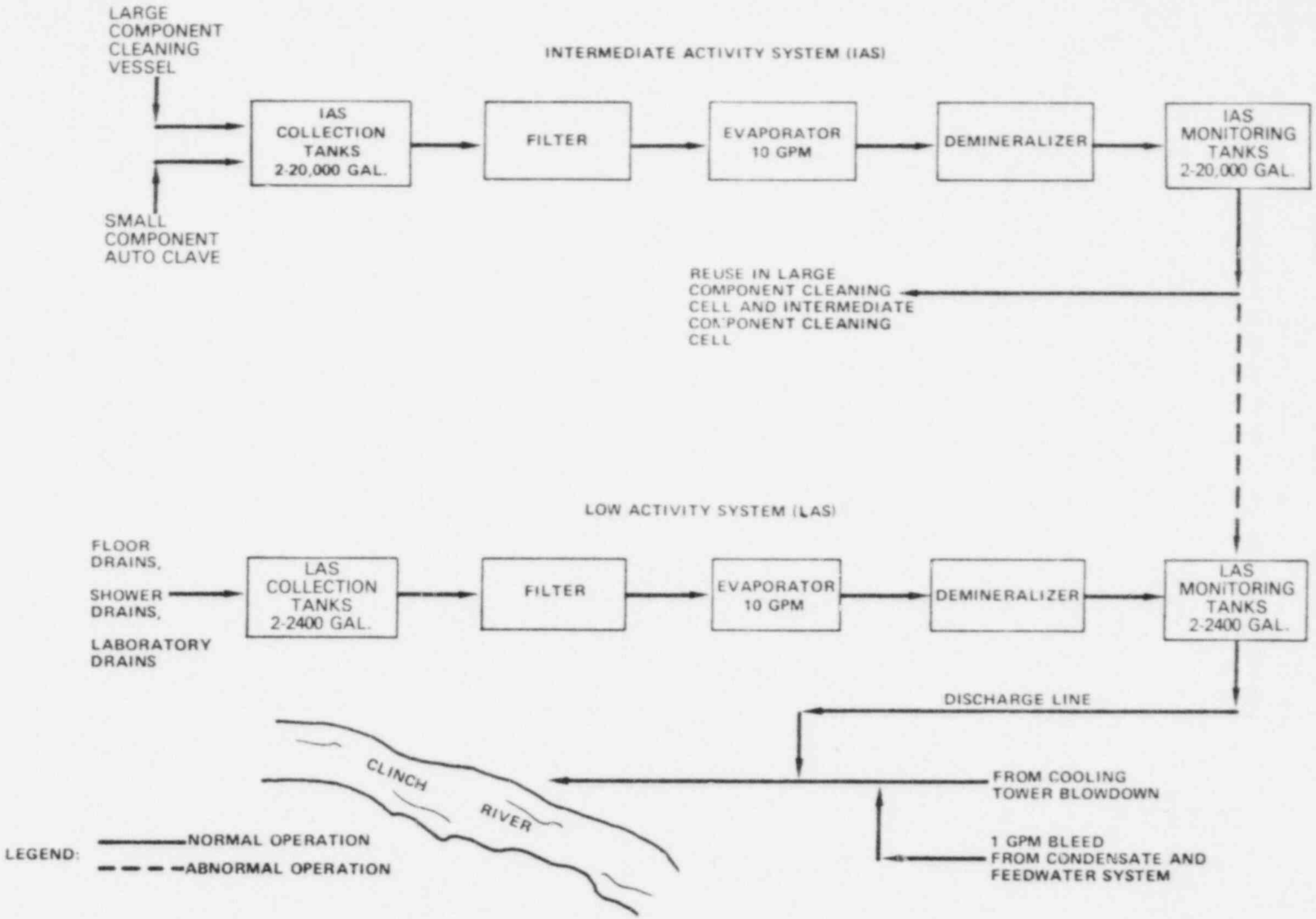

Figure A3.7 Liquid radioactive waste system
(replaces FES Fig. 3.15)

and dissolved gases, instead of 6.1×10^{-5} Ci/yr. The staff results differ from those of the applicants 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.

3.5.2 Gaseous Waste

Changes in FES Figure 3.16 (herein Figure A3.8) are discussed below.

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. In the process, as revised from that described in the FES, radioactive cover gases from the spaces in the reactor, reactor overflow vessel, and primary system pumps would be collected in the vacuum vessel and transferred by compressor to the surge vessel where they would be stored under pressure (Figure A3.8).

The effluent gases from the surge vessel would enter a cryogenic still that has liquid argon in the still bottom. The liquid argon would adsorb the radioactive krypton and xenon isotopes and permit their separation from the bottoms by periodic draining, evaporating, and transferring to the noble gas storage vessel. The purified argon would be directed to the vacuum vessel as recirculation throughput (4.85 scfm) and to the recycle argon vessel (5.15 scfm) for reuse in the primary system as cover gas. The applicants propose to process gases from the noble gas storage vessel through the cell atmosphere processing system. 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 cells (containing nitrogen atmosphere) which house the reactor, primary heat transfer system (PHTS), PHTS pumps, and reactor overflow vessel. The provision that CAPS also collect and process any leakage of gases in the nitrogen or air atmosphere cells housing the RAPS and CAPS components, as described in the FES, is no longer included. Because the flow input to the CAPS would be variable, the staff has assumed for its calculations that the rate through the charcoal beds would be 50 scfm.

3.5.2.3 Reactor Containment Building Ventilation System

The atmosphere in the head access area would be ventilated by an air stream exhausted to the environment through the reactor containment building (RCB) ventilation system without treatment. The estimated volume of this air stream has been increased to 14,000 cfm from the 12,000 cfm estimate in the FES.

3.5.2.4 Intermediate Bay Ventilation System

Tritium that diffuses from the PHTS into the intermediate heat transfer system (IHTS) also would diffuse at a small but finite rate through the IHTS piping

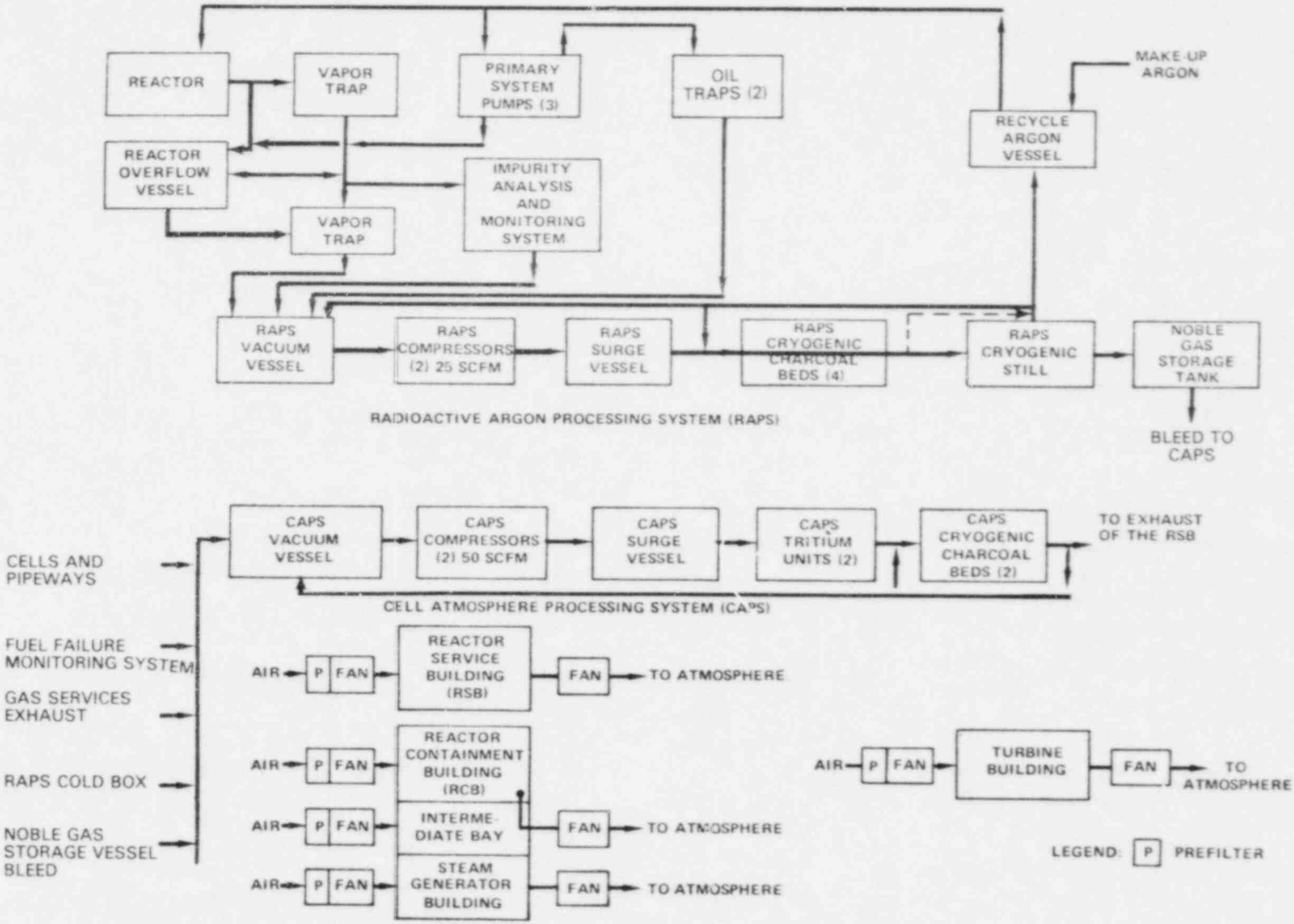

Figure A3.8 Gaseous radioactive waste systems and CRBRP ventilation (replaces FES Fig. 3.16) and components into the intermediate bay (IB) cell atmospheres. The cell atmospheres would be vented to the environment through the IB ventilation system with a total flow rate of 64,000 cfm.

3.5.2.5 Turbine Building Ventilation System

A small quantity of tritiated water vapor would be removed from the steam water system by the mechanical vacuum pumps of the condenser offgas system along with noncondensable gases. According to the revised design of the turbine building ventilation system, the gases would be discharged through the turbine generator building lube oil areas exhaust duct with a flow rate of 8000 cfm.

3.5.2.6 Gaseous Waste Summary

The staff now calculates that the release of radioactive materials in gaseous effluents would be about 389 Ci/yr (the same as in the FES) for noble gases and 1 (instead of 3.1) Ci/yr for tritium. In comparison, the applicants estimated a total release of 700 (instead of 6.4) Ci/yr for noble gases and 0.1 (instead of 3.1) Ci/yr for tritium. The difference between the staff's and applicants' estimates of noble gases released results from 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 and increased the tritium release by a factor of 10, for the reasons stated in FES Section 3.5.1.4.

In FES Table 3.4, the H-3 releases in Ci/yr should be shown as 0.1 from RCB, 0.6 from IB, 0.3 from TB, and 1.0 total.

3.5.3 Solid Waste

The applicants now estimate that approximately 1100 (instead of 1000) ft^3 of solidified liquid radwaste containing 2800 (instead of 56) Ci of activity would be shipped off site annually. The staff agrees with this estimate.

The staff also agrees with the applicants' revised estimate that approximately 800 (instead of 1500) ft^3 of noncompactible solid waste containing 300 (instead of 100) Ci of activity would be shipped annually.

Metallic sodium waste from fuel handling operations would be processed into a form suitable for shipment to a burial facility or for onsite storage. The staff agrees with the applicants' revised estimate that approximately 15 (instead of 42) ft^3 of sodium waste containing 40 (instead of 10) Ci of activity be generated annually and approximately 750 (instead of 240) ft^3 of sodium-bearing waste containing 1.6 (instead of 1.9) x 10^4 Ci of activity would be generated annually.

The applicants now estimate that approximately 210 (instead of 290) ft^3 of compacted waste containing less than 1 Ci of activity would shipped off site annually.

3.5.3.1 Solid Waste Summary

As stated in the FES, the staff concludes that the solid waste system is acceptable. The waste would be packaged and shipped to a licensed burial site in accordance with NRC and Department of Transportation regulations, or stored on site.

Table A3.2 Preliminary estimates of effluent water concentrations

	Clinch River		CRBRP waste streams, mg/l[a]				Discharge to river[a]		
	Background,* mg/l		Cooling tower blowdown**		Neutralized plant wastes†	Sanitary wastes	Ann amt††	Conc, † mg/l	
	Max conc	Mean conc	Based on avg river conc	Based on max river conc	Based on avg disch, 100 gpm	Based design loading	10^4 lbs/yr)	Avg	Max
Total alkalinity ($CaCO_3$)	100	87	2.18	250	<50	--	NA	239	286
Ammonia nitrogen (N)	0.23	0.04	0.10	0.58	--	0.5	0.47	0.70	2.50
BOD	1.3	<1.0	5.3	15.0	--	12	3.5	5.3	15.0
Calcium	35	29	72	87.5	224	--	57	85	108
Chloride	40	3.0	7.50	100	43	--	7.8	11.8	32.3
Chlorine residual	--∆∆	--∆∆	0.2	0.5	--	1	0.1	0.14	0.14
COD	12	<4.0	10	30.0	--	25	11.2	16.8	32.3
Copper† (µg/l)	170	36	90	425	--	--	0.13	0.20	0.93
Total dissolved solids	142	174	312	37.5	1,350	--	279	355	415
Total iron† (µg/l)	6500	530	1,325	16,250	--	--	0.63	0.95	1.72
Lead (µg/l)	35	<11	<28	<87.5	--	--	<0.01	<0.03	<0.03
Magnesium	9.6	7.7	19.25	23.5	75	--	13.0	19.6	21.4
Manganese† (µg/l)	180	55	138	450	1	--	0.09	0.13	0.18
Nickel† (µg/l)	60	<50	125	150	--	--	0.01	0.02	0.11
Nitrate (NO_3)	1.4	0.45	1.13	3.5	3.2	66	2.3	2.4	5.6
pH	8.2	7.6	7.6	8.2	6.5-8.5	6-9	NA	6.5-8.5	6.5-8.5
Total Phosphate	0.04	0.02	--	--	1	5	0.10	0.14	100
Potassium	1.7	1.26	3.15	4.25	15	--	2.3	3.5	4.8
Silica (SiO_2)	6.0	6.3	10.75	15	27	--	6.5	9.8	15.3
Sodium	7.0	3.3	8.25	17.5	345	--	21	22	31
Sulfate (SO_4)	27	16	40	67.5	780	--	62	70	97
Total suspended solids	40	7.0	17.5	100	<30	5	21.9	33	114
Zinc††† (µg/l)	570	36	90	1,425	--	--	0.03	0.05	0.08

*"Status of the Nonradiological Water Quality and Nonfisheries Biological Communities in the Clinch River Prior to Construction of the Clinch River Breeder Reactor Plant, 1977-78," TVA, Feb. 1979.

**Includes several minor recycled waste streams (makeup water system equipment rinses, backwashes, and blowdown, and nonradioactive floor drains). These do not measureably affect the cooling tower blowdown chemical concentrations.

†Includes makeup water demineralizer and steam condensate polisher regeneration wastes, auxiliary boiler blowdown, and nonradioactive lab and sampling wastes.

††Computed as follows: quantity from cooling tower blowdown = (avg conc) (annual avg blowdown = 2327 gpm) (plant load factor = 68.5%)
quantity from neutralized plant wastes = (conc) (flow = 100 pgm) (24 hr/day operation) (365 operating days/yr)
quantity from sanitary wastes = (conc) (flow = 5 gpm) (24 hr/day operation) (365 operating days/yr)

$\frac{\Sigma \text{(conc) (Flow)}}{\Sigma \text{(Flow)}}$ where avg conc is based on average river conc (cooling tower blowdown) and average discharge flow (neutralized plant wastes) and max conc is based on max river conc and max discharge flow

∆∆Field measurements using the orthotolidine calorimtric method repeatedly showed the chlorine residual concentration to be below the limits of detection (<0.05 mg/l). As there are no nearby sources of chlorine additions to the river, it can be assumed that the ambient level is zero.

†††Includes contribution to effluent for condenser erosion/corrosion

(a)To be modified slightly when ECP B76-043 is finalized.

3.6 Chemical Effluents

The revised EPA draft NPDES Permit that would limit chemical discharges as necessary to protect other water users is included as Appendix H to this document. The notable changes in the FES discussion of chemical waste effluents are given below.

3.6.1 Circulating Water System Output (NPDES 001 and 011)

Consumptive use of water at the plant will be essentially the result of evaporation in the cooling towers. As shown in Figure A3.4, an average of 3729 gpm would be lost by evaporation and drift from the tower out of a makeup stream of 6145 gpm. Chemicals or chemical species expected to be in plant cooling water discharged to the river are shown in Table A3.2 of this assessment (ER Am VIII, Table 3.6-1, which replaces FES Table 3.5). The comparison of chemical concentrations in the station effluent shown in FES Table 3.6 have not been revised here because the NPDES Permit Rationale demonstrates how Federal effluent limitations and state water quality criteria are considered in developing permit limitations (see Appendix H).

3.6.2 Chemical Biocides (NPDES 010)

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. Chlorination will be accomplished in compliance with Federal effluent limitations and state water quality criteria. The draft NPDES Permit limits the instantaneous maximum concentration of total residual chlorine to 0.14 (instead of 0.5) mg/l.

3.6.3 Water Treatment Wastes (NPDES 009)

Approximately 110,000 (instead of 96,000) gal of river water would be treated each day to meet the plant's process water needs. The raw river water would be treated by coagulation/sedimentation and filtration to remove particulate matter. Clarified water from the process water treatment systems would be treated further by ion exchange to produce demineralized water for the steam cycle and other plant uses. The ion exchanger demineralization process will use sulfuric acid and sodium hydroxide to regenerate the ion exchange beds (ER Sec 3.6.3). Fig. A3.9 (supersedes FES Fig. 3.17) shows the current plan for the waste water treatment system.

3.6.4 Steam Generator System Waste Discharges (NPDES 009)

Regeneration cycle wastes and rinses from the condensate polishing system and the makeup water treatment system and other minor nonradiological process water waste streams are directed to the waste water treatment system. This system neutralizes pH and removes particulates before discharging the waste streams to the Clinch River. Effluent may be recycled as cooling tower makeup if chemical quality allows it.

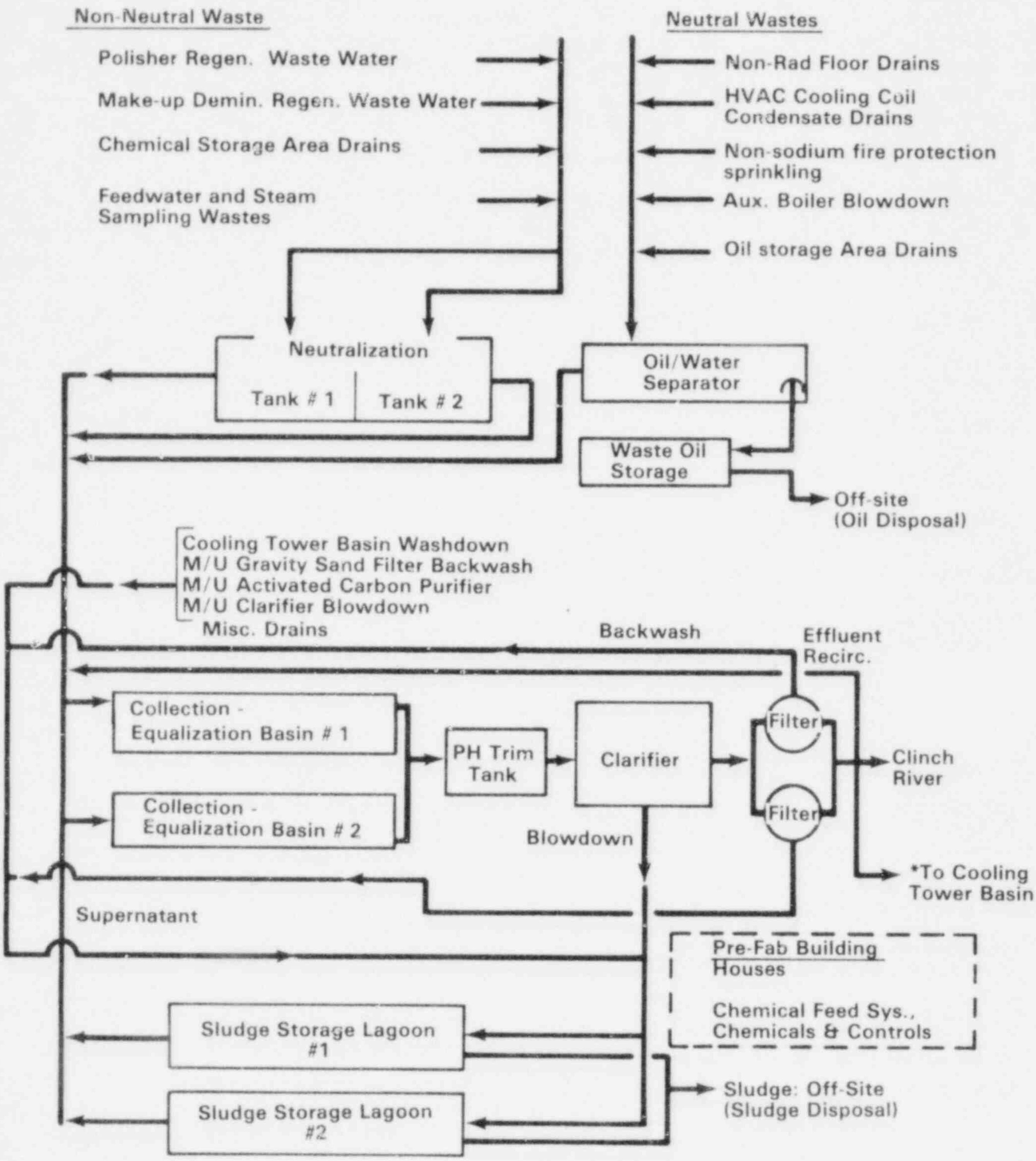

Figure A3.9 Chemical waste treatment system (replaces FES Fig. 3.17)

3.6.5 Chemical Cleaning Waste (NPDES 012)

The waste generated by chemical cleaning procedures are proposed for disposal offsite in an environmentally acceptable manner. Details of such disposal are to be provided to EPA not later than 90 days before any cleaning operation. The draft NPDES Permit provides effluent limitations and monitoring requirements in the event that discharge at the plant site is ultimately utilized.

3.6.6 Oily Waste (NPDES 009)

The NPDES serial number has been added.

3.6.7 Polychlorinated Biphenyls (NPDES Part IIIB)

The draft NPDES Permit now prohibits discharges of polychlorinated biphenyls (PCBs) and requires that EPA be notified should major equipment containing PCBs be brought onto the site.

3.6.8 Chemical and Oil Storage

No changes are needed in this section of the FES.

3.6.9 Storm Drainage

The first sentence in this section of the FES has been reworded as follows: "Storm water would be collected from roof and yard drains and sent to runoff treatment ponds (ponds A, B, and D) for removal of suspended solids prior to discharge to the Clinch River."

3.6.10 Cooling Tower Drift

The anticipated rate of cooling tower drift now is estimated to be 106 gpm instead of 107 gpm.

3.6.11 Nonradioactive Chemical Coolants

No changes have been made to this section of the FES.

3.7 Sanitary and Other Waste

3.7.1 Sanitary Waste (NPDES 002)

The capacities of waste treatment facilities have been changed. Before the construction permit is issued, sanitary waste generated by personnel participating in site preparation under a limited work authorization would be treated by a 13,000-gpd capacity extended aeration activated sludge sewage treatment. If the construction permit is issued, a larger extended aeration unit with a capacity of 52,000 gpd would be installed, giving a total capacity of 65,000 gpd. The larger unit would be removed when construction is complete.

The 13,000-gpd unit would remain for treating the wastes generated during normal plant operation. The maximum number of personnel needed during annual shutdowns now is estimated to be 300. With an expected waste generation rate of 35 gpd per person, about 10,500 gpd of waste would be generated, which is within the capacity of the unit.

In the operation of the 13,000-gpd unit, an aeration step would precede the slow sand filtration (FES Fig 3.18). A chlorination step prior to discharge is included. The extended aeration unit alone is expected to remove 65 to 91% of the suspended solids and 75 to 95% of the biochemical oxygen demand. Table A3.3 shows the expected characteristics of the final effluent.

Table A3.3 Plant sanitary waste system estimated ef[illegible]nt characteristics

	Sanitary waste effluent (mg/l)	Draft NPDES Permit limit daily avg (mg/l)
Suspended solids	5	30
BOD	12	30
COD	25	--
Total phosphate(PO_4)	5	--
Nitrate nitrogen(N)	15	--
Residual chlorine	1	N/A
Ammonia nitrogen(N)	0.5	5.0
pH	6.0-9.0	6.0-9.0
Fecal coliform (organisms/100 ml)	--	200*
Settleable solids (ml/l)		1.0

Source: ER Table 3.7-1 and NPDES Permit and 401 certification.

*From 401 certification.

3.7.2 Other Waste

The first paragraph of this section has been revised to read:

> The only nonradioactive gaseous effluents discharged into the atmosphere would be those in the exhaust from emergency operation or periodic testing of the three diesel generators, which serve the plant in case of power failure, and the diesel-driven fire pumps. The maximum rate of emission of pollutants from the largest of these standby units would be as follows: particulates, 1 lb/hr; sulfur dioxide, 72 lb/hr; nitrogen oxide, 402 lb/hr; organic compounds, 7 lb/hr; and carbon monoxide, 14 lb/hr. Testing frequency would be once per month for 2 hours or until normalization of operating conditions, whichever is sooner.

3.8 Power Transmission System

In FES Figure 3.19, the 161-kV transmission line passing through the CRBRP site should be labelled "DOE-Owned Ft. Loudon - K31 161 kV."

On page 3-26 of the FES first paragraph, fourth line, the following sentence should be inserted after "corridor":

> Prior to construction of the offsite corridor, additional archeological investigations will be made; these will be done in consultation with the State Historic Preservation Office and the NRC.

The next sentence (on page 3-26 of the FES, first paragraph, fourth line) should read:

> Should these archeological investigations reveal any significant site in the proposed transmission line corridor or close vicinity, relocation of the route, relocation of specific towers, or possible salvage excavation would be considered (ER Sec 3.9.6).

On page 3-36 of the FES, the second sentence of the third paragraph should read: "The right-of-way is 37% hardwood, 43% pine, 10% mixed, and 8% unforested (ER Table 3.9-1, Am IX)."

3.9 Conclusion Regarding Changes in Facility Description

The changes in the facility described above are not substantial and they do not result in significant changes or additions to the staff's assessment of the impacts from constructing and operating the CRBRP.

4 ENVIRONMENTAL IMPACTS DUE TO CONSTRUCTION

4.1 Construction Schedule and Manpower

Site preparation is now planned to begin by May 1983, and completion of this phase of the work is expected within 14 months. The applicants have requested a Limited Work Authorization (LWA) under 10 CFR 50.10(e)(1) to perform the site preparation activities before the anticipated issuance of the construction permit (CP) in June 1984.

The facilities to be constructed under the LWA are essentially as described in the FES. The 32-acre borrow pit shown in FES Figure 4.1 has been eliminated and the 25-acre quarry would now occupy 45 to 60 acres (Figure A4.1).

Although the construction phase after issuance of the LWA is expected to last 7 years, most of the construction would be completed within 6 years. The fifth paragraph of this section in the FES should be deleted because the Centar enrichment plant and the Exxon reprocessing plant are no longer in current plans for the Oak Ridge area, and construction of the Phipps Bend Nuclear Plant has been suspended.

Table A4.1 provides data on the labor required to construct and operate the CRBR. Updated information on the labor force and its probable impact on the community is presented in Section 4.5.

4.2 Impacts on Land Use

4.2.1 Onsite and Immediate Vicinity

The total area now planned to be cleared and graded at the proposed CRBRP site is approximately 292 acres of mostly forested land, which is approximately 20% of the 1364 acres of the site (see Table A4.2). About 113.5 acres of the total area to be cleared would be permanently disturbed, including 34 acres for access roads and railroads, 10 acres for the meteorological tower area, 4 acres for barge unloading area, 2 acres for parking area, and 37 acres for all land within the security barrier. These increases of approximately 50% in land use are not significant because the entire 1364-acre site is zoned for industrial development.

Specific forest types that would be disturbed by construction activities are given in Table 4.1-2 of the applicants' ER (Am III).

As stated in the FES, timber of commercial value on the construction areas would be harvested and removed from the site in accordance with the DOE Forest Management Program. The remaining plants and brush would now be burned in accordance with state and Federal air pollution regulations (ER Sec 4.1.1); this would have a slightly adverse effect on air quality in the immediate vicinity. Conventional garbage would be disposed of offsite. The applicants have deleted the use of a borrow pit from their plans.

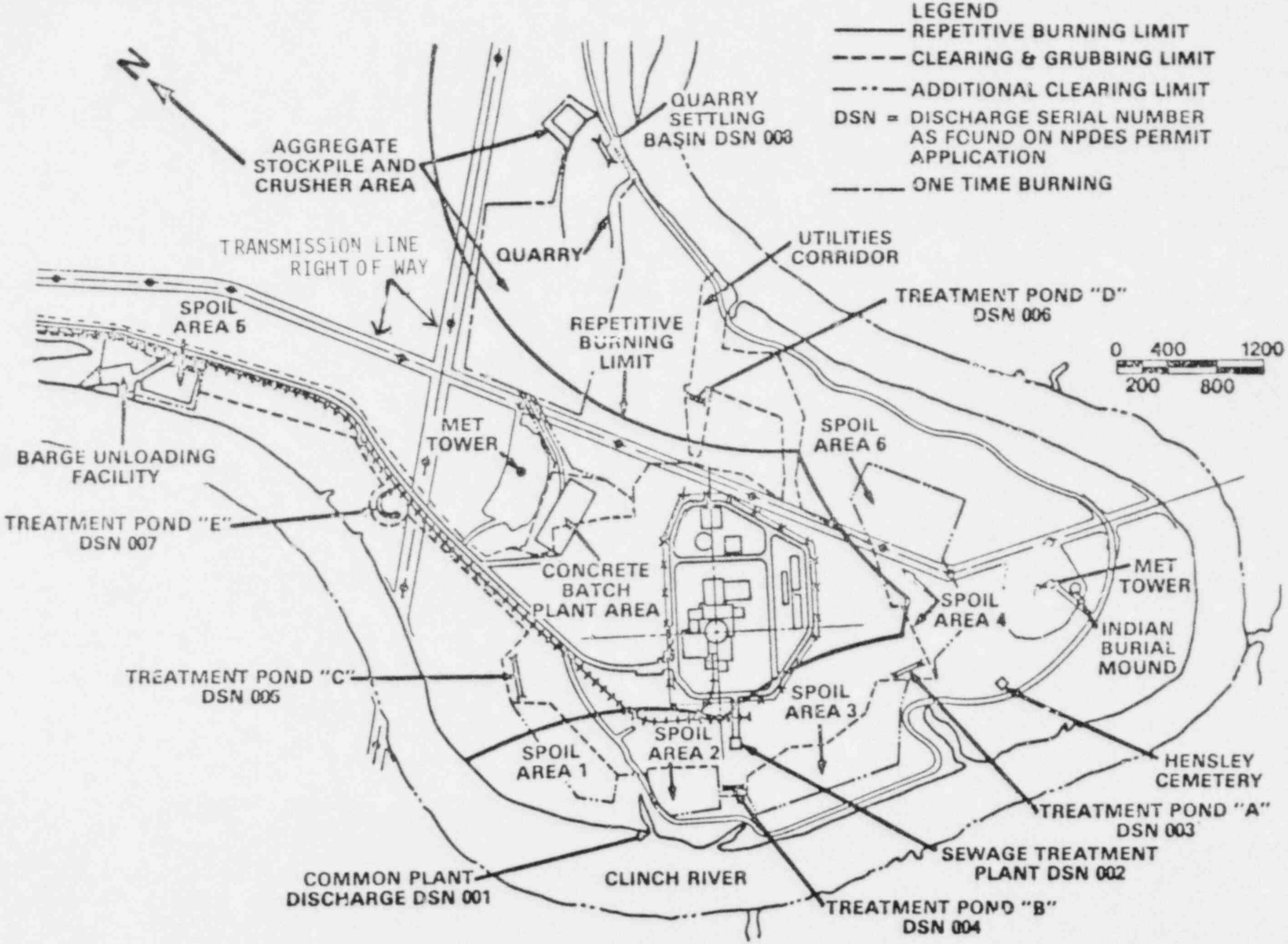

Figure A4.1 Proposed site construction layout

Table A4.1 Schedule of direct and induced employment for the CRBRP by type of employee[1]

Type of employee	Construction phase (year after LWA)							Operation phase (year after startup)						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Direct manual	86	693	2551	3835	2924	883	55	0	0	0	0	0	0	0
Nonmanual	211	388	546	685	655	398	81	0	0	0	0	0	0	0
Subcontractor	304	210	190	163	244	178	23	0	0	0	0	0	0	0
CRBRP project office	267[2]	274	256	240	240	223	201	141	109	81	54	44	25	0
Contractor support	189	190	188	181	172	169	148	87	0	0	0	0	0	0
Operations[3]	0	6	13	71	140	222	282	255	247	246	246	246	246	246
All types of direct employees	971	1761	3744	5175	4375	2073	790	483	356	327	300	290	271	246
Induced[4]	17	27	24	31	48	69	84	77	75	75	75	75	75	75
Total direct and induced employees	988	1788	3788	5206	4423	2142	874	560	431	402	375	365	346	321

[1] Reported numbers are yearly averages.

[2] 237 project office staff and 142 contractor support personnel were already living in the project area as of February 1971.

[3] Includes security personnel during operation.

[4] The number of induced workers hired during the construction phase is based on the number of relocated direct relatively permanent workers hired by Contractor Support, Operations, and Project Office Staffs. The staff assumed a 50-percent inmover rate for employees over and above the number of employees living in the project area for the employment groups listed above as of February 1981. The staff assumed a 0.6 multiplier for calculating induced employment by year with 75 percent of induced workers hired within the current year and 25 percent the following year.

Table A4.2 Land areas that would be affected by proposed site preparation activities*

Category	Acres disturbed: Temporary facilities	Acres disturbed: Permanent facilities
Access roads and railroads (onsite)	30	30
Access railroad (offsite)	4	4
Parking area	19	2
Barge unloading area	4	4
Impounding ponds	7	7
Quarry including stock pile area and crusher facility	60*	-
Concrete batch plant	5	-
River water intake, pumphouse, and discharge line and sanitary landfill areas	6	0.5
Spoil areas	43*	-
Storage and other work areas	67	-
Permanent plant building and all land within security barrier	37	37
Meteorological tower areas	10	10
Additional security areas required for 150-ft line of sight beyond security barrier--to be grassed and mowed	-	19
TOTAL	292	113.5

Source: ER Table 4.1-1 Am XIII, April 1982.

*Maximum

The barge-unloading facility (Figure A4.1) has been redesigned in a manner which minimizes dredging. The concrete-slab-on-piling type of barge unloading facility would now occupy a 100-by-250-ft area recessed into the river bank. On one side and one end of the area, sheet piling would be driven to form two boundaries of the area to be excavated. The bottom of the dredged area would

Topsoil on the areas to be excavated would be removed and stockpiled for use in later landscaping. Beneath the topsoil, about half of the excavated materials would satisfy requirements for structural fill. The excess would be stockpiled for backfill. Additional backfill would now be obtained from the 45-acre quarry and stockpile areas (Figure A4.1). Building material (sand, stone, slate, limestone) would now be quarried on site. Surface soils of the quarry area would be stockpiled for revegetation of the quarry area at the end of construction.

The Indian Mound has been excavated and no longer exists.

The above changes do not significantly affect the staff's impact assessments in Section 4.4.

4.2.2 Transmission Lines

About 58 acres, rather than 54 acres, would be used for tranmission lines. This is not a significant increase in environmental impacts.

4.3 Impacts on Water Use

The maximum water requirement during construction would be 210,000 gpd, up from the figure of 190,000 gpd given in the FES, about 0.007% of the river's annual average flow. Water for other than quarry use could be as much as 150,000 gpd and would be piped along existing roadways from the nearby Bear Creek Water Filtration Plant.

This small increase in water use is not environmentally significant.

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 292 acres concerned with the plant (Table A4.2) and 58 acres in connection with the transmission lines, both on and off site. This increase of approximately 50% percent over the 195 acres (stated in the FES) to be cleared for construction of the plant proportionately increases the amount of biota affected. However, the biota affected would still be less than 1% of such resources on the Oak Ridge Reservation. The staff therefore concludes that their increased impact is not environmentally significant.

Under the applicants' restoration plans, the 45 acres for the quarry would probably start supporting wildlife about 10 years after restoration and provide habitat equivalent to the present habitat in another 10 years.

4.4.2 Aquatic

The second sentence of the second paragraph of the FES has been revised to read:

> The staff recommends that the cofferdam be installed and removed when sauger are not spawning and striped bass are not utilizing

the Clinch River as a thermal refuge (this is consistent with ER Section 4.6.1.2(2)) unless it can be substantiated that there will be no adverse effects.

The river and shoreline area to be excavated or dredged during installation of the pumphouse and intake pipes is now described as having an area of 9400 ft^2 (the FES states that 3440 m^3 of river bottom would be excavated); this is not a significant change.

The discharge pipe would be installed with some excavation and dredging taking place. Approximately 2600 ft^2 (the FES states that 190 m^3 of river bottom would be excavated) of river bottom and shoreline would be disturbed; this is not a significant change.

About 11,000 yds^3 (instead of 14,500 m^3 (19,000 yds^3)) of material would be dredged to accommodate the barge-unloading facility; this is a slight reduction in terms of impact. Approximately 700 yds^3 of sand fill (rather than 4940 m^3 (6500 yds^3) of granular fill) would be used to line the bottom of the facility. About 600 linear feet of shoreline and about 1700 ft^2 of river bottom below the 741-ft elevation would be disturbed during construction. The sequence of construction for the facility is: drive piling, construct concrete slab, excavate bottom, and place sand as required. Aquatic life would be destroyed in the area of the barge-unloading facility. However, based on the amount of area impacted, the temporary nature of the activities, and the fact that a large portion of this area is dry during part of the year, no significant long-term impact is expected.

Limited dredging and placement of granular fill and riprap would be associated with improvement of the access road and construction of the railroad spur. These activities would impact approximately 34,000 ft^2 of existing river bottom below the normal pool elevation of Watts Bar Lake. Deposition of the fill material would initially destroy the underlying benthic community; however, this impact would be temporary, and benthic organisms would rapidly colonize the new rock substrate. The staff recommends that fill material not be placed in the river during the period in late summer when striped bass are utilizing the Clinch River as a thermal refuge or in late spring when sauger are spawning.

Clearing rights-of-way for the transmission corridors and moving construction equipment along the corridors would result in some soil erosion and stream siltation. Such effects, although significant for the streams affected, would be temporary and even areas severely affected would be recolonized. FES Section 3.8 describes construction practices designed to minimize these effects.

An Erosion and Sediment Control Plan has been developed by the applicants for the planned construction activities at the site. The NPDES Permit requires the approval of such a plan by EPA. The objective of the plan is to control the erosion and sedimentation resulting from construction activities by minimizing soil exposure, collecting and controlling rainfall runoff in the construction area, and by shielding and/or binding soil on cut slopes where stabilization is required. Sedimentation to the Clinch River would be controlled by placing runoff treatment ponds and sand filters so they collect and treat rainfall runoff.

The plan incorporates the EPA and State of Tennessee standards of performance for new sources, best professional judgment, and other applicable guidance documents to control the potential pollution resulting from the construction activity. The extent and comprehensiveness of the plan eliminates the need for an aquatic biological monitoring program. The plan requires that specific methods be used to minimize erosion from water, wind, and gravity as described in the above paragraph.

The NPDES Permit, Page I-3, sets forth effluent limitations and monitoring requirements for point source runoff from areas of construction. As noted in the NPDES Permit Rationale, these requirements are based on 40 CFR 423.45 and best professional judgments. Use of runoff collection ponds with sand filtration is considered by EPA to be a best management practice for control of site runoff.

In summary, the aquatic ecosystem, including the Federally protected species, Lampsilis orbiculata orbiculata, is expected to sustain no significant impact from construction of the plant and transmission lines provided that: (1) activities are timed to minimize effects during critical periods of activity in the Clinch River and (2) requirements in the Erosion and Sediment Control Plan and the NPDES Permit are met.

The above changes and additional information do not constitute a significant change in the FES assessment of ecological impacts.

4.5 Impacts on the Community

This section now includes relevant material in FES Section 4.1. To a large extent, the severity of socioeconomic effects is dependent on time. In the case of Clinch River, the staff felt that enough time had passed since the earlier analysis was completed to warrant a reanalysis of socioeconomic effects. Moreover, certain background factors (competing construction projects) had changed as did the assumptions originally used by the staff analysts. The resulting analysis differs considerably from that which was developed for the staff's FES and is presented below.

4.5.1 The Inmover Construction Labor Force

Existing residents of the four-county impact area would supply most of the demand for labor through the release of construction laborers and craftsmen from other construction projects, through the movement of laborers as they are bid away from other industries, and through a decline in unemployment. The applicants' analysis (ER App C) discusses a range of 26 to 40% inmovement of construction labor, which is based on TVA experience in constructing nuclear power stations. The lower value reflects TVA construction experience and ordinary competition for regional labor. The upper value reflects the possibility that another large, heavy construction project--notably the Koppers coal liquefaction plant--could bid for skilled workers from the same labor shed supplying the proposed CRBRP during the same time frame.

Additional employment could 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 an increased demand for goods and services. The applicants reference an Appalachian Regional Commission study (ER Sec 8.2.2.2) showing, for Anderson County, that every economic base job generates an additional 0.75 job in local service and production activities. The applicants adopted a multiplier of 1.6 that more closely reflects the temporary nature of impacts associated with construction projects than does the multiplier calculated by the Appalachian Regional Commission (ER Table 8.2-3). The applicants further assumed that because workers would not migrate to fill indirect employment opportunities created by the proposed CRBRP, levels of inmigration would not be affected by the number of indirect jobs created (ER App C, Sec 1.0). The staff agrees with these assumptions and finds them reasonable in light of the temporary nature of construction employment.

At an inmovement level of 26% many as 1300 direct employees might move into four-county impact area during the peak year of construction (ER Sec 8.3.2.1). The corresponding figure at the 40% level would be 1600. Previous TVA studies indicate that 70% of the employees moving into an area are accompanied by their families, which contain 3.2 persons on the average (TVA, 1981, 1979, 1980, 1980a, 1978, and 1980b). Applying these factors to the number of inmoving workers under both migrant conditions yields the total number of people who would move into the four-county area during the peak year of construction. At the lower level of migration the number of people would be 3200, whereas 5040 people would move into the impact area under the higher alternative assumption (ER App C, Sec 1.0).

4.5.2 Distribution of Inmover Construction Labor Force

The ability to absorb a temporary population influx in existing communities will depend to a large degree on the distribution of the new population among those communities. The average construction worker is willing to commute long distances (approximately 50 miles), if necessary, to take a temporary job. However, as the commuting distance increases beyond 50 miles, construction workers increasingly prefer to relocate in either transient housing (rental units, hotels, motels, rooming houses) or mobile homes.

Once the decision to relocate is made, construction workers typically consider the following factors at a minimum in deciding upon the specific communities in which to locate:

(1) distance to the site
(2) size of the community
(3) housing vacancy rate
(4) prevalance of mobile homes

In general, construction workers will move to areas that are close to construction sites to minimize the time and cost of travel and to communities which are either large or close to large communities whose facilities and services are attractive. A relatively high vacancy rate suggests the availability of housing, while the importance of mobile homes reflects the temporary nature of construction industry employment (NUREG/CR-2002).

More specifically, the applicants based their assignment of inmoving workers to individual jurisdiction on TVA experience at six nuclear plant construction sites (TVA, 1981, 1979, 1980, 1980a, 1978, and 1980b). Differences between these six cases and the four-county area in terms of municipal population size, distances to the sites, housing additions by type, and the location and capacity of highways were used to adjust the level of inmovements to specific jurisdictions. Planners from local planning agencies were also consulted prior to developing the final distribution of workers (applicants' response to Question 19 in Amendment X).

FES Figure 4.2 shows the road mileage distances between the site and nearby population centers; FES Figure 4.3 shows existing and potential mobile home sites.

In the opinion of the staff, the highest concentration of inmover construction workers would be in the Rockwood-West Knox County strip because this zone combines the factors of accessibility to the site and suitability of temporary housing. The lack of mobile homes and high housing costs would 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.

The area along Highway 61 between Clinton and Oliver Springs in Anderson County is considered to be a zone of potential mobile home sites that 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 and an inmover would have to balance the possible advantages against 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 inmoving temporary construction workers.

Those inmovers 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 inmovers would choose to do so because of opportunities closer to the proposed CRBRP site. However, even if many did, Knoxville, with a 1980 population of 183,139, could absorb an influx better than a smaller municipality because the percentage of change would be much smaller. Table A4.3 indicates the applicants' estimated allocation of inmoving workers and their families to communities within the four-county impact area.

4.5.3 Social Effects

Except for possible traffic problems, construction workers who do not relocate in order to become employed on the project would not cause any social change. They would use the same public and private sector services that they always used. However, inmoving construction workers and their families could cause social changes as a result of making added demands on housing, schools, and other publicly and privately delivered services. The following sections address the problems generated by new, temporary population additions to the four-county area of Anderson, Roane, Loudon, and Knox. Although some inmoving construction workers might choose to live in the more distance counties such as Morgan, Cumberland, Scott, Campbell, Blount, Monroe, McMinn, Meigs, and Rhea, the numbers of such workers to be considered are so few as to constitute a negligible impact.

Table A4.3 Estimated number and location of relocated CRBRP project employees, spouses, and children at peak of construction activity

County	% of movers	26% inmovement Population Total	26% inmovement Population School age	40% inmovement Population Total	40% inmovement Population School age
Anderson					
Oak Ridge	15	480	100	756	147
Clinton Area	5	160	30	252	49
Knox					
Knoxville	5	160	30	252	49
West Knox County	40	1290	240	2016	392
Loudon					
Lenoir City Area	10	320	60	504	98
Roane					
Kingston Area	15	480	100	756	147
Rockwood Area	5	160	30	252	49
Harriman Area	5	160	30	252	49
Total	100	3210	620	5040	980

Source: ER, Table 8.3-3

Housing

Tables A4.4 and A4.5 summarize the housing requirements for relocating direct project employees at the peak of employment. The numbers reflect in part the estimated availability of specific housing types in different places (ER Sec 8.3.2.1.1). Knox County would experience the greatest demand for housing, and the majority of the demand for mobile home sites would in Roane County. A large part of the demand for mobile homes sites would be in nonincorporated areas near towns and cities (ER App, Sec 2.1).

Under both inmovement scenarios no community other than Kingston, Lenoir City, or Oak Ridge would experience housing pressures during the peak construction period because of the availability of housing units; that is, the number of units annually added to the housing stock would be sufficient to accommodate increased demand (ER Sec 8.1.3.1, Tables 2.11 through 2.18.) If housing construction activity between 1980 and the mid-1980s does not exceed levels prevailing during the 1970s, Oak Ridge, Lenoir City, and Kingston could be faced with tight housing markets during the peak construction period. Additional data are in Section 8.1.3.1 and ER Appendix Tables 2.1-1 through 2.1-8.

The staff supports the applicants' assessment and finds that it is conservative because the analysis does not consider doubling up of (1) inmoving workers who

Table A4.4 Estimate of housing units required at peak employment for inmoving construction workers under alternative scenarios

Place	Inmovement level 26%	Inmovement level 40%
Anderson County	65	99
City of Oak Ridge	190	299
Knox County	571	896
Loudon County	125	199
Roane County	320	479
Total*	1270	1990

Source: ER Table 8.3-4 and Appendix Table 2.1-8.
*Sum of numbers may not equal totals because of rounding.

Table A4.5 Estimate of housing types required at peak employment under alternative scenarios

Housing type	Inmovement level 26%	Inmovement level 40%
Single family	613	959
Multi-family	295	464
Mobile home	361	567
Total*	1270	1990

Source: ER Appendix Tables 2.1-4 and 2.1-8.
*Sum of numbers may not equal totals because of rounding.

are unaccompanied by families and (2) single workers (30% percent of total), the analysis does not consider the use of motels and hotels as transient housing. Both considerations would reduce projected needs in the housing markets considered by the applicants.

School Systems

Enrollment statistics for county and city school systems are provided in Tables A4.6 and A4.7. These data include enrollments for the 1980-81 school year and for the peak construction year, assumed to be 1987. As indicated in Table A4.6, the school systems in Anderson County, Clinton City, Oak Ridge, and Harriman have moderately high levels of excess capacity while the remaining systems are either close to or exceed full utilization.

During the peak year of construction three of the eight school systems for which data are available could experience enrollment levels exceeding system-wide capacity. For the Knox County school system, the overutilization could reach 6% Harriman and Loudon schools would have lower levels of utilization for the year coinciding with peak onsite employment (ER App Sec 2.2).

The applicants estimated the need for additional teachers and classrooms under both inmovement scenarios (ER App Sec 2.2). These data are summarized in Table A4.8. It should be noted that the applicants' analysis assumes that the student enrollment and the number of classrooms and teachers are in balance before any the impact of CRBR project-related students would occur. Therefore, the data in Table A4.8 should be viewed as the additions required to meet increased demands at the peak of construction, assuming no underutilization.

In general, the staff agrees with the applicants' determinations of the impact on local educational systems. Nonetheless, several points should be borne in mind. First, as indicated, CRBRP could impact an already overutilized system in West Knox County. Of the 900 students above capacity in 1985 (under the 40% inmovement scenario), 400 would be project related. However, the peak of CRBRP project-related students would be present for less than 2 years when their numbers would decline (ER App Table 2.22). Second, the growth in the number of CRBRP project-related students in all systems would occur over a period of time, thereby permitting facility and personnel adjustments. Third, the applicants did not consider private schools as a potential resource which could be acceptable to some percentage of inmoving construction worker households. Finally, the State of Tennessee Department of Public Health has issued age-specific projections of population which indicate an overall 6% decline in school age children in the four-county area between 1980 and 1985. These figures are in marked contrast to estimates made by school authorities in the four-county impact area, which indicate increasing enrollment.

Transportation

The applicants' analysis of transportation impacts utilized the following assumptions:

(1) no sponsored van or bus program

(2) two persons per commuting vehicle

(3) no truck deliveries to the construction site during the day shift commuting hours

(4) CRBRP traffic would be staggered to avoid coinciding with existing rush hour traffic

Table A4.6 Capacity and enrollment of area schools by system and grade: 1980-1981 school year

System	K	1	2	3	4	5	6	7	8	9	10	11	12	Total	Excess Capacity
Anderson															
Capacity	442	530	539	530	548	1501	1501	653	653	618	645	618	500	9,278	13.4%
Enrollment	429	514	523	514	532	1029	1029	626	626	592	626	592	400	8,032	
Clinton															
Capacity	138	160	117	149	160	160	181							1,065	15.0%
Enrollment	116	134	99	124	140	135	157							905	
Oak Ridge															
Capacity	360	372	391	409	477	501	496	496	490	515	508	583	602	6,200	18.7%
Enrollment	291	302	316	342	386	406	401	405	396	417	415	475	490	5,042	
Roane															
Capacity	428	564	578	593	592	564	571	565	578	571	528	535	471	7,139	6.8%
Enrollment	404	530	541	555	552	528	535	511	538	530	495	496	437	6,652	
Harriman															
Capacity	127	218	217	214	190	182	166	204	201	270	251	217	204	2,665	17.3%
Enrollment	125	182	178	168	156	149	135	168	164	226	207	178	168	2,204	
Knox**															
Capacity	1148	1042	1043	1043	1158	1148	1399	1375	1345	1271	1254	1118	969	15,113	-0.6%
Enrollment	1160	1053	1054	1054	1069	1160	1312	1388	1358	1251	1266	1129	949	15,203	
Loudon															
Capacity	300	122	409	383	335	370	364	376	346	225	225	190	161	3,806	1.3%
Enrollment	299	122	389	373	325	350	367	384	346	225	225	190	161	3,756	
Lenoir City															
Capacity	106	118	133	139	135	136	106	100	96	297	237	241	213	2,057	3.5%
Enrollment	106	118	110	114	110	136	106	100	96	297	237	141	213	1,984	

Source: ER Table 8.1-15.
*First 5 months of school year.
**Only the north, northwest, and southwest sectors of the Knox School System.
NOTE: The K-12 enrollment and capacity figures for the Knoxville City System are not included in this table because they do not maintain capacity numbers on a grade-by-grade basis. The June 1980 total system enrollment was 25,931 students with a system capacity of about 37,800 students.

Table A4.7 Projected school system capacities, enrollment, and excess capacities at peak of construction

System	Resident Capacity[1]	Resident Enrollment[1]	Enrollment increment at 26% inmovement	Enrollment increment at 40% inmovement	Excess capacity at 26% inmovement	Excess capacity at 40% Inmovement
Anderson	9,278	8,558	15	25	705	695
Clinton	1,065	877	15	25	173	163
Oak Ridge	6,200	6,000	100	150	100	50
Roane	7,230	6,066	130	200	1040	970
Harriman	2,265	2,327	30	50	-92	-112
Knox[2]	15,300	15,850	240	390	-790	-930
Knoxville[3]	N/A	N/A	30	50	N/A	N/A
Loudon	3,806	3,842	40	65	-76	-101
Lenoir City	2,057	2,000	20	35	37	22

Source: ER Table 8.3-5 and Appendix Table 2.2-8.

[1]Capacity and enrollment projected to 1987.
[2]Only the north, northwest and southwest sectors of the Knox School System
[3]The Knoxville City System was unable to provide projections for 1985 because of uncertainty of Knoxville's annexation proposals.

Source: ER Table 8.3-5 and Appendix Table 2.2-8.

Table A4.8 CRBRP project-related requirements for teachers and classrooms for alternative inmovement scenarios*

System	26% inmovement Teachers/Classrooms	40% inmovement Teachers/Classrooms
Anderson	**	**
Clinton	**	1
Oak Ridge	2	4
Roane	4	5
Harriman	**	2
Knox	8	12
Knoxville	**	2
Loudon	1	2
Lenior City	**	1
Total	15	29

Source: ER Appendix Tables 2.2-3 to 2.2-6

*Data are for peak year of construction, assuming one new teacher is needed for each new classroom.
**Less than one-half

(5) three intersections (SR 95 and SR 58, SR 58 and Bear Creek Road, SR 95 and Bear Creek Road) would be upgraded

(6) annual increase in non-CRBRP traffic equal to 2%.

The applicants estimate that 80% of the construction work force would work the day shift and would contribute the major CRBRP project-related traffic loads, estimated to be 2000 vehicles to the highway net (ER Table 8.3-6). Table A4.9 summarizes the effect of adding CRBRP project-related traffic to regional access roads in terms of "levels of service." Levels of service are gradations of traffic conditions ranging from free flow of low volume traffic at high speed (level of service A) to forced flow operation at low speed and vehicle volumes exceeding road capacity (level of service F) (Nat'l Acad Sci, 1965). The applicants' analysis indicates that in no instance does the CRBRP project-related traffic exceed capacities in the five road segments. Witn the exception of road segment 2, CRBRP project-related traffic would reduce traffic conditions on all segments by one level of service. Traffic service on segment 2, which passes the Oak Ridge Gaseous Diffusion Plant, would be reduced by two levels. All segments except highway segment 3 would operate at low levels

Table A4.9 CRBRP project-related commuter traffic impacts on selected highway segments

Highway segment	Existing peak hour level of service	Existing level of service for hour which CRBRP commuter traffic contributes	Projected level of service for hour which CRBRP commuter traffic contributes
State Rt 58 Between I-40 and Bear Creek Rd (CBRRP Access Rd)	D	C	D
State Rt 58 Between Bear Creek Rt (CRBRP Access Rd) and ORGDP	D	B	D
State Rt 58 Between ORGDP and Intersection State Rt 95	D	B	C
State Rt 95 from Intersection State Rt 58 to Beginning of 4-Lane in Oak Ridge	E	C	D
State Rt 95 Between I-40 and Bear Creek Rd (CRBRP Access Rd)	E	D	E

of service for approximately 2 consecutive hours during the peak commuting hours. The 2-hour duration results from the CRBRP project-related traffic immediately preceding the existing peak hour traffic, thereby extending the peak traffic period (ER Sec 8.3.2.1.3). Finally, levels of service would be the same for both inmovement conditions during the peak year of construction for the following reason: movers are expected to relocate in areas near the impacted highway segments and travel the same roads that they would were they not to relocate. Therefore, the number and distribution of automobiles is assumed to be relatively constant (ER App Sec 2.7).

The applicants' analysis provides the basic data for understanding how traffic would move from points of origin to the proposed CRBRP site. However, the staff believes that three additional social impacts must be considered. First, an increase in accident frequency and unlawful behavior (speeding, drunk driving) can be expected as by-products of increased road usage. Second, local residents using the regional highway network could be inconvenienced by increased traffic on local roads. During peak commuting hours, drivers may be subjected to periods of unstable traffic flow and stoppages of short duration. These inconveniences would occur during a relatively short, well-defined peak period in the work day, thereby affording local residents an opportunity to avoid CRBRP project-related traffic through a rescheduling of activities. Third, increased use of local roads by commuting workers, trucks, and equipment could cause structural damage to these thoroughfares.

Health Care

Current relationships between health care facilities and providers and the population are summarized in ER Table 8.1-18. The applicants' analysis of the impact on health care during the peak construction period utilized U.S. Department of Health and Human Services standards* (HHS, 1977) to determine the number of hospital beds, physicians, and dentists that would be necessary to accommodate the project-related population under the two inmovement scenarios (ibid). Under the "worst case" assumption--40% of the workers move into the four-county impact area--20 hospital beds, 5 physicians, and 1 dentist would be required during the peak year of construction (ER App, Sec 2.3). Based on its review of this information, the staff agrees that these are reasonable figures.

Because the applicants' analysis does not account for current underutilization of facilities and services (hospitals in the four-county area are at most 76% occupied), the staff looked at changes to current relationships between services and people resulting from peak-year inmovement. Table A4.10 provides the results of the staff's analysis, which indicates that the impact of the inmoving population on the availability of health care services would be minor.

Municipal Water Supply

Current water sources, treatment capacities, and consumption rates for major water supply systems are indicated in Table 8.1-16 of the ER. Eleven of the 16 water systems listed are operating at 60% or less of system treatment capacity, and three are operating at 75% or less of capacity. Only two systems, First Utility District in Anderson County and Piney Utility District in Loudon County, are operating at capacity. However, both systems have entered into agreements with neighboring districts to provide additional water on a regular basis (ER Sec 8.1.3.3.1).

Overall, the utility systems in the four-county area have considerable underutilized capacity. One-half of the current excess capacity could supply the needs of an additional 150,000 people at a consumption rate of 150 gpd per person. This additional population far exceeds the expected residential population growth between 1981 and 1985 plus the inmovement of population under a worst case assumption.

Waste Disposal

Waste disposal includes both wastewater collection and treatment and solid waste collection and disposal.

The wastewater systems in the impact area are described in terms of treatment type, capacities, and average daily flows in ER Table 8.1-17.

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*Four hospital beds and one physician per 1000 persons; one dentist per 1000 persons.

Table A4.10 Impact of inmoving construction workers on health care under alternative scenarios

County	Current			26% inmovement				40% inmovement			
	No./1000 population				No./1000 population				No./1000 population		
	Hospital beds	Physicians	Dentists	No. of inmovers	Hospital beds	Physicians	Dentists	No. of inmovers	Hospital beds	Physicians	Dentists
Anderson	4.23	1.29	0.56	640	4.19	1.28	0.54	1010	4.17	1.27	0.54
Roane	3.63	0.66	0.43	800	3.58	0.65	0.43	1260	3.54	0.64	0.42
Knox	7.62	2.04	0.67	1450	7.59	2.03	0.67	2270	7.57	2.02	0.66
Loudon	1.75	0.46	0.39	320	1.73	0.45	0.38	500	1.72	0.45	0.38

Source: ER Table 8.1-18 and Section 8.1.3.4

All utility districts are operating well below treatment capacity except the Harriman district, which is operating at capacity. Of the 11 districts listed in ER Table 8.1-17, the capacities of six systems will be enlarged by 1985, including those in Rockwood, Kingston, and Harriman, which have the lowest differentials between average daily flow and treatment capacity (ER Sec 8.1.3.3.2). At 100 gpd per person, one-half of the existing capacity would be more than enough capacity to serve the anticipated growth of the resident population and the population associated with a 40% level of construction worker inmovement. Although excess capacity is available to accommodate projected growth, the distribution of growth may present problems. Most of the wastewater systems serve municipalities; in contrast, the rural areas are served by septic tanks and disposal fields. However, much of the land in rural areas is not suitable for these subsurface disposal systems.

Given the distribution of peak year project-related population, it seems unlikely that large numbers of inmovers would settle in areas unsuited for septic tank use to the point where collection systems would be required (ER Sec 8.1.3.3).

Anderson, Loudon, and Roane Counties operate their own landfills for solid waste disposal while Knox County utilizes contract hauling. The only landfill facility which is nearing capacity is the one used by Anderson County, and the county is taking action to have the capacity of that facility expanded. Each day approximately 525 tons of solid waste are collected and disposed of by the four jurisdictions (ER Sec 8.1.3.3.3). This number should be compared with the 10 tons that would be generated by inmoving population under the 40% migration assumption (ER App, Sec 2.6). The staff characterizes the solid waste generated by inmoving worker households as an insignificant incremental addition, approximately 1%, to the total waste currently disposed.

Public Safety

Table 8.1-19 in the ER provides information on the number and distribution of law enforcement officers and firemen in the four-county area. Considering the incremental and temporary nature of the work force inmovement and the small number of relocating workers in relation to the area's population, expansion of existing safety services would not be required (ER Sec 8.1.3.5.)

Recreation

Publicly supplied recreation facilities are listed and described in ER Table 8.1-20. Three of the four counties are served by full-time recreation and park agencies; Loudon County does not have a full-time parks and recreation staff, although the county does offer recreational facilities. In addition to publicly provided facilities and services, the four-county area offers opportunities for bowling, movies, hunting, and fishing.

The staff agrees with the applicants that recreational facilities in communities designated to receive inmovers will experience incremental demands on those facilities and services. Moreover, the increased usage of recreational facilities will be proportional to the number of persons that may temporarily move into a specific community. Despite increased usage, the staff concludes that the temporary nature of inmovers and their dispersed distribution will limit adverse impact on any community or county recreation program (ER Sec 8.3.2.15).

Visual Aesthetics

The proposed CRBRP would be located in a fairly isolated place and may be visible to the public from only a few vantage points. These points are mainly from the Gallaher Bridge (about 1.5 miles away), scattered residences on the opposite bank of the river, and portions of both I-40 and SR 58. The applicants have also indicated that the plant will not be visible from any significant off-site structure (applicants' response to Question 24, ER Am X).

The most noticeable visual feature would be the domed reactor containment structure, abcut 179 ft tall. The outer surface would be covered with a surfacing material harmonizing with other building finishes.

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

4.5.4 Economic Effects

Private Sector

The economic impact of construction of the proposed 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. The direct project construction payroll is estimated by the staff to have a value of $446.2 million (1981 dollars) through the construction period (Table A4.11). The tabulation shows that the payroll generated by induced (secondary) employment would add another $2.5 million throughout the construction period. If a local expenditure rate of 40% is realized, this would be equivalent to a flow of $179 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 A4.12 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 public project would not be subject to either local property or sales and use taxes. These two taxes would represent the majority of public revenues attributable to a private project. On the other hand, DOE 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 arises from 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). Appropriations for fiscal year 1982 are currently under Congressional review, and the future of such payments is in question.

Table A4.11 Direct and induced employment income ($ millions)[1]

Year after construction start	Direct income	Induced[2] income	Total income
1	26.2	0.1	26.3
2	42.5	0.2	42.7
3	88.0	0.2	88.2
4	119.2	0.3	119.5
5	101.3	0.4	101.7
6	48.9	0.6	49.5
7	20.1	0.7	21.8
Total	446.2	2.5	448.7

Source: ER Tables 8.2-2 and 8.2-4

[1]All dollar figures are in constant 1981 dollars.

[2]Based on average annual salary of $8356.

Table A4.12 Tax revenues generated directly or indirectly from the proposed CRBRP compared to a hypothetical private project

Revenue source	Private project	CRBRP
Property tax	Yes	No
Sales and 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
DOE in lieu-of-tax payments	No	Yes
PL 81-874 aid to schools	No	Yes

The inmovement of construction workers and their families would result in increased revenues to the general fund and school fund of local governments in the four-county area. The applicants estimated the property, sales, beverage, and miscellaneous tax benefits resulting from the inmoving population in the peak year of construction. These benefits are summarized in Table A4.13; a detailed analysis is in ER Appendix Section 3. The data emphasized major selected revenues from the peak influx of population and should only be used to provide insight into the relative magnitude of CRBRP's influence on local fiscal conditions. The inmovement of construction workers and their families would also create additional demands on public facilities and services. However, because the inmovement of population would be small relative to the existing resident population, the only service which might require expansion is education. The applicants compared the maximum requirement for additional teachers that might be needed in the school systems during the peak year of construction with local education revenues expected to be generated by new residents and found that such revenues should be sufficient to accommodate the increased costs of the required teachers. These data are provided in Table A4.14.

4.5.5 Summary of Socioeconomic Effects*

The forecasted effects of the CRBRP assumed two levels of inmoving construction labor which prevail under differing conditions of labor market completion. Extensive TVA construction work force experience was used to determine the specific levels of inmovement.

All of the inmoving workers were assumed to relocate to a four-county area surrounding the proposed CRBRP site. Knox County would receive 45% of the inmoving workers and their families, the largest portion of the inmoving population; Loudon County would receive the smallest percentage of inmoving population, 10%. Schools in western Knox County would experience an increase in existing overutilized conditions. The staff indicated that overutilization of county schools could reach 6% depending on the level of inmovement. Harriman and Loudon schools would have lower levels of overutilization coinciding with peak employment at the site. No school system would be faced with the need for capital expenditures, although additional teachers might be required in all systems.

The staff's analysis of housing needs was based on a 50% requirement for conventional housing, 30% for mobile home sites, and 20% for apartments and rooms. Under certain conditions of housing supply, the communities of Oak Ridge, Lenoir City, and Kingston could be faced with tight housing markets. However, the effects in the housing market could have been overstated by the applicants because hotel/motel use and doubling up were not considered. Moreover, any adverse effect that does occur would last during a limited period and would end without any adverse, lingering effects for existing residents.

The existing level of service on four of five road segments evaluated would be expected to deteriorate by one level as a result of CRBRP project-related traffic. In the fifth segment, the deterioration would be two levels. However, in all cases the level of service prevailing when CRBRP project-related traffic would be on the road would be the same or higher than service at normal rush

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*The discussion in FES Section 4.5.5 on visual effects is included at the end of Section 4.5.3 above.

Table A4.13 Selected revenues resulting from peak population influx during construction[1] ($ thousands)

Location	Project-related general fund revenues[2]	Project-related school fund revenues[3]	Totals
Clinton	1,130	1,880	3,010
Oak Ridge	8,080	10,180	18,260
Lenoir City	1,400	2,090	3,490
Kingston	2,210	N/A	2,210
Rockwood	980	N/A	980
Harriman	560	2,980	3,540
Anderson County	4,370	7,290	11,660
Knox County	6,860	27,280	34,140
Loudon County	1,190	4,480	5,670
Roane County	2,680	10,170	12,850
Total	29,460	66,350	95,810

Source: ER Table 8.2-5.

Note: All figures are in 1981 dollars.

[1]Twenty-six percent mover rate during estimated peak year of construction.
[2]Includes property tax, sales tax, beer and beverage tax, fines, fees, and charges.
[3]Includes property tax, sales tax, and state foundation and equalization funds.

hours. In fact, the most noticeable impact on traffic would be an extension of peak from 1 to 2 consecutive hours commuting hours during the peak of construction. The staff also noted the potential for increases in accident frequency, inconvenience, and accelerated road deterioration.

Water supply and treatment capacity are expected to be adequate to meet the demands of increased resident population growth and inmoving population. However, distribution and wastewater collection systems may require expansion or improvement in rural utility districts in the unlikely event that all inmovers choose rural locations.

Health care, public safety, and recreation are expected to receive additional demands but the increased demands are not expected to reduce the quality of existing service. Extensive mobile home development in areas not having adequate water systems could impose problems on the delivery of fire-fighting services.

The data indicate a $446 million direct payroll thoughout the construction period. If 40% of that payroll is spent in the four-county area, the private

Table A4.14 Expenditures and revenues for education related to peak population influx ($ thousands)

School System	Cost/teacher*	26% inmovement				40% inmovement			
		Teachers needed	Peak yr cost	Peak yr revenues	Peak yr revenue-cost balance	Teachers needed	Peak yr cost	Peak yr revenues	Peak yr revenue-cost balance
Clinton	1,850	0	0	1,880	1,880	1	1,850	3,080	1,230
Oak Ridge	1,990	2	3,980	10,180	6,200	4	7,960	15,720	7,760
Harriman	1,400	0	0	2,980	2,980	2	2,800	4,890	2,090
Lenoir City	1,600	0	0	2,090	2,090	1	1,600	3,740	2,140
Anderson County	1,220	0	0	7,290	7,290	0	0	11,820	11,820
Knox County	1,660	8	13,280	27,280	14,000	12	19,920	43,230	23,310
Loudon County	1,490	1	1,490	4,480	2,990	2	2,980	6,950	3,970
Roane County	1,360	4	5,440	10,170	4,730	5	6,800	15,770	8,970

Source: ER, Table 3.13

*Based on FY 1981 financial documents.

NOTE: All figures are in 1981 dollars.

economy would receive a benefit of $178 million. The benefit to the public sector would arise from sales taxes, taxes on property and beverages, and fees and fines. These revenues were compared with the maximum requirement for teachers in each school system; additional teachers were identified as the only probable item of expenditure by local government. In all instances, the revenues generated by the inmoving population would be more than sufficient to cover the local costs of increased educational expenditures.

4.5.6 Dust and Noise

The applicants have provided additional information since the issuance of the FES on construction-phase noise levels and their duration (ER Sec 4.1; Longnecker, 1982e). In an attempt to quantify these values for the various construction phases, the applicants have estimated--on the basis of the noisiest equipment expected to be operated on site during each phase--the noise pollution level (NPL) for each phase. The applicants' estimates of NPL for the various construction phases are within the ranges of values given in the literature for industrial and public works construction projects in an ambient acoustic environment typical of suburban residential areas.

The closest residences to the site are two, located across the river approximately 1000 m (3000 ft) from the center of the site. For the 0.8-km (0.5-mile) NPL estimates given by the applicants for site construction-related noise, the noise exposures are characterized by available criteria as "normally acceptable"--that is, reasonably pleasant for recreation and play in outdoor areas, and acceptable for all activities indoors. This characterization applies to all of the construction phases except foundation work. For this phase, construction noise exposures are estimated to be less, so that both indoor and outdoor environments at and beyond the 0.8-km (0.5-mile) distance would be characterized by available criteria as "clearly acceptable," that is, pleasant.

Factors affecting these characterizations of noise acceptability include the time and duration of exposure to site construction noise, deviation from normally experienced site-generated noise patterns, and impulse noises and their rate and time of occurrence. The factors are discussed below.

Noise generating construction activities at the site are projected by the applicants (ER Sec 5.7.2.2, Am XIV) to continue throughout the day and evening hours (until about 11 pm), with two work shifts planned for all construction phases. No weekend work is currently scheduled, however. The overall period that nearby residents and transients would be exposed to construction noise is estimated to last approximately 5 years (site preparation and excavation, 1 year; foundation work, 9 months; plant erection; 3 years, 5 months; and site finishing; 1 year).

The applicants have identified some construction activities that, by necessity, will not conform to the above-mentioned schedule. These activities will be continuous and therefore will involve around-the-clock work activity. The cited activities include continuous concrete pouring for up to several weeks in the foundation and erection phases; reactor vessel installation over a 2-3-day period during the erection phase; and containment dome installation during a 1-week period in the erection phase.

Facility construction would also involve blasting throughout much of the construction period (the onsite quarrying operation is expected to last about 4 years). These activities, which are likely to have the greatest potential for causing offsite annoyance or activity interference, would be controlled and timed by the applicants to minimize their offsite effects (ibid). In addition to the use of small multiple charges for blasting, this activity, when necessary, would be scheduled for early in the second weekday workshift, and thus would be expected to occur during hours of about 3:30-6:30 pm.

These factors, along with the characterizations given earlier, provide the bases for staff conclusions that: (1) construction noise will be audible off site and at nearby residences throughout the construction period of about 5 years and (2) activity interference, including sleep interference, could occur during evening and nighttime hours, but only for residents and transient facility users within about 1.6 km (1 mile) of the site. This interference would most likely be limited to the site preparation and excavation phases of construction.

The potential for activity interference or annoyance from construction activities, other than blasting, at distances beyond about 1.6 km (1 mile) in southerly directions (across the Clinch River) is judged to be considerably less than those stated above because of (1) the presence of several intervening ridges in the topography of equal or greater height than the site area; (2) presence of forested areas on and beyond these ridges; and (3) the existence of other noise sources beyond the ridges (such as highways) that are likely to dominate noise levels in these areas.

The above information is cumulative and does not significantly change the staff's assessment of noise effects in the FES.

4.6 Measures and Controls To Limit Adverse Effects During Construction

For convenience of reference, this entire section of the FES is reproduced below, with appropriate updating changes.

4.6.1 Applicants' Commitments

The commitments made by the applicants to limit adverse effects during construction have been modified and expanded as shown below. Where such changes have been made, an asterisk appears beside the number of the item.

4.6.1.1 From the ER, Sections 4.1.1.8 and 6.1.4.3.4, Am I, Part II; ER Am XIII Table 4-4

(1) Open burning will conform to state and Federal air pollution requirements.

*(2) Disposal of wastes will conform to Tennessee Solid Waste Management Regulations.

*(3) Blasting will be restricted to small multiple charges.

*(4) Encroachment upon the Hensley Cemetery will be avoided. (The use of a borrow pit has been eliminated and the Indian Mound has been removed.)

*(5) In constructing the barge-unloading facility, river siltation would be controlled by building the facility on dry ground. (Some temporary turbidity increase and minor siltation will occur during final dredging.) Reclamation of land affected will consist of grading and returning topsoil, and seeding native grasses and other appropriate groundcover.

*(6) Disposal of hazardous wastes and pollutants will conform to Federal and state regulations.

*(7) Garbage generated during construction activities will not be burned. It will be discarded by a licensed contractor in regulated disposal facilities.

*(8) Treated sanitary wastewater discharged to the river will meet standards of the Tennessee Department of Public Health. Chemical toilets will be used primarily during site preparation and resultant waste disposal will comply with approved practices.

(9) General erosion control will 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, retaining drainage water in runoff treatment ponds 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 (see Section 4.4.2 for discussion of applicants' sedimentation and control plan).

*(10) The site access road will be paved; onsite traffic will be controlled by the constructor.

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

*(12) Construction access roads will be restored to equal or better than original condition.

*(13) Chemicals would not be used in clearing land, although maintenance of rights of way may involve localized applications of authorized herbicides. If herbicides are used, they will be applied only under certified supervision.

*(14) Water discharged from runoff treatment ponds will meet the effluent limitations which are promulgated by EPA. (This was FES item 4.6.2.b.)

*(15) Work schedules staggered with those of other plants will be established, if needed, to avoid unreasonable congestion on State Road 58 in Roane County. (This was FES item 4.6.2.c.)

*(16) Prior to construction, the plant construction manager will be provided with locations of critical ecological elements. On-the-ground inspections of species and community locations will be made semi-annually and, if

required, site preparation activities will be modified. (This replaces FES item 4.6.1.1(1).)

*(17) Prior to construction of the offsite corridor, additional archeological investigations will be made. Should any significant site be revealed in or in the close vicinity of the corridor, relocation of the route, relocation of specific towers, or possible excavation will be considered and done in consultation with the State Historic Preservation Office and NRC.

*(18) Dredging for the barge-unloading facility will 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. (This replaces FES item 4.6.1.1(2).)

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

(20) Siltation impacts will be reduced by dredging and constructing behind temporary dams for structures as specified in the NPDES Permit.

Items 6, 8, 9, 13, 14, and 20 have been reviewed by EPA; NRC will defer to EPA for approval of or departures from these water-related commitments. It is the staff recommendation that the other commitments become conditions of any limited work authorization or the construction permit that may be issued for CRBRP.

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 applicants, as summarized above, are adequate to ensure that adverse environmental effects would be at the minimum practicable level with the following additional precautions:

a. The applicants should set aside an appropriate buffer zone upslope of cover type vegetation 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. Dredging, cofferdam construction, and fill deposition in the Clinch River should not coincide with striped bass use of the Clinch River as a thermal refuge or when sauger are spawning, unless there is evidence showing that these activities would not adversely affect the two species. (This replaces FES item 4.6.2.d; FES item 4.6.2.b was deleted as unnecessary.)

c. Local costs for additional public services needed by construction workers and other project personnel and their families would probably not exceed the local benefits from the project. The staff's opinion is that the only reliable way to establish the balance between local costs and benefits caused by CRBRP construction is for a monitoring program to be established. The results of this program should be made available to the State of Tennessee and affected local government entities, and negotiations should be conducted with them so agreement can be reached on financial assistance and/or other suitable measures to migitate adverse impacts of the project.

The above requirements have been updated to make them current and more explicit. No significant changes in environmental impacts predicted in the FES are anticipated.

5 ENVIRONMENTAL IMPACTS OF PLANT OPERATION

5.1 Land Use

No change in expected effects on land use has occurred. The sentence in the first paragraph stating that the "dedication of the land as a plant site represents an improved use of the land which is presently forested" has been deleted.

In the second paragraph, the sentence beginning "Indian artifacts...." has been deleted.

5.2 Water Use

Primarily because of changes in the cooling system design, plant operation at full power would require an increase from 3584 gpm (8 cfs) to 3733 gpm (8.3 cfs) in the annual average use of water. This increase is not environmentally significant.

Chemical and sanitary sewage discharges would be regulated by the NPDES Permit and the State of Tennessee 401 Certification (see Appendix H).

5.3 Heat Dissipation System

5.3.1 Water Intake

The material in this section of the FES has been reorganized for clarification, and some new information from recent intake studies is presented. FES Figure 5.1 and FES Table 5.1 have been deleted because the pertinent data are now included in the text. EPA has tentatively determined that the location, design, construction, and capacity of the proposed intake reflect the best technology available for minimizing adverse environmental impacts in accordance with Section 316(b) of the Clean Water Act (NPDES Permit Rationale, Part II.H).

5.3.1.1 Impingement

The intake system would consist of two perforated pipes submerged in the Clinch River several feet above the bottom. (A description of the two pipes is in Section 3.4.2.) Several characteristics of the system should result in reduced fish impingement: (1) low intake velocity, with the maximum average velocity of entering water measured 0.75 in. from the surface of the perforated pipe estimated to be less than 0.4 fps, and with normal estimated velocities of less than 0.2 fps; (2) orientation of the perforated pipes parallel to the shoreline, thus facilitating passage of debris and aquatic biota past the structures; (3) uniform velocities through the perforations due to internal sleeving of pipes; (4) low approach velocities; and (5) elimination of need for trash racks, vertical traveling screens, and intake canals (ER Sec 3.4 and 10.2).

Organisms that cannot withstand the intake currents surrounding the perforated pipes and that are not large enough to pass through the perforations will be impinged on the intake pipe. Such susceptible organisms would be principally large fish larvae and weakened or stressed juvenile and adult fish. The ability of a fish to maintain its position in water currents varies with species, size, water temperature, dissolved oxygen, and the physical condition of the organism. Smallmouth bass fry (Micropterus dolomieui) 20-25 mm long have sustained swimming 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 long can maintain themselves in currents of 1 fps (Kerr, 1953). For most freshwater fishes, the darting speed is almost 10 times the body length per second (Gray, 1957).

Impingement of threadfin shad on the perforated pipes could occur during the winter as a result of cold stress when ambient water temperatures get below 54°F (Griffith and Tomljanovich, 1975). Low water temperatures can cause loss of equilibrium and eventual death. Shad in the moribund or weakened state would be susceptible to any flow rate, and large numbers could become impinged. Back washing of the perforated pipes would release these organisms. Impingement of severly debilitated threadfin shad would hasten their death; however, the impact this might have on the fish community would be undetectable because a majority of the Watts Bar population would be cold stressed and likely to die even without becoming impinged.

A potential problem with the intake system is the clogging of intakes by the Asiatic clam, Corbicula sp. Dead spaces and areas of very low velocities within the perforated pipes may cause Corbicula sp. larvae to settle out and clog the pipes. Partial obstruction of the pipes and perforations would tend to slowly increase approach and intake velocities and increase the potential for greater impingement and entrainment losses. Normal intake pipe maintenance would include back flushing, inplace scrubbing by scuba divers, 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 sp. 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 applicants' maintenance plans are adequate to prevent any significant adverse effects to the intake structures.

The staff concludes that the design and operation characteristics of the intake structure the small volume of water in relation to the river flow being withdrawn through the intakes and the known swimming speeds of the various species of local fishes preclude the possibility of any significant impact to the Watts Bar fishery. This conclusion is further supported by the results (WPPS, 1980) of intake inspection studies conducted at the Washington Public Power Supply System Unit 2 Nuclear Station, which is located in the State of Washington on the Columbia River and which has an almost identical perforated pipe intake structure. The results showed that no fish were impinged during the inspection periods. During this test, the velocities at the intakes were maintained at near-operational levels.

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 16.7C°

(30F°) across the condensers. In addition, they would experience the physical and chemical stress of pumping and passing through the cooling tower before return to the river. Because most entrained organisms would be killed, the staff assumes 100% mortality for all entrained organisms.

Because of flow manipulation at the Melton Hill Dam, the Clinch River in the vicinity of the site has in the past experienced about 17 days of no flow per year. The number of phyloplankton, zooplankton, drift invertebrates, and fish eggs and larvae available for entrainment depends on the number in the immediate vicinity of the perforated pipes. The number available for entrainment under lotic conditions is greater than in a lentic environment because the flowing of water would move eggs and larvae from upstream to the vicinity of the intake. Under lentic conditions, localized depletion of organisms would occur; however, the total number loss to the system would probably be less than in the reverse condition. The staff, therefore, performed its analysis of impact for the more conservative lotic conditions.

The entrained phytoplankton, zooplankton, drift invertebrates, and ichthyoplankton all would suffer about 100% mortality. Based on the fraction of total river flow withdrawn by the plant using the lowest average monthly flow of 3716 cfs for May and the maximum water makeup of 22.3 cfs, the average loss would be 0.6% of the entrainable organisms, assuming a uniform distribution of organisms throughout the water column. Under low flow conditions of 1000 cfs, the loss would be only 2.2%. Even if the entrainable organisms are found to be in higher concentrations in the vinicity of the intake, a doubling or tripling of the number of organisms entrained would probably not have a significant effect on the aquatic ecosystem in the vicinity of the plant.

Based on the results of studies conducted by the applicant (Loar et al., 1981; Cada and Loar, 1981; and Scott, 1980), the intake structure would not be located in a stretch of river that is uniquely important for the spawning or early life history of any species of fish. It is concluded that the anticipated impact to Clinch River and Watts Bar Lake fisheries due to impingement or entrainment would be minor and undetectable.

The results of the above analysis do not constitute a significant change in the FES assessment.

5.3.2 Water Discharge

5.3.2.1 Thermal Plume Characteristics

New design parameters for the plant cooling system have arisen as a consequence of the selection of the turbine generator and refinements in cooling tower design. The result is that small increases (less than 5% in the size of the extended no-flow plumes would be expected (ER Sec 5.1.1.1.1, Am IX). Another change is that river flow rates are slightly higher, based on a longer data record (ER Table 2.5.3). This new information leads to very small changes, so that the staff considers its analysis of the thermal plume in the FES to be still valid. In FES Figure 5.2, the applicants' reanalysis shows that the thermal plumes, bottom, are changed to 1.2F° and 0.9F° from 1.25F° and 0.9F°, respectively.

The above changes are not environmentally significant.

5.3.2.2 Thermal Plume Effects

The material regarding thermal plume effects has been revised primarily for clarification and to provide consideration of more recent information (Section 2.7.2) on striped bass.

The plant's thermal discharge would not have a detrimental effect on phytoplankton, zooplankton, ichthyoplankton, juvenile fishes, or macrobenthic drift. Temperature increases in the plume will be small and within the thermal tolerance limits of most of the dominant species present in the river. Under normal operation the plume size would be small in relation to the river so only a small portion of the planktonic organisms drifting past the site would experience temperatures elevated more than a few degrees. Furthermore, the small size of the plume minimizes the time the organisms are exposed to the elevated temperature. The rapid regeneration rates of phytoplankton and zooplankton could compensate for decreases due to plant operation.

Ichthyoplankton are more sensitive to temperature differences than most other planktonic organisms. Fish egg temperature tolerances are generally lower than those for larvae or adults (Levin et al., 1970). Most fish in the plant vicinity have demersal and adhesive eggs not normally found in the water column. The loss of fish eggs due to plume entrainment and subsequent mortality due to elevated temperatures are expected to be insignificant.

Larvae and juveniles of most fish species in the vicinity of the plant would avoid open areas and areas of high flow, preferring backwaters, shorelines, and the portion of the water column nearest the bottom. This behavior lessens significantly the number that potentially could be entrained in the discharge plume. Ichthyoplankton presence in the river is seasonal (usually April through August with highest densities in late spring and early summer) and consequently would not be subject to the winter thermal regimes, which are the most severe.

Temperatures above 30°C (86°F) are not suitable for many macrobenthic invertebrates (Jensen et al., 1969). However, the 25.6°C (78°F) maximum river temperature recorded in the plant vicinity plus a ΔT of 3.4C° (6.1F°) gives a potential maximum temperature of 29°C (84.1°F), below temperatures reported harmful for most organisms.

The scouring of periphyton and benthic organisms by the discharge plume is predicted to be confined to about 100 ft^2 of river bottom and, therefore, insignificant. Typical bottom temperatures are predicted to be 0.7C° (1.2F°) above ambient over less than 450 ft^2 of bottom. Even under extended no-flow conditions during the winter, elevated temperatures on the order of a few degrees would affect only several acres of river bottom. Because daily ambient temperature variation in the water column can be as great at 1 to 1.5C° (2 to 3F°), no impact due to the thermal discharge on periphyton and benthic organisms is predicted.

During typical summer conditions, temperatures lethal to fish could potentially 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.

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. The staff concludes that, although temperatures lethal to the species found in the Clinch River will be present during the summer, under normal flow conditions fish will avoid these areas and mortality due to the thermal discharge would be nonexistent.

During an extended period of no release from Melton Hill Dam during the late summer, the surface near the southwest bank at CRM 16 would be elevated approximately 0.72C° (1.3F°) above ambient (ER Sec 5.1.3.1). The 0.56C° (1F°) isotherm would extend for over 0.75 mile in either direction, affecting a large area of the Clinch River. The effect of this increased temperature on warm water species inhabiting the Clinch, even during the highest recorded ambient water temperature, would be insignificant. FES Table 5.8 lists the estimated effects of increasing water temperatures on the fish community of the Tennessee River (Bush et al., 1972). With a 25.6°C (78°F) maximum reported ambient river temperature and a ΔT of 0.72C° (1.3F°), the maximum temperature of a significant portion of the top 1 m (3 ft) of water would not be detrimental to any native warm water species known to inhabit the Clinch in the vicinity of the plant. The striped bass, a cool-water introduced species, however, may be adversely affected by concurrent plant operation and an extended no-flow condition in the Clinch River. The striped bass utilize the Clinch River in the vicinity of the station as a late summer, early fall thermal refuge (see Section 2.7.2).

A large portion of the area extent of the thermal refuge and the portion of the water column inhabited by the fish would probably be subjected to increased temperatures. Depending on the ambient conditions of the river, such temperatures could approach or exceed lethal limits. The exact location of the striped bass in the upper Clinch River is not known with certainty; therefore, the magnitude of this effect cannot be predicted. However, the frequency of occurrence of extended no-flow conditions in the Clinch River has been low, particularly in recent years.

In summary, the staff judges the impacts from the thermal discharge upon aquatic biota for all species, during normal operation and with flow in the Clinch River, to be insignificant. Because of the small size of the plume, the small rise in temperatures, high river flow rates, the small quantity of water discharged (5 cfs), and the short time organisms are exposed to the plume, the impact from the thermal discharge would not produce a significant change on the aquatic ecosystem.

During periods of no river flow and plant operation, impacts to species other than striped bass are expected to be insignificant and undetectable. Striped bass may be detrimentally affected under these conditions during late summer and early fall. The lack of specific information on the location and densities of fish in the vicinity of the plant site precludes a precise assessment of potential impact to the Watts Bar striped bass population. The NPDES Permit (Part III) requires that the applicants conduct the following studies: (1) a statistical analysis of stream flow during the critical months of July through September; (2) a reevaluation of the thermal plume dispersion incorporating consideration of the discharge into a stratified water body; and (3) a review of alternative diffuser designs and a two-dimensional modelling of this far field, if the results of the first two analyses indicate there is no suitable zone of passage for striped bass. If these additional studies show that there still is a potential for impact to striped bass during extended periods of no river flow, the NPDES Permit further states that the permit will be modified to impose more stringent thermal limitations on plant dischanges. The applicants have formally committed to these precautionary measures to protect this species (Longenecker, 1982d). The staff, however, does not expect impacts to striped bass to occur because future periods of no river flow are unlikely (Section 2.5.1).

The results of the above thermal analysis do not constitute a significant change in the FES assessment.

5.3.2.3 Cold Shock

No change is necessary in this section of the FES.

5.3.2.4 Scouring

No changes have been made to this section of the FES.

5.3.3 Atmospheric Heat Transfer

No changes have been made to this section of the FES.

5.3.4 Threatened and Endangered Aquatic Species

(This is a new section; however, the last paragraph of FES Section 2.7.2 should be noted.)

The FES (Section 2.7) addressed rare and endangered species. However, in compliance with Section 7 of the 1978 Amendments to the Endangered Species Act, the NRC asked the U.S. Fish and Wildlife Service (FWS) to provide a current list of those Federally recognized threatened and endangered species (including species listed, proposed to be listed, and under status review) as well as designated critical habitats, which might be affected by the licensing of the CRBRP (Check, 1981). The FWS response (Hickling, 1981) listed 1 species of fish and 11 species of freshwater mussels (Appendix B). No critical habitat has been designated in the vicinity of the site. The FWS requested, under a provision of the Endangered Species Act, that the NRC perform a biological assessment for each of the listed species.

The staff conducted a preliminary analysis and has concluded that the species of fish Hybopsis cahni is not present at the site; therefore, no potential for impact exists.

In May 1982 TVA conducted a comprehensive freshwater mussel survey in the vicinity of the proposed CRBRP site. The methodology and results of the survey are given in Section 2.7.2. Only one Federally protected species, Lampsilis o. orbiculata, the pink mucket pearly mussel, has been taken recently from the Clinch River near the site. The live specimen was collected approximately 1 mile upstream of the site boundary. The 1982 mussel survey that examined transects adjacent to as well as upstream and downstream of the site failed to find additional live specimens of this or any other Federally protected species. Area surveys conducted in the immediate vicinity of the proposed intake, discharge, and barge-unloading facilities also resulted in no additional specimens.

The staff has conducted a preliminary analysis on the potential impact of CRBRP operation on L. o. orbiculata in the Clinch River at and downstream of the site and has tentatively concluded that no significant impact would occur. The design of the discharge and the low discharge flow would minimize bottom scouring. The thermal and chemical plume would only infrequently intersect the river bottom and then only in a small area.

The final staff position of the potential for impact will be incorporated in the endangered species assessment that will be submitted shortly to the U.S. Fish and Wildlife Service for review.

The only species declared endangered or threatened by the State of Tennessee that is not Federally recognized and that may occur in the vicinity of the site is the blue sucker, Cycleptus elongatus. FES Section 2.7.2 summarizes the known captures of this species in Watts Bar Lake. Because this species has not been taken in the vicinity of the station despite recent sampling by Oak Ridge National Lab, TVA, and Tennessee Technological Institute personnel, no impact to this species is anticipated. Consequently, the current list of endangered species does not constitute significant new information in terms of impacts attributable to the CRBRP.

5.4 Other Nonradiological Effects

All nonradiological discharges from the plant are expected to comply with standards of performance for new sources (40 CFR 423.15 and 423.45) and Tennessee Water Quality Standards requirements (see Appendix H).

5.4.1 Impacts of Chemical Effluents

The maximum release of total residual chlorine is now limited to 0.14 mg/l, a decrease from the 0.5 mg/l maximum concentration estimated in the FES. This more stringent limit has been established by EPA to avoid significant impacts on aquatic biota and is included in the NPDES permit (NPDES 011). The discharge design will ensure a dilution of 14 to 1 within 20 m (66 ft) of the discharge point (draft NPDES Permit Part III.D).

5.4.2 Sanitary and Other Waste

In the second paragraph, the material following the first sentence has been revised and replaced as follows:

Gaseous emissions from emergency generators and firepumps are regulated by the Tennessee Department of Health, Division of Air Pollution Control. These units appear to comply with state limitations; however, a state permit has not yet been issued. The limit for nitrogen oxide does not apply because the total fossil-fueled heat input rate of 159 million Btu/hr is less than the regulatory threshold of 250 million Btu/hr. Regulations limit the sulfur dioxide emission rate and the particulate emission rate to 5 lbs and 0.13 lbs per million Btu of heat input, respectively. The diesel units are well within this limit. Carbon monoxide emissions are not regulated. The state air permit may include a limitation on organics when issued.

5.5 Transmission Lines

The applicants' plan to control vegetation growth now calls for mechanical cutting every 4 or 5 years and limited use of approved herbicides (ER Am I, Part II, B2).

5.6 Community Impacts

The following updated discussion replaces that in the FES:

The socioeconomic impacts during the operating period arise primarily from absorption of the work force members and their families into the existing community. The applicants now estimate that CRBRP will operate with approximately 250 personnel, including the security force hired locally. In addition, the number of people associated with the CRBRP project office will rise to about 240 during the peak year of construction, then taper down to 140 people in the first operating year and 25 in the sixth year of operation (ER Table 8.2-1). The applicants indicate that 75 jobs would be created as a result of the direct employment on CRBRP (ER Table 8.2-3). In the staff's judgment, a higher fraction of the direct workers will be inmovers than was the case for the construction labor force because of the specialized nature and long-term stability of the work.

However, as indicated by the applicants' estimates, operating work force impacts to an extent will have taken place during the construction period. About 70 operating workers would be on site during the peak year of construction and the number of such workers would increase to 280 during the last year of construction (ER Table 8.2-1). With respect to induced employment, the staff's judgment is that such positions would be filled by people entering the labor force, internal shifts in the labor force, by reductions in unemployment, and by spouses of inmoving operation workers.

In order to determine the maximum net possible impact of operating phase workers on housing and schools, the staff considered the 180 operations personnel (the difference between the 250 operations phase workers and the about 70 such workers who would be present during the construction phase) as the primary source of social impact. The staff conservatively assumed that these operating personnel would all be inmovers, would all be married, and would have 1.2 children per household, of which 0.7 would be school age (see ER Table 8.3-2). These conditions result in a total population influx of approximately 580 people, including 126 children of school age. Table A5.1 shows the expected distribution of operating personnel and school-age children. For each community the number of operating personnel and school-age children to be accommodated is less than the number of inmovers expected during the construction phase. Because of the small numbers of people involved and their dispersion throughout the area, the staff believes no one jurisdiction would have difficulty in accommodating operating phase inmovers.

The payroll impact of the total operating staff is estimated by the applicants to be $5.1 million per year in constant 1981 dollars. For the 30-year life of the plant, the direct payroll effect would be $153.2 million in constant 1981 dollars (ER Sec 8.2.2.1).

Table A5.1 Geographic distribution of CRBRP operating personnel and school-age children

Location	Households	School-age children
Anderson County	9	6
Oak Ridge	27	19
Knox County	80	56
Loudon County	19	13
Roane County	45	32

Source: Percentage distribution from ER Table 2.1-4.

5.6.1 Taxes

The project would neither contribute directly to the tax base of the local area through the payment of property (plant and land) taxes, nor would it detract from current revenues. 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, DOE in-lieu-of-tax payments, and PL 81-874 payments to schools.

Taxes from Payroll Spending

Local communities now can add to the state sales tax of 4.5% on designated items an additional tax of up to 2.25% which is returned to the counties and often used for school system support.

The applicants estimate the value of local revenues derived from workers at approximately $89,000 (1981 dollars) for a typical operating year (Longenecker, 1982a). Revenues included in this estimate are those paid as a result of local property taxes, sales ta es, beverage taxes, fines, fees, and state transfer funds.

In-Lieu-of-Tax-Payments

In the case of CRBRP, it is now DOE that has the authorization to make in-lieu-of tax payments to Roane County, Anderson County, and the City of Oak Ridge.

PL 81-874 Payments

This program provides Federal aid to school districts when schools are adversely impacted by concentrations of Federal employment. However, since the FES was written, PL 81-874 has come under Congressional review and its future is in question.

5.7 Radiological Impacts from Routine Operations

Changes to this section are: (1) revised dose estimates from exposure to airborne effluents based on revised meteorological dispersion factors; (2) revised dose estimates from exposure to liquid effluents based on revised aquatic dilution factors; (3) revised dose estimates from the CRBRP fuel cycle based on more conservative estimates of the quantities of radionuclides released; and (4) inserts concerning potential health impacts from occupational and offsite exposure to radiation. The conclusions relative to these modifications are essentially unchanged from those in the FES.

5.7.1 Radiological Impacts on Biota Other Than Humans

The following material replaces that in Section 5.7.1 of the FES (The conclusions are essentially the same.):

> Depending on the pathway and radiation source (FES Fig. 5.5), terrestrial and aquatic biota will receive doses that are approximately the same or somewhat higher than humans receive. Although guidelines have not been established for acceptable limits for radiation exposure to species other than humans, it is generally agreed that the limits established for humans are sufficiently protective for other species.
>
> Although the existence of extremely radiosensitive biota is possible and increased radiosensitivity in organisms may result from environmental interactions with other stresses (for example, heat or biocides), no biota have been identified as showing a sensitivity (in terms of increased morbidity or mortality) to radiation exposures as low as those expected in the area surrounding the proposed CRBRP. Furthermore, at all nuclear plants for which radiation exposure to biota other than humans has been analyzed (Blaylock, 1976), there have been no cases of exposure that can be considered significant in terms of harm to the species, or that approach the limits for exposure to members of the public that are permitted by 10 CFR 20 (1981). Inasmuch as the 1972 BEIR Report (BEIR I) (Nat'l Acad Sci, 1972) concluded that evidence to date indicated that no other living organisms

are very much more radiosensitive than humans, no measurable radiological impact on populations of biota is expected as a result of the routine operation of CRBRP.

5.7.2 Radiological Impact on Humans

5.7.2.1 Exposure Pathways

The staff's evaluation provides dose estimates that can serve as a basis for a determination that releases to unrestricted areas are as low as practicable in accordance with 10 CFR 50 and within the limits specified in 10 CFR 20.34.

Estimates of radiation doses to humans at and beyond the site boundary via the the most significant pathways among those diagrammed in FES Figure 5.6 were made using models described in Regulatory Guide 1.109, Revision 1 (October 1977).

5.7.2.2 Liquid Effluents

The potential individual doses from liquid effluents are summarized in Table A5.2, which replaces FES Table 5.11.

Table A5.2 Annual individual doses from exposure to liquid effluents from CRBRP

Location	Pathway	Dose, mrem*/yr			
		Total Body	GI Tract	Thyroid	Bone
Coolant discharge region	Fish ingestion (21 kg/yr)	<0.01	<0.01	<0.01	<0.01
	Beef ingestion (110 kg/yr)	0.11	0.11	0.11	<0.01
	Swimming (100 hrs/yr)	<0.01			
	Boating (600 hrs/yr)	<0.01			
	Shoreline activities (500 hrs/yr)	<0.01			
	Milk* ingestion (330 l/yr)	0.94	0.94	0.96	<0.01
Oak Ridge Gas Diffusion Plant intake	Water ingestion (370 kg/yr)	0.06	0.06	0.06	<0.01

*These dose rates are for an infant.

In the second paragraph of this section in the FES, the third sentence has been modified to read as follows: "The total body dose to a hypothetical individual who receives all drinking water from the plant discharge region of the Clinch River was estimated to be 1.6 mrems/yr."

The third paragraph of this section has been modified to read:

> 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 evaluated using the biological accumulation factors listed in Regulatory Guide 1.109. Humans are not expected to consume Clinch River invertebrates. However, if someone does consume 5 kg/yr of invertebrates caught in the discharge region, the dose rate would be less than 0.1 mrem/yr to the total body. Potential individual doses from swimming, boating, and shoreline recreation in the discharge region were also evaluated. Table A5.2 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 FES 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 (Regulatory Guides 1.111 and 1.109). Doses to a maximally exposed individual at the site boundary as a result of gaseous effluents are summarized in Table A5.3, which replaces FES Table 5.12. The changes shown in the new table are not environmentally significant.

Table A5.3 Annual individual doses due to exposure to gaseous effluents from CRBRP at site boundary*

	Dose, mrem/yr		
Pathway	Total Body	Skin	Thyroid
Plume	0.34	2.3	0.34
Inhalation	0.02	0.02	0.02
Vegetable, meat, and milk food chains	0.07	0.07	0.07

*0.44 miles NW, $\chi/Q = 1.2 \times 10^{-4}$ sec/m^3.

5.7.2.4 Direct Radiation from the Facility

No changes have been made to the plant design that would significantly affect the environmental impacts considered in this section of the FES.

5.7.2.5 Occupational Radiation Exposure

The following discussion is provided as an addition to this section of the FES.

The average annual dose of about 0.8 rem per nuclear plant worker at operating BWRs and PWRs has been well within the limits of 10 CFR 20 (NUREG-0713). In Table A5.4, the staff has estimated the risk to nuclear power plant workers and compared it to risks that are published for other occupations. Based on these comparisons, the staff concludes that the risk to nuclear plant workers from plant operation is comparable to the risks associated with other occupations.

In estimating the number of health effects resulting from both offsite (see Section 5.7.3) and occupational radiation exposures due to normal operation of CRBRP, the staff used somatic (cancer) and genetic risk estimators based on widely accepted scientific information. Specifically, the staff's estimates are derived from the National Academy of Sciences' Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR I). The estimates of the risks to workers and the general public are based on conservative assumptions (that is, the estimates are probably higher than the actual number). The following risk estimators are used to estimate health effects: 135 potential deaths from cancer per million person-rems and 258 potential cases of all forms of genetic disorders per million person-rems. The cancer mortality risk estimates are based on the "absolute risk" model described in BEIR I. Higher estimates can be developed by use of the "relative risk" model, along with the assumption that risk prevails for the duration of life. Use of the "relative risk" model would produce risk values up to about four times greater than those used in this report. The staff regards the use of the "relative risk" model values as a reasonable upper limit of the range of uncertainty. The lower limit of the range would be zero because health effects have not been detected at doses in this dose-rate range. The number of potential nonfatal cancers would be approximately 1.5 to 2 times the number of potential fatal cancers (BEIR III).

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

The preceding values for risk estimators are consistent with the recommendations of a number of recognized radiation protection organizations, such as the International Commission on Radiological Protection (ICRP, 1977), the National Council on Radiation Protection and Measurement (NCRP, 1975), the National Academy of Sciences BEIR III Report (Nat'l Acad Sci, 1980), and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR, 1977).

The risk of potential fatal cancers in the exposed work force population at CRBRP is estimated as follows: Multiplying the conservative annual plant worker

Table A5.4 Incidence of job-related mortalities

Occupational Group	Mortality Rates (premature deaths per 10^5 person-years)
Underground metal miners*	~1300
Uranium miners*	420
Smelter workers*	190
Mining**	61
Agriculture, forestry, and fisheries**	35
Contract construction**	33
Transportation and public utilities**	24
Nuclear-plant worker***	23
Manufacturing**	7
Wholesale and retail trade**	6
Finance, insurance, and real estate**	3
Services**	3
Total private sector**	10

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

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

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

population dose of 1000 person-rems by the risk estimators, the staff estimates that about 0.14 cancer death may occur in the total exposed population and about 0.26 genetic disorder may occur in all future generations of the same exposed population. The value of 0.14 cancer death means that the probability of 1 potential cancer death over the lifetime of the entire work force due to 1 year of CRBRP operation is about 1 chance in 7. The risk of potential genetic disorders attributable to exposure of the workforce is a risk borne by the progeny of the entire population and is thus properly considered as part of the risk to the general public.

5.7.2.6 Transportation of Radioactive Materials

The analysis of radiological impacts from normal transportation operations of the CRBRP fuel cycle is detailed in Appendix D of this statement. The staff assessment is based primarily on the applicants' projections and assessments of impacts of transportation from the CRBRP fuel cycle as contained in Amendment XIV to the applicants' ER. In addition, the transportation of fresh mixed oxide fuel to a reactor, of spent fuel from the reactor to a fuel reprocessing plant, and of radioactive wastes from the reactor to a burial ground is discussed generically for liquid metal fast breeder reactors in ERDA's summary report, "Environmental Impact of Transportation of Nuclear Materials in the LMFBR Program" (ERDA, 1975). Most of the information in that report is applicable to the transportation requirements of the CRBRP, although there would likely be reductions in environmental impact because of the much smaller rating of the CRBRP compared with the reference LMFBR Plant (350 MWe versus 1000 MWe). Additional information on the transportation of nuclear materials was obtained from "Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes" (NUREG-0170). An analysis of potential transportation accident impacts is presented in Section 7.2.

As shown in Table D.16 of Appendix D, the cumulative radiation dose to transport workers and the general population from normal transportation activities is conservatively (high-side) estimated to be 24 person-rems annually. This value represents an average annual exposure over the 30-year assumed life of the plant. To provide some perspective on this number, the cumulative dose to the workers and the population along the route from naturally radioactive sources would be about 75,000 person-rems per year. On basis of the above information and the staff's independent evaluation, the staff has concluded that the environmental risk from transportation of fresh fuel materials, irradiated fuel, and waste materials related to the CRBRP fuel cycle operations is small. Moreover, the dose to the exposed population is less than 0.1% the natural background dose and is within the range of normal variations of natural background dose at a given location.

5.7.2.7 Fuel Cycle Impacts

The CRBRP fuel cycle activities that have the potential to result in radiological impacts are: blanket fuel fabrication, core fuel fabrication, fuel reprocessing, waste management from all facilities including the CRBRP, and transportation of radiological materials to and from the reactor and fuel cycle facilities.

The fuel cycle shown in Figure A5.1 was based on the applicants' ER and was the basis for the staff's environmental analysis. A number of the facilities that would be involved in this fuel cycle are not specifically established at this time. (The commercial blanket fuel fabrication plant has not yet been selected; the fuel reprocessing plant operation may be handled in several alternative ways; and the sites for low level, transuranic (TRU), and high level waste storage and

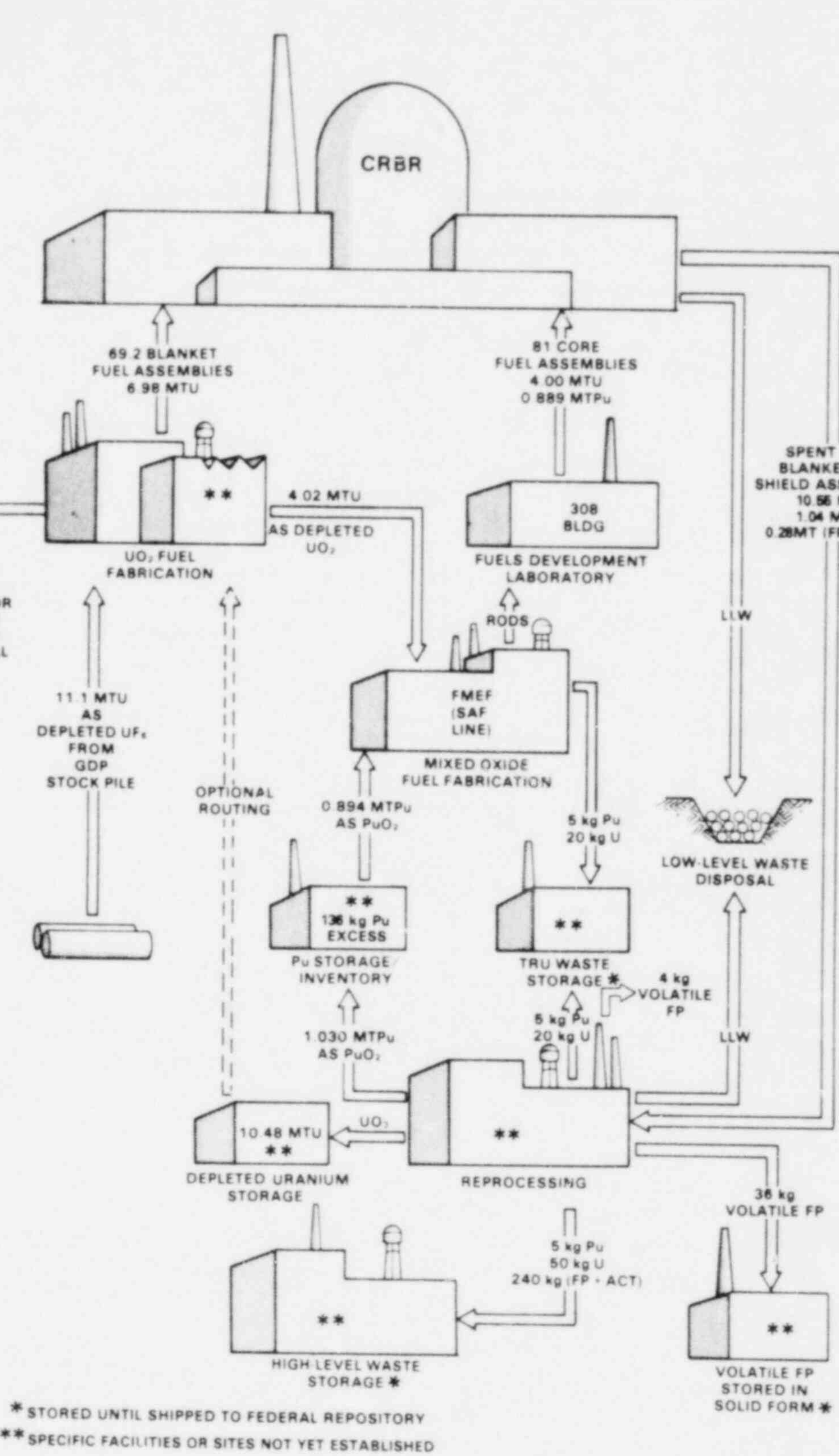


Figure A5.1 Average annual fuel cycle requirements for CRBRP disposal are not yet established.) Accordingly, many aspects of the staff assessment have been based upon generic or model facility concepts and generic site conditions.

In that fuel cycle, depleted uranium hexafluoride from tails stockpiles at DOE's gaseous diffusion plants would be converted to uranium dioxide at a commercial fuel fabrication facility. Blanket fuel assemblies would be manufactured at the same facility, as well as depleted uranium dioxide fuel materials for the core fuel assemblies. For the assessment, the staff has used both generic data on such facilities and information from experience with operating plants.

The uranium dioxide materials for core fuel rod and axial blankets would be shipped to the Fuels and Materials Examination Facility (FMEF) at the Hanford reservation. At the FMEF the uranium dioxide powder and plutonium dioxide powder would be mixed and fabricated into sintered pellets for the core fuel rods in the Secure Automated Fabrication (SAF) Line. Core fuel rods containing the mixed oxide pellets in the center segment of the rod and depleted uranium dioxide pellets in the end segments of the rod (as axial blanket) would be the product of the SAF Line. The rod would be welded shut and sealed, cleaned and inspected, and transported to the nearby Fuels Development Laboratory (308 Building) where the core fuel would be fabricated into assemblies. No radioactive release would occur during operations in the 308 Building. The staff assessment of these operations is based upon DOE data for these facilities.

The completed core fuel assemblies, as well as blanket fuel assemblies, would be shipped to the CRBRP for use. After irradiation, and storage on site for a minimum of about 100 days, the irradiated (spent) fuel assemblies would be transported to a reprocessing plant where the plutonium would be separated from the uranium and fission products and other transmuted actinides. The plutonium required for new fuel under equilibrium conditions would be shipped to the FMEF for recycle. Plutonium in excess of that consumed would be stored for future use.

The staff based its assessment of the reprocessing step on the Developmental Reprocessing Plant (DRP) proposed by DOE and described in Amendment XIV of the ER. The staff believes, consistent with DOE views, that this facility, represented by design concepts, provides bounding conditions for environmental effluents that can be met by any of several alternatives for fuel reprocessing that might be chosen.

Radioactive wastes would be produced at the CRBRP and in each of the fuel cycle steps. Low level waste (LLW) produced at the uranium hexafluoride and uranium dioxide conversion and blanket fuel fabrication facility would be disposed of on site or at commercial burial grounds. Transuranic (TRU) waste would result from operations at both the core fabrication facility and at the reprocessing facility. These would be placed in temporary retrievable storage (on the Hanford reservation, for example) prior to eventual disposal in a Federal geologic repository. High level waste (HLW), after solidification at the reprocessing plant, would also be temporarily stored until it could be disposed of in a Federal geologic repository. LLW from reprocessing and from the CRBRP would be disposed of in a licensed, commercial burial ground. The staff assessment of these waste management activities is based upon generic consideration of such activities since specific sites are not available for evaluation.

Table D.4 of Appendix D summarizes the environmental considerations (resource requirements and the radioactive and nonradioactive effluents) associated with each of the fuel cycle steps, as well as the total fuel cycle.

The radiological impacts of all of these fuel cycle operations have been evaluated by the staff, and the results of these evaluations are presented in Table D.17 of Appendix D. Based on that summary of the staff assessment, the annual U.S. population whole-body dose from normal operations of the fuel cycle is projected to be approximately 170 person-rems, including the contribution from transportation discussed in Section 5.7.2.6. This estimate is higher than the values in the FES (33 person-rems from transportation and the fuel cycle) due primarily to higher levels of gaseous radiological releases from the reprocessing step. However, both assessment findings are very small fractions of the annual whole-body dose to the U.S. population from naturally occurring radioactive sources (approximately 28,000,000 person-rems). The potential radiological consequences of the above CRBRP fuel cycle exposures are discussed in Section 5.7.3.

5.7.2.8 Summary of Population Annual Doses

Population dose estimates are based on a projected 2010 population of 910,000 persons living within 50 miles of the plant and 29,000 receiving drinking water from Clinch River and its tributaries. At the drinking water intakes the discharge would be fully diluted by a factor of 67 over the unmixed plant discharge.

The staff assumed that 1.8×10^5 kg of fish would be caught downstream of the plant, where the discharge would be fully diluted by a factor of 67 for about one-fifth of the catch and by about 6100 for the remainder of the catch over the unmixed plant discharge. The staff assumed that the entire fish catch would be consumed by the population within the 50-mile radius.

The cumulative dose (person-rems) received from recreation by the total population was estimated by assuming that 25% of the 50-mile 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 (person-rems) received by the 50-mile 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 (that is, by a factor of 67) had taken place.

The staff also assumed that all of the milk and beef produced from those cattle would be consumed by the 50-mile 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 1 year (such as 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 from CRBRP 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 drinking water from the Tennessee and Mississippi Rivers downstream of the Clinch River.

The estimated doses to the 50-mile 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 A5.5, which replaces FES Table 5.13. Although some of the dose estimates in the new table are larger than previously shown, the doses associated with nuclear plant operation are not significant compared with the dose to the population from exposure to natural background radiation. Also shown in the table for completeness of information is the annual population dose expected from the CRBRP supporting fuel-cycle facilities.

5.7.3 Evaluation of Radiological Impact to the General Public

The average annual dose to the total body of an individual living, playing, and working at the site boundary and eating fish, beef, and milk exposed to plant effluents now is estimated to be less than 2 mrems/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. The average dose to other individuals within a 50-mile radius of the plant would be significantly less than 2 mrems/yr.

Using conservative assumptions, a total dose of about 2 person-rems/yr would be received by the estimated 2010 population of 910,000 living in unrestricted areas within a 50-mile radius of the plant. By comparison, an annual total of about 9.1×10^4 person-rems is delivered to the same population as a result of the average natural background dose rate of about 0.1 rem/yr.

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

The risk to the maximally exposed individual is estimated by multiplying the risk estimators presented in Section 5.7.2.5 by the estimated annual total body

Table A5.5 Summary of annual whole body doses to the population in the year 2010

Category	Population dose (person-rems/yr)	
	Population within 50 miles	U.S. population
Natural environmental radioactivity	9.1×10^4	2.8×10^7 (a)
Nuclear plant operation		
Plant work force	(b)	1.0×10^3
General public		
Gaseous effluents	0.04	0.08
Liquid effluents		
Fish ingestion	<0.01	0.01
Recreation (fishing, swimming, boating	<0.01	<0.01
Water ingestion	1.5	1.5
Beef ingestion	0.1	0.2
Milk ingestion	0.2	0.3
Transportation and supporting fuel cycle facilities	-	170

(a) 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).

(b) A large portion of the 1.0×10^3 person-rems to the U.S. population would be received by the population within 50 miles.

doses to the maximally exposed individual. This calculation results in a risk of potential premature death from cancer to that individual from exposure to radiaoctive effluents from 1 year of reactor operations of less than 1 chance in 1 million. The risk of potential premature death from cancer to the average individual within 50 miles of the reactor from exposure to radioactive effluents from the reactor is much less than the risk to the maximally exposed individual. These risks are very small in comparison to natural cancer incidence from causes unrelated to the operation of CRBRP. Multiplying the annual U.S. population dose from exposure to radioactivity attributable to the normal operation of CRBRP and its related fuel cycle (i.e., 170 person-rems) by the preceding somatic risk estimator, the staff estimates that about 0.023 potential cancer death may occur in the exposed population, and about 0.30 potential genetic disorder may occur in all future generations of the exposed population. The significance of these risk estimates can be determined by comparing them to the natural incidence of cancer death and genetic abnormalities in the U.S. population and in the first generation of the U.S. population, respectively. Multiplying the estimated U.S. population for the year 2010 (~280 million persons) by the current incidence of actual cancer fatalities (~16%) and the current incidence of actual ill health (~11%), about 45 million cancer deaths and about 31 million genetic abnormalities in the first five generations are expected (ACS, BEIR III). The risks to the general public from exposure to radioactivity attributable to the annual operation of CRBRP are very small fractions (less than 10 parts in a billion) of the estimated normal incidence of cancer fatalities and genetic abnormalities in the year 2010 population and in the first five generations of the year 2010 population, respectively.

On the basis of the preceding comparison, the staff concludes that the potential risk to the public health and safety from exposure to radioactivity attributable to normal operation of CRBRP and its related fuel cycle will be very small.

5.8 Conclusion

Although various minor changes are noted in this chapter relative to environmental parameters and effects of plant operation and some new information is presented, there are no significant changes in the impacts to the environment from those assessed in the FES.

6 ENVIRONMENTAL MEASUREMENT AND MONITORING PROGRAMS

6.1 Preoperational

6.1.1 Hydrological

No changes have been made to this section of the FES.

6.1.2 Radiological

The applicants have modified their proposed offsite preoperational radiological monitoring program identifying background levels of radiation and radioactivity in the plant environs. The program would permit the applicants to train personnel and evaluate procedures, equipment and techniques, as indicated in Regulatory Guide 4.1. The applicants' modified program, to be started 2 years before plant operation, is summarized in Table A6.1, which replaces FES Table 6.1. Vertical lines in the right-hand column of the table indicate where changes were made. Sampling locations are shown in Figures A6.1 and A6.2, which supersede similar figures in the FES. More detailed information is in ER Section 6.2. The number of thermoluminescent dosimeter (TLD) locations will have to be updated to conform to the criteria in the Radiological Assessment Branch Technical Position, Revision 1, November 1979, "An Acceptable Radiological Environmental Monitoring Program." However, provided the number of TLD locations is thus updated, the staff considers the proposed program adequate.

6.1.3 Meteorological

Since April 1973 a temporary 200-ft instrumented tower has been in operation southward of the proposed reactor site. In February 1977, two permanent instrumented towers were installed: a 10-m tower south of the site and a 110-m tower southeast of the site. Simultaneous measurements were taken on the temporary and permanent towers during the period February 16, 1977 to March 2, 1978. No measurements are currently being taken, but they would be resumed during construction of the facility. The data acquisition equipment was located in a trailer at the base of the 110-m tower with data from the 10-m tower being telemetered to this same location. The 10-m tower instrumentation consisted of wind speed and wind direction sensors located at the 10-m level. The 110-m tower instrumentation consisted of wind speed and direction sensors located at the 10-, 60-, and 110-m levels; temperature sensors at the 10-, 60-, and 110-m levels; dew point sensors at the 10-m level; and solar radiation, atmospheric pressure, and precipitation sensors at the 1-m level.

The present measurement system, which is currently not in use, consists of the following sensors (ER pp. 6.1-32a, 32b, and 32c):

> Wind Sensors - Climet Model 011-1 wind speed sensor and Climet Model 012-110 wind direction sensor. The operating range of the wind speed sensor is 0.6 to 110 mph, with an accuracy of 1% of true value or 0.15 mph, whichever is greater. The direction sensor operates through a range of 0-540° with an accuracy of ±3°.

Table A6.1 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, Sr, and U quarterly
	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 with weekly sample collection	Biweekly composite-H-3
	1 control sample		
Soil	Same as airborne particulate locations	Annually	Gross beta Gross alpha Gamma scan Pu U
Direct radiation	Near plant boundaries and at airborne particulate locations	Quarterly	Thermoluminescent dosimeters

Table A6.1 (Continued)

Sample type	Number of samples and locations	Sampling and collection frequency	Type and frequency of analysis
Vegetation (grass, weeds, and so forth)	Same as airborne particulate	Quarterly	Gross beta Heavy metal total alpha Gamma scan Sr-89, 90 Pu
Pasturage grass	Nearby dairy farms	Quarterly	Same as vegetation analyses
Beef		Based on trigger levels in pasture grass	
Milk	Nearby milk animals	Monthly	Gamma scan Sr-89, 90 I-131
		Biweekly during pasture months	I-131
Groundwater	Nearby wells	Monthly	Gross beta, gross alpha, and gamma scan monthly Pu quarterly
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 upstream and downstream	Automatic sequential sampling, collected monthly	Gross beta, gross alpha, and gamma scan H-3, Pu quarterly
	Samples at Clinch River 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)

Table A6.1 (Continued)

Sample type	Number of samples and locations	Sampling and collection frequency	Type and frequency of analysis
Fish	Upsteam and downstream of Melton Hill Dam	Semi-annually	Recreational-gross beta Gross alpha Gamma scan Commercial same as recreational plus Sr-89, 90, and Pu
Sediment	4 to 6 locations	Semi-annually	Same as commercial fish analysis
Asiatic clams	4 to 6 locations	Semi-annually	Shell-Sr-89, 90, Pu Edible portion-gross beta gross alpha gross scan

Dry Bulb Temperature - Aspirated Aerodet Model R-22.3-100 platinum resistance temperature sensor is currently located at the 10-, 60-, and 110-m tower levels. The sensor range is -10°F to 100°F with an accuracy of ±0.06F°.

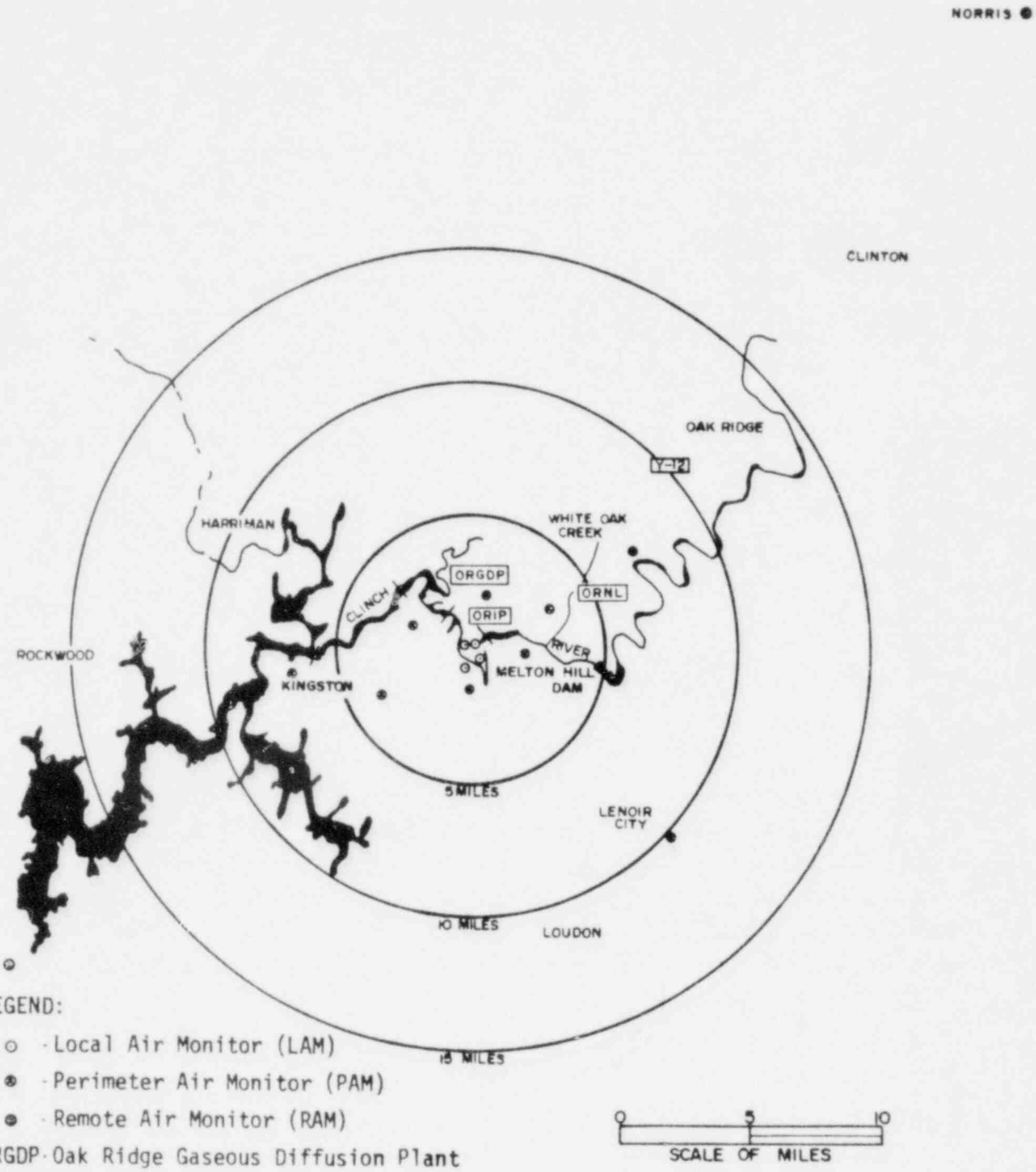
Temperature Difference - Between the tower levels of 10-, 60-, and 110-m, Δ temperature values are determined from the separate dry bulb temperature sensors. In view of radiation and recording device errors common to both temperature sensors, the Δ temperature system has a maximum error of ±0.14F°.

Dew Point - An EG&G Model 110s(M) dew point hygrometer records dew point temperatures in the range of 0° to 100°F. The accuracy of this sensor is ±0.5F°.

Rainfall - Bellfort Instrument Co. Model 5915-12 spring weighing and potentiometer output type in the range 0-9.99 in. with an accuracy of ±0.06 in.

Solar Radiation - Eppley Laboratories, 180 Pyranometer.

Atmospheric Pressure - H.S. Sostman and Co. Model 2014-28/32-HAL pressure transducer in a range of 28 to 32 in. Hg with an accuracy of ±0.06 in. Hg.



LEGEND:

- ○ - Local Air Monitor (LAM)
- ⊗ - Perimeter Air Monitor (PAM)
- ● - Remote Air Monitor (RAM)

ORGDP - Oak Ridge Gaseous Diffusion Plant

ORNL - Oak Ridge National Laboratory

ORIP - Oak Ridge Industrial Park

NOTE: The following samples are collected at each monitoring site:

Air Particulates	Rainwater
Radioiodine	Soil
Heavy Particles	Vegetation
Fallout	

Figure A6.1 Atmospheric and terrestrial radiological monitoring network for CRBRP

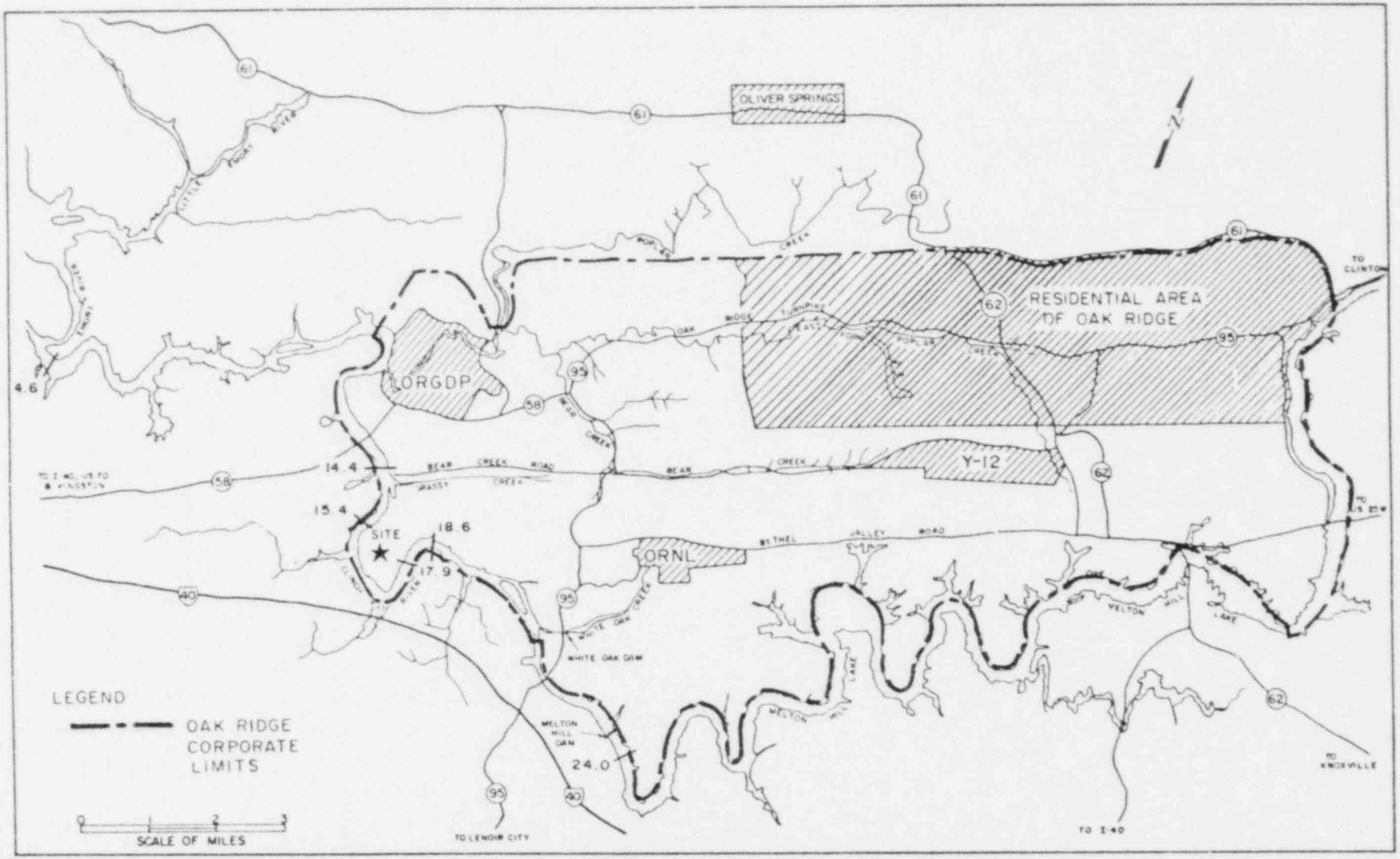


Figure A6.2 Reservoir radiological monitoring network for CRBRP (ER Fig. 6.2-2)

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

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

To provide relative concentrations (χ/Q) and deposition (D/Q) values for use in making radiological dose assessments (Section 5.7), the staff used the joint frequency distributions of wind speeds and direction by atmospheric stability class collected on site on the permanent towers for the period February 17, 1977 through February 16, 1978. Wind speed and direction were measured at the 10-m level, while atmospheric stability was derived from the vertical temperature gradient measurements made between the 10-m and 60-m levels. The joint data recovery rate of 10-m wind speed and wind direction, and the temperature difference between the 10-m and 60-m levels, was 97%.

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 to be at ground level. The calculations also included an estimate of the maximum increases in calculated relative concentration and deposition due to recirculation and stagnation of airflow not considered in the straight-line trajectory model.

6.1.4 Ecological

6.1.4.1 Aquatic

In accordance with Section 511(c)2 of the Clean Water Act, EPA now has the lead role in establishing nonradiological aquatic monitoring requirements.

The baseline aquatic monitoring program was conducted between March 1974 and May 1975. The purpose of this program was to identify the important ecological characteristics of the CRBRP site. Sampling transects and locations according to biotic category are shown in FES Figure 6.3; that figure is reproduced here with several minor additions as Figure A6.3. The sampling schedule was given in FES Table 6.2 (ER Table 6.1-1) and the methods and frequencies in FES Table 6.3 (ER Table 6.1-2); however, those tables in the ER were amended in 1981, as shown in Tables A6.2 and A6.3.

The preconstruction effects monitoring program was initiated in March 1975 and discontinued in January 1978. The initial preconstruction monitoring was conducted monthly during the period from March 1975 through October 1975 and included monitoring water quality, phytoplankton, periphyton, zooplankton, and benthic macroinvertebrates at four transects in the Clinch River. The monitoring program was revised in January 1976, and a reduced monitoring program with varying sampling frequency was conducted from January 1976 through January 1978, monitoring water quality and benthic macroninvertebrates at four transects in the Clinch River. FES Table 6.4 summarized this program; however, that table

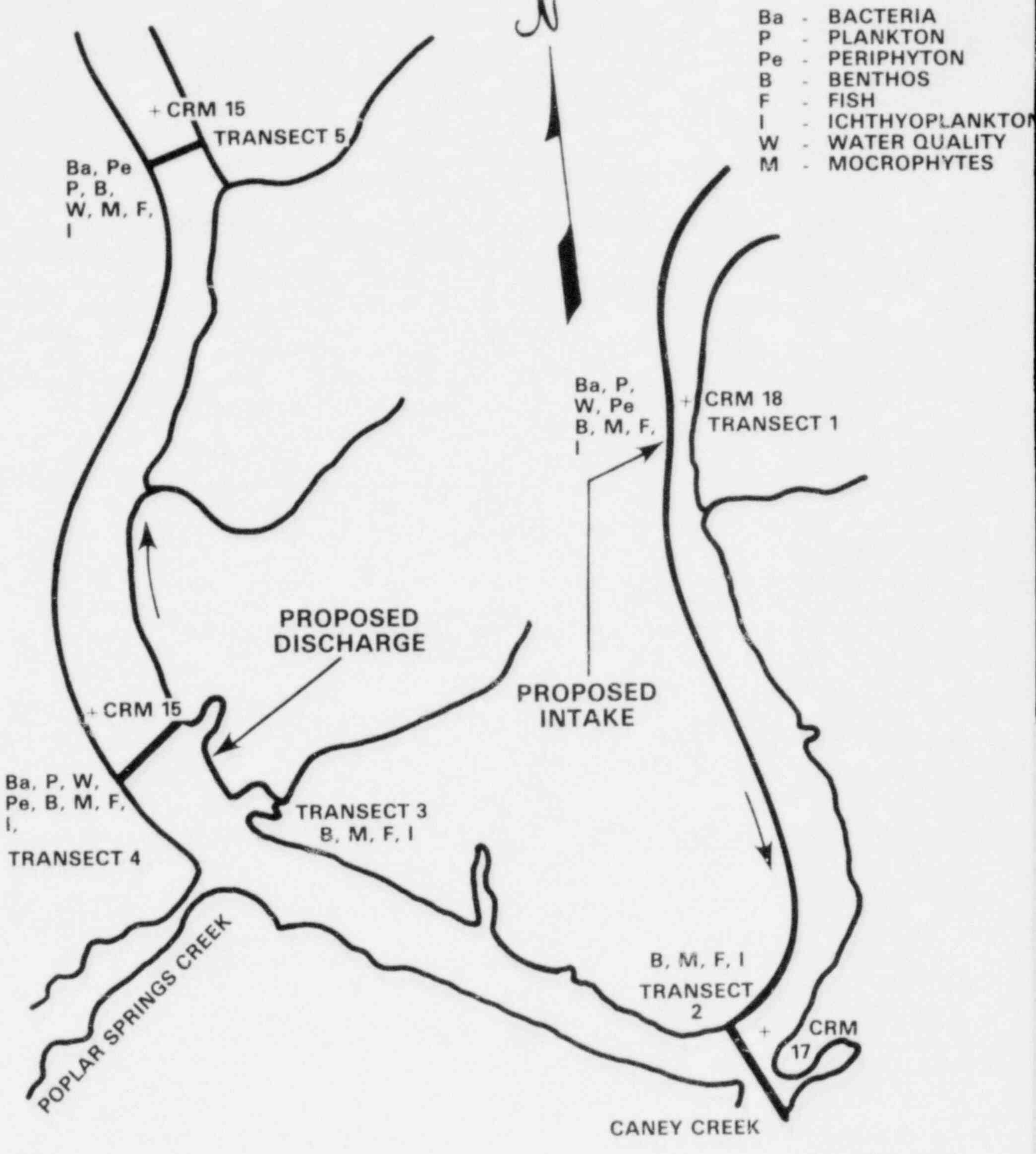


Figure A6.3 River sampling transects for the baseline aquatic monitoring program (replaces FES Fig. 6.3)

Table A6.2 Aquatic sampling schedule

	1974										1975				
	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M
Biological parameters															
Bacteria	X		X	X	X	X	X		X		X			X	
Phytoplankton	X		X	X	X	X	X		X		X			X	
Zooplankton (tows)	X		X	X	X	X	X		X		X			X	
Zooplankton (pumping)	X		X	X	X*										
Periphyton	X		X	X		X		X			X				X
Benthos (dredging)	X		X	X	X	X	X		X		X			X	
Benthos (artificial substrate)	X**		X**	X**	X	X	X		X		X				X
Macrophytes	X		X		X										
Fish populations	X		X	X	X	X	X		X		X			X	
Fish eggs and larvae	X+	X+	X+	X+	X+	X+									
Fish stomach contents	X		X	X		X	X		X		X				
Physical and chemical parameters															
Field measurements	X		X	X	X	X	X		X		X			X	
Routine lab analyses	X		X	X	X	X	X		X		X			X	
Additional analyses	X						X								
Sediment analyses															
Particle size and organic content	X		X		X		X				X			X	
Heavy metal content	X													X	
Total phosphate content	X													X	
Trace elements														X	
Polychlorinated biphenyls (PCBs)														X	
Insecticides														X	

*Pump sampling was discontinued after this trip.
**Most samplers were damaged in river.
+Once every 2 weeks.

Source: ER Table 6.1-1

Table A6.3 Aquatic sampling methods and frequencies

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 March, May-Sept, and Nov. (1974); and Jan and April (1975)	surface collection (1 ft below surface) using sterilized glass containers	(1) concentration expressed as colonies/100 ml (2) analyses according to "Standard Methods"*	Figure 6.3
Phytoplankton	Once each month during March, May-Sept, and Nov (1975); and Jan and April (1975)	(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 6.3
Zooplankton tows	Once each month during March, May-Sept, and Nov (1974); and Jan and April (1975)	(1) vertical tows (2) 0.5 m diameter 0.76μ mesh plankton net with TSK outside and inside flow meters (3) horizontal surface tows beginning in September	(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 6.3
Zooplankton pumping	Once each month during March, May, June, and July (1974)	(1) submersible pump (2) filtered through a 0.76μ mesh plankton net (3) surface, mid, and bottom collections	(1) identification to the specific level, which practical (2) number/liter (3) species diversity (4) composite biomass (volume by displacement or measurement of cells depending on abundance)	Figure 6.3
Periphyton	Once each month during May, June, Aug, and Oct (1974); and Jan	(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 6.3
Benthos dredging	Once each month during March, May-Sept, and Nov (1974); and Jan and April (1975)	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 biomas (blotted wet weight and ash-free dry weight)	Figure 6.3

Table A6.3 (Continued)

Parameter	Sampling/Frequency	Sampling Method	Analyses	Sampling location
Benthos artificial substrate	Once each month during March, May-Sept, and Nov (1974); and Jan and May (1975)	(1) hardboard, multi-plate sampler suspended 1 to 2 ft above bottom	(1) identification to the specific level, when practical (2) number/m^2 (3) species diversity (4) composite biomass (blotted wet weight and ash-free dry weight)	Figure 6.3
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 6.3
Fish	Once each month during March, May-Sept, and Nov (1974); and Jan and April (1975)	(1) electoshocking (2) gill nets (3) scale collection of 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 6.3
Fish eggs and larvae	Once every 2 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 ft from bottom	(1) density (number/m^3) (2) stage of development (3) species identification, when practical	Figure 6.3
Fish stomach contents	Once each month during March, May, June, Aug, Sept, and Nov (1974) and Jan (1975)	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 fullness of stomach (4) net weight of stomach contents	Figure 6.3

Source: ER Table 6.1-2

is replaced here by Table A6.4 (ER Table 6.1-4a) to provide more complete information. Detailed accounts of these programs are presented in ER Section 6.1.1.2.

The applicants submitted to EPA an erosion control plan, and they are now modifying it. A plan approved by EPA must be implemented prior to commencement of site preparation activities (NPDES Permit Part III.J; see Appendix H of this document).

The staff maintains that the most effective method to minimize the impact of plant construction on aquatic organisms is to utilize sound engineering practices and to monitor pertinent water quality parameters (such as turbidity) at or near the source(s) of construction runoff so that potential impacts can be detected at an early stage. Then, through direct feedback of information to appropriate construction personnel, such impacts can be minimized before adverse conditions affect aquatic life in the river. The staff concludes that the protection of the aquatic environment is adequately achieved by the erosion control plan and by the recommended scheduling of construction activities in the river. Therefore, the staff will not require the studies indicated by the applicants in the ER.

The staff recommended that, before significant site preparation and inriver activities begin, the applicants conduct a one-time survey of the Clinch River for species of threatened or endangered freshwater mussels. This survey was completed during May 1982, and the results are discussed in Section 5.3.4.

The NPDES Permit (Part III.M) also requires, prior to the start of construction of the plant discharge structure, that studies be made to ensure that thermal discharges will have minimal impact on striped bass.

The preconstruction and construction effects monitoring program is separate from the preoperational monitoring program. In accordance with the NPDES Permit (Part III.N), the latter will be designed and implemented 2 years before the scheduled fuel loading and will be based on details of the final plant design and environmental data available at that time.

6.1.4.2 Terrestrial

No changes has been made to this section of the FES.

6.1.5 Chemical and Physical

During the baseline program (March 1974 through May 1975), water quality sampling was done at three transects in the river (Figure A6.3) and the measurements were scheduled as shown in FES Table A6.2. The parameters measured were identified in FES Table 6.6, which is replaced here by Table A6.5 (ER Table 6.1-2) to provide more complete information.

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. The program was discontinued in 1978 at the request of ERDA. Under the revised program, TVA collected physical/chemical data by sampling at CRM 23.1, CRM 19.0, and CRM 17.9, upstream from the site, and CRM 15.4 and

Table A6.4 Preconstruction aquatic environmental monitoring program

		Physical-Chemical				Biological			
Station Location	Horizontal Location[1]	In situ[2]	General[3]	Comprehensive[4]	Fecal coliforms[4]	Primary productivity (in situ C^{14})[5]	Submarine photometer[5]	Benthos (artificial Substrates)[6]	Benthos (dredge)[7]
CRM 19.0	50								X
	95							X	
CRM 17.9	50	0.3,1,1.5,3, 5,6	1,3,5	1,3,5	0.1	0.1,1,3,5	0.1,1,3,5		X
	5	(0.3,1,1.5,3)[8]				0.1,1,3	0.1,1,3		
	95	(0.3,1,1.5,3)[8]8				0.1,1,3	0.1,1,3,5	X	
CRM 15.4	50	0.3,1,1.5,3 5,6	1,3,5			0.1,1,3,5	0.1,1,3,5		X
	5	(0.3,1,1.5,3)[8]				0.1,1,3	0.1,1,3		
	95	(0.3,1,1.5,3)[8]				0.1,1,3	0.1,1,3	X	
CRM 14.4	50	0.3,1,1.5,3, 5,6	1,3,5	1,3,5	0.1	0.1,1,3,5	0.1,1,3,5		X
	5	(0.3,1,1.5,3)[8]				0.1,1,3	0.1,1,3		
	95	(0.3,1,1.5,3)[8]				0.1,1,3	0.1,1,3	X	
Peripheral stormwater runoff									
CRM 15.5	0.4[9]			S[10]					
CRM 15.95	0.1			S					
CRM 16.10	0.2			S					
CRM 16.50	2.4			S					
Groundwater									
Well A-58				X[11]					
Well E-60				X					
Well R-62				X					
Well G-68				X					
Well A-70				X					
Well N-70				X					
Well-auto sampled					X.				

[1]Percent from the left bank, facing the downstream direction.
[2]Measurements made in situ for di<solved oxygen, pH, temperature, and conductivity once during January and monthly March through October.
[3]Measurement made for alkalinity (field), nitrogens, phosphorus, COD, TOC, solids, turbidity, and colors once during January and monthly March through October.
[4]Measurements made for BOD, fecal coliform, Cd, Ca, Cl, Cr, Cu, Fe, Pb, Mg, Mn, Hg, Ni, K, SiO_2, Na, SO_4, and Zn once during months of January, April, July, and October.
[5]Primary productivity (in situ C_{14} uptake) and submarine photometer (percent light perbiastion) measurements made once during months of March through October.
[6]Artificial substrates for benthos - 2-month exposures; Placed in months of March, May, July, and September and removed in May, July, September, and November. Samples used to quantify biomass, numbers, and diversity.
[7]Dredge for benthos and particle-size analysis once during months of March, May, July, and September. Samples used to quantify biomass, numbers, diversity, and substrate type.
[8]Initiated in June 1977.
[9]Kilometers from mouth of drainage ways all located at 100 percent from left bank, facing the downstream direction.
[10]Samples analyzed for pH and temperature in the field, and suspended solids and turbidity in the laboratory. Sampling initiated in June 1976 on a monthly basis.
[11]Samples analyzed for pH and temperature in the field and conductivity, alkalinity, P, solids, Na, SO_4, B, Cd, Cr, Cu, Pb, Mn, Ni, and Zn in the laboratory. Sampling initiated in June 1976 on a quarterly basis.

Source: ER Table 6.1-4a

Table A6.5 Sampling methods for physical and chemical parameters--aquatic baseline survey

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 March, May-Sept, and Nov (1974) and Jan and April (1975)	(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 Savonium meters; current direction by internal compass (4) Water depth measured by recording fathometer	(1) Temp in ^{o}C (2) pH in pH units (3) Dissolved oxygen in mg/l (4) Conductivity in µmbo (5) Light penetration in foot-candles and % 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 March, May-Sept, and Nov 1974 and Jan and April (1975)	"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

Table A6.5 (Continued)

Parameter	Sampling/Frequency	Sampling Method	Analyses
C. Additional Analyses Chlorine demand Fluoride Nitrogen gas Silicate Calcium Magnesium Molybdenum Solenium Tin Aluminum Manganese Zinc Copper Mercury Silver Arsenic Cadmium Chromium 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 during March and Sept 1974	"Standard Methods"*	Analyses were done using "Standards Methods"* except for: (a) mercury, molybdenum, and nickel in which case "Methods for Chemical Analysis"** was used, (b) nitrogen gas in which case the Van Slyke method+ was used, and (c) selenium in which case "Proposed Tentative Method"++ was used
SEDIMENT A. Particle size and total volatile (organic) solid content	Once each month during March, May, July and Sept (1974) and Jan and April (1975)	Collection by dredge	(1) Particle size determination as in "Shore Protection"∇ (2) Total volatile solid content by combustion according to "Standard Methods"*
B. Total Phosphate Content Heavy Metal Content Molybdenum Selenium Tin	Once at the beginning of the study and once at the end of the study, March 1974 and April 1975	Collection by dredge	Acidification, then procedure as in "Standard Methods"* for metal analysis

Table A6.5 (Continued)

Parameter	Sampling/Frequency	Sampling Method	Analyses
Aluminum			
Manganese			
Zinc			
Copper			
Mercury			
Silver			
Arsenic			
Cadmium			
Chromium			
Lead			
Nickel			
Cobalt			
Iron (total)			
C. Trace Elements Polychlorinated Biphenyls Insecticides	Once in April 1975	Collected by dredge	(1) Metals: acidification, then procedure as in "Standard Methods"* (2) Other "Standard Methods"* or "Methods for Chemical Analysis""**
Beryllium			
Fluoride			
Magnesium			
Antimony			
Vanadium			
Bromine			
Bismuth			
Calcium			
Strontium			
Potassium			
Sodium			
Niobium			
Silica			
Titanium			
Zirconium			
Barium			
Lithium			
Scandium			
Germanium			
PCBs			
Chlordane (α and γ)			
DDE			
DDD			
DDT			

Source: ER Table 6.1-2

*Standard Methods for the Examination of Water and Waste Water, American Public Health Asociation, Washington, D.C., 1971.

**Methods for Chemical Analysis of Water and Wastes, EPA, Water Quality Office, Analytical Quality Control Laboratory, Cincinnati, Ohio, 1971.

+Van Slyke, Donald D., and Neil, J. H., Journal of Biological Chemistry, 61:523, 1924.

++Proposed Tentative Method of Test for Selenium in Water, American Society of Testing Materials, November 1970.

∇Shore Protection, Planning and Design, Technical Report No. 4, U.S. Army Corps of Engineers, 1966.

CRM 14.4, both downsteam from the site (see Figure A6 4, which supersedes FES Figure 6.4) (ER Fig 6.1-11). The additional data gathered after January 1978 were considered in updating Chapters 2, 3, 4, and 5 of this document.

Requirements for monitoring during construction are specified in the NPDES Permit, Page I-3 (see Appendix H).

The staff will provide input, as appropriate, to EPA in the review of the monitoring programs proposed under the terms of the NPDES Permit.

6.1.6 Socioeconomic

The staff's analysis in Chapter 4 indicated that increased utilization of community facilities and services would occur as a result of the construction of the CRBRP but that tax revenues to local governments would probably balance such demands. To assist the affected communities to plan for changes, the staff recommends that the applicants be required to conduct surveys of the construction work force, as described in FES Section 6.1.6.1, and submit appropriate reports (FES Section 6.1.6.2). With this information, combined with background data on normal growth in the area and capacity utilization of current facilities and staff, the impacted units of government can make enlightened plans to accommodate or control growth effects related to the construction and operation of the CRBRP.

6.1.6.1 Primary Work Force Survey

No changes have been made to this section of the FES except to delete the last sentence relative to an alternative program for providing the desirable data.

6.1.6.2 Reporting

No change has been made in this section of the FES.

6.2 Operational

6.2.1 Hydrological

A brief operational 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). If found necessary, such efforts will be included in the program required by the NPDES Permit.

6.2.2 Radiological

No change has been made in this section of the FES.

6.2.3 Meteorological

No change has been made in this section of the FES.

6.2.4 Ecological

As with pre-operational monitoring, EPA now has the lead in establishing the nonradiological aquatic monitoring programs (see NPDES Permit, Part III.0). The

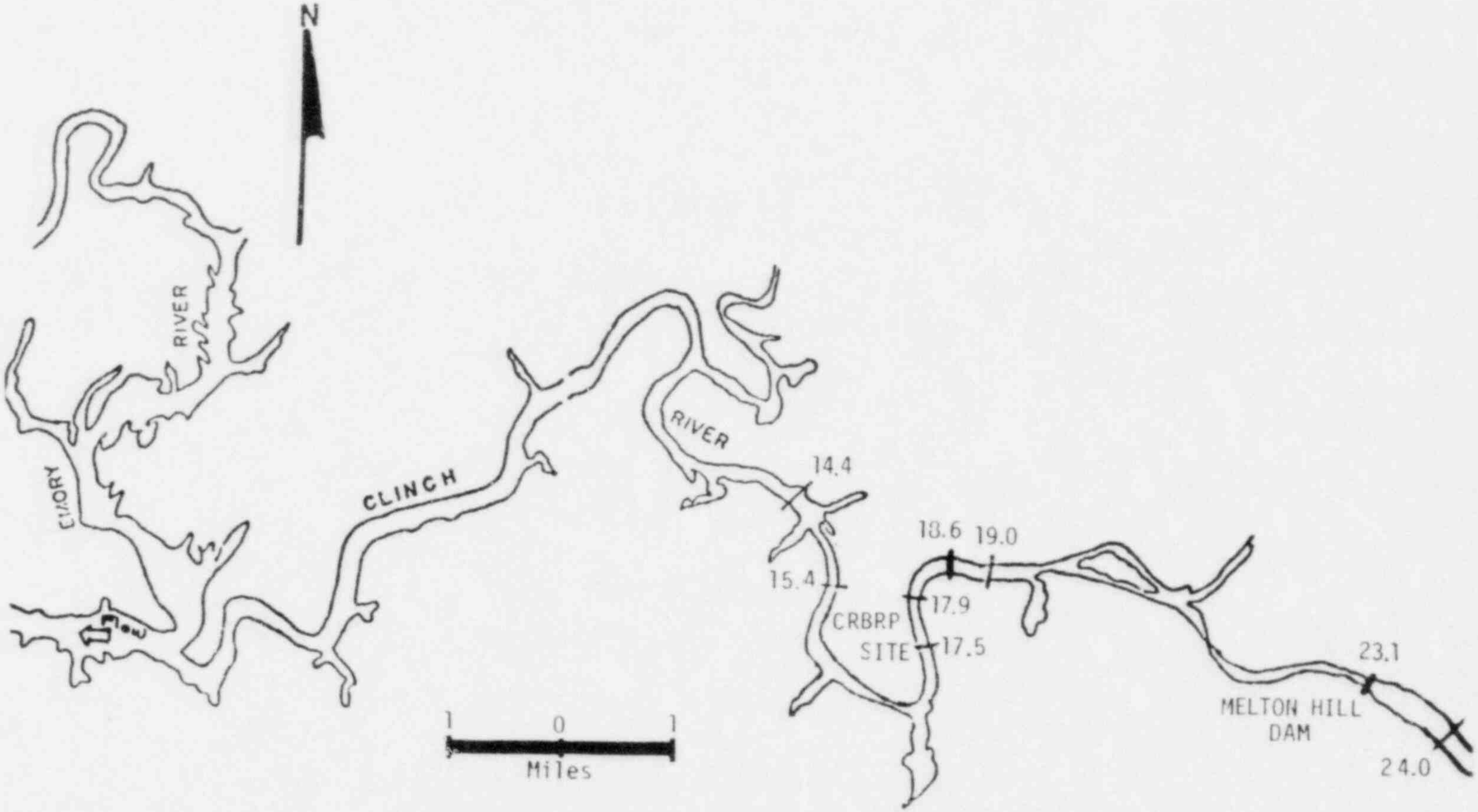


Figure A6.4 Reservoir environmental radiation monitoring network, preconstruction-construction phase operational aquatic monitoring program would be conducted in accordance with the Environmental Protection Plan to be issued by the NRC as part of the Operating License and the NPDES Permit issued by EPA or the State of Tennessee.

No change has been made in this section relative to the applicants' tentative terrestrial program.

6.2.5 Chemical and Physical

No change has been made in this section of the FES.

6.2.6 Socioeconomic

No change has been made in this section of the FES.

6.3 Related Programs and Studies

No change has been made in this section of the FES.

6.4 Conclusion

The applicants have made various minor changes in their monitoring programs to improve the quality of the data obtained and have provided additional information in amendments to their Environmental Report. In evaluating the additional information, the staff has not found substantial changes that would alter significantly its assessments of environmental impacts in the FES (see Chapters 4 and 5).

7 ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS

7.1 Plant Accidents Involving Radioactive Materials

No changes have been made to page 7-1 in the FES.

7.1.1 Classification of Accidents

No changes have been made to the first six paragraphs of the text.

In FES Table 7.1, the following changes have been made: "S-G leaks" is corrected to "SG tube rupture"; in the note for RAPS, "core" has been corrected to "cover"; and in the note for EVST, "in" has been corrected to "for."

The third sentence in the seventh paragraph of Section 7.1.1 has been corrected to read: "The staff is of the opinion that these requirements can be met (other guidance in the letter is being reconsidered)."

The first sentence in the footnote to the seventh paragraph has been corrected to: "*Radiological health and safety hearings are expected to be held in 1983."

The 11th paragraph has been corrected to read as follows:

> A final illustration concerns the manner in which the containment system would be protected from the effects of sodium releases in the equipment cells, particularly those cells containing the main heat transport system equipment. Sodium released into these cells would react with the oxygen in the cell atmosphere and the combustion would increase cell temperatures and pressures, especially if the release were a sodium spray. The containment design basis, including the inner cell system, must envelope the pressures and temperatures resulting from a spectrum of sodium spray and pool fires. The staff's present view is that these effects are not coupled with any sodium-concrete reactions because the applicants have proposed that the steel cell liners be engineered safety features. The staff considers it feasible to implement provisions to satisfy the design-basis requirements, such as by providing adequate cell structural capability, controlled venting of the cell, and decreased cell oxygen content. To provide accommodation against accidental releases of sodium, the applicants have committed to a cell design pressure of 30 psig, and the staff is evaluating the safety adequacy of the applicants' proposal.

The footnote to the 12th paragraph is out-of-date and therefore has been deleted.

The footnotes to Table 7.2 are unchanged with these exceptions:

In footnote 10, after the first sentence, the following has been inserted: "The selection of this source term is discussed in the June 1982 Site Suitability Report (NUREG-0786)."

At the end of footnote 11 this sentence has been added: "See Appendix J, Addendum to Section 7.1."

7.1.2 Comparison of Probabilities of Class 9 Events: LWRs vs. CRBRP

No changes have been made to this section of the FES, except the first sentence, which has been corrected to read:

> The staff has considered the information available at this time concerning assessments of very unlikely accidents and events involving multiple successive failures, particularly those which may result in core melting or severe core damage (see FES Table 7.3; see also Appendix J for a discussion of the probabilities and releases).

7.1.3 Consequences of Class 9 Accidents

This section of the FES is unchanged except that at the end of the first paragraph the following has been added: "Alternative guidelines are also being considered, in lieu of the 24-hour requirement."

In the fourth (final) paragraph, the third-from-last sentence (beginning "The consequences of the event....") has been deleted.

At the end of Section 7.1.3 this new paragraph has been inserted:

> Appendix J, Addendum to Section 7.1, provides a more detailed listing of the potential consequences of severe accidents, which may be compared to the descriptions of such consequences for LWRs in recent environmental statements. In the appendix the staff has evaluated the environmental impacts of a severe accident including potential radiation exposure to the population as a whole, the risk of near- and long-term adverse health effects that such exposures could entail, and the potential economic and societal consequences of accidental contamination of the environment. The overall assessment of environmental risk of accidents, assuming reasonable protective action, shows that it is not significantly different from the risk from light water reactors currently being licensed for operation, and the conclusions reached in the 1977 FES remain unchanged by this evaluation.
>
> Appendix J also includes a discussion of liquid pathway impacts for accidental releases and the economic risks of loss of the facility as a result of accidents.

7.1.4 Accidents: Conclusions

This section of the FES and the conclusions expressed in it remain unchanged.

7.2 Transportation Accidents Involving Radioactive Material

The following discussion of transportation accidents replaces Section 7.2 of the FES. This evaluation is similar in most respects to the earlier assessment; however, it differs primarily in two ways: (1) This evaluation recognizes that DOE fuel cycle facilities would be used to support the CRBRP rather than largely commercial facilities as assumed in the FES; and (2) NRC regulations in 10 CFR 71 and similar DOT requirements (49 CFR 173) relative to radioactive shipments have been updated since the FES was issued.

Evaluation of the potential accident risks from transportation of radioactive materials in the CRBRP fuel cycle requires an assessment of the probability and consequences of an accident. Statistics are readily available on accident frequencies for both truck and rail transport. However, accident consequences cannot be evaluated on a statistical basis because of the paucity of data. In the 10 years from 1971 to 1980, only five accidents resulted in release of radioactive material. These releases involved materials of low radiological hazard that were not required to be in accident-resistant packages. No deaths or other significant health effects due to radiation exposure were experienced in any of these release events.

Available statistics indicate that the probability of an accident occurring in transportation is small and decreases with increased severity of the accident. An accident in which some Type A package[1] containment, such as a steel drum containing low level wastes, may be breached occurs about once per 2 million vehicle kilometers for truck shipments. Extremely severe accidents occur very rarely: once in 800 million vehicle kilometers for truck shipments and once in 5 billion vehicle kilometers for train shipments (NUREG-0170) Using these statistics and the estimates of truck and rail shipments per year as reported in Appendix D for the CRBRP fuel cycle, frequencies of accidents involving CRBRP shipments were estimated. Accordingly, an accident that might result in a container breach for CRBRP low level waste transported in Type A packages would occur once in 50 years. An extra severe accident that could result in a container breach of Type B packages[2] associated with the CRBRP fuel cycle would occur less than once in 2800 years for truck shipments and less than once in 40,000 years for rail shipments. Type B packages, such as a cask containing spent fuel, are designed to withstand severe accident environments.

Even though a radioactive release resulting from a transportation accident is unlikely, such an event could conceivably happen. Therefore, an examination of the potential consequences of an accident involving material release has been performed for each class of materials transported in the CRBRP fuel cycle.

Transportation accident risks associated with shipments of fresh fuel materials are not considered to be significant because of the inherent nature of the material and the measures taken to prevent releases of radioactivity and nuclear criticality in such accidents. Depleted uranium hexafluoride is shipped from gaseous diffusion plants to the blanket fabrication plant. It is classified as a low specific activity material under the regulations of the DOT and is shipped in steel cylinders. Uranium dioxide is produced from the depleted uranium hexafluoride and may be shipped either in powder or pellet form. The consequences

[1]A Type A package contains only a small quantity of radioactive material in packaging (see 49 CFR 173.389(j)) that is adequate to prevent loss or dispersal of the radioactive contents under normal transport conditions but not necessarily under accident conditions.

[2]A Type B package is radioactive material in packaging that meets the standards for Type A packaging and meets the standards for hypothetical accident conditions of transportation, as prescribed in 49 CFR 173.398(c), without release of contents.

of a release of either of these materials to the environment, should it occur, would be limited by the low level of radioactivity of the material.

The CRBRP fresh fuel rods and assemblies would be shipped in special containers designed for that purpose. In the event of a package breach, the consequences would be expected to be small because the material is confined within the fuel cladding and is in a form that is not readily dispersible. Radiological consequences of accidents to shipments of fresh fuel materials for LWR and MOX fuel were discussed in WASH-1238 (AEC 1972) and NUREG-0002, respectively, and were found to be insignificant. Accidents to shipments of fresh CRBR core fuel materials and fuel would be expected to have similarly insignificant consequences because of design similarities.

The CRBR irradiated fuel assemblies and other irradiated material would be transported to or from the reprocessing plant in heavy shielded casks on rail cars. The irradiated assemblies would generate significant amounts of heat and penetrating radiation after removal from the reactor core. They would be stored at the plant for a minimum of 100 days to permit decay of short-lived isotopes before being shipped to the reprocessing facility. The spent fuel cask is planned to be designed to carry relatively hot assemblies and to be built to current standards using proven technology. Each cask would be designed and constructed so that there is little probability of it being breached in an accident. The form of the nuclear fuel is such that, should a breach occur, releases of solid radioactive materials are unlikely; those releases that might occur are likely to be limited to gases and liquid coolant present in the cask cavity. (The use of sodium as a cask coolant was not proposed by DOE or considered by the staff. In the event that its use is projected in the future, any potential effects of explosion and fire would have to be analyzed.) The uranium, actinides, and most of the fission products would remain in the oxide pellets. Some of the gases and most of the volatile and semivolatile actinides and fission products released from the oxide pellets would be retained within the cladding in the void spaces in the rods. Rupture of a fuel rod would release some of the gases and volatile products into the cask cavity and coolant. However, because of the cask design and quality control measures to ensure a high level of containment integrity and the nature, form, and physical properties of the fuel assemblies, the probability of a significant radiological release is small (NUREG-0002).

The CRBRP fuel would be irradiated to greater exposure than typical LWR fuel (up to about 80,000 megawatt-days/MT exposure for CRBRP fuel vs. 30,000 megawatt days/MT for LWR fuel). Based on ORIGEN 2 calculations performed by ORNL for the NRC, calculated radioactivity of LWR and CRBRP fuels was estimated to be similar for cooling periods of up to 100 years (NUREG/CR-2762) Hence, the analyses and conclusions of previous environmental assessments for transportation of irradiated LWR fuels (WASH-1238, NUREG-0002) appear to be applicable to accidents involving irradiated CRBRP fuel. The casks designed to transport spent CRBRP fuel would be subject to DOT regulations given in 49 CFR 173. There have been no reported accidents to date with LWR spent fuel shipments by rail (McClure, 1981).

Radioactive wastes from the fuel fabrication plants, the CRBRP, and the reprocessing plant would include low level wastes in the form of compactible solids and concentrated liquids, transuranic contaminated materials, and high level wastes. These radioactive wastes would be solidified and packaged for shipment to a commercial low level waste burial ground or a Federal repository as appropriate. Shipments of high level and transuranic (TRU) waste would contain the greatest radioactivity, about 6E+6 and 7E+5 Ci/shipment, respectively (see Appendix D, Table D.13).

Regulations define packages and performance requirements for radioactive materials (49 CFR 173 and applicable DOE Orders), depending upon the radioactivity content of the package. Non-TRU, low level waste, as low specific activity material, may be shipped in Type A packages that are designed to prevent loss of the contents under normal transport conditions but not under accident situations. Thus, Type A packages containing LLW material might be ruptured in an accident with the possibility of release of radioactivity. The solid form of the material reduces the likelihood that significant dispersal of radioactive material would result. In any event, accidental exposures would be limited to low levels (NUREG-0116).

Other more highly radioactive wastes are required to be shipped in Type B packages that are designed to contain the contents under severe accident conditions including fire and immersion in water. Only in the event of extremely severe accidents would radioactivity be expected to be released from Type B packages. Even in such an event, the solid, noncombustible, nonreactive form of the contents and the hardiness of the package would limit the radioactive release so that the environmental impact would be small.

The applicants indicate that wastes containing metallic sodium coolant used at the CRBRP would be stored on site. If these materials were required to be transported for disposal at some future date, they would treated to nullify the chemical reactivity of the sodium before being transported.

High level wastes (HLW) from fuel reprocessing would be solidified and packaged in sealed canisters that in turn would be enclosed in a shielded shipping cask. The shipping cask for HLW is anticipated to be similar in design to the cask used for shipping spent fuel and is required to be constructed to withstand accident conditions. It is extremely unlikely that this cask could be breached even if involved in an accident. Also, the high level wastes are postulated to be incorporated into nondispersible, stable, solid material (for example, borosilicate glass) and sealed in separate canisters within the cask. If the cask were to be breached, high radiation exposure might occur only in the immediate vicinity of the accident because of the nondispersible nature of the material.

The consequences of an accident involving radioactive material are further mitigated by the procedures that carriers are required to follow. These procedures include segregation of persons from packages and materials and immediate notification of the shipper, DOT, and DOE in case of an accident, fire, or leaking package.

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 control exercised over the shipment during transport, the staff concludes that transportation accidents involving radioactive material from CRBRP present a low risk of fatality or other serious health effects from radiation exposure. This conclusion is essentially the same as that in Section 7.2 of the FES.

7.3 Safeguards Considerations

The following discussion of safeguards and revised Appendix E replace Section 7.3 and Appendix E of the FES. These have been updated in recognition of two facts: (1) that DOE fuel cycle facilities would be used to support the CRBRP rather than largely commercial facilities as assumed in the FES; and (2) that upgraded NRC physical security requirements for nuclear power reactors (10 CFR 73.55) and facilities possessing formula quantities of special nuclear material (10 CFR 73.45 and 73.46) have been put into effect.

Potential abnormal environmental impacts could occur during CRBRP operation as a result of (1) acts of sabotage directed at the CRBRP itself or at materials during transport, or (2) thefts or diversion of plutonium from CRBRP, its associated fuel cycle facilities, or transportation links.

Safeguards are defined as those measures employed to prevent the theft or diversion of special nuclear materials and to protect against sabotage of nuclear facilities. Special nuclear material (SNM) is defined as plutonium, uranium-233, or uranium enriched in the 235 isotope. The only SNM in the CRBR fuel cycle would be plutonium.

The staff's assessment of DOE's proposed CRBRP fuel cycle safeguards systems is in Appendix E, "Safeguards Related to the CRBR Fuel Cycle and Transportation of Radioactive Material." Because many of the facilities are conceptual in nature, general safeguards criteria were used to perform the assessment. Individual assessments were performed for all CRBRP fuel cycle activities that would involve the handling of plutonium, including initial plutonium conversion, fuel fabrication, spent fuel reprocessing, waste management, all transportation activities, and the operation of the CRBRP. In addition, Appendix E evaluates the reasonableness of the safeguards system costs estimated by DOE.

The staff believes that the environmental impact of a successful theft of plutonium or act of sabotage could range from insignificant to severe. The staff has evaluated DOE's proposed safeguards systems, which are designed to minimize the likelihood of such events, and has concluded that the probability of successful theft, diversion, or sabotage is low and, therefore, the risks associated with these events do not represent a significant increase over the risks associated with currently operating facilities. This conclusion is essentially the same as that in Section 7.3 of the FES.

8 NEED FOR THE PROPOSED FACILITY

8.1 Historical Background of the LMFBR Program

A supplement to ERDA-1535, the LMFBR Program Final Environmental Impact Statement (PES-Supplement), has been issued (DOE-EIS-0085-FS, May 1982) that focuses on changes in the program since 1975. Appropriate excerpts quoted below add to the discussion in the FES:

> In April 1977, the previous Administration deferred any U.S. commitment to advanced nuclear technologies that were based on the use of plutonium. In addition, it decided that the U.S. would defer indefinitely commercial reprocessing and recycling of plutonium. Consequently, that Administration proposed to cancel the Clinch River Breeder Reactor Plant (CRBRP) project. Research and development activities were to be continued. At ERDA's request, the U.S. Nuclear Regulatory Commission (NRC) suspended the licensing proceedings regarding the CRBRP. Congress, however, continued to authorize the appropriate funds for CRBRP, and design and component fabrication activities have continued until the present. At the present time, design work is about 90% complete and about 60% percent of the hardware has been delivered or is on order, amounting to about $600 million.
>
> Though work on the CRBRP was significantly slowed over the intervening years, very significant progress was made in other elements of the LMFBR program. For example, the Fast Flux Test Facility, a major fuels and materials test reactor, was brought to initial criticality in February 1980 and, having undergone a successful startup test program, is now being operated at full reactor power.
>
> The decisions made by the previous Administration were modified on October 8, 1981, when President Reagan announced that he was lifting the suspension on commercial reprocessing and directing government agencies to proceed with the demonstration of breeder reactor technology, including completion of the CRBRP.
>
> The LMFBR program described in ERDA-1535 contemplated gradual scale-up of demonstration facilities with government participation both in early commercial breeders and ultimately in making a decision with respect to the acceptability of widespread commercial deployment of LMFBR technology. There have been changes to the emphasis of this program, the most important of which is that the decision on deployment and commercialization of the LMFBR will be made by the utility industry. The government role will be limited to early development of the technical, engineering, and industrial base needed to lower risks and uncertainties to levels consistent with normal commercial ventures....

Current LMFBR development planning includes, among other things, the construction and operation of the intermediate-size Clinch River Breeder Reactor Plant (CRBRP) as soon as possible, and the near-commercial size Large Developmental Plant (LDP). Because of the long lead-times involved, even with vigorous pursuit of this plan, a commercially viable LMFBR and significant LMFBR market penetration are decades away. Although there is uncertainty as to precisely when the LMFBR will be economically competitive with alternatives, prudent planning indicates that LMFBR development should be geared toward potential deployment early in the next century. This necessitates that the program progress expeditiously even at the risk of developing the option before it is economically competitive with LWRs. The consequences of early development, however, are minor compared to the risk of possible electricity shortages and economic penalties associated with late development. Furthermore, significant program delays may destroy the continuity that is essential to any high technology development program.

8.2 Role of the Demonstration Plant

As indicated above, a decision on the development and commercialization of LMFBRs is now intended to be made by the utility industry with government providing early development of supporting technical bases. This change, however, does not alter the role of the CRBRP.

8.3 The Ability of CRBRP [illegible] Its Objectives

This section of the FES is unchanged except as follows:

Technical Performance and Reliability - The record of performance of the major breeder reactors has been extended considerably since the FES was issued. Except for major shutdowns in 1977 to repair intermediate heat exchangers and for normal refueling/maintenance outages, Phenix (see Table A8.1) has operated continuously from 1975 to the present. The Prototype Fast Reactor (PFR) has operated essentially continuously from 1977 to the present, except for one major shutdown of about 8 months. In the Soviet Union, BN-350 has operated extensively since 1973 and BN-600 commenced operation in 1980. Japan placed its Joyo plant in operation during 1977 and has broken ground for its successor, Monju. While construction is continuing on its SNR 300, West Germany is reviewing its plans for future LMFBRs, as is Great Britain. Experience gained from the operation of these foreign breeder reactors is providing useful information about their particular designs.

Confidence in U.S. capability is based on continuing EBR-II performance after 19 years of operation and recent FFTF startup and operation at full power (Longenecker, 1982b). EBR-II operated at 71 to 77% capacity and supplied electrical power while serving as a fuels and test facility from 1976 through 1980.

The FFTF reactor, with which fuel element reliability and performance are being studied, began operating in February 1980. It achieved full power in December 1980 after remarkably few systems or component problems during the assent to

Table A8.1 World-wide fast breeder reactor plants

Name	Country	Power (megawatts) Thermal	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
Dounredy Fast Reactor	UK	60	14	Loop	1959
Rapsodie	France	20/40[b]	--	Loop	1966[b]
Operable					
BR-5/BR-10a	USSR	5/10[a]	--	Loop	1959[a]
Experimental Breeder Reactor-II	USA	62.5	18.5	Pool	1963
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
Joyo	Japan	50/100	--	Loop	1977
KNK-II[d]	W. Germany	58	20	Loop	1977
FFTF	USA	400	--	Loop	1980
BN-600	USSR	1470	600	Pool	1980
Under Construction/Procurement					
Superphenix 1	France	2900	1200	Pool	1983
Prova Elementi di Combustible	Italy	135	--	Loop	1983
Madras FBTR	India	42	17	Loop	1983
SNR-300	W. Germany[e]	770	312	Loop	1985
Monju	Japan	714	300	Loop	1987
CRBRP	USA	975	350	Loop	1990

[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 with "Fortissimo" core.

[c]Also produced the equivalent of 200 megawatt electric as process steam for desalination.

[d]Operated 1971 through 1974 as a thermal reactor, KNK-I.

[e]In cooperation with Belgium and the Netherlands.

power and preoperational testing phases (Horton, 1982). The first FFTF full-length operation cycle (100 days at full power) was initiated in April 1982.

It is the staff's judgment that the additional experience accumulated with LMFBRs, outlined above, tend to support its conclusions in the FES that CRBRP can meet its technical programmatic objectives under the LMFBR Program.

Safety - No credit has been given for natural convection circulation for decay heat removal in CRBRP because there has been no demonstration of this process on the geometry and scale of the CRBRP reactor system. However, a testing program to study natural circulation effects in the FFTF was carried out during 1981. The results of this program are being evaluated through current computer codes to determine their applicability to the CRBR system for sodium coolant circulation.

The CRBRP core design has been modified to include internal breeding blankets. This introduces a degree of heterogeneity that complicates the analysis of bowing, Doppler, and local reactivity effects. The CRBRP in its current heterogeneous design will be a valuable demonstration of the ability to calculate complex fast reactor systems.

Timing - The DOE supplement to the ERDA PES emphasizes that the timing objective of the CRBRP is to complete its construction "as expeditiously as possible." Operation of the plant is now scheduled to begin early in 1990, as shown in Figure A8.1 (PES-Supp Fig 2), which replaces FES Figure 8.1. However, the DOE plan is less specific as to the timing of the overall program, reflecting current uncertainties about projected growth of electrical demand and the transfer of the commercialization decision to private industry. The program visualizes a successor to the CRBRP called the Large Developmental Plant (LDP), which would begin operation at an unspecified date in the 1990s. Work on the LDP is not currently being funded.

8.4 Technical Alternatives to the CRBRP

A revised list of fast breeder reactor plants world-wide is given in Table A8.1. Section 8.4.7 has been added.

8.4.1 Pool Type Reactors

No changes have been made to this section.

8.4.2 Advanced Fuels

No changes have been made to this section.

8.4.3 A Different Size Plant

No changes have been made to this section.

8.4.4 FFTF Role Expanded

No changes have been made to this section.

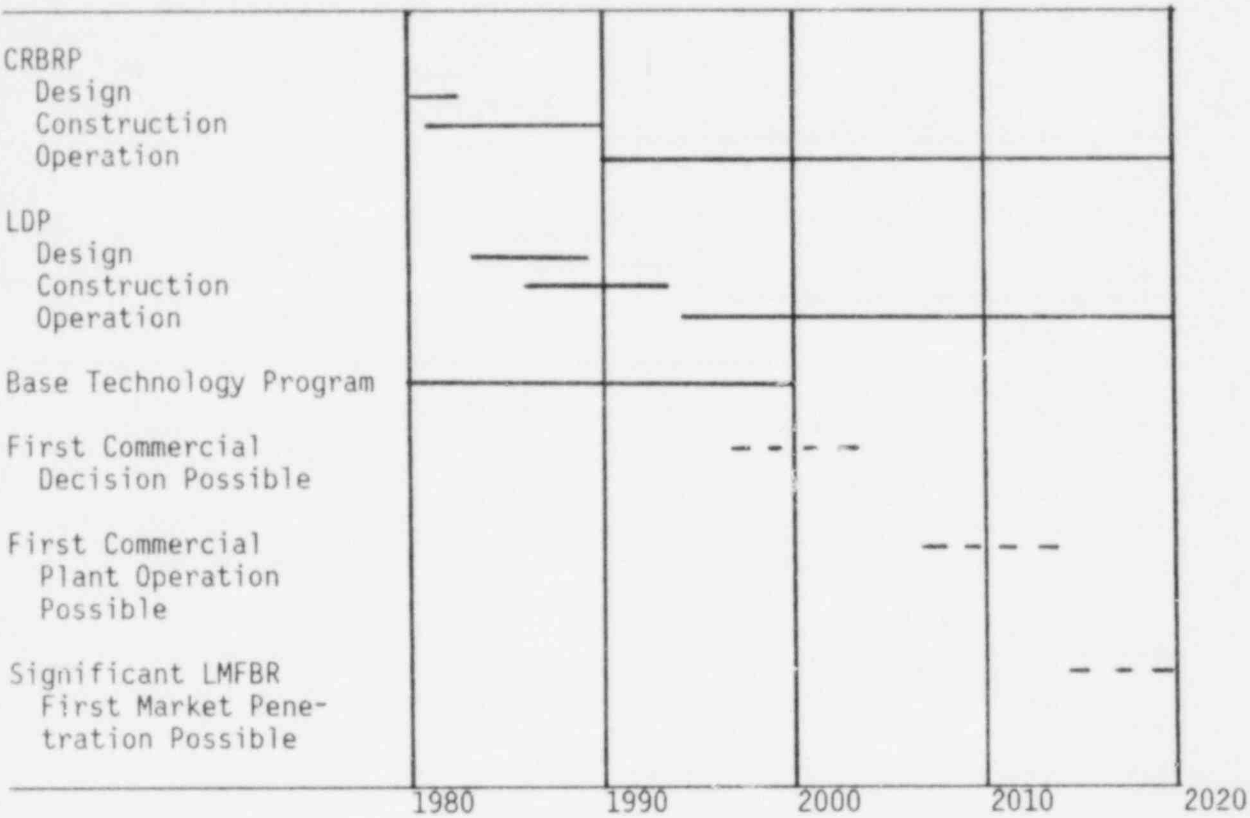


Fig. A8.1 - LMFBR development schedule (replaces FES Fig. 8.1)

8.4.5 Base Loading as a Performance Goal

No changes have been made to this section.

8.4.6 Foreign Purchase of a Demonstration Plant Design or Technology

No changes have been made to this section.

8.4.7 Nonproliferation Alternatives

(This is a new section.)

The Nonproliferation Alternative Systems Assessment Program (NASAP), undertaken in 1977-1979, and its counterpart study, the International Fuel Cycle Evaluation program (INFCE), were primarily motivated by considerations related to safeguarding fuel materials against diversion to weapons programs by developing technical alternatives to the traditional lines of reactor and fuel cycle development. Because the efficient utilization of natural resources and the technical feasibility of proposed variations were included, the studies were fairly comprehensive. It became clear that none of the proposed alternatives was entirely suitable to meet the goals of the program. A summary of the conclusions of the NASAP and INFCE programs is given in Section VI.a.(2) of the DOE PES Supplement.

It is clear that the CRBR system, and fast reactors in general, can adopt different fuels and reprocessing schemes, so that if such variants are judged to be required, there is some flexibility for their accommodation.

8.5 Summary and Conclusion

Additional information presented in this chapter is cumulative and does not result in significant changes in the staff's assessment of the CRBRP's environmental impacts.

The staff's conclusions stated in the FES remain essentially the same, even though the timing of the CRBRP has changed, based on the Commission's decision (NRC, 1976) that the need for the LMFBR program, including its objectives, structure, and timing, is established by the ERDA (DOE) impact statement and associated processes. The earlier scheduled startup of the plant toward the end of 1982 cannot be accomplished because of the suspension of licensing activities between April 1977 and October 1981. The staff believes it is feasible to meet the new startup date of February 1990, which has been established by DOE under the LMFBR Program (PES Supplement, 1982).

9 ALTERNATIVES

9.1 Energy Sources

There have been no changes to this section.

9.2 Sites

9.2.1 Background

There have been no changes to this section.

9.2.2 TVA Site Selection Criteria

There have been no changes to this section.

9.2.3 Alternative Sites for the Hook-on Option

Since the FES was issued in 1977, the design of CRBRP as a complete new plant has progressed to such an advanced stage that reworking the design for the hook-on option would result in substantial economic and schedular penalties (Longenecker, 1981). For that reason, the applicants no longer consider the hook-on arrangement to be viable. The staff agrees with that position (see Section 9.2.5).

9.2.4 Alternative New Sites in the TVA Service Area

At the staff's request, upon resumption of the CRBRP licensing review in the fall of 1981, the applicants augmented their discussion of alternative sites in the ER in the context of NRC's Proposed Rule on Alternative Sites (45 FR 24168, April 9, 1980; see Appendix K). The proposed rule is one of the principal references currently used by the staff as guidance in its review of alternative sites for nuclear power plants. Although the proposed rule was developed to ensure that environmental factors are appropriately considered in siting commercial nuclear power plants, the staff believes the guidance therein is generally appropriate for review of alternative sites for CRBRP, because one of the project objectives is to demonstrate licensability in a utility environment.

The purpose of this review is to determine whether the applicants' proposed site represents a reasonable choice from a group of alternative sites selected by a process sensitive to environmental concerns. While the staff has used the Proposed Rule on Alternative Sites to guide its independent review of the alternative sites, the staff is bound by standards set forth by the Commission in its 1976 Order (CLI-76-13) that only alternative sites which are "substantially better" than Clinch River need be identified by the staff's alternative site selection process. The scope of the review includes analyses directed at making the following determinations:

(1) Whether the reconnaissance level information submitted by the applicants is sufficient to support the analyses necessary to reach reasoned conclusions.

(2) Whether the region of interest (ROI) considered is of sufficient size to reflect reasonably available environmental diversity of water bodies and associated physiographic units.

(3) Whether the candidate sites are among the best that could reasonably be found, based on analysis of the merits of the candidate sites.

(4) Whether one or more alternative sites is substantially better than the applicants' proposed site, based on a sequential two-part analytical test. The first part of the test determines whether any of the alternative sites is substantially environmentally preferable to the proposed site, using a set of threshold criteria. The second part considers any site found environmentally preferable in terms of project economics, technology and institutional factors to determine whether such a site is a substantially better site. As part of the latter determination, the staff also considers whether locating the plant at another site would affect the project's ability to meet its programmatic objectives.

9.2.4.1 TVA's Site Selection Process

The Region of Interest

The applicants state that the region of interest considered for siting the demonstration plant was the entire TVA power service area, which includes most of Tennessee and parts of several adjacent states (Longenecker, 1982c and d). As shown in Figure A9.1, this region includes many rivers ranging in size from small to rather large and water bodies varying from free-flowing streams to impounded lakes. The physiographic units associated with these rivers include coastal plains, interior low plateaus, the Appalachian Plateau, the Valley and Ridge Province, and the Blue Ridge. Table A9.1 lists the various rivers and their associated physiographic units.

The staff agrees that the features described above provide sufficient environmental diversity to establish the TVA service area as an acceptable region of interest.

Selection of Candidate Sites

Within the region of interest, the applicants state that the original siting assessment considered 11 TVA plants for a possible hook-on arrangement and 109 potential sites for an entirely new plant (Longenecker, 1982d). These sites were on or near the rivers identified in Table A9.1. The slate of 13 candidate sites (2 hook-on and 11 "new") was derived from the above 120 sites on the basis of engineering and environmental assessments. While TVA did not provide details about the potential sites that were eliminated during the screening process, the factors cited for eliminating them included poor foundation conditions, water supply, flooding potential, and environmental factors such as proximity to wildlife and recreational areas. Potential sites along the Mississippi and Ohio Rivers in the northwestern part of the region were excluded because their proximity to the New Madrid high seismic zone is good reason to doubt their licensability. The Green, Pearl, Barren, Goose, Tombigbee, and Black Warrior Rivers were excluded by TVA because only their headwaters are within the ROI and these headwaters did not appear to provide adequate cooling water capabilities.

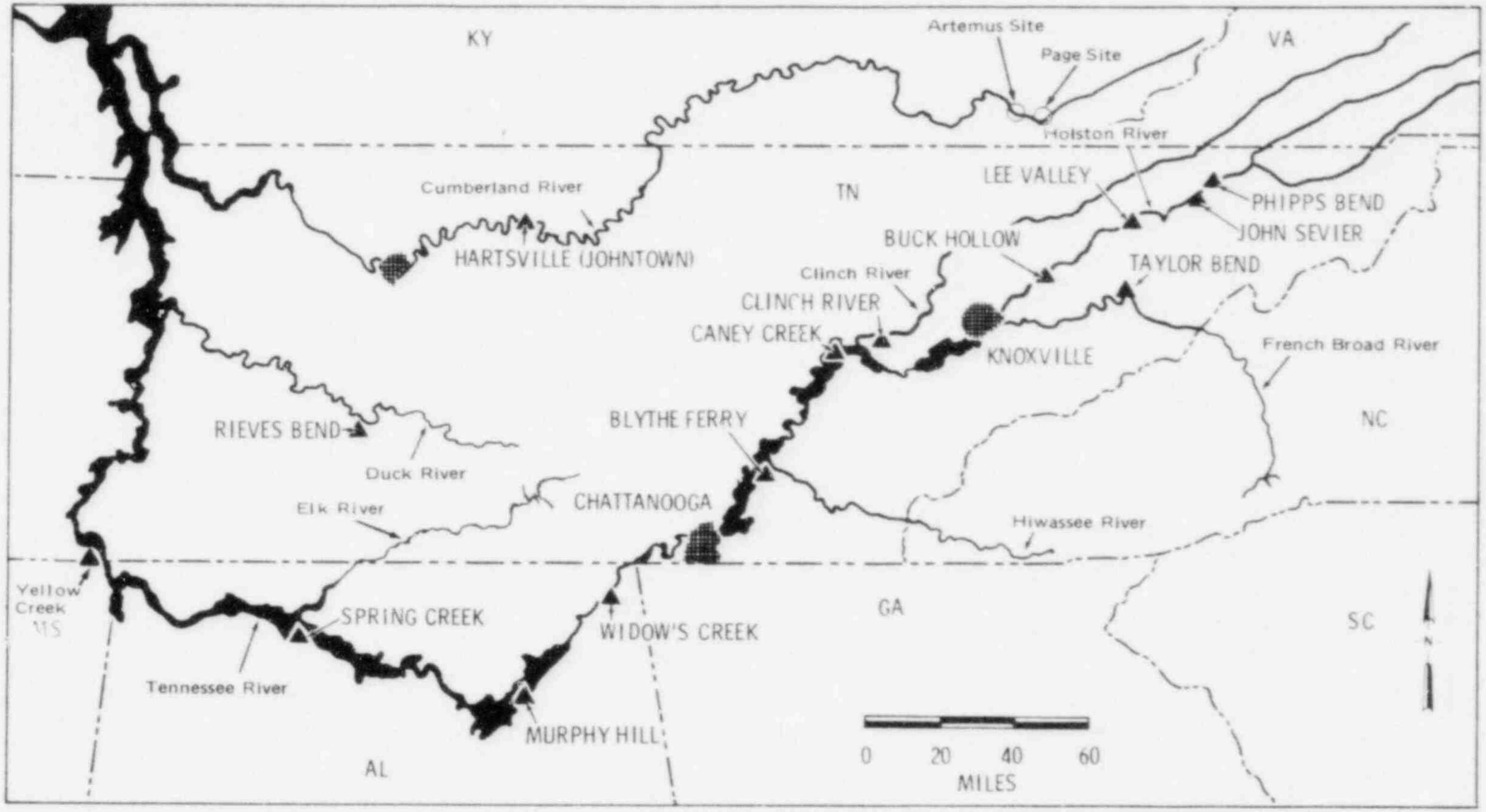


Figure A9.1 CRBRP region of interest and candidate sites

Table A9.1 Classification of rivers where TVA sites were considered for the CRBRP in terms of environmental diversity

River	River Type	Associated Physiographic Units
Tennessee	Large, impounded	Originates in valley and ridge and flows through Cumberland Plateau and interior low plateau to coastal plain
Duck	Small, impounded	Interior low plateau
Sequatchie	Small, headwater	Appalachian Plateau
Clinch	Medium to small, impounded, headwaters	Valley and ridge
Emory	Small, impounded, headwaters	Valley and ridge
Little Tennessee	Small, impounded, headwaters	Originates in Blue Ridge and flows to valley and ridge
Tellico	Small, headwater	Originates in Blue Ridge and flows to valley and ridge
Holston	Medium to small, impounded, headwaters	Valley and ridge
French Broad	Medium, impounded, headwaters	Originates in Blue Ridge and flows to valley and ridge
Nolichucky	Small, impounded, headwaters	Originates in Blue Ridge and flows to valley and ridge
Cumberland River Basin		
Cumberland	Large to medium, impounded	Originates in interior low plateau and flows to coastal plain
Red	Small, headwater	Interior low plateau
Caney Fork	Small, impounded, headwater	Interior low plateau

The 11 candidate new sites listed in FES Table 9.2 are also listed here in Table A9.2 with the river, river type, and character of the physiographic unit pertinent to each site. All of those sites were considered potentially licensable at the time of their selection and, since then, NRC has issued permits for construction of LWR plants at the Hartsville and Phipps Bend sites. The John Sevier and Widows Creek sites, where hook-on to existing turbines was initially considered, are shown in the table for completeness; the Yellow Creek site in the northeast corner of Mississippi, for which NRC granted a construction permit subsequent to the initial selection process, has also been added to the list as representative of the western part of the TVA power service area. As can be seen from Figure A9.1 and Table A9.2, these 14 sites reflect the environmental diversity of the feasible siting areas within the region of interest.

Guidance from the proposed rule on alternative sites (see Appendix K for the proposed Appendix A to 10 CFR 51) provides two ways of demonstrating that the sites qualify as among the best that could reasonably be found. They must either (1) be identified through the use of site-selection methodology that includes an environmentally sensitive site screening process, which, in addition, meets seven process-oriented criteria (Appendix A, Section VI.3); or (2) meet eight environmental threshold criteria (Appendix A, Section VI.2.b), in which case there shall be no further review of the site-selection process. The applicants chose the second review option and evaluated the candidate sites for conformity with the following threshold criteria listed in Section VI.2.b:

(1) Consumptive use of water would not cause significant adverse effects on other water users.

(2) There would not likely be any further endangerment of a state or Federally listed threatened or endangered plant or animal species.

(3) There would not likely be any significant impacts to spawning grounds or nursery areas of significance in the maintenance of populations of important aquatic species.

(4) Discharges of effluents into waterways would likely be in accordance with state and Federal regulations (e.g., avoidance of discharges to waters of the highest state quality designation) and would not likely adversely affect efforts of state or Federal agencies to implement water quality objectives (e.g., additional discharges to waters of currently unacceptable quality as determined by a state).

(5) There would be no preemption or likely adverse impacts on land uses specially designated for environmental or recreational purposes such as parks, wildlife preserves, state and national forests, wilderness areas, floodplains, wild and scenic rivers, or areas on the National Register of Historic Places.

(6) There would not likely be any significant impact on terrestrial and aquatic ecosystems, including wetlands, which are unique to the resource area.

Table A9.2 Candidate sites

Site	River	River type	Physiographic character
Spring Creek	Tennessee	Large, impounded	Interior low plateau
Blythe Ferry	Tennessee	Large, impounded	Valley and ridge
Caney Creek	Tennessee	Large, impounded	Valley and ridge
Clinch River	Clinch	Small, riverine, impounded	Valley and ridge
Taylor Bend	French Broad	Small, impounded, headwater	Valley and ridge
Buck Hollow	Holston	Medium, headwater	Valley and ridge
Phipps Bend	Holston	Medium, headwater	Valley and ridge
Lee Valley	Holston	Small, headwater	Valley and ridge
Murphy Hill	Tennessee	Large, impounded	Appalachian Plateau
Johntown (Hartsville)	Cumberland	Medium, riverine, impounded	Interior low plateau
Rieves Bend	Duck	Small, potentially impounded	Interior low plateau
John Sevier	Holston	Medium, impounded, headwater	Valley and ridge
Widows Creek	Tennessee	Large, impounded	Appalachian Plateau
Yellow Creek	Tennessee	Large, impounded	Coastal Plain

(7) The population density, including weighted transient population, projected at the time of initial operation of a nuclear power plant, would not exceed 500 persons/mi^2 averaged over any radial distance out to 30 miles from the site, and the projected population density over the lifetime of the nuclear power plant would not exceed 1,000 persons/mi^2.

(8) The site is not in an area where additional safety considerations (geology; seismology; hydrology; meteorology; and industrial, military, and transportation facilities) or environmental considerations for one site compared to other reasonable sites within the region of interest would result in the reasonable likelihood of having to expend substantial additional sums of money (cumulative expenditures in excess of about 5% of total project capital costs) to make the project licensable from the safety standpoint or to mitigate unduly adverse environmental impacts.

In considering the 14 candidate sites for compliance with the eight threshold criteria, the applicants found that all of the sites meet the criteria with the exception of Rieves Bend, which would not meet criteria (1), (4), and (8) relative to water sources. This finding with respect to Rieves Bend is consistent with the staff's view expressed in the FES (p. 9-6) that the lack of an assured supply of cooling water at that site is adequate reason for its rejection. FES Section 9.2.4 indicates that several of the candidate sites would be more costly to develop, primarily because of geological characteristics, or are otherwise less desirable than the Clinch River site. However, the staff's review of information in the applicants' ER, the staff's environmental statements on various TVA projects (Hartsville, Phipps Bend, Yellow Creek, Watts Bar, Bellefonte, and Browns Ferry), and other documents (e.g., TVA's environmental statement on a proposed coal gasification plant at the Murphy Hill site) indicates that all of the candidate sites except Rieves Bend would meet the eight threshold criteria.

The proposed rule on alternative sites (Appendix K, Section VI.2.a) also indicates that the final slate of candidate sites should include: (1) at least four sites to provide reasonable representation of the diversity of land and water resources within the ROI; (2) one or more sites associated with each type of water source and physiographic unit reasonably available within the ROI; and (3) one alternative site with the same water source as the proposed site. Accordingly, the applicants have identified 4 of the 14 candidate sites (in addition to the proposed site at Clinch River) as adequately representing the diversity within the TVA region (Longenecker, 1982c), as follows:

Phipps Bend represents an acceptable site for a nuclear plant on a medium river in the headwaters located in valley and ridge areas; Hartsville represents an acceptable site on a medium river impounded in a plateau area; Murphy Hill represents an acceptable site on a large river in the Appalachian plateau; and, Yellow Creek represents an acceptable site on a large river at the junction of the Coastal Plain, the Interior Low Plateau, and the Appalachian Plateau. No alternative site on the Clinch River was included, as called for in (3) above, because none of the potential sites identified earlier on the river and upstream on Norris Reservoir had been found suitable for a nuclear plant, except the proposed site near Oak Ridge (TVA, 1975).

In light of the diversity represented by the above four sites, and the fact that NRC already has considerable information about them, the applicants proposed that the staff evaluate these four representative sites to determine whether any TVA alternative sites would be environmentally preferable to the proposed site on the Clinch River. Based on their original and updated evaluations, the applicants have concluded that there are no sites in the TVA area which are environmentally preferable to the proposed site.

Staff Evaluation

The staff agrees with the applicants' view that the Clinch River, Hartsville, Murphy Hill, Phipps Bend, and Yellow Creek sites adequately represent the diversity of environmental resources within the TVA area, with the possible exception of the aquatic ecological characteristics of small headwaters. Also lacking is an alternative candidate site on the same water sources as the proposed site, as called for in NRC's proposed rule on alternative sites (Sec- VI.2.a). However, neither of these deficiencies is important to this review, in the staff's opinion, because the aquatic impacts of siting the demonstration plant on the headwaters of a small river or at another location on the Clinch River are likely to be greater than at the proposed site or the other candidate sites.

More than the usual reconnaissance-level information is available on the Hartsville, Phipps Bend, and Yellow Creek sites where LWR nuclear power units were under construction until TVA decided recently to postpone their completion. Considerable information is also available on the Murphy Hill site, which is being prepared by TVA for the planned construction of a coal gasification plant (TVA, 1981b). The staff finds that the level of information (quantity and accuracy) is such that the staff can make the comparison and has a high degree of confidence that perceived advantages and disadvantages are reflective of the true situation at each of the alternative sites.

9.2.5 Selected Alternative Sites in the TVA Service Area

The staff compared the four TVA candidate sites identified in the foregoing section with the Clinch River site in Appendix L of this document (included in Appendix L are three DOE sites which are discussed in Section 9.2.6). In making this comparison, the staff has assumed that the nuclear units for which TVA has construction permits at the Hartsville, Phipps Bend, and Yellow Creek sites and the coal gasification plant planned for Murphy Hill will be completed and that the LMFBR demonstration plant would be constructed on a presently uncleared portion of each site. This would probably not be possible at the Murphy Hill site since there does not appear to be room at that site for both the synfuel plant and the breeder plant. Hence, the staff regards the Murphy Hill site to be a surrogate for similar sites in the vicinity.

The results of this comparison are presented in Table L.1 at the end of Appendix L. As indicated by the composite ratings, the staff concluded that none of these TVA alternative sites would be environmentally preferable to the proposed site for construction and operation of the CRBRP.

As indicated by the comparison, the characteristics of these TVA sites (including Clinch River) are roughly similar except for water availability and minor differences in potential impacts on aquatic ecology. The larger flow rates of the Tennessee River would dilute and disperse blowdown from an operating power plant more effectively than would smaller streams in the region, but the discharge from the CRBRP (2412 gpm) would be so small in relation to river flow that this is not an important factor in comparing sites. The affinity of striped bass for the stretch of the Clinch River next to the proposed site during the hottest time of year would be a potentially adverse situation if there are no-flow conditions simultaneously in the river for an extended period. Because a similar situation does not exist at the alternative sites, they would appear to have an advantage in this respect were it not for the NPDES Permit requirement that the applicants demonstrate lack of impact or accept more stringent thermal limits, and the applicants' commitment to restrict thermal discharges from the plant if necessary to mitigate the impact of thermal discharges on the striped bass (Longenecker, 1982d).

In its assessments in Appendix L, the staff has considered whether significant environmental benefits could be gained from locating the plant on one of the four alternative sites if the partially constructed or planned facilities are cancelled and some of the cleared areas become available. Obviously, locating the plant on the cleared areas would be an advantage even though the existing structures could not be utilized because their designs are different than the CRBRP. Possibly, the CRBRP could utilize any water intake and discharge facilities that have already been constructed, and there may be other existing facilities that would be useful. The staff believes there would be a degree of environmental preferability for a site where site preparation has already occurred for energy projects that are cancelled. However, it is the staff's opinion that the degree of environmental preferability would be marginal in view of the fact that the proposed CRBRP site is zoned for industrial use and future developments of that type are likely to cause some of the same impacts that would be attributable to the CRBRP.

Whether the partially built nuclear facilities at Hartsville, Phipps Bend, and Yellow Creek, and the coal gasification plant planned for the Murphy Hill site will be cancelled or completed is unknown and can only be speculated about at this time. The staff therefore considers the option of constructing the CRBRP on the cleared areas that are committed to those facilities to be equally uncertain.

Because no alternative site was found to be environmentally preferable, the staff concludes that no alternative site is substantially better than the proposed site for the CRBRP.

Only upon identification of an environmentally preferable site would the staff normally conduct the second part of the two-stage analysis (NUREG-0555, draft revision of Section 9.2) in which economics, technology, and institutional factors are also considered in making its determination.

Assuming that TVA would agree to continue in the same role it now has at the Clinch River site, the programmatic objective of utility participation would be satisfied for any site within the TVA power service area. However, the applicants state that the programmatic timing objective for CRBRP (that it be completed as expeditiously as possible) cannot be met if a decision is made to locate the plant at a different site (Longenecker, 1982d). DOE estimates that such a change of location would delay the project a bare minimum of 33 months to a more probable 43 months from the time a decision is made to change sites (see FES Section 9.2.6.1).

The applicants have made a recent cost comparison of locating the demonstration plant at an alternative TVA site (Table A9.3, which supersedes FES Table 9.4). A range of cost differences was provided to encompass any possible TVA alternative site.

Item 1 in the table is the additional escalation due to the 43-month-delay period on the Clinch River year-of-expenditure costs. It does not include escalation on the increased costs resulting from relocation to a different site (other items in the table) with the exception of item 16, reduced revenue from the sale of power. These other costs include, within the values given, escalation for the 43-month-delay period.

Typically the staff employs a computer program (CONCEPT) (Hudson, 1979) to develop an independent check on the reasonableness of an applicant's capital

Table 9A.3 Applicants' estimated cost impact of relocting CRBRP to an alternative TVA site in year of expenditure dollars - reference 43-month-delay case

Item		Incremental cost $ (million)
1.	Escalation	601
2.	Staff and Support Stretch Out	164
3.	Equipment Procurement	7-36
4.	Relocate Project Office	0
5.	Additional Travel	1
6.	Difference in Prevailing Labor Rates	0-137
7.	Site Studies - Other than Geological	1
8.	Site Studies - Geological	7
9.	Site Work Package	3
10.	Seismic	11-162
11.	Foundation Materials and Walls	2
12.	Site Adaptation Redesign	10-88
13.	Excavation	0-6
14.	ER Rework	1
15.	PSAR Rework	1
16.	Reduced Revenue from Sale of Power	0
	Maximum Range of Cost Impacts	809-1210

investment cost estimate. An attempt was made to apply CONCEPT to the CRBRP; however, the results are viewed as indeterminate. The staff does not feel it can derive a meaningful independent estimate in this instance because of the large research and development component of the capital cost for CRBRP and because of a number of differences between the breeder reactor and the light water reactor technologies for which the CONCEPT code is not applicable.

The staff concluded in this section of the FES that a hook-on arrangement offered potential dollar savings on the order of $50 to 100 million. Nevertheless, the applicants and the staff found the stand-alone plant design to be preferable because its benefits were perceived to be significantly greater. The staff update of these alternatives indicates that the hook-on option is no longer viable. The potential dollar savings for the hook-on plant no longer exist, and, in fact, substantial economic and schedule penalties would result if this option were pursued (Longenecker, 1981). Plant investment expended for CRBRP through 1981 totals 21.2% of the total plant cost (Table A10.3), which is equivalent to $530 million. This represents a sunk cost in equipment and design, a large part of which would not be suitable for a hook-on plant. In addition, the hook-on facilities would now be 6 years older than during the FES review, resulting in decreased reliability and remaining life. These penalties would result because outlays for much of the site and plant design costs as well as equipment for the stand-alone plant have continued over the years, thus making the to-go costs and scheduling requirements for this option far more cost effective than for the hook-on option.

9.2.6 Alternative TVA Sites Outside Its Service Area and Alternative DOE Sites

DOE has reviewed the screening conducted previously by ERDA of government properties in its custody and confirmed that the Hanford, INEL (Idaho), and Savannah River Plant are feasible sites for the LMFBR demonstration plant (Longenecker, 1982b, Attachment 1, Part 2). No DOE properties not previously screened were found of sufficient size to warrant consideration. The Nevada test site was again rejected for the reasons stated in the third paragraph on FES page 9-11.

The applicants have reexamined the data relative to the three candidate sites and have concluded, as in the FES, that:

(1) Atmospheric dispersion and site isolation factors (minimum exclusion boundary distance, surrounding population density) are somewhat more favorable at Hanford, Savannah River, or INEL than at the Clinch River site. However, it must be emphasized that the Clinch River site is still a completely acceptable site for construction of a nuclear facility.

(2) A comparison of all siting parameters would not lead one to select the Hanford, Savannah River, or INEL areas as preferable to the Clinch River site.

The population figures in FES Table 9.5 have been updated to 1980 Census figures as follows:

Site	Population center	Population within 50 miles
Clinch River	27,532 (Oak Ridge)	830,840
Hanford	33,582 (Richland)	263,746
INEL	38,696 (Idaho Falls)	140,550
Savannah River	47,532 (Augusta)	~500,000

The applicants have also reconfirmed that utility groups in the vicinities of the above three sites are unavailable to participate extensively in the project or to operate the plant as TVA would at the Clinch River site (ER App F, Am XV).

An independent review of these three DOE candidate sites was made by the staff; this review is summarized in Appendix L of this document. As indicated in Table L.1 at the end of that appendix, the staff did not find any of these DOE candidate sites to be substantially better than the Clinch River site for the CRBRP.

9.2.6.1 Schedule Impacts

The applicants estimate a schedule delay of 43 months for relocation of the demonstration plant, the same as in the FES. The only difference is that in calculating the cost differences due to a change in site the applicants have now established October 1, 1982 rather than October 1, 1977, as Reference Time Zero for the start of their delay schedules. In the FES, the staff estimated that the delay period could possibly be reduced to as little as 27 months following an unfavorable FES on Clinch River if all means were pursued to accelerate the effort. In today's regulatory climate, the staff believes a delay period of 36 months would be reasonable as an optimistic schedule.

9.2.6.2 Cost of Delay

The applicants' current estimates of additional cost requirements at alternative sites are summarized in Table A9.4 (which replaces FES Table 9.6). These costs are in year-of-expenditure dollars and are based on a 43-month delay. The escalation value shown does not include escalation on the subsequent values in table except on item 16, reduced revenue. The applicants' cost estimates are from an appropriations standpoint and do not reflect interest during construction or present worth discounting.

For calculation purposes, to include the cost of money effects, the staff has rounded the 43-month delay period to 4 years and performed a sensitivity analysis of the economic effect of the delay period by comparing a 3-year delay case to a 4-year delay case, and used an 11% discount rate to reflect the costs in 1982 present worth dollars (Table A9.5). The effect of the longer delay period is to increase the total year-of-expenditure costs due to the additional escalation and prolonged staff support while decreasing the present worth cost since the discount rate of 11% exceeds the escalation rate of 8%. The period of delay chosen has minimal effect on the present worth cost, as can be seen by comparing the 48-month delay case to the 36-month delay case. The difference between the present worth costs between the two cases was only $0.2 million (Table A9.5).

The staff has also revised the applicants' estimated revenue adjustments for the sale of power to reflect recent fuel cost statistics. The effect of this adjustment was a reduction in revenues from the plant at Clinch River and at each of the alternative sites except Hanford. The resulting revenues over the 7-month test and 5-year demonstration period are as follows:

Revenues in Millions of Dollars				
Clinch River	Hanford	Idaho	Savannah River	Other TVA Sites
350	1097	253	486	477

Table A9.4 Applicant's estimate of the 43-month-delay cost impact of changing CRBRP to an alternative site, in year of expenditure dollars

Item		Incremental Cost $ (million)			
		Hanford	INEL	SRP	Other TVA sites
1.	Escalation	601	601	601	601
2.	Staff and Support Stretch Out	164	164	164	164
3.	Equipment Procurement	6	13	10	7-36
4.	Relocate Project Office	7	6	5	0
5.	Additional Travel	3	3	1	1
6.	Difference in Prevailing Labor Rates	429	376	51	0-137
7.	Site Studies - Other than Geological	1	1	1	1
8.	Site Studies - Geological	7	7	7	7
9.	Site Work Package	3	3	3	3
10	Seismic	11	162	11	11-162
11.	Foundation Materials and Walls	2	3	2	2
12.	Site Adaptation Redesign	10	88	10	10-88
13.	Excavation	(15)	0	(6)	0-6
14.	ER Rework	1	1	1	1
15.	PSAR Rework	1	1	1	1
16.	Reduced Revenue from Sale of Electrcity	356	214	(27)	0
	Total Cost Impact	1587	1643	835	809-1210

Table A9.5 NRC staff estimate of costs for location of breeder reactor at alternative sites as compared to Clinch River

Site	Year of Expenditure		1982 Present Worth	
	$Million	% of Base	$Million	% of Base
Clinch River (base)[1]	3,525.2	100.0	3,422.6	100.0
Clinch River[2]	4,507.2	127.9	3,427.9	100.2
Hanford[2]	4,353.3	123.5	3,516.3	102.7
Idaho[2]	5,395.7	153.1	3,860.0	112.8
Savannah River[2]	4,594.7	130.3	3,483.0	101.8
TVA Alternatives[2] (high range)	4,952.4	140.5	3,726.0	108.9
TVA Alternatives[2] (low range)	4,551.2	129.1	3,461.9	101.1
TVA Alternatives[3]	4,276.6	121.3	3,462.2	101.2

[1]No delay

[2]4-year delay

[3]3-year delay

The staff assumed for the purpose of the present worth analysis that the additional "Staff and Support Stretch Out Costs" projected by the applicants would be allocated evenly over a 4-year delay period during 1983 through 1986 and that the additional labor costs projected by the applicants would be allocated in proportion to the projected balance-of-plant construction for 1987 through 1993. The staff further assumed that the additional costs for other relocation and site-related activities would be evenly spread over the 1983 through 1986 delay period.

The resulting net cost differences, considering costs and revenues of alternative sites as compared to Clinch River, are summarized in Table A9.6. The Clinch River site has the lowest cost both in year of expenditure dollars and in present worth dollars. The table also shows that relocation would cost (1% worth basis) $39-303 million more at another TVA site, $94 million more at Hanford, $437 million more at Idaho (INEL), or $61 million more at Savannah River. As can be seen by comparing the Clinch River (base) case to the Clinch River 4-year delay case, a delay has considerable effect on the year of expenditure dollars, but little effect on the 1982 present worth cost. Thus, the period of delay chosen for the analysis is not important in comparing the present worth costs. This fact is also illustrated by comparing the 1982 present worth costs of the 3-year and 4-year delay TVA alternative (low range) cases.

9.2.6.3 Reduced Benefits of LMFBR Program

In the DOE Supplement (May 1982) to ERDA-1535 the applicants stated that they have not updated the cost-benefit analysis because key parameters (e.g., commerical LMFBR introduction dates, future nuclear capacity, etc.) used in complex cost-benefit analyses of the LMFBR are so uncertain at present that the value of such analyses would be questionable. The staff's evaluation in the FES of the benefits is no longer current, but any attempt to update it would be speculative. Nevertheless, the staff recognizes that any delay would result in reduced benefits from the CRBRP, and therefore the LMFBR program, in a present-worth context.

9.2.6.4 Radiological Risk

There have been no changes to this section.

9.2.7 Conclusion

In the first paragraph of this section, the first two sentences have been changed to read:

> The staff concluded in its current evaluation of alternative sites that the DOE sites at Hanford, INEL, and Savannah River are not substantially better than the Clinch River site for the CRBRP (Section 9.2.6). Atmospheric dispersion is greater and population densities are lower at those three sites than at the proposed Clinch River site.

The remainder of FES Section 9.2.7 is unchanged except for the following:

The second and third sentences of the third paragraph have been deleted because the utility industry, rather than the ERDA administrator, is expected to make the commercialization decision at some unknown date. The last two sentences of the same paragraph have been updated as follows: "The staff currently estimates that relocation would result in an increase in the cost of the project of $39-437 million on a 1982 present value basis and considerably more on an appropriations basis (Table A9.5). Also a reduction of the program benefits could be attributed to such a delay."

9.3 Facility Systems

9.3.1 Cooling System Exclusive of Intake and Discharge

There have been no changes to this section.

9.3.2 Intake Systems

There have been no changes to this section.

9.3.3 Discharge Systems

There have been no changes to this section.

9.3.4 Chemical Waste Treatment

There have been no changes to this section.

9.3.5 Biocide Systems

Upstream of the main condenser, continuous hypochlorite injection now is allowed to prevent colonization of algae, bacteria, and fungi in the cooling water system. This is not a significant change because of more stringent NPDES Permit limitations on discharge concentration.

9.3.5.1 Organic Biocides

There have been no changes to this section.

9.3.5.2 Ozone

There have been no changes to this section.

9.3.5.3 Mechanical Cleaning System

In the second paragraph, the specific number (0.2 ppm) for the level of residual chlorine to be discharged has been deleted because it differs from provisions of the NPDES Permit. EPA is presently establishing the applicable limitations. However, the change is not expected to be significant.

9.3.6 Sanitary Waste System

The specifications for the sanitary waste system have been revised to stipulate that it must provide treatment for a maximum of 13,000 gpd of sewage generated during operation with a staff of a maximum of 300 persons.

9.3.6.1 Tap-In to Existing Facility

This alternative has been revised to stipulate pumping waste to an existing treatment plant that has sufficient capacity to handle the additional flow.

9.3.6.2 Ground Discharge

There have been no changes to this section.

9.3.6.3 Incineration

This alternative is <u>not</u> under consideration.

9.3.6.4 Activited Sludge/Membrane Filtration

There have been no changes to this section.

9.3.6.5 Clarification/Filtration/Carbon Adsorption

There have been no changes to this section.

9.3.7 Transmission System

There have been no changes to this section.

9.4 Benefit-Cost Comparison

In the FES the economic cost differentials for the various alternative designs were considered. The values reported therein reflect cost analyses performed by the applicants in 1976. Since that review, no technological or economic advance has occurred that would make any one of the alternative systems more economically attractive. However, in nominal terms, these estimates understate the current absolute difference because escalation as a result of general inflation has caused the dollar cost of all system designs to increase. In addition, because much of the design, testing, and procurement associated with the proposed plant design have already occurred, there has been a real economic shift in favor of adopting the preferred system design. Because neither of these changes would result in an improvement in the ranking of the alternatives relatives to the proposed systems, the staff has not updated the economic cost estimates in this section.

9.4.1 Cooling System

There have been no changes to this section.

9.4.2 Intake Systems

There have been no changes to this section.

9.4.3 Discharge Systems

There have been no changes to this section.

9.4.4 Sanitary Waste Systems

There have been no changes to this section.

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 are now expected to disturb a total of 292 acres of land for CRBRP and 58 acres for transmission line rights of way. Approximately 113.5 acres would be dedicated on a long-term basis to plant structures and adjacent graded areas within a security barrier (37 acres), access roads and railroad (30 acres on site, 4 acres off site), a barge-unloading area (4 acres), and other facilities. These changes represent increases of 97 acres temporarily disturbed and 40 acres dedicated on a long-term basis; however, these increases in land use are insignificant compared to the total land available on the Oak Ridge reservation. As stated in the FES, all of the transmission tower bases would occupy less than 1 additional acre.

10.1.1.2 Water

Water consumed by the project is now expected to be a maximum of 210,000 gpd for construction purposes and an average of 8.3 cfs (3733 gpm) during full-power operation. These figures are higher than the 190,000 gpd and 8 cfs (3584 gpm), respectively, estimated in the FES, but these increases in water use are environmentally insignificant. The water use during plant operation would still be less than 0.2% of the annual average river flow, as indicated in the FES (Sections 4.3 and 5.2).

Plant operations would add total residual chlorine to the river at an intermittent 6 cfs rate in concentrations of up to 0.14 mg/l. This is a decrease from the 0.5 mg/l maximum concentration estimated in the FES and represents a slight improvement in the expected effect on river water quality (Section 5.4.1).

10.1.1.3 Air

The plant is now expected to discharge heat to the atmosphere at a rate of 2.26×10^9 Btu/hr at full load with the initial reactor core, or 2.5×10^9 Btu/hr at maximum design capability (Section 3.4.1). This increase of about 4% would have negligible incremental effects on the environment.

The last sentence of this section in the FES should have referred to about 57 lb/hr of particulates (not 57 lb/hr of pollutants) that would be released as a result of testing the emergency diesel generators. Hence, this quantity was vastly understated in this section of the FES. Other pollutants released because of such operation would be nitrogen oxide (23,138 lb/yr), sulfur dioxide (4132 lb/yr), carbon monoxide (829 lb/yr), and organic compounds (403 lb/yr) (Section 3.7.2). These quantities are typical for operation of diesel generators and are not environmentally significant.

10.1.1.4 Other

Reanalysis of the CRBRP socioeconomic effects in the light of current data indicates that local tax receipts would probably (instead of would not) compensate for the increased public services needed by the work force associated with the CRBRP construction (Section 4.5.4.4). The staff recommends that the applicants monitor these effects during the construction period to determine whether additional compensation to the local communities is needed (Section 6.1.6).

The reference to "borrow pit activity" should be deleted from the second paragraph of this section since a borrow pit is no longer planned on site. The sentence has been changed to read: "Historic and archeological resources on site should not be affected if construction activities are restricted as planned (Section 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 350 acres disturbed for the plant and transmission lines, rather than 260 acres as stated in the FES. Approximately 113 acres, rather than 73 acres, would be permanently disturbed. Although the numbers of biota affected would increase proportionately, the staff continues to regard the impacts on terrestrial biota as minimal in view of the fact that the amount of land affected would be less than 1% of similar land on the Oak Ridge reservation.

10.1.2.2 Aquatic

The following conclusions in this section have modified; however no significant changes have occurred with respect to thermal, chemical, and mechanical effects on aquatic biota:

- Excavation - An area of approximately 63,000 ft^2 (rather than a volume of 20,000 m^3 as given in the FES) of river bank and bottom temporarily would be disturbed during construction as a habitat for benthic organisms (Section 4.4.2).

- Impingement - No impact significant to the fishery in Watts Bar Reservoir would occur (Section 5.3.1.1).

- Entrainment - The phrase "losses at the average river flow of 4800 cfs would be 0.46%" has been deleted since changes in river flow, as controlled by TVA, make such a calculation inexact. As indicated in the FES, the maximum loss of plankton and drift invertebrates at low river flow would be 2.2% (Section 5.3.1.2). This level of loss would not be detrimental over the long term.

- Thermal discharge - Under normal flow conditions, fish would be able to avoid potentially harmful elevated temperatures, and mortality due to the thermal discharge would be nonexistent. Plant operation under extended no-flow conditions in the Clinch River during periods of high ambient water temperature has the potential for detrimentally impacting striped bass using this stretch of the river as a thermal refuge. This adverse combination of conditions is not expected to occur; however, the applicants have committed to restricting thermal releases from the plant if necessary to protect the striped bass (Section 5.3.2.2), and EPA proposes a condition to that effect in the NPDES Permit (Appendix H).

- Cold shock - Effects would be insignificant, as indicated in the FES.

10.1.3 Radiological Effects

Increases in the dose numbers are presented throughout the following discussion; however, these changes are primarily due to more conservative assumptions in making the calculations and do not constitute any significantly different environmental impact from that indicated in the FES.

The average annual dose to the total body of 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 less than 2 mrems/yr. This value, which is less than 2% of the natural background exposure of 100 mrems/yr, is below the normal variation in background dose. The average dose from the plant effluents to other individuals among the population would be signficantly less than 2 mrems/yr.

A total dose of about 2 person-rems/yr would be received by the general public in the estimated 2010 population of 910,000 living in unrestricted areas within a 50-mile radius of the plant. By comparison, an annual total dose of about 9.1×10^4 person-rems would be delivered to the same population as a result of the average natural background dose. The 1000 person-rems estimated as the annual occupational onsite exposure is about 1% of this annual total background dose (Section 5.7.3).

The annual dose of about 170 person-rems from transport of radioactive materials to and from the CRBRP and exposure to effluents from its supporting fuel cycle facilities (rather than 17 person-rems from transport and 16 person-rems from the fuel cycle, as stated in the FES) would also be nonsignificant fractions of the dose from natural background radiation (Section 5.7.3).

As indicated in the FES, the risks associated with accidental radiation exposure would be very low (Chapter 7).

10.2 <u>Short-term Use and Long-term Productivity</u>

10.2.1 Scope

No changes have been made to this section of the FES.

10.2.2 Enhancement of Productivity

No changes have been made to this section of the FES.

10.2.3 Uses Adverse to Productivity.

No changes have been made to this section of the FES.

10.2.4 Decommissioning

The following assessment replaces the discussion of decommissioning in this section of the FES. Much of the information in the FES has been updated and included here, with additional new information from generic studies of decommissioning PWRs and BWRs.

10.2.4.1 Introduction

NRC regulations do not require an applicant for a construction permit or operating license to submit decommissioning plans at the time of the application. The applicant/licensee is required to file a decommissioning plan at the completion of the operating period. An evaluation of environmental impacts is a required part of the licensee's decommissioning plan. On the basis of environmental reports and assessments of decommissioning actions accomplished to date, no unacceptable impacts have resulted from reactor decommissioning.

The CRBRP applicants have not developed any definite plan for decommissioning the CRBRP. As the CRBRP approaches the end of its useful lifetime, which is expected to be about 30 years, the applicants/licensees must submit a specific decommissioning plan for review by the NRC. The plan must comply with all NRC rules and regulations in effect at that time.

The current regulation on reactor decommissioning, 10 CFR 50.82, states the Commission requirements for dismantling a reactor and for terminating a reactor license. The current staff guidelines for evaluating decommissioning plans are set forth in Regulatory Guide 1.86 (June 1974).

NRC regulations and guidance on decommissioning are now being revised. Publication of proposed revisions to regulations is expected by February 1983. Revisions to Regulatory Guide 1.86 are expected within a year after the revisions to regulations go into effect.

A generic discussion of environmental impacts associated with decommissioning of nuclear facilities is in Draft NUREG-0586. Draft NUREG-0586 is undergoing revisions to reflect comments received; its publication in final form is expected by February 1983.

10.2.4.2 Decommissioning Alternatives

Decommissioning alternatives acceptable to the NRC staff are described in Regulatory Guide 1.86.

Mothballing/SAFSTOR consists of placing a facility in such a condition that the residual radioactivity can be stored safely to allow radiation levels to be reduced by decay. With this alternative, continuing radiation monitoring, environmental monitoring, maintenance, and access control must be accomplished at the facility. In general, with this alternative, the facility may be left intact, except that fuel assemblies, radioactive fluids, and radioactive waste have to be removed from the site. The reactor license and necessary license conditions would remain in effect until the residual radioactivity is less than or equal to the levels acceptable for unrestricted use of the site, in accordance with criteria applicable at the time of decommissioning.

Maximum surface contamination levels currently acceptable to the staff are in Regulatory Guide 1.86, Table 1. In addition, licensees are required to demonstrate by analysis that any residual imbedded activation/radioactivity in shielding structures, reactor components, or soil has been reduced to levels acceptable for release to unrestricted access. In recent decommissioning actions, gamma radiation from reactor-generated radionuclides imbedded in reactor shielding structures, reactor components, or soil has been considered acceptable to the staff if the potential exposure, as measured 1 meter from any surface, is 5 microR/hr or less (Reid, 1981). Five microR/hr above natural background is an exposure rate that is detectable with reasonable accuracy by state-of-the-art instrumentation.

The value of 5 microR/hr represents a potential exposure to an individual of 10 mrems/yr if one conservatively assumes 2000 hours per year of occupancy in a structure in which the exposure rate is 5 microR/hr.

The risk to the exposed individual is estimated by multiplying the risk estimators presented in Section 5.7.2.5 by the conservatively estimated annual total body dose of 10 millirems. This calculation results in a risk of potential premature death from cancer to that individual from 1 year of exposure of about 1 chance in 1 million. This risk is very small in comparison to natural cancer incidence from causes unrelated to the operation of CRBRP, and a very small fraction of the risk from 1 year of exposure to natural background radiation (see Section 5.7.3 for additional information).

The safe storage period may be as long as 50 to 100 years to allow significant radiation decay of cobalt 60. Cobalt 60 is the most dominant radionuclide with respect to occupational exposure during the safe storage period because of its half life, its relatively high abundance in stainless steel, the high energy of its gamma emissions, and its large dose rate per curie. The long safe storage period reduces radioactive waste quantities, exposure to workers, and exposure to the public when the reactor is eventually dismantled and the residual radioactivity is removed. At the end of the safe storage period, the facility is dismantled and decontaminated, with the residual radioactivity in excess of acceptable limits disposed of at licensed low level waste burial grounds. Certain components (the reactor internals and portions of the reactor vessel) contain some long-lived radionuclides such as niobium 94, nickel 63, and nickel 59. These components would be evaluated at the end of the safe storage period with respect to the need for disposal at a deep geologic disposal facility in accordance with NRC criteria in effect at that time. The disposal of these components containing long-lived radionuclides is being considered in the ongoing development of NRC rules and guidance regarding decommissioning.

Entombment/ENTOMB consists of sealing the remaining radioactive components within a structure integral with the biological shield after all fuel assemblies, radioactive fluids, and radioactive wastes--and in most cases the reactor vessel internals and the reactor vessel itself--have been removed. For this alternative, the entombment structure must provide a barrier sufficient to ensure adequate control when the residual radioactivity is above levels acceptable for release to unrestricted access. Levels currently acceptable to the staff are given in the third paragraph of this section (10.2.4.2). This period may be as long as 100 to 150 years. As was the case in Mothballing/SAFSTOR, the reactor license and necessary conditions would remain in effect until the residual radioactivity has decayed sufficiently or has been removed from the site, in accordance with criteria applicable at that time.

Dismantlement/DECON consists of removal of all significantly radioactive components from structures and the site so that radiation levels are consistent with NRC criteria applicable at that time. Levels currently acceptable to the staff are given in the third paragraph of this section (10.2.4.2). Most radioactive material exceeding such criteria would go to licensed low level waste burial grounds. Exceptions would be certain components such as the reactor internals and portions of the reactor vessel with the long-lived radionuclides that may have to be disposed of at a deep geologic disposal facility, as previously discussed.

10.2.4.3 Environmental Impacts

Each decommissioning alternative has some environmental impacts. SAFSTOR and ENTOMB result in the commitment of a few acres of land where the reactor structures are situated for the time that the facility remains in the safe storage or entombed status. The applicants have estimated in the ER (Section 5.9) that this could be up to 11.3 acres. All three alternatives involve the commitment of land at the licensed low level waste burial grounds for disposal of radioactive waste. In NUREG-0586 (Page 0-12) and NUREG/CR-0130, the volumes of low level waste are estimated for a 3500 MWt PWR. NUREG-0586 estimates that the 17,900 m^3 of low-level radioactive waste produced by immediate or early dismantling could be disposed of in less than 2 acres of land. After 50 years of safe storage, the volume of waste for disposal is estimated to be 1830 m^3, corresponding to an area of 0.25 acre or less.

The estimates of low level waste land commitment for a 3500 MWt PWR are adequately conservative with respect to the CRBRP because the CRBRP thermal power is one-third as large and the structural volumes are smaller than for the PWR.

Decommissioning may also involve commitment of space at a deep geologic disposal facility for disposal of components with long-lived radionuclides. In NUREG-0586 (page 0-12), this space is estimated to be 88 m^3 for a 3500 MWt PWR. This estimate is also adequately conservative for the CRBRP.

In addition, there may be a commitment of resources to ensure continued security at the licensed low level waste burial grounds. The cost of this security would, of course, be shared with the many other users of these radioactive waste facilities.

The disposal of radioactive sodium from the CRBRP cooling system is unique to breeder reactors and other sodium-cooled reactors. At Hallam and Fermi 1 (see Section 10.2.4.4) the primary system sodium was saved for use in other AEC/DOE reactor programs. A similar solution could be used for the CRBRP. The secondary system sodium could also be reused or could be sold commercially after verification that it is free of significant radioactivity, as was done at Fermi 1. If radioactive sodium must be disposed of, it would have to be converted to a less chemically active substance prior to burial.

As with the PWR, the use of SAFSTOR or ENTOMB for the CRBRP would probably result in the commitment of less land for radioactive waste disposal than DECON because much of the radioactivity in components and structures would decay in place to levels acceptable for unrestricted access. Transportation of waste material to waste burial grounds would result in increased traffic and an increased risk of exposure to the public, depending on the transportation mode.

Exposure to workers during decommissioning will be maintained as low as reasonably achievable (ALARA) by careful health physics surveillance of activities and especially by maximum use of remote operations. Some personnel exposure will result from any of the alternatives, but the SAFSTOR option would result in less exposure than DECON because radiation levels would be reduced at the time of dismantling. Decommissioning experience indicates that occupational exposures can be adequately controlled.

Although more information on possible environmental effects of decommissioning is presented here than in in the FES, the staff does not find that the expected environmental effects are significantly different.

10.2.4.4 Experience

A number of licensed power reactors and demonstration nuclear power plants have been decommissioned. There is no reason to expect that decommissioning of the CRBRP would introduce any new or unknown technical problems of a safety or environmental nature.

Experience with decommissioning Fermi 1, a 200 MWt power reactor, is directly relevant to CRBRP because Fermi 1 was also a sodium-cooled breeder reactor. The Fermi reactor was decommissioned during the period from 1973 to 1975. The fuel, the depleted uranium blanket, and the sodium were removed; accessible areas were decontaminated. Fermi 1 is now maintained in a safe storage status, with continued access control, radiation monitoring, and maintenance. The fuel was shipped to the Savannah River reprocessing facility and the blanket material to a retrievable waste storage facility at the Idaho National Engineering Laboratory. The sodium was removed from the reactor primary and secondary systems. The nonradioactive secondary system sodium was sold to a commercial user. The primary system sodium is now stored in tanks and drums at the Fermi 1 site and will be held there under contract with DOE until it is shipped to the CRBRP or another DOE facility for reuse. The cost of decommissioning Fermi 1 was approximately $4.0 million, exclusive of the core fuel use charges, fuel removal cost, and reprocessing cost. The cost related to core fuel was $3.0 million. The Fermi licensee (Detroit Edison) estimates the cost of maintaining Fermi 1 in the safe storage mode has been less than $40,000 per year, including 1980, the year in which the health physics building was removed. The decommissioning of Fermi 1 is described in "Retirement of the Enrico Fermi Atomic Power Plant," NP-20047, Supplement 1 (Power Reactor, 1975).

Occupational exposures were sufficiently low enough at Fermi 1 during decommissioning so that no outside contract workers were needed to supplement Fermi 1 plant personnel because of exposure levels. An NRC contractor is compiling Fermi 1 exposure data and a summary of Fermi 1 occupational exposures during decommissioning; this compilation should be available by July 1982.

The Hallam Nuclear Power Facility, a 254 MWt sodium-cooled, graphite-moderated reactor, was decommissioned by entombment during 1968 and 1969. Sodium was removed from the reactor systems, with primary system sodium transferred to the AEC site at Richland, Washington and secondary system sodium transferred to the AEC Liquid Metal Engineering Center in Santa Susana, California for further use in AEC programs. Fuel was shipped to the Savannah River plant for reprocessing.

An analysis of the residual activity at the site and the integrity of the entombment structure was performed. Potential pathways to the environment were considered and the groundwater pathway was identified as the most important. Nickel 63 was considered to be the dominant isotope for potential exposures through biological pathways 100 years after reactor shutdown. Results indicated that the maximum concentration of nickel 63 likely to occur in groundwater adjacent to the facility would be less than 1% of 10 CFR 20 limits for water in unrestricted areas (Morris, 1967). DOE performs periodic radiation monitoring at the Hallam site. The cost of the Hallam decommissioning was $3.15 million. The decommissioning of Hallam is described in "Report on Retirement of Hallam Nuclear Power Facility" (Atomics International, 1970).

The Elk River Reactor Power Station was a 58 MWt BWR, decommissioned by dismantlement during the period 1972 to 1974. All fuel was removed and shipped to an AEC reprocessing facility. All structures, both radioactive and nonradioactive, were removed from the site during dismantlement. Radioactive waste was disposed of in licensed burial grounds in Illinois, Kentucky, and Washington. Nonradioactive waste was disposed of in a local landfill area. All material with "detectable reactor-originated radioactivity" was disposed of in licensed burial grounds. The cost of dismantling the Elk River reactor was approximately $6 million, and dismantling occupational exposures totaled 75 person-rems. The Elk River decommissioning process is described in "Final Elk River Reactor Program Report" (United Power).

10.2.4.5 Cost

Estimated costs of decommissioning vary, depending on the characteristics of the particular reactor, whether the reactor is on a single- or multiple-reactor site, and the decommissioning mode chosen. For a large PWR (3500 MWt) on a single-reactor site, DECON is estimated to cost $33.3 million (in 1978 dollars). SAFSTOR is estimated to cost $42.8 million with a 30-year safe-storage period, and $41.8 million with a 100-year safe-storage period. ENTOMB is estimated to cost $21 million with the pressure vessel and its internals retained, or $27 million with the pressure vessel and internals removed, plus a $40,000 annual maintenance-and-surveillance cost in both cases (Table 4-3-1, NUREG-0586, and NUREG/CR-0130).

The above costs are considered to be adequately conservative with respect to the CRBRP because the CRBRP thermal power is less than one-third of the example PWR power level, and, except for removal of the sodium from the CRBRP cooling system, CRBRP decommissioning operations would involve the same level of effort as decommissioning of a PWR. The cost of removal of the primary sodium from all systems, disposal of the primary cold trap, and future shipment of the primary system sodium to DOE for reuse was estimated at $250,000 for Fermi 1. The secondary sodium was not radioactive and was sold by the Fermi 1 licensee for commercial reuse. CRBRP is about five times the power level of Fermi 1, but the cost of handling the sodium would be expected to be no more than five times as much (about $1.25 million in 1978 dollars).

10.3 Irreversible and Irretrievable Commitments of Resources

10.3.1 Scope

No changes have been made to this section of the FES.

10.3.2 Commitments Considered

No changes have been made to this section of the FES.

10.3.3 Biotic Resources

No changes have been made to this section of the FES.

10.3.4 Material Resources

10.3.4.1 Materials of Construction

No changes have been made to this section of the FES.

10.3.4.2 Replaceable Components and Consumable Materials

At the end of the first paragraph of this section in the FES, the maximum output of 379 MWe net should be changed to 1121 MWt.

The last paragraph have been revised as shown below:

> The extent of fuel consumption over the plant's 30-year life cannot be accurately predicted because of uncertainties in the fuel recycle philosophy. Operated on a once-through fuel cycle, the total requirement could be 27 MT of plutonium and 332 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 58 MT, with 27.6 MT recoverable at the time of plant decommissioning in addition to 30.4 MT previously removed. The applicants estimate that 3.5 MT of ^{239}Pu would be required for startup and that a net gain of 3.2 MT would be produced over the plant's 30-year life. Thus, 14.2 MT of depleted uranium would be consumed and there would be a net gain of 3.2 MT of bred plutonium. A supply of depleted uranium would be available as spent fuel from light water reactor power plants. About 600 MT of stainless-steel fuel cladding would become contaminated with radioactive material, making it irretrievable, since recycling is uneconomical (ER, p 3.8-3).

10.3.5 Water and Air Resources

The consumptive use of river water is now expected to be 8.3 cfs instead of 8 cfs. This amount would not curtail downstream uses, even during extremely low flow.

10.3.6 Land Resources

Thirty of the 37 acres committed to plant use could be restored for other purposes, with a moderate decommissioning effort. The 7 acres for principal plant buildings could be restored only at a high cost.

10.4 Benefit Cost

10.4.1 Benefits

10.4.1.1 LMFBR Concept Demonstration

No changes have been made to this section of the FES.

10.4.1.2 Electrical Energy Produced

The CRBRP has a nominal rating of 350 MWe, with a stretch rating potential of 402.5 MWe. This capacity and the electrical energy it provides to the TVA system is viewed as a secondary benefit. Assuming the applicants' estimate of an average annual capacity factor of 76.5% (based on 350 MWe) is realized, the plant will generate about 2.35 billion kWh per year. Over an assumed 30-year plant life, a total of slightly over 70 billion kWh could be produced. The energy generated by the CRBRP can be viewed as displacing the highest incremental cost energy available to TVA, which is expected to be coal. An equivalent amount of electricity supplied by burning coal in a steam generator would consume about 900,000 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

Expenditures for research and development (R&D) by DOE in support of the CRBRP are now expected to be a total $530 million between 1975 and 2020, with about $900 million more for safety-related R&D applicable to the total LMFBR program.

10.4.1.4 Environmental Enhancement

No changes have been made to this section of the FES.

10.4.1.5 Employment and Payroll

This section of the FES has been replaced by the following:

> The direct payroll during the construction period is now expected to be $446 million; it is expected to induce a secondary payroll of $2.5 million through creation of local demand for goods and services. During the demonstration period, the $50 million direct payroll is expected to induce a secondary payroll of $4.4 million. The data in FES Table 10.2 have been updated, as shown below in Table A.10.1.

10.4.1.6 Taxes

This section has been revised in accordance with the staff's updated assessment of socioeconomic impacts.

State and local taxes generated from payroll spending would be the principal source of public funds generated by the project for use in the project area. These revenues would be generated principally in Anderson, Knox, Loudon, and Roane Counties.

The staff estimate of the value of tax revenues for the peak year of construction is summarized in Table A4.13. As indicated in that table, $29.5 million in general fund revenues and $66.4 million in school fund revenues would be generated in the peak year of construction.

Table A10.1 Summary of employment benefits

Item	Construction period	Demonstration period
Direct Employment[a]	2700	325
Induced Employment[a]	43	75
Direct Payroll[b]	$446,200,000	$49,800,000
Induced Payroll[b]	$2,500,000	$4,400,000

[a] Annual average based on Table A4.1.

[b] See Table A4.11 and ER Am X.

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 and updated in Table A10.2, which replaces FES Table 10.4. Vertical lines in the margins of the table indicates where changes have been made.

10.4.2.2 Monetary Costs

The applicants' current estimated cost of the CRBRP is $3.196 billion for plant investment, development, and operation through 1995. The estimated cost breakdown is presented in Table A10.3, which replaces FES Table 10.5. The base cost estimates are in 1974 dollars without escalation. The applied escalation rate is 8%/yr. Estimated revenues for electricity sold to TVA totalling about $680 million are credited to operating costs. The applicants' cost estimate is from an appropriations standpoint and does not reflect interest during construction or present worth discounting.

As shown in Table A10.4, the staff has revised the applicants' estimate to recognize the time value of money using an 11% interest rate. The staff also believes that applicants' estimate of revenues from the sale of power is overly optimistic and, based on recent coal cost statistics, has reduced this amount from $679 million to $350 million. The resulting accumulated costs by year of expenditure and in 1982 dollars are as follows:

	$ millions	
	Year of expenditure	1982 present worth
1974 through 1982	1370	1949
1983 through 1995	2155	1474
TOTAL	3525	3423

Table A10.2 Summary of environmental costs, CRBRP

Effect	Reference section	Summary description
Land Use		
Construction activities	4.2.1	About 292 acres disturbed during construction of the plant and support facilities.
Long-term dedication	4.2.1	About 113 acres permanently dedicated, including 34 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	210,000 gpd maximum rate.
Operation	5.2	8.3 cfs (3733 gpm) water consumptively used during operation.
Thermal effects	3.4.1	Cooling water would be heated 22°F by passage through the condensers.
Intake velocities	3.4.2	Intake velocity is expected to be about 0.43 fps.
Discharge volume	3.4.3	Minimum rate of 1030 gpm; maximum rate of about 2412 gpm.
Chemical and sanitary waste	5.4	Rapidly diluted to harmless concentrations under flowing river conditions.
Siltation	4.3	Material to be removed for construction of access road and railroad, intake and discharge structures, and barge slip; suspended solids in site runoff would have minor, temporary effects.
Terrestrial Ecological Effects		
Rare and endangered species	2.7.1.2.2	The Bald Eagle, an endangered species, has been observed on the site, but no nesting activities have occurred.
	4.2.1	Rare wild flower collection areas on the site would not be disturbed.

Table A10.2 (Continued)

ffect	Reference section	Summary description
rrestrial Ecological ffects (continued)		
getation 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.
oling tower drift	5.3.3	Worst case deposition would be 90 lb/acre/mo of salts; no adverse effect is expected.
quatic Ecological ffects		
nthic losses		
uring construction	4.4.2	Benthic organisms lost as a result of dredging and other construction activities would be easily reestablished.
uring 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.
mpingement	5.3.1.1	Negligible.
ntrapment	5.3.1.1	Negligible.
ntrainment	5.3.1.2	A maximum loss of 2.2% of phytoplankton, zooplankton, drift invertebrates, and ichthyoplankton is estimated.
hermal effects	5.3.2.2	No significant impact on fish is expected with flow in the Clinch River. During extended periods on no flow flow and high ambient water temperatures, the potential exists for impacts to striped bass; however, such conditions are unlikely and the applicants have committed to restricting thermal discharge if necessary.
old shock	5.3.2.3	Fish loss is unlikely from any interrruption of heated effluents
anitary waste	5.4.2	Negligible.

Table A10.2 (Continued)

Effect	Reference section	Summary description
Dose from Exposure to Radioactivity		
Individual	5.7.7	Less than 2 mrems/yr average annual dose to an individual at site boundary, less than 2% of 100 mrems/yr natural background dose.
Cumulative	5.7.8	About 2 person-rems/yr to total 910,000 population within 50 miles in year 2010, insignificant compared to about 9.1×10^4 person-rems/yr from natural background.
Occupational	5.7.9	1000 person-rems/yr conservatively estimated, 1% of the 50-mile population natural background dose.
Transportation and fuel cycle	5.6.2.6	170 person-rems/yr, nonsignificant compared to exposure to natural background radiation.
Accidental	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 Hensely Cemetary would be allowed.
Visual impact	5.1	The structures would be partly visible from the Gallagher 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		(deleted because this was incorrectly shown in the FES as an environmental cost)
Payroll		(deleted because this was incorrectly shown in the FES as an environmental cost)
Public services	4.5.4	No firm provisions have been made for funds to provide public sector services; however, DOE has recognized its responsibility to make payments if adverse impacts occur.
Traffic	4.5.3	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.

Table A10.2 (Continued)

Effect	Reference section	Summary description
Physical Resources		
Uranium	10.3.4.2	Less than 332 MT
Plutonium	10.3.4.2	Less than 27 MT

Table A10.3 Applicants' estimated cost of CRBRP through 1995

Item	Cost ($ millions)	% of project cost expended through 1981
Plant investment		
Base	1122.3	
Escalation	1198.1	
Contingency and escalation	182.8	
Plant investment total	2503.2	21.2
Development		
Base	535.3	
Escalation	269.1	
Contingency and escalation	13.7	
Development total	818.1	77.6
Operating		
Base	146.6	
Escalation	405.2	
Contingency and escalation	2.9	
Less Revenues	(679.2)	
Operating total	(124.8)	0
Project total	3196.5	36.1

Source: Letter of May 26, 1982 to Harold Denton from applicants (Percy Brewington, Jr., DOE; William R. Rolf, PMC; and William F. Willis, TVA) amending their application for the CRBRP construction permit, Appendix G.

Table A10.4 Staff's total plant cost estimate for CRBRP in millions of dollars

Year	YOE[1] Dollars	PW[2] Factor	1982 P.W.	Accumulated YOE Dollars	Accumulated 1982 PW
1974	29.9	2.305	68.9	29.9	68.9
1975	70.1	2.076	145.5	100.0	214.4
1976	140.2	1.870	262.2	240.2	476.6
1977	184.4	1.685	310.7	424.6	787.3
1978	166.2	1.518	252.3	590.8	1,039.6
1979	175.1	1.368	239.5	765.9	1,279.1
1980	189.4	1.232	233.3	955.3	1,512.4
1981	199.5	1.110	221.4	1,154.8	1,733.8
1982	215.6	1.000	215.6	1,370.4	1,949.4
1983	307.3	0.901	276.9	1,677.7	2,226.3
1984	312.8	0.812	254.0	1,990.5	2,480.3
1985	293.3	0.731	214.4	2,283.8	2,694.7
1986	389.3	0.659	256.5	2,673.1	2.951.2
1987	385.4	0.593	228.5	3,058.5	3,179.7
1988	241.4	0.535	129.1	3,299.9	3,308.8
1989	148.0	0.482	71.3	3,447.9	3,380.1
1990	101.9	0.434	44.2	3,549.8	3,424.3
1991	28.7	0.391	11.2	3,578.5	3,435.5
1992	22.5	0.352	7.9	3,601.0	3,443.4
1993	(7.3)	0.317	(2.3)	3,593.7	3,441.1
1994	(31.6)	0.286	(9.0)	3,562.1	3,432.1
1995	(36.9)	0.258	(9.5)	3,525.2	3,422.6

[1] Year of expenditure dollars; includes 8% escalation
[2] Factor for projecting or discounting, to the end of 1982, using an 11% discount rate.

Table 10.3 of the FES and the remaining discussion in this section of the FES have been deleted since they are now out of date.

The costs of safeguards shown in this section of the FES have been revised to a total of $57.7 million in capital costs for measures necessary to protect the CRBRP, the related fuel cycle facilities, and transport of radioactive materials. Annual operating costs for these safeguards would be approximately $15 million. These figures include the full safeguards costs of $50 million capital investment and $10 million annual operating costs for the Developmental Reprocessing Plant (DRP) because no LMFBR near-term applications have been identified other than CRBRP which would utilize its capacity (Appendix E, Section E.6.3).

Estimated costs for decommissioning would vary, depending on the decommissioning mode chosen, from about $21 million to about $43 million in 1978 dollars (see Section 10.2.4.5).

10.4.3 Benefit-Cost Summary

Changes have been made in items (2) and (3) in the second paragraph in this section of the FES, as shown below. These changes recognize that design and procurement for the complete plant are so far along that switching to a hook-on arrangement would no longer be less expensive. The staff's previous conclusion (3) has been deleted since reanalysis of the CRBRP socioeconomic effects in the light of current data indicates that local tax receipts would probably (instead of would not) compensate for the increased public services needed by the work force associated with its construction and operation.

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, and (2) locating the project at an alternative TVA site using the hook-on arrangement would now be more expensive and the attendant technological risks could jeopardize the ability of the project to meet its intended objectives. 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 also concludes that the CRBRP would meet the demonstration plant's objectives within the LMFBR program (see Chapter 8).

11 DISCUSSION OF COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL STATEMENT

In updating the Final Environmental Statement related to construction and operation of the Clinch River Breeder Reactor Plant (NUREG-0139), the staff has reviewed its responses to the comments in Appendix A of the FES to ensure that the responses are also current. Where corrections have been found necessary and additional information would be helpful, they are provided below.

11.1 Summary and Conclusions, Introduction, and General Comments

11.1.1 ERDA (DOE) Involvement (CC, A-44; PMC, A-94, Encl. 2, Item 1)

DOE has succeeded ERDA as the Federal agency with 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)

No changes have been made to this section.

11.1.3 NEPA Review After 5 Years (EPA, A-17, Item 3)

No changes have been made to this section.

11.1.4 State and Local Licenses and Permits (OR, A-39, Items D.5 and D.6; TN, A-25, 28)

No changes have been made to this section.

11.1.5 State Contacts with State and Local Officials (OR, A-39, Item D.4)

No changes have been made to this section.

11.1.6 Completion Date and Cost Overruns (NRDC, A-51, 52)

As indicated in the application amendment dated May 26, 1982, the earliest scheduled date for reactor criticality is February 1990, and the total project cost estimate is $3196.5 million, including research and development expenditures of $818 million, 8% per year escalation during construction, substantial contingency allowances, and operating costs during the 5-year demonstration period. The latest date for completion of construction is stated to be January 1992.

11.1.7 Site Suitability (TN, A-25)

No changes have been made to this section.

11.1.8 Concentration of Water Impurities (TN, A-25)

The concentration factor has increased from approximately 2.5 to 2.7 because of changes in the cooling system requirements (see Section 3.3). This increase is environmentally insignificant.

11.2 The Site and Environs

11.2.1 Additional Baseline Information (BN, A-86 to A-91)

No changes have been made to this section.

11.2.2 Distance from CRBRP to Oak Ridge (OR, A-39, Item D.7)

No changes have been made to this section.

11.2.3 Jurisdictional Districts (OR, A-39, Item 8)

No changes have been made to this section.

11.2.4 General Site Description (BN, A-86)

No changes have been made to this section.

11.2.5 Population Within 5 Miles of the Site (OR, A-39, Item 9; ETDD, A-43)

No changes have been made to this section.

11.2.6 Relationship of Population to Agricultural Production (BN, A-86)

No changes have been made to this section.

11.2.7 Historic and Archeological Values (BN, A-86; HUD, A-9)

No changes have been made to this section.

11.2.8 Soils and Geologic Information (AG, A-2; NRDC, A-52)

No changes have been made to this section.

11.2.9 Karst Features (BN, A-86)

No changes have been made to this section.

11.2.10 Surface Water and Groundwater (BN, A-86)

No changes have been made to this section.

11.2.11 River Width (OR, A-39, Item D.11)

No changes have been made to this section.

11.2.12 Melton Hill Dam Releases and Milfoil (BN, A-86; TN, A-26; OR, A-39, Item D.12).

No changes have been made to this section.

11.2.13 1953 Tornado (BN, A-86; OR, A-40, Item D.14)

No changes have been made to this section.

11.2.14 χ/Q Values (OR, A-40, Item D.15)

The staff does not attempt to duplicate the χ/Q values which the applicants provide. Rather, the staff performs an independent analysis, as described in FES Section 6.1.3. In its updated analysis, the staff used meteorological data gathered between February 1977 and March 1978 and the values were slightly higher than those reported in the applicants' ER (Table 2.6-29). However, the changes are environmentally insignificant.

11.2.15 Frequency of Heavy Fog (OR, A-40, Item D.16)

No changes have been made to this section.

11.2.16 Unfavorable Meteorology (NRDC, A-52)

In the second paragraph, the second and third sentences have been replaced by the following:

> However, nuclear power plant sites with similar or poorer dispersion factors have been deemed to be licensable. The atmospheric dispersion at the Clinch River site is comparable to that at other nuclear power plant sites in the northern Appalachian region of the country.

This change is not environmentally significant.

11.2.17 Air Quality (BN, A-86)

No changes have been made to this section.

11.2.18 Terrestrial Ecology (BN, A-87; TN, A-102; ERDA, A-13)

No changes have been made to this section.

11.2.19 Aquatic Ecology (BN, A-88, TN, A-30)

Section 2.7.2 has been updated. It is the staff's opinion that this section is sufficient for assessing aquatic biological impacts.

Table 2.5 has been updated. The four additional species of minnows (ER, Tables 2.7-87 and -88) taken by the applicants, as well as records from other investigations, have been included.

11.2.20 Social and Community Characteristics (BN, A-88)

No changes have been made to this section.

11.2.21 Mobile Homes in Oak Ridge (OR, A-40, Item 18)

The staff understands that Oak Ridge may adopt a change in ordinance to permit mobile homes within the city; however, there are no such mobile homes available at this time.

11.2.22 Overcrowding in Oak Ridge Schools (OR, A-40, Item 19)

No changes have been made to this section.

11.2.23 Personal Property Tax (OR, A-40, Item 20)

No changes have been made to this section.

11.2.24 Higher Costs for Low Income Citizens (ECNP, A-45, Item 1)

The first two paragraphs have been modified and combined as follows:

> The construction of CRBRP could result in a large influx of people who would demand public and private services. In rural areas where the supply of services is limited, a rise in price could occur. In Section 6.1.6, the staff has recommended a monitoring program to determine actual impacts.

11.3 <u>Facility Description</u>

11.3.1 Public Use of the River (AR, A-5; DOI, A-11)

No changes have been made to this section.

11.3.2 Reactor and Steam-Electric System (ECNP, A-45, Item 2)

No changes have been made to this section.

11.3.3 Breeding (NRDC, A-53)

The applicants now project a breeding ratio of 1.29/1 with the initial core, and 1.24/1 with equilibrium cores (ER Table 3.3-2). This change from 1.2/1 in the FES is not significant to the staff's evaluation of environmental impacts of constructing the CRBRP.

11.3.4 Water Use at Maximum Power (TN, A-26)

Maximum water use would occur in the summer with a 7022 gpm makeup need, of which 4240 gpm would be consumed and 2782 gpm would be discharged to the river. These figures have increased only slightly over those in the FES; the changes are environmentally insignificant.

11.3.5 Design Parameters of Heat Dissipation System (PMC, A-95, Item 5)

Sections 3.3 and 3.4 have again been revised to reflect slightly lower cooling water requirements which have resulted from the project's choice of cooling towers. The changes are environmentally insignificant.

11.3.6 Intake and Discharge Locations (AR, A-6)

No changes have been made to this section.

11.3.7 Impingement Losses (TN, A-26)

The intake structure is subject to the requirements of Section 316(a) of the Clean Water Act.

Section 5.3.1.1 provides an updated assessment of the potential for impingement losses. Based on the design of the intake, its location, the biota inhabiting the river, and the preliminary results of studies conducted at similar intake structures, no significant losses due to impingement are expected. No reimbursement to the state for losses due to impingement and no degradation in water quality due to intake backwashing are anticipated.

This change in response provides further information and does not imply any change in the staff's previous assessment.

11.3.8 Use of Appendix I Criteria (EPA, A-17, 18; TN, A-25)

No changes have been made to this section.

11.3.9 NRC's Release Estimates More Conservative than ER (PMC, A-94, Item 3.F4)

No changes have been made to this section.

11.3.10 Liquid Radwaste Dilution Flow (TN, A-26)

No changes have been made to this section.

11.3.11 Filter or Evaporator Malfunctions (TN, A-26)

No changes have been made to this section.

11.3.12 Decay Time in Low-Activity System (PMC, A-95, Item 6)

No changes have been made to this section.

11.3.13 Chemicals in Low-Activity System (TN, A-26)

The suspended solids limitations and pH requirements in the draft NPDES Permit are now found on page I-6 of the permit (see Appendix H).

11.3.14 Barriers to Tritium Releases (EPA, A-18)

No changes have been made to this section.

11.3.15 Chemicals in Condensate-Feedwater System (TN, A-26)

No changes have been made to this section.

11.3.16 Activity in the Cooling Water Intake (TN, A-25)

No changes have been made to this section.

11.3.17 Bottling the Noble Gases (NRDC, A-53, 54)

No changes have been made to this section.

11.3.18 Effluent From Cell Air Processing System (ERDA, A-13)

The effluent release rate from the CAPS will range from 0 to 64 scfm, rather than 0 to 72 scfm.

11.3.19 Radwaste Treatment Similarities to Other Reactor Types (DH, A-101)

No changes have been made to this section.

11.3.20 Disposition of Sodium-Bearing Wastes (EPA, A-17, 18)

The first paragraph has been revised to read as follows:

> In updated Section 3.5.3 of this document, the staff estimates that approximately 750 ft^3 of sodium-bearing waste containing 1.6×10^4 Ci of activity would be generated annually, and it would be stored onsite since no currently licensed offsite disposal facility will accept sodium-bearing waste. This is a change from the FES, in which shipment offsite of about one-third that quantity of waste, but with somewhat greater total activity, was contemplated.

This change is not significant environmentally because either method of disposal would have to meet NRC limitations.

11 3.21 Contradiction on Page 3-18 (TN, A-25)

No changes have been made to this section.

11.3.22 Sodium Nitrate Waste (TN, A-26)

No changes have been made to this section.

11.3.23 Radioactive Waste Shipments (TN, A-25)

Because no burial sites presently will accept radioactive sodium, the applicants now state that elemental sodium will be stored or processed to a disposable form in a to-be-determined manner (amended ER pages 3.5-18 and -19). This is a change from shipment off site, as discussed in the FES, but it is not environmentally significant because either method must meet NRC limitations.

11.3.24 Radwaste Disposal Site (EPA, A-17; TN, A-25, 26, 27)

The third and fifth paragraphs of this response have been modified as follows:

The staff has estimated the environmental impact associated with all waste management operations, including a Federal repository. These impacts are now shown in Table D-4 of Appendix D.

Table 4.18 of the task force report (NUREG-0116) indicates negligible doses to the population resulting from operation of a waste repository. As discussed in Appendix D, the nature of the waste from fast reactor fuel is not sufficiently different to change this result, and, therefore, the staff concludes that the environmental impact of short-term operation of the waste repository facilities is negligible.

The above changes simply point out where the updated information is currently in Appendix D.

11.3.25 Description of Licensed Burial Site (AR, A-6)

The second paragraph has been updated to read as follows:

Specific criteria for an acceptable burial site are developed under 10 CFR 61. A description of the reference disposal facility is provided in the draft EIS which supports 10 CFR 61 (NUREG-0782). An adequate land burial facility consists of an area that is sparsely settled, with access to highway transportation. Groundwater level should be well below the deepest trench. 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.

The sixth paragraph has been changed to read as follows:

After burial operations cease, the disposal facility will be subject to an institutional control period to restrict access to the site. Individual states and/or the Federal government are responsible for perpetual care and maintenance and for ensuring restriction from other uses.

The above changes are primarily to direct the reader to current regulations and do not represent a significant change environmentally.

11.3.26 Health Consequences from Delayed Releases from Licensed Burial Sites (NRDC, A-54)

The response in the FES has been replaced by the following:

A comment on Section 3.5.3 was that the staff should analyze the health consequences of "delayed releases" of solid radioactive waste from burial grounds. The performance objectives in proposed 10 CFR 61 for a low level waste disposal facility would require that the facility be sited, designed, operated, and closed in a manner to preclude offsite doses in excess of 25 mrems per year. The long-term radiological impacts for a low level burial site have been assessed in NUREG-0782.

The above response simply directs the reader to the reference which contains the information desired and does not represent a change in expected impacts of the CRBRP.

11.3.27 Chemicals in Plant Discharge (TN, A-27)

No changes have been made to this section.

11.3.28 Corrosion Inhibitors, New Source (ERDA, A-13; EPA, A-22, Item 3)

No changes have been made to this section.

11.3.29 Hypochlorite Use at Intake (OR, A-40, Item 21)

The NPDES chlorine requirements are now found on page I-17 (see Appendix H).

11.3.30 Oil and Grease Discharge (TN, A-27)

No changes have been made to this section.

11.3.31 Wastewater Characteristics (TN, A-27)

No changes have been made to this section.

11.3.32 Use of Polychlorinated Biphenyls (TN, A-27)

Special conditions governing the use of PCBs are now found in item III.B of the revised draft NPDES Permit (see Appendix H).

11.3.33 Storm Drainage (TN, A-27)

The response has been replaced with the following:

> In accordance with the draft NPDES Permit, item III.J., the applicants must have an approved Erosion and Sediment Control Plan prior to the start of construction.

This new requirement by EPA is not expected to result in significant differences in environmental impacts attributable to plant construction and operation.

11.3.34 Off-Site Disposal of Non-Radioactive Waste (OR, A-40, Item 22; TN, A-27)

No changes have been made to this section.

11.3.35 Sanitary Waste (TN, A-27)

No changes have been made to this section.

11.3.36 Residual Chlorine in Sanitary Waste Effluent (ERDA, A-13)

No changes have been made to this section.

11.4 Environmental Impacts Due to Construction

11.4.1 LWA and NEPA Procedures (AR, A-5)

The Corps of Engineers has issued the permits needed by the applicants prior to construction of facilities at or in the river for the CRBRP.

11.4.2 Construction Employment (OR, A-40, Item 24; PMC, A-93, Item 3.B.1)

No changes have been made to this section.

11.4.3 Secondary Employment (PMC, A-93, Item 3.B.2)

No changes have been made to this section.

11.4.4 Exxon Nuclear Fuel Plant (OR, A-40, Item 23; PMC, A-93, Item 3.B.3)

The Exxon project has been cancelled.

11.4.5 Erosion Control (AG, A-2)

No changes have been made to this section.

11.4.6 Revegetation of Transmission Line Corridor (DOI, A-11)

No changes have been made to this section.

11.4.7 Terrestrial Impacts (BN, A-89)

No changes have been made to this section.

11.4.8 Barge Traffic (AR, A-3)

No changes have been made to this section.

11.4.9 Materials Barged (AR, A-3)

No changes have been made to this section.

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 further reduced from 20,000 m^3 to 8,500 m^3 as a result of the redesign of the barge-unloading facility. This is an environmental benefit but does not represent a significant environmental change since the impact of dredging was already considered to be of minor consequence (see Section 4.4.2).

11.4.11 TWQCB Certification (TN, A-27)

The Tennessee Division of Water Quality Control has stated its conditions for certification of the NPDES Permit (see Appendix H, Attachment D).

No significant change in the staff's assessment of impacts is expected.

11.4.12 Minimizing Socioeconomic Impacts (HEW, A-8, HUD, A-9)

No change is needed in this section of the FES. However, the staff assessments in Sections 4.5 and 5.6 have been revised.

11.4.13 School Impacts (PMC, A-93, Item 3.C)

The second paragraph of the response in the FES has been deleted.

11.4.14 Impact on Housing (HUD, A-9; RC, A-33, Item 4)

In ER Amendment X (1982), the applicants indicate that approximately 30% of the workers are expected to locate in mobile homes (ER, Appendix to Chapter 8, Tables 2.1-2 and 2.1-6).

11.4.15 Water, Wastewater, and Solid Waste Impacts on Communities (TN, A-27)

No changes have been made to this section.

11.4.16 General Impacts on Roane County (RC, A-31, 32)

No changes have been made to this section.

11.4.17 Traffic Congestion (TN, A-29; RC, A-32, Item 1; OR, A-36, Item A.1)

No changes have been made to this section.

11.4.18 Sanitary Sewage Discharges (RC, A-32, Item 2)

No changes have been made to this section.

11.4.19 Solid Waste Disposal (RC, A-32, Item 3)

No changes have been made to this section.

11.4.20 Local Planner (RC, A-33, Item 5)

No changes have been made to this section.

11.4.21 Assessment of Socioeconomic Impact (RC, A-33, Item 6)

The word "significant" has been removed from the first sentence, which now reads as follows:

> The staff assessment of socioeconomic impacts resulting from CRBRP indicated that impacts could occur within the local rural counties.

This change indicates that the staff now believes that such impacts will not be as large as previously forecast (see revised Section 4.5).

11.4.22 Tax Revenues (RC, A-34, Item 7; OR, A-36, Item A.2)

The staff has now concluded that the portion of increased state sales tax, gas tax, cigarette taxes, and liquor taxes that would be returned to the communities as a result of the project would generally be equal to increased expenditures for public services. (See the revised evaluations in Chapters 4 and 5 of this document.)

11.4.23 Miscellaneous Roane County Questions (RC, A-34, Item 8)

Changes have been made in responses g, h, and j as shown below:

g. PMC, TVA and DOE are co-applicants. The NRC construction permit would be issued to them jointly.

h. DOE is the proper entity with which to discuss mitigation of CRBRP impacts.

j. The magnitude of the increased county services required, as suggested by Roane County, has been estimated by the applicants (ER Am X), but should become further quantified as a result of monitoring by the applicants (see Section 6.1.6).

The above changes are environmentally insignificant.

11.4.24 Mitigation of Impacts on Oak Ridge (OR, A-37, Item A.3)

No changes have been made to this section.

11.4.25 Combined Construction Effects (OR, A-37, Item A.4)

No changes have been made to this section.

11.4.26 Costs to Local Businessmen (OR, A-37, Item A.5)

In the first paragraph the second sentence has been replaced by the following:

> Short-term costs may accrue to local businessmen who are forced to replace existing workers who leave in order to work on the CRBRP.

The above changes is not a significant change in predicted impacts.

11.4.27 Source of Work Force During Plant Operation (ETDD, A-43)

It is quite probable that a percentage of the support personnel will be recruited from the unemployed, the underemployed, and spouses of technical workers. This statement more directly addresses the comment but does not indicate a significant change of impact.

11.4.28 Morgan County Impacts (ETDD, A-43)

No changes have been made to this section.

11.4.29 Local Government Costs for Services (ETDD, A-103)

No changes have been made to this section.

11.4.30 In-Lieu-of-Tax Payment Applications (ETDD, A-103; AC, A-30)

No changes have been made to this section.

11.4.31 Local Government Services for Mobile Homes (ETDD, A-104)

No changes have been made to this section.

11.4.32 Availability of Socioeconomic Impact Data (ETDD, A-104)

No changes have been made to this section.

11.4.33 Impacts on Lake City (ETDD, A-105)

No changes have been made to this section.

11.4.34 Health Services (ETDD, A-106)

No changes have been made to this section.

11.4.35 Property Taxes During Construction (PMC, A-93, Item 3.D)

No changes have been made to this section.

11.4.36 Plant Appearance (OR, A-40, Item 25)

No changes have been made to this section.

11.5 Environmental Impacts of Plant Operation

11.5.1 Switchyard 60-cycle Hum (OR, A-40, Item 26)

No changes have been made to this section.

11.5.2 Melton Hill Dam (AR, A-6; PMC, A-92, Item 1; TN, A-28)

No changes have been made to this section.

11.5.3 Closure of the Waterway (AR, A-3)

No changes have been made to this section.

11.5.4 Downstream Water Use (ERDA, A-13; TN, A-28)

No changes have been made to this section.

11.5.5 Classified Uses of the River (TN, A-28)

No changes have been made to this section.

11.5.6 Sport Fishing Activity (OR, A-4, Item 29)

No changes have been made to this section.

11.5.7 Cumulative Effects of Discharges (DOI, A-11)

No changes have been made to this section.

11.5.8 Impingement Losses (OR, A-4, Item 30)

The intake velocity has been reduced from a range of 0.3 to 0.5 fps to 0.2 to 0.4 fps. This is an insignificant change.

11.5.9 Compliance with FWPCA (EPA, A-17, Item 4 and A-21)

The following has been added to the response:

> The draft NPDES Permit specifies conditions for compliance with the Clean Water Act (formerly referred to as the FWPCA). See Appendix H of this document. While this current version of the permit is more restrictive than the previous one, no significant difference in environmental impacts is expected.

11.5.10 Impacts of Cooling Water Discharge (MPC, A-92, Item 2)

No changes have been made to this section.

11.5.11 Cooling Tower Drift Rate (OR, A-41, Item 32)

No changes have been made to this section.

11.5.12 Interaction With Atmospheric Plume from ORGDP (OR, A-41, Item 33)

No changes have been made to this section.

11.5.13 Fog on Route 95 and Bear Creek Road (OR, A-41, Item 34)

No changes have been made to this section.

11.5.14 Chlorine in the Cooling Tower Drift (OR, A-40, Item 27)

No changes have been made to this section.

11.5.15 Long-Term Drift Deposition (OR, A-40, Item 28)

No changes have been made to this section.

11.5.16 Drift Effects on Cave-Related Species (BN, A-89)

No changes have been made to this section.

11.5.17 Downstream Chemical Concentrations (PMC, A-95, Item 8)

No changes have been made to this section.

11.5.18 Disposal of Nonradioactive Waste (TN, A-26, 28)

No changes have been made to this section.

11.5.19 Medical Facilities (HEW, A-8)

No changes have been made to this section.

11.5.20 Required Community Services (PMC, A-93, Item 3.E.1)

No changes have been made to this section.

11.5.21 Population Increase During Plant Operation (PMC, A-93, Item 3.E.2)

The staff analysis of the population increase during plant operation has been revised as shown in Section 5.6 of this document. The Centar and Exxon projects contemplated for the area when the FES was being prepared have not materialized and further construction of the Phipps Bend Nuclear Plant has been deferred.

11.5.22 Personal Property Taxes During Operation (PMC, A-93, Item 3.F.1)

No changes have been made to this section.

11.5.23 In-lieu-of-Tax Payments by TVA (PMC, A-93, Item 3.F.2)

No changes have been made to this section.

11.5.24 Reference to Radiation Pathway Model in Section 5.7 (AC, A-31)

The current version of Regulatory Guide 1.109 is dated October 1977.

11.5.25 Radiological Impact on Biota Other Than Man (NRDC, A-54)

No changes have been made to this section.

11.5.26 Concentration of Radioactive Elements in Wildlife (DOI, A-11)

No changes have been made to this section.

11.5.27 Bioaccumulation Factor in Table 5.1 (ERDA, A-13)

No changes have been made to this section.

11.5.28 Dispersion of Gaseous Releases (C, A-8)

No changes have been made to this section.

11.5.29 Dose to Most Critical Individual (EPA, A-22, Item 2)

No changes have been made to this section.

11.5.30 Occupational Radiation Exposure (NRDC, A-55)

No changes have been made to this section.

11.5.31 Radioactive Waste Transport Route (NC, A-24)

No changes have been made to this section.

11.5.32 Summary of Annual Radiation Doses (EPA, A-18; NRDC, A-55)

The response given in the FES to NRDC comment item 3 on page A-55 has been modified as follows:

(3) Although calculation of health effects from very low level population doses is subject to great uncertainties, the staff has estimated potential health effects in updated Sections 5.7.2.5 and 5.7.3 of this document.

As indicated above, the staff is now providing the calculated health effects information requested. However, these effects are very small and do not represent a significant change in predicted impacts.

11.6 Environmental Measurement and Monitoring Programs

11.6.1 Radionuclide Analyses (ERDA, A-13)

No changes have been made to this section.

11.6.2 Radiological Monitoring of Filter Feeders (C, A-7)

Table 6.2 in the DES became Table 6.1 in the FES. No change has been made in the response to the comment.

11.6.3 Surface Water Radiological Monitoring (DOI, A-10)

No changes have been made to this section.

11.6.4 Environmental Monitoring for Tritium (EPA, A-20)

No changes have been made to this section.

11.6.5 Preoperational Radiological Monitoring (TN, A-25)

No changes have been made to this section.

11.6.6 Health Survey (ECNP, A-45, Item 3)

No changes have been made to this section.

11.6.7 Enforcement of Applicants' Monitoring Programs (NRDC, A-55)

No changes have been made to this section.

11.6.8 Modifications to Meteorological Tower (PMC, A-97, Item 22)

Section 6.1.3 has again been revised to include new data supplied by the applicants in ER Am XI. These data are cumulative and do not significantly change the basis for the staff's environmental assessments.

11.6.9 Commercial Fisheries (C, A-7)

The response in the FES has been replaced as follows:

> The draft NPDES Permit, Sections III.N and O, requires the applicants to have approved preoperational and operational nonradiological aquatic monitoring programs. The details of these programs are to be developed after construction is under way (see Appendix H of this document). The staff's opinion is that adequate information would thus become available for detecting CRBRP-caused changes in commercial fisheries and assessing their significance.

The above changes inform the reader that EPA rather than NRC is now responsible for specifying the aquatic monitoring requirements; this is not environmentally significant.

11.6.10 Heavy Metals in Biota and Sediments (C, A-7)

The following has been added: "Such monitoring should be considered for inclusion in the nonradiological aquatic monitoring programs required by the NPDES Permit."

The above addition to the previous staff response is intended to clarify the fact that the EPA, rather than NRC, is responsible for specifying what aquatic monitoring is required.

11.6.11 Groundwater Monitoring (DOI, A-10)

No changes have been made to this section.

11.7 Environmental Impacts of Postulated Accidents

Plant Accidents

11.7.1 Acceptability of Reactor Accident Risk (EPA, A-15, -20; DOI, A-10; TN, A-25; CC, A-44, 45)

In the fourth paragraph, the guideline doses to "other organs" have been revised, so that the third sentence now reads as follows:

> The exclusion area is of such size that an individual located at any point on its boundary for 2 hours immediately following onset of the postulated fission product release would not receive a total radiation dose in excess of 25 rems to the whole body or 300 rems to the thyroid, or equivalent doses to other organs (75 rems to the lung and 300 rems to bone surfaces). An additional guideline coupled to the guidance on doses to specific organs is that the mortality risk equivalent whole body dose from any postulated design-basis accident (on a calculated dose basis) for the CRBRP should be no greater than the mortality risk equivalent whole body dose value of 10 CFR 100 for a light water reactor (i.e., 34 rems whole body risk equivalent). The dose guidance of 10 CFR 100 was primarily developed for light water reactors; for the CRBRP, because it is a liquid metal fast breeder

reactor (LMFBR), dose guidelines are provided for the lung and bone surfaces which are equivalent to the 10 CFR 100 dose guideline for the thyroid dose. These dose guidelines will be used in the preparation for the CRBRP operating license; during preparation for the construction permit, however, smaller guideline values are used to allow for greater uncertainties in plant- and site-specific data (see Section 11.7.5).

The above guideline values also apply to the low population zone discussed in the fifth paragraph.

The change in guideline dose to bone is intended to better specify what is intended. No significant difference is expected in terms of environmental impact.

11.7.2 Comparability of Accident Risks to LWRs (HEW, A-8; EPA, A-19; TN, A-26; ECNP, A-46)

No changes have been made to this section.

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)

No changes have been made to this section.

11.7.4 Adequacy of Criteria and Standards (AR, A-5; EPA, A-17, 20; ECNP, A-46)

In the fourth paragraph, the fourth sentence has been modified to read as follows:

> 10 CFR 100 can be applied to LMFBRs (it has been so used previously) provided that due allowance is made for the risks of doses to other organs than the thyroid, and the limited experience with this type of plant.

11.7.5 Plutonium Dose Guidelines (ERDA, A-14; EPA, A-20; TN, A-30; OR, A-39; CC, A-44; NRDC, A-57)

The second sentence of the fourth paragraph has been changed to read:

> The staff's dose conversion factors are based on International Commission on Radiological Protection (ICRP) Publication 11.

The fifth paragraph of this section has been corrected to read as follows:

> The staff specified in its May 6, 1976 letter to the applicants that plutonium dose values 1/10th of those identified in the DES (Table 7.2, footnote 5) were to be used at the construction permit stage of review (see Appendix I). To bring the dose guidelines into conformance with more recent authoritative scientific consensus on the health risks of radiation exposure, the staff has since modified the additional dose guidelines to be applied for the CRBRP operating license review as given in Section 11.7.1. For the construction permit review, the

dose guidelines have also been updated from the 1977 FES, considering both recent scientific opinion and more recent data on the CRBR plant and site, and now are specified as 150 rems to the thyroid, 20 rems whole body, 35 rems to the lung, and 150 rems to bone surfaces, with a mortality-risk-equivalent whole-body-dose value of 24.5 rems. The equivalency of the additional organ dose guidelines to the 10 CFR 100 thyroid guideline value and the mortality risk equivalent whole body dose guideline value were determined using the stochastic weighting factors in ICRP Publication 26.

The modified guideline values above are not expected to be environmentally significant in terms of doses or health effects.

11.7.6 Design Details Affecting Accident Analysis (ECNP, A-46; PMC, A-97; DH, A-101)

No changes have been made to this section.

11.7.7 Quality Assurance (ECNP, A-46)

No changes have been made to this section.

11.7.8 Table 7.1 (PMC, A-97, Item 23A)

No changes have been made to this section.

11.7.9 Table 7.2 (PMC, A-97, Item 23B)

No changes have been made to this section.

11.7.10 Accidental Releases of Stored Noble Gases (EPA, A-20)

No changes have been made to this section.

11.7.11 Table 7.3 (PMC, A-97, Item 23C)

No changes have been made to this section.

11.7.12 Seismic Considerations (NRDC, A-52)

The third and fourth sentences of the response have been replaced by the following:

> It has been proposed that an earthquake of intensity MM VIII, characterized by a horizontal ground acceleration of 0.25 g, anchoring a Regulatory Guide 1.60 spectrum, is appropriate for CRBRP structural design. The appropriateness of this earthquake characterization is under review and will be discussed in the staff's Safety Evaluation Report. Plant features required to maintain containment and essential heat sinks will be required to be designed to withstand the appropriate earthquake without serious risk to the public or to the environment.

The above change is for clarification of the response and is not environmentally significant.

11.7.13 Sodium Behavior (CC, A-44)

No changes have been made to this section.

11.7.14 Self-Activated Shutdown Systems (EPA, A-19, 20)

No changes have been made to this section.

11.7.15 Flooding (DOI, A-10)

No changes have been made to this section.

11.7.16 Emergency Preparedness Plans (OR, A-38; CC, A-45)

The fifth sentence of the first paragraph has been replaced by the following:

> In addition, the Commission has issued NUREG-0654/FEMA-REP-1, "Criteria for Preparation and Evaluation of Radiological Response Plans and Preparedness in Support of Nuclear Power Plants," Revision 1, November 1980, for the purpose of providing detailed guidance to applicants and state and local agencies for the preparation of plans to cope with emergencies. NUREG-0654 has been endorsed by Regulatory Guide 1.101 (Revision 2).

In the second paragraph, NUREG-0654 has been substituted for Regulatory Guide 1.101.

The third paragraph has been replaced by the following:

> Because 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. Further, the facility operator is required to coordinate the onsite emergency plan with the emergency response plans of state and local authorities. As provided in a Presidential Directive dated December 7, 1979, the Federal Emergency Management Agency (FEMA) is responsible for the review and evaluation of state and local radiological emergency response plans and preparedness for areas around nuclear power plants.

In the fourth paragraph, the last sentence has been modified to read:

> Consistent with the above, the NRC staff in its safety review of an applicant's plans for coping with emergencies--and in its review of FEMA's findings and determinations as to whether state and local emergency plans are adequate and capable of being implemented--must be able to conclude that there is a reasonable assurance that protective measures can and will be taken both onsite and offsite in behalf of the public health and safety.

The above changes provide updated information, but they are not environmentally significant.

11.7.17 Insurance Liability (OR, A-38; CC, A-45, Item E)

In the first paragraph of the FES response, the words "currently $125 million" have been deleted and the following sentences inserted:

> That insurance, presently $545 million, is comprised of primary private nuclear liability insurance of $160 million available from two nuclear liability insurance pools, American Nuclear Insurers (ANI) and Mutual Atomic Energy Liability Underwriters (MAELU), and a secondary retrospective premium insurance layer up to $5 million per reactor per incident but not in excess of $10 million for a single reactor in any year. With 77 commercial reactors operating under the system, the secondary layer totals $385 million. 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 $160 million primary insurance layer.

The second paragraph has been deleted.

In the third paragraph, the following has been inserted after the first two sentences:

> The present government indemnity level is $15 million, the difference between the financial protection layer of $545 million and the $560 million liability limit.

The last sentence of the fourth paragraph and paragraphs five and six have been deleted.

The above changes provide updated information which is not significant to the staff's environmental assessment.

11.7.18 Packages of Radioactive Materials Shipped (OR, A-41, Item 35a)

NUREG-0034 has been superseded by NUREG-0170, the final environmental statement on the "Transportation of Radioactive Material by Air and Other Modes," December 1977.

11.7.19 Category 5 Shipping Accidents (OR, A-41, Item 35b)

No changes have been made to this section.

11.7.20 Spent-Fuel Shipment (OR, A-41, Item 35d)

No changes have been made to this section.

11.7.21 Beta-Gamma Waste Shipment (OR, A-41, Item 35e)

The reference to Table 5 has changed to Table D.15 of this document.

11.7.22 Doses from a Postulated Transportation Accident (OR, A-41, Item 35f)

The following sentence has been inserted after the second sentence in this section:

Doses for children would generally be higher than doses for adults at 3 meters as well as at 50 meters for most nuclides of concern.

The above insert is not environmentally new or significant information.

11.7.23 Table 7.4 - Doses from Category 5 Accidents (OR, A-41, Item 35g; ERDA, A-14)

No changes have been made to this section.

11.7.24 Risk in Shipping Fresh Fuel (OR, A-41, Item 35h)

No changes have been made to this section.

11.7.25 Safeguards Approach (EPA, A-17, Item 2(2))

The safeguards portions of the 1977 CRBRP Final Environmental Statement, principally Appendix E, have been updated and substantially revised. However, the changes do not result in significantly different impacts than those predicted in the FES. In the updated version the staff's assessment does not rely heavily on the assumption that new safeguards technologies will be developed.

Safeguards Considerations

11.7.26, 11.7.27, 11.7.28 Safeguards Considerations (NRDC, A-59)

In the years since these comments were received (early 1976) several of the issues raised have been addressed by the NRC. The NRC safeguards objective was specified in the following Commission statement, issued in May 1976:

> Safeguards measures are designed to deter, prevent, or respond to (1) the unauthorized possession or use of significant quantities of nuclear materials through theft or diversion; and (2) sabotage of nuclear facilities. The safeguards program has as its objective achieving a level of protection against such acts to insure against significant increase in the overall risk of death, injury, or property damage to the public from other causes beyond the control of the individual.

The nature of the safeguards threat to nuclear facilities has been studied extensively by the NRC and conclusions have been published in NUREG-0703, "Potential Threat to Licensed Nuclear Activities from Insiders (Insider Study)," July 1980, and in NUREG-0414, "Safeguarding a Domestic Mixed Oxide Industry Against a Hypothetical Subnational Adversary," May 1978. In addition, the current version of the physical security regulations in 10 CFR 73 contains a specification of the threat that must be used by NRC licensees as a design basis (10 CFR 73.1). Economic costs of safeguards and societal impacts were also discussed in NUREG-0414. This report concluded that the safeguards measures required to protect a mixed oxide (MOX) industry are not likely to have severe societal effects or to cost more than the safeguards required for the non-MOX nuclear industry.

The NRDC comment of about 7 years ago includes the statement that existing NRC safeguards regulations are inadequate. Since that time, upgraded physical security requirements for nuclear power reactors (10 CFR 73.55) and facilities possessing formula quantities of special nuclear material (10 CFR 73.45 and 73.46) have been put into effect. The staff believes that the CRBRP can be adequately safeguarded under the current regulations. It should be noted that the conversion, fuel fabrication, reprocessing facilities, and transportation activities related to the CRBR will be carried out under DOE regulations. The staff has performed a general assessment of the applicants' proposed safeguards systems for licensed and unlicensed CRBR fuel cycle activities and has concluded that the probability of a successful theft, diversion, or sabotage is low and, therefore, the risks associated with the events do not represent a significant increase over the risks associated with currently operating facilities. This assessment is in Appendix E.

Although the above information indicates that NRC requirements have become more formalized in recent years, no significantly different impacts from safeguards are now anticipated.

11.8 Need for the Proposed Facility

11.8.1 Objectives of the CRBRP (ECNP, A-46, Item 9)

No changes have been made to this section.

11.8.2 Progress Since Fermi (ECNP, A-46, Item 10)

No changes have been made to this section.

11.8.3 Need for the CRBRP (NRDC, A-59, 60)

No changes have been made to this section.

11.9 Alternatives

11.9.1 Alternative Energy Sources (EP, A-91; GEI, A-47; NRDC, A-60, 61)

The first sentence of the response has been replaced with the following:

> The principal purpose of the CRBRP is to demonstrate the LMFBR concept in a utility environment rather than to meet electricity requirements, consequently, this statement considers only alternatives permitting attainment of that objective.

This change is not environmentally significant.

11.9.2 Alternatives to the CRBRP (NRDC, A-60, 61)

No changes have been made to this section.

11.9.3 Sites With More Favorable χ/Q Values (NRDC, A-61)

No changes have been made to this section.

11.9.4 Sites at Hanford, Idaho, and Nevada (NRDC, A-61)

No changes have been made to this section.

11.9.5 Co-Location with Fuel Cycle Facilities (EPA, A-20, 21; NRDC, A-61)

No changes have been made to this section.

11.9.6 Underground Sites (NRDC, A-61)

The last paragraph of the response has been replaced by the following:

> Early in 1975 a study was initiated by the NRC to obtain authoritative answers to generic questions associated with the underground siting concept. This research resulted in publication of a report (NUREG-0255) entitled "Underground Siting of Nuclear Power Plants: Potential Benefits and Penalties," which was published in August 1977. The study examined the potential benefits to safety as well as any potential penalties that might result from siting plants underground in mined cavities or by covering plants with fill earth after construction in an excavated cut.
>
> The study concluded that underground plants had safety advantages over surface plants with regard to
>
> (1) protection against aircraft crashes or warfare munitions which could conceivably initiate a reactor accident, and
>
> (2) improved retention of radioactive releases to the atmosphere following a core meltdown, provided that the numerous penetrations to the surface from an underground plant were promptly isolated and maintained closed during and subsequent to an accident to prevent release of radioactivity to the atmosphere. The study identified the design and appropriate maintenance of such seals as a critical design problem for underground plants, and also pointed out that prompt isolation of such seals could reduce the movement of any operating or maintenance personnel located below ground at the time of an accident.
>
> The study also found that there may be a modest reduction in seismic vulnerability for underground plants.
>
> The principal disadvantages of underground plants were found to be
>
> (1) greater operational problems associated with inservice inspection and maintenance which, in turn, could lead to decreased equipment reliability and an increased probability of an accident,
>
> (2) groundwater contamination, which was more likely in an underground plant following an accident, and
>
> (3) the increased cost for an underground plant, which was estimated to be 20 to 40% greater than that for a surface plant.

The overall conclusion of the study was that the expected benefits of underground siting in terms of improved safety do not appear to offset the penalties.

The above information is cumulative and does not significantly change the staff's conclusions on this matter in the FES.

11.9.7 Cooling Tower Arrangement (PMC, A-97, Item 24)

No changes have been made to this section.

11.9.8 Corrections in Table 9.5 (ERDA, A-14)

The comment referred to Table 9.5 of the DES, which became Table 9.8 in the FES. There has been no change in the response.

11.9.9 Thermal Effects at the Discharge (OR, A-41, Item 31)

The following has been added to the response:

Conditions for protection of the aquatic environment from thermal impacts are specified in the draft NPDES Permit (see Appendix H of this document).

11.9.10 Ease of Monitoring (TN, A-26)

No changes have been made to this section.

11.9.11 Proximity to the Gaseous Diffusion Plant and ORNL (NRDC, A-62)

The first paragraph of the FES response has been replaced with the following:

The Oak Ridge Gaseous Diffusion Plant, which produces enriched uranium, is about 3 miles north-northwest from the Clinch River site. Oak Ridge National Laboratory, located about 4 miles east-northeast from the site, is engaged in basic and applied research for nuclear and other energy-related technologies. Production, research, and development for DOE's national defense programs are provided by the facilities at the Y-12 plant located about 9 miles northeast of the proposed CRBRP site. These facilities at the Oak Ridge reservation are under the control of DOE; long range land-use planning and selection of sites for future activites are governed by official DOE procedures and instructions.

In the second paragraph, the last sentence has been replaced with the following:

There are existing DOE plans and facilities for coping with plant emergencies, such as a release of toxic material. However, it must also be recognized that due to the nature of operations at the gaseous diffusion plant and other Oak Ridge facilities, information is not readily available. Consequently, the staff has not evaluated the impacts of severe accidents on activities at the DOE-controlled facilities.

The above changes are not environmentally significant.

11.10 Evaluation of the Proposed Action

11.10.1 Risks Associated with Accidental Radiation Exposure (NRDC, A-62)

No changes have been made to this section.

11.10.2 Health Consequences (NRDC, A-62)

The second sentence of the response has been changed to read:

> Potential health effects are estimated in updated Sections 5.7.2 5 and 5.7.3.

11.10.3 Alternative Development of Site (OR, A-38, Item B)

No changes have been made to this section.

11.10.4 Complementary Uses of Site (OR, A-38, Item B)

No changes have been made to this section.

11.10.5 Public Uses of "Restricted Area" (OR, A-38, Item 3B)

No changes have been made to this section.

11.10.6 Decommissioning (NRDC, A-63)

The response to the first comment has been replaced by the following:

> An isolation period has not been estimated for any decommissioned licensed reactor but has been estimated for Piqua, Hallam, and Bonus (Demonstration power plants), which were entombed. The radionuclide Ni-63 (92-year half life) was analyzed in determining the acceptability of the entombment structures. In the Piqua decommissioning report (AI/AEC 12832, 1970) the Ni-59 inventory was determined to be about 1% of the Ni-63 inventory. NUREG/CR-0130 predicts about the same ratio of Ni-59 to Ni-63 for PWR reactors. Isolation periods for Piqua, Hallam, and Bonus were estimated at 100 to 140 years. For these periods of time, the inventory of NI-63 would be expected to exceed the inventory of Ni-59 by a factor of 30 to 50.

The response to the second comment has been replaced as follows:

> The NRC staff position is that long-lived isotopes (Nb-94, NI-63, and Ni-59) in excess of quantities acceptable for release to unrestricted access areas would be removed at the end of a mothball/safe storage period or removed before entombment. Therefore, there is no need to consider an isolation period of 1.5 million years.

The response to the third comment has been replaced as follows:

Section 10.2.4.1 of this document addresses the environmental impacts of decommissioning the CRBRP more completely than does the 1977 FES. The NRC anticipates that the plant will either be dismantled shortly after final shutdown or dismantled after a period of 50 to 100 years in a safe storage status. For these alternatives, there is no isolation period following decommissioning, because decommissioning is not complete and the license is not terminated until residual radioactivity, above levels acceptable for release to unrestricted access areas, is removed from the site. If the CRBRP is entombed, components with long-lived radionuclides, such as the reactor vessel internals and the reactor vessel itself, would have to be removed prior to entombment. For this alternative also, decommissioning would not be complete and the license would not be terminated until residual radioactivity meets the current criteria for release of the facility to unrestricted access areas.

The staff presently relies on estimates of neutron activation products in NUREG/CR-0030 and data from previously decommissioned reactors. In addition, the NRC has contracted with Battelle/PNL to review the applicants' estimates of neutron activation products important to decommissioning.

The above information has been updated to provide information available at this time. No significant changes in the impacts assessed in the FES are anticipated.

11.10.7 Achieving CRBRP Objectives (NRDC, A-63)

No changes have been made to this section.

11.10.8 Payroll 1991-2013 (EP, A-91)

The response in the FES has been updated as follows:

The CRBRP payroll is estimated in amended ER Section 8.2.2.1 to be a total of $613,300,000 during construction and the 30-year operation of the plant.

The increased payroll constitutes a substantial benefit to the local area, but it does not significantly change the staff's evaluation of the CRBRP.

11.10.9 Cost Estimates (EP, A-91)

The response in the FES has been replaced as follows:

The applicants' revised cost estimate for the CRBRP to a project total of $3196.5 million and the staff's analysis are given in Section 10.4.2.2. Capital cost information for commercial LMFBR reactors is provided in WASH-1535, Section 11, and ERDA-1535, Section III F.2, but it has not been updated.

The above change in cost is not significant to the staff's environmental review since the Congress and the President determine whether the project is worth its cost.

11.10.10 Benefit Cost Balance (EP, A-91)

The second paragraph in this section has been replaced with the following:

> The staff's overall cost-benefit conclusion is that the Clinch River project, as currently defined, offers the "least cost" solution for meeting the programmatic objectives under the LMFBR program (Section 10.4.3).

11.11 Appendix D - Environmental Effects of the CRBRP Fuel Cycle and Transportation of Radioactive Materials

11.1.1 and 11.11.2 Doses from Fuel Cycle Effluents (ERDA, A-14)

The staff has reassessed the doses from normal CRBRP fuel cycle operations in light of DOE's latest information as contained in ER Am XIV. These assessments are summarized in Table D.17 of Appendix D to this document. Although the estimated doses to the U.S. population are somewhat higher than previously projected, they are still a small fraction (0.001%) of the corresponding population dose from 1 year of exposure to natural background radiation.

The above changes are insignificant in terms of environmental effects.

11.11.3 Basis for Estimates Used in Tables of Appendix D (NRDC, A-63, 64)

The NRDC comment was related to the contention that NRC had developed its assessment of the CRBRP fuel cycle from a scale down of a generic analysis of a much larger commerical LMFBR industry. In Appendix D of this updated document, the staff has based its assessment on normal operation of the specific facilities projected by DOE to be used for CRBRP fuel cycle activities. (See Figure D.1 and Section D.2 for details of assumptions and bases for assessments. Summaries of environmental considerations and U. S. population doses are in Table D.4 and D.17, respectively.)

The above changes are insignificant in terms of environmental effects.

11.11.4 Radiological Consequences of Fuel Transportation (PMC, A-98, Item 26)

No changes have been made to this section.

11.11.5 Coolant for Fuel Transport Casks (EPA, A-17, Item 2 (4))

No changes have been made to this section.

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)

The response in the FES has been replaced as follows:

> The safeguards systems for the CRBRP fuel cycle facilities will employ a variety of material control and accounting (MC&A) components as well as extensive physical security measures. These are broadly

described in Appendix E. Physical security measures--such as access controls, intrusion detection systems, response forces, and communications systems--are viewed as the first line of defense against theft, diversion, or sabotage. Material control measures, such as monitoring programs and special nuclear material (SNM) containment syste[illegible] reinforce the protection provided by physical security and provide a background against which material accounting systems can function effectively. A material accounting system performs measurements and maintains records in order to provide positive assurance that all SNM is present. Should a loss occur, accounting systems must be able to determine the general location of a loss and estimate the amount of SNM involved. As a secondary function, accounting systems provide backup loss detection capabilities and help ensure that the physical security and material control systems and not being circumvented.

The 1% measurement uncertainty mentioned in the comment is apparently a reference to the NRC requirement (see 10 CFR 70.51 for details) that a reprocessing licensee must establish a limit of error on a 6-month inventory difference of no more than 1% of the plant's plutonium throughput. In 1977 it was generally assumed that licensed facilities would be used to support the CRBRP. The facilities that the applicants are now proposing to use for reprocessing, plutonium conversion, and core fuel fabrication will be subject to DOE, not NRC, regulations. In their Environmental Report, the applicants specified the expected limits of error for each of these plants: 0.5% of throughput for bimonthly balances in the conversion and fabrication facilities and 0.7% of throughput for yearly balances in the reprocessing plant. In addition to the conventional material accounting capabilities described by these figures, the applicants stated that the conversion, fabrication, and reprocessing facilities will be equipped with prompt accounting systems to provide more sensitive and rapid indications of material loss.

The above changes are insignificant in terms of environmental impacts.

11.13 Other Considerations and Changes

Section 6.1 and 6.2 - In the third paragraph, the reference to FES Section 5.4 has been corrected to 5.6.

Section 7.3 and Appendix E - In this updated document, Appendix E contains a description of the planned safeguards proposed by DOE in ER Am XIV and the staff assessment of those safeguards. Section 7.3 contains a discussion of potential abnormal environmental impacts that could occur as a result of acts of sabotage or theft or diversion of plutonium from CRBRP or its associated fuel cycle or transportation links. Thus, the bulk of the safeguards material is contained in Appendix E.

Section 9.4.1, Paragraph 3 - The response should have referred to Table 9.8 rather than amended Table 9.5.

Appendix D - Note the updated response in Section 11.11.3.

REFERENCES

Alabaster, J. S., "Effects of Heated Discharges on Freshwater Fish in Britain," in P. A. Krenkel and F. A. Parker, eds, Biological Aspects of Thermal Pollution, Vanderbilt Univ. Press, pp. 161-185, 1969.

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

Atomics International, "Adsorption Bed Performance Equations for Isothermal Steady State Streams," Report No. T1-009-630-001, October 1973.

---, "Piqua Decommissioning Report," report prepared for AEC, AI/AEC 12832, January 1970.

---, "Retirement of the Hallam Nuclear Power Facility, report prepared for AEC, AI/AEC 12709, May 15, 1970.

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

Bush, R. M., E. B. Welch, and B. W. Mar, "Potential Effects of Thermal Discharges on Aquatic Systems," Univ of Wash., Seattle, 1972.

Cada, G. F. and J. M. Loar, "Ichthyoplankton," in J. M. Loar, ed, "Ecological Studies of the Biotic Communities in the Vicinity of the Oak Ridge Gaseous Diffusion Plant," ORNL/TM-6714, Oak Ridge National Laboratory, TN, 1981.

Cheek, P. S., NRC, letter to William C. Hickling, U.S. Fish and Wildlife Service, Ashville, NC, October 29, 1981.

Check, T. E., "Distribution and Habitat Selection of Adult Striped Bass, Morone saxatilis (walbaum), Watts Bar Reservoir, Tennessee," master's thesis, Tennessee Technological Univ, March 1982.

Copeland, R. L., DOE, letter to P. S. Check, NRC, response to Question 290.5R, November 18, 1981.

Coutant, C. C., "Striped Bass and the Management of Cooling Lakes," in S. S. Lee and S. Sengupta, eds, Proceedings of the 3rd conference on Waste-Heat Management and Utilization, 11-13 May 1981, Hemisphere Publishing Co., Washington, D.C, 1982.

Exxon Nuclear Company, Inc., "Nuclear Fuel Recovery and Recycling Center Environmental Report," Vols I and II, USNRC Docket No. 50-564, December 16, 1976.

Fitz, R. B., "Fish Habitat and Population Changes Resulting from the Impoundment of Clinch River by Melton Hill Dam," Tenn. Acad. Sci., 43(1):32-38, 1968.

Fletcher, J. W., "Assessment of Adult and Larval Fish Populations of the Lower Clinch River Below Melton Hill Dam," master's thesis, Tennessee Technological Univ, 1977.

Geraghty, J., D. Miller, F. Van der Leeden, and F. Troise, 1973 Water Atlas of the U.S., Water Information Center, New York, 1973.

Gray, J. "How Fishes Swim," Sci Am, Vol 197, pp 48-54, 1957.

Griffith, J. S. and D. A. Tomljanovich, "Susceptibility of Threadfin Shad to Impingement," Proc Am Conf Southeast Assoc Game and Fish Comm, 10:85-91, 1975.

Hickling, W. C., U.S. Fish and Wildlife Service, letter to P. S. Check, NRC, November 5, 1981.

Horton, K.E., DOE, "Fast Breeder Reactor Development in the United States of America," March 31, 1982.

Hudson, C. R., III, "CONCEPT-5 Users' Manual," ORNL 5470, Oak Ridge National Laboratory, January 1979.

International Commission on Radiological Protection (ICRP), "Recommendations," ICRP Publication 11.

---, Publication 26, January 1977.

Jensen, L. D., R. M. Davies, A. S. Brooks, and C. D. Meyers, "The Effects of Elevated Temperatures Upon Aquatic Invertebrates," Johns Hopkin Univ, prepared for the Edison Electric Institute, Report No. 4, 1969.

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.

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.

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, OH, 1970

Loar, J. M. and F. A. Burkhart, "Zooplankton," in J. M. Loar, ed, "Ecological Studies of the Biotic Communities in the Vicinity of the Oak Ridge Gaseous Diffusion Plant," ORNL/TM-6714, Oak Ridge National Laboratory, TN, 1981.

Loar, J. M., J. A. Solomon, and G. F. Cada, "Technical Background Information for the ORNL Environmental and Safety Report," Vol 2, ORNL/TM-7509/V2, Oak Ridge National Laboratory, TN, 1981.

Longenecker, J. R., letter to P. S. Check, NRC, response to Question 320.1R, December 22, 1981.

---, letter to P. S. Check, NRC, January 29, 1982a.

---, letter to P. S. Check, NRC, response to Question 320.6R, February 5, 1982b.

---, letter to P. S. Check, NRC, February 12, 1982c.

---, letter to P. S. Check, NRC, May 28, 1982d.

---, letter to P. S. Check, NRC, transmitting ER Am XIV, June 4, 1982e.

Masnik, M., NRC, memorandum to files on telephone conversation on striped bass on December 14, 1981, dated July 7, 1982a.

---, memorandum to files on conversation with John Jenkinson, TVA, on mussels, June 16, 1982, dated July 7, 1982b.

McClure, J. D., "The Probability of Spent Fuel Transportation Accidents," Sandia National Laboratories, SAND 80-1721, 1982.

Morris, P., AEC, letter to R. Kamber, Consumers Public Power District, November 3, 1967.

Morton, T., "Characterization of Benthic Macroinvertebrate Communities Influenced by Winter Reservoir Drawdown and Stream Recovery," master's thesis, Tennessee Technological Univ, 1978.

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

---, BEIR III, 1980.

---, "Highway Capacity Manual - 1965," Special Report 87, 1965.

National Council on Radiation Protection and Measurements (NCRP), "Review of the Current State of Radiation Protection," Report 43, January 1975.

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)," Ph.D. dissertation, Univ of Wisc, Madison, WI, 1970.

Oakley, D. T., "Natural Radiation Exposure in the United States," ORP/SID 72-1 USEPA, June 1972.

Power Reactor Development Co., "Retirement of the Enrico Fermi Atomic Power Plant," report prepared for DOE, Supplement 1, October 1975.

Reid, R., NRC, letter to Dr. J.L. Thomas, NC State Univ, March 6, 1981.

Sasson, A. M., "Benthic Macroinvertebrates," in J. M. Loar, ed, "Ecological Studies of the Biotic Communities in the Vicinity of the Oak Ridge Gaseous Diffusion Plant," ORNL/TM-6714, Oak Ridge National Laboratory, TN, 1981.

Schroedl, G. F., "Archeological Reconnaissance and Test Excavation at the Clinch River Liquid Metal Fast Breeder Reactor Site," report submitted to TVA, December 1972.

Scott, E. M., "Clinch River Sauger Study," manuscript prepared for TVA, 1980.

Sherry, D., TWRA, letter to Mike Webb, State Planning Office, State of Tennessee, Nashville, dated November 6, 1981.

Sinclair, R. M., "Corbicula variation and Dreissena parallels," paper presented to the 36th Annual Meeting of the American Malacological Union, Key West, FL, 1970.

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, 1974.

Taylor, M. P., "Phytoplankton Productivity Response to Nutrients Correlated with Certain Environmental Factors in Six TVA Reservoirs," in G. E. Hall, ed, "Reservoir Fisheries and Limnology," Am. Fish. Soc. Spec. Publ. No. 8., Washington, 1971.

Tennessee Valley Authority, "Final Environmental Impact Statement, Code Classification Project," TVA 10NR/PCS-81/3, July 1981b.

---, Division of Community Development, "Hartsville Nuclear Plant Socioeconomic Monitoring and Mitigation Report, March 31, 1979," October 1979.

--- "Phipps Bend Nuclear Plant Socioeconomic Monitoring and Mitigation Report, May 31, 1980," January 1981a.

---, "Results of May 1978 Survey of Bellefonte Nuclear Plant Construction Employees," October 1980a.

---, "Site Evaluation Report, Nuclear Units x21-22, x24-25," February 1975.

---, "Sequoyah Nuclear Plant Construction Employee Survey, September 1978," September 1980b.

---, "Yellow Creek Nuclear Plant Socioeconomic Monitoring and Mitigation Report, December 30, 1979," October 1980c.

---, Division of Navigation Development and Regional Studies, "Watts Bar Nuclear Plant Construction Employee Survey, October 1977," September 1978.

Tennessee Water Quality Control Board, "General Water Quality Criteria for the Definition and Control of Pollution in the Waters of Tennessee," October 1973.

Tennessee Wildlife Resources Commission, "Proclamation - Endangered or Threatened Species," Proclamation No. 75-15, June 12, 1975.

Thomas, P. M. Jr., "A Map of Two Historical Sites in the Clinch River Liquid Metal Fast Breeder Reactor Plant Area," March 1973.

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

United Power Association, "Final Elk River Reactor Program Report," COO-651-93.

U.S. Atomic Energy Commission, "Final Environmental Statement (FES), Alvin W. Vogtle Nuclear Plant," March 1974

---, WASH-1238, "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," 1972.

---, WASH-1535, "Proposed Final Environmental Statement-Liquid Metal Fast Breeder Reactor Program," December 1974.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Survey, "Sectional Aeronautical Charts for the U.S."

U.S. Department of Energy (DOE), "Site Preparation Activities Report," November 1981.

---, "LMFBR Conceptual Design Study, Final Report, Preliminary Environmental Review Summary," CDS-400-10, March 1981.

---, "LMFBR Conceptual Design Study, Final Report, Site Evaluation Report," CDS-400-91, March 1981.

---, DOE-EIS-0082, "Final Environment Statement, Defense Waste Processing Facility, Savannah River Plant, Aiken, SC," February 1982.

---, DOE-EIS-0085-FS, "Supplement to the LMFBR Program Environmental Statement, May 1982."

U.S. Department of Health and Human Services (HHS), "Summary of Criteria for Designation of Health Manpower Shortage Areas," 1977.

U.S. Department of Transportation, "Trends and Choices (to the Year 2000)," January 1977.

U.S. Energy Research and Development Agency (ERDA), ERDA-40, "Environmental Impact of Transportation of Nuclear Materials in the LMFBR Program," 1975.

---, ERDA-1535, "Final Environmental Statement for the Liquid Metal Fast Breeder Reactor Program," December 1975.

---, ERDA-1536, "Final Environmental Impact Statement, Waste Management Operations, Idaho National Engineering Laboratory," September 1977.

---, ERDA-1537, "Final Environmental Impact Statement, Waste Management Operations, Savannah River Plant," September 1977.

---, ERDA-1538, "Final Environmental Statement, Waste Management Operations, Hanford Reservation," Vols 1 and 2, December 1977.

U.S. Environmental Protection Agency (EPA), "Proposed Criteria for Water Quality," Vol 1, October 1973.

U.S. Nuclear Regulatory Commission, Memorandum and Order, in the matter of CRBRP, August 27, 1976.

---, NUREG-0002, "Final Generic Environmental Statement on the Use of Recycled Plutonium in Mixed Oxide Fuel in Light Water Cooled Reactors," August 1976.

---, NUREG-0014, "Safety Evaluation Report, Hartsville Nuclear Plant Units A1, A2, B1 and B2," April 1974.

---, NUREG-0101, "Safety Evaluation Report, Phipps Bend Nuclear Plant Units 1 and 2," April 1977.

---, NUREG-0116, "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," 1976.

---, NUREG-0170, "Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes," December 1977.

---, NUREG-0255, "Underground Siting of Nuclear Power Plants," August 1977.

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

---, NUREG-0347, "Safety Evaluation Report, Yellow Creek Nuclear Plant Units 1 and 2," December 1977.

---, NUREG-0414, "Safeguarding Domestic Mixed Oxide Industry Against Hypothetical Subnational Adversary," May 1978.

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

---, NUREG-0555, "Environmental Standard Review Plan," May 1979; draft revision of Section 9.2, Alternative Sites, November 1981.

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

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

---, NUREG-0703, "Potential Threat to Licensed Nuclear Activities," July 1980.

---, NUREG-0713, B. G. Brooks, "Occupational Radiation Exposures at Commercial Nuclear Reactors, 1980," Vol 2, December 1981.

---, NUREG-0782, "Draft Environmental Impact Statement on 10 CFR Part 61: Licensing Requirements for Land Disposal of Radioactive Waste," September 1981.

---, NUREG-0786, "Site Suitability Report in the Matter of Clinch River Breeder Reactor Plant," June 1982.

---, NUREG/CR-0130, "Technology, Safety, and Costs of Decommissioning a Reference PWR Power Station," June 1978; Addendum, August 1979.

---, NUREG/CR-2002, S. Malhotra and D. Manninen, "Migration and Residential Location of Workers at Nuclear Power Plants," Pacific Northwest Laboratories, Vol 1, April 1981.

---, NUREG/CR-2762, A. G. Croff and M. A. Bjerke, "An ORIGEN 2 Model and Results for the Clinch River Breeder Reactor," 1982 (also ORNL/NUREG-5884).

Van Nort, P.S., PMC, letter to R.S. Boyd, NRC, April 14, 1976.

Washington Public Power Supply System (WPPSS), "Skagit/Hanford Nuclear Project Preliminary Safety Analysis Report."

---, "Preoperational Environmental Monitoring Studies Near WPN-1, 2, and 4, August 1978 through March 1980," WPPSS Columbia River Ecology Studies, Vol 7, Beak Consultants, Portland, OR, 1980.

APPENDIX A

COMMENTS ON THE DRAFT ENVIRONMENTAL STATEMENT

No changes have been made to this Appendix.

APPENDIX B

TENNESSEE WILDLIFE RESOURCES COMMISSION
PROCLAMATION
ENDANGERED OR THREATENED SPECIES

AND

U.S. DEPARTMENT OF THE INTERIOR
LETTER REGARDING
LISTED AND PROPOSED ENDANGERED
AND THREATENED SPECIES

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

MOLLUSCS

ENDANGERED

Birdwing pearly mussel	*Conradilla caelata*
Dromedary pearly mussel	*Dromus dromas*
Yellow-blossom pearly mussel	*Epioblasma (-Dysnomia) florentina florentina*
Green-blossom pearly mussel	*Epioblasma (-Dysnomia) torulosa gubernaculum*
Tuberculed-blossom pearly mussel	*Epioblasma (-Dysnomia) torulosa torulosa*
Turgid-blossom pearly mussel	*Epioblasma (-Dysnomia) turgidula*
Tan riffle shell pearly mussel	*Epioblasma (-Dysnomia) walkeri*
Fine-rayed pigtoe pearly mussel	*Fusconaia cuneolus*
Shiny pigtoe pearly mussel	*Fusconaia edgariana*
Pink mucket pearly mussel	*Lampsilis orbiculata orbiculata*
White warty-back pearly mussel	*Plethobasis cicatricosus*
Orange-footed pimpleback	*Plethobasis cooperianus*
Rough pigtoe pearly mussel	*Pleurobema plenum*
Cumberland monkeyface pearly mussel	*Quadrula intermedia*
Appalachian monkeyface pearly mussel	*Quadrula sparsa*
Pale lilliput pearly mussel	*Toxolasma (-Carunculina) cylindrella*
Painted snake coiled forest snail	*Anguispira picta*

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 tanasi*

Proc. No. 75-15*

**Section I amended by Proc. No. 77-4 dated May 13, 1977, Proc. No. 78-14 dated Sept. 22, 1978; and, Proc. No. 78-20 dated Dec. 8, 1978.*

SECTION I. (Continued)

FISH (Continued)

THREATENED

Silverjaw Minnow	*Ericymba bucatta*
Slender Chub	*Hybopsis cahni*
Blue Sucker	*Cycleptus elongatus*
Pigmy madtom	*Noturus sp. (cf. N. hilderbrandi)*
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 Longperch	*P. sp. (cf. P. caprodes)*

AMPHIBIANS

THREATENED

Tennessee Cave Salamander	*Gyrinophilus palleucus*

REPTILES

THREATENED

Northern Pine Snake	*Pituophis m. melanoleucus*
Western Pigmy Rattlesnake	*Sistrurus miliarius streckeri*

BIRDS

ENDANGERED

Mississippi Kite	*Ictinea mississippiensis*
Golden Eagle	*Aquila chrysaetos*
Bald Eagle	*Haliaeetus leucocephalus*
Osprey	*Pandion haliaetus*
Peregrine falcon	*Falco peregrinus*
Red-cockaded Woodpecker	*Picoides 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*
Black-Crowned Night Heron	*Nycticorax nycticorax*

Proc. No. 75-15*

**Section I amended by Proc. No. 77-4 dated May 13, 1977, Proc. No. 78-14 dated Sept. 22, 1978; and, Proc. No. 78-20 dated Dec. 8, 1978.*

SECTION I. (Continued)

MAMMALS

ENDANGERED

Eastern Cougar	*Felix concolor cougar*
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.

Date: June 12, 1975

Proc. No. 75-15*

**Section I amended by Proc. No. 77-4 dated May 13, 1977, Proc. No. 78-14 dated September 22, 1978; and, Proc. No. 78-20 dated Dec. 8, 1978.*

United States Department of the Interior
FISH AND WILDLIFE SERVICE
PLATEAU BUILDING, ROOM A-5
50 SOUTH FRENCH BROAD AVENUE
ASHEVILLE, NORTH CAROLINA 28801

November 5, 1981

RECEIVED
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U.S. NUCLEAR REGULATORY COMMISSION

Mr. Paul S. Check
Director
CRBR Program Office
Office of Nuclear Reactor Regulation
Nuclear Regulatory Commission
Washington, DC 20555

Re: 4-2-82-047

Dear Mr. Check:

We have reviewed the proposed Clinch River Breeder Reactor Plant in Anderson County, Tennessee, as requested by letter of October 26, 1981, received October 29, 1981.

Federally listed Endangered (E) and/or Threatened (T) and/or species proposed for listing as Endangered (PE) or Threatened (PT) may occur in the area of influence of this action.

To facilitate compliance with Section 7(c) of the Endangered Species Act of 1973, as amended, Federal agencies or designated non-Federal representatives are required to obtain from the Fish and Wildlife Service information concerning the possible presence of any species, listed or proposed to be listed, which may be present in the impact area of a proposed major Federal action significantly affecting the quality of the human environment. Therefore, we are furnishing you the following list of species which may be present in the concerned area:

Gray bat (Myotis grisescens) - E
White warty-back pearly mussel (Plethobasis cicatricosus) - E
Dromedary pearly mussel (Dromus dromas) - E
Yellow-blossom pearly mussel (Epioblasma florentina florentina) - E
Fine-rayed pigtoe pearly mussel (Fusconaia cuneolus) - E
Shiny pigtoe pearly mussel (Fusconaia edgariana) - E
Pink mucket pearly mussel (Lampsilis orbiculata orbiculata) - E
Orange-footed pearly mussel (Plethobasis cooperianus) - E
Rough pigtoe pearly mussel (Pleurobema plenum) - E
Birdwing pearly mussel (Conradilla caelata) - E
Green-blossom pearly mussel (Epioblasma torulosa gubernaculum) - E
Alabama lamp pearly mussel (Lampsilis virescens) - E
Slender chub (Hybopsis cahni) - T

In addition to listed and proposed Endangered and Threatened species, there are species which, although not now listed or officially proposed for listing as Endangered or Threatened, are under status review (SR) by the Service and may be listed at some time in the future. Status review species

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are not legally protected under the Endangered Species Act and the biological assessment requirements do not apply to them. However, we would appreciate any efforts you might make to avoid adversely impacting them. The following species under status review may occur within the project area:

Cimicifuga rubifolia
Saxifraga careyana
Spiny River snail (Io fluvialis)

Section 7(c) and regulations being prepared to implement Section 7(c) also require the Federal agency or the designated non-Federal respresentative proposing a major Federal action to conduct and submit to the Service a biological assessment to determine the effects of the proposal on listed and proposed Endangered and Threatened species. The biological assessment shall be completed within 180 days after the date on which initiated or within a time frame mutually agreed upon between the agency and the Service and before initiating the proposed action. If the biological assessment is not begun within 90 days, this list must be verified informally (via phone) with us prior to initiation of your assessment. We do not feel that we can adequately assess the effects of the proposed action on listed and proposed Endangered and Threatened species or Critical Habitat without a complete assessment. When conducting a biological assessment, the Federal agency or the designated non-Federal representative must, at a minimum:

1. Conduct a scientifically sound on-site inspection of the area affected by the action, which must, unless otherwise directed by the Service, include a detailed survey of the area to determine if listed or proposed species are present or occur seasonally and whether suitable habitat exists within the area for either expanding the existing population or potential reintroduction of populations;

2. Interview recognized experts on the species at issue, including those within the Fish and Wildlife Service, the National Marine Fisheries Service, state conservation agencies, universities, and others who may have data not yet found in scientific literature;

3. Review literature and other scientific data to determine the species' distribution, habitat needs, and other biological requirements;

4. Review and analyze the effects of the action on the species, in terms of individuals and populations, including consideration of the cumulative effects of the action on the species and habitat;

5. Analyze alternative actions that may provide conservation measures;

6. Conduct any studies necessary to fulfill the requirements of (1) through (5) above;

7. Review any other relevant information.

Should you require additional information on this subject, please contact Mr. Gary Henry, Mr. Robert Currie, or Ms. Nora Murdock in the Asheville Area Office, FTS 672-0321, commercial 704/258-2850, ext. 321.

After the assessment has been completed and reviewed, it is the responsibility of the Federal agency to determine if the proposed action "may affect" any of the listed species or Critical Habitats or if it is likely to jeopardize the continued existence of proposed species or result in the destruction or adverse modification of any Critical Habitat proposed for such species. If the determination is "may affect" for listed species the Federal agency must request in writing formal consultation from this office. Requests for formal consultation must include: (1) a description of the action to be considered; (2) a description of the specific area that may be affected by the action; (3) a description of any listed species or Critical Habitat that may be affected by the action; (4) a description of the manner in which the action may affect any listed species or Critical Habitat and an assessment of any cumulative effects; (5) reports including any environmental impact statement, environmental assessment, or biological assessments prepared; and (6) any other relevant available information on the action, the affected listed species, or Critical Habitat.

In addition, if the proposed action is likely to jeopardize the continued existence of proposed Endangered or Threatened species or result in the destruction or adverse modification of proposed Critical Habitat, the Federal agency must confer with this office for assistance in identifying and resolving potential conflicts at an early stage in the planning process.

Attention is also directed to Section 7(d) of the Endangered Species Act, as amended, which underscores the requirement that the Federal agency and/or the permit or license applicant shall not make any irreversible or irretrievable commitment of resources during the consultation period which, in effect, would deny the formulation or implementation of reasonable alternatives regarding their actions on any listed Endangered or Threatened species.

If we can be of further assistance, please advise.

Sincerely yours,

William C. Hickling
Area Manager

cc:
Mr. Bob Hatcher, Wildlife Res. Agency, Nashville, TN
Program Administrator, TN Heritage Program, Nashville, TN
Director, FWS, Washington, DC (OES)
Regional Director, FWS, Atlanta, GA (ARD-FA/SE)
Field Supervisor, ES, FWS, Cookeville, TN

APPENDIX C

ADDITIONAL CORRESPONDENCE REGARDING ARCHEOLOGICAL AND HISTORICAL RESOURCES

TENNESSEE DEPARTMENT OF CONSERVATION
TENNESSEE HISTORICAL COMMISSION
701 Broadway
Nashville, TN 37203
615/742-6716

May 17, 1982

Mr. Maxwell D. Ramsey
Program Manager, Cultural Resources
Division of Land and Forest Resources
Tennessee Valley Authority
Norris, Tennessee 37828

Re: Clinch River Breeder Reactor Project (CRBRP)-review of recent archaeological, historical and architectural identification studies

Dear Max:

The above reports were reviewed by the State Historic Preservation Officer and his staff with regard to compliance in federal historic preservation laws and regulations. Based on the information supplied and previous work in the CRBRP area, it is our opinion that the project as presently planned will not affect any properties included in or eligible for inclusion in the National Register of Historic Places.

No further action is required to comply with the National Historic Preservation Act unless project plans are changed or archaeological sites are discovered during construction.

Thank you for your continued cooperation.

Sincerely,

Herbert L. Harper

Herbert L. Harper
Executive Director and
Deputy State Historic
Preservation Officer

HLH:sd

APPENDIX D

ENVIRONMENTAL EFFECTS OF THE CRBRP FUEL CYCLE AND TRANSPORTATION OF RADIOACTIVE MATERIALS

The material in this appendix replaces the material in Appendix D in the original issuance of the FES.

D.1 INTRODUCTION

In February 1977 the Nuclear Regulatory Commission (NRC) issued NUREG-0139 (NRC 1977a), Final Environmental Statement Related to Construction and Operation of Clinch River Breeder Reactor Plant (CRBRP). The environmental effects of the CRBR fuel cycle and of the transportation of radioactive materials between supporting facilities were considered in Appendix D of that document based upon the then-postulated future commercial facilities. The NRC Atomic Safety and Licensing Board admitted contentions of intervenors (Natural Resources Defense Council, et al.) relating to the alleged inadequacy of the Appendix D analysis to address environmental impacts of the specific CRBRP fuel cycle, including location and mode of operation for the management of radioactive wastes. The analysis which follows addresses both new information and responds to the admitted contentions.

In the Appendix D analysis, the NRC staff considered the applicants' environmental analysis which was supplied in their Environmental Report on the CRBRP, as amended (AEC 1974a). As part of that analysis for fuel cycle impacts, the applicants relied on the Atomic Energy Commission (AEC) and Energy Research and Development Administration (ERDA) generic programmatic environmental impact statements for liquid metal fast breeder reactors, WASH-1535 (AEC 1974c) and ERDA-1535 (ERDA 1975a). That analysis assumed the availability of commercial-scale facilities to support a large-scale LMFBR fuel cycle and considered the total impacts of an entire breeder industry. The applicants estimated the impacts of the CRBRP fuel cycle by prorating the impacts of a large breeder industry to the corresponding CRBRP fuel cycle. The factor used represented that fraction of the total industrial LMFBR thermal power output to that attributable to CRBRP.

In the mid-1970s, the staff considered this method acceptable since commercial-scale reprocessing and recycle facilities were planned for the LWR fuel cycle and could be projected to be applicable to the CRBRP fuel cycle. Accordingly, the staff followed this rationale to some extent in preparing the CRBRP Draft Environmental Impact Statement which was issued in February 1976. However, in the CRBRP Final Environmental Statement (NRC 1977a), the staff relied to a large extent on information derived from its own staff work on generic fuel cycle models, such as those published in NUREG-0002, i.e., GESMO (NRC 1976a) and Table S-3 of 10 CFR 51. The staff also used environmental impact data it had developed for the Barnwell Nuclear Fuel Plant (NRC 1976b). These analyses depend, in large measure, upon the nearly 40-year experience that has been gained in reprocessing facilities used in government programs and currently operating under contract for the Department of Energy (DOE).

At the present time there appears to be little prospect of commercial operations which could support the CRBRP fuel cycle requirements in the near future. Consequently, DOE (now the lead applicant) plans to undertake CRBRP supporting fuel cycle functions at its own facilities. The technology of processes and services for the fuel cycle remains essentially the same as originally perceived. The updated ER and this EIS address the proposed use of DOE facilities rather than commercial suppliers. Therefore, DOE has responded to the contentions on fuel cycle considerations by amending its Environmental Report with Amendment XIV (DOE 1982), which addresses the facilities now proposed by the DOE for use in the CRBRP fuel cycle, and the environmental impacts of using those facilities. The staff has used Amendment XIV to the CRBR Environmental Report as a basis for performing an independent assessment of the environmental effects of the CRBRP fuel cycle.

The current fuel cycle proposed by DOE for the CRBRP is represented by Figure D.1. The average annual CRBRP fuel requirements for the plant operation after equilibrium has been reached were developed from DOE CRBRP data bases (e.g., PSAR, ER, etc.) for the NRC staff by ORNL (NRC 1982a). The ORIGEN 2 Program (Croff 1980) was used to produce this data output. The proposed loading of the CRBRP includes segmented fuel assemblies containing active centers with mixed oxides of uranium and plutonium in the core portion and upper and lower axial blanket segments containing depleted uranium dioxide. Depleted uranium dioxide would also used in the radial blanket fuel assemblies. The depleted uranium comes from the DOE-operated gaseous diffusion plants. This uranium, containing a nominal 99.8% of U-238, will absorb neutrons and ultimately form Pu-239. The net production of plutonium in the reactor is expected to be positive (i.e., more plutonium is produced than undergoes fission).

On the basis of information provided by DOE in its PSAR and ER, as summarized in this EIS, the composition of the initial loading of the CRBRP is as described in Table D.1.

Table D.1 CRBRP initial loading

Component	Quantity in Initial Loading (MT) Uranium	Plutonium
Core Assemblies (156)[1]		
Active Middle Sections	3.48	1.71
Axial Blanket	4.22	
Radial and Inner Blanket Assemblies (208)	21.0	
TOTAL	28.7	1.71

[1]The core assemblies consist of three segments: the active middle sections and upper and lower axial blankets sections.

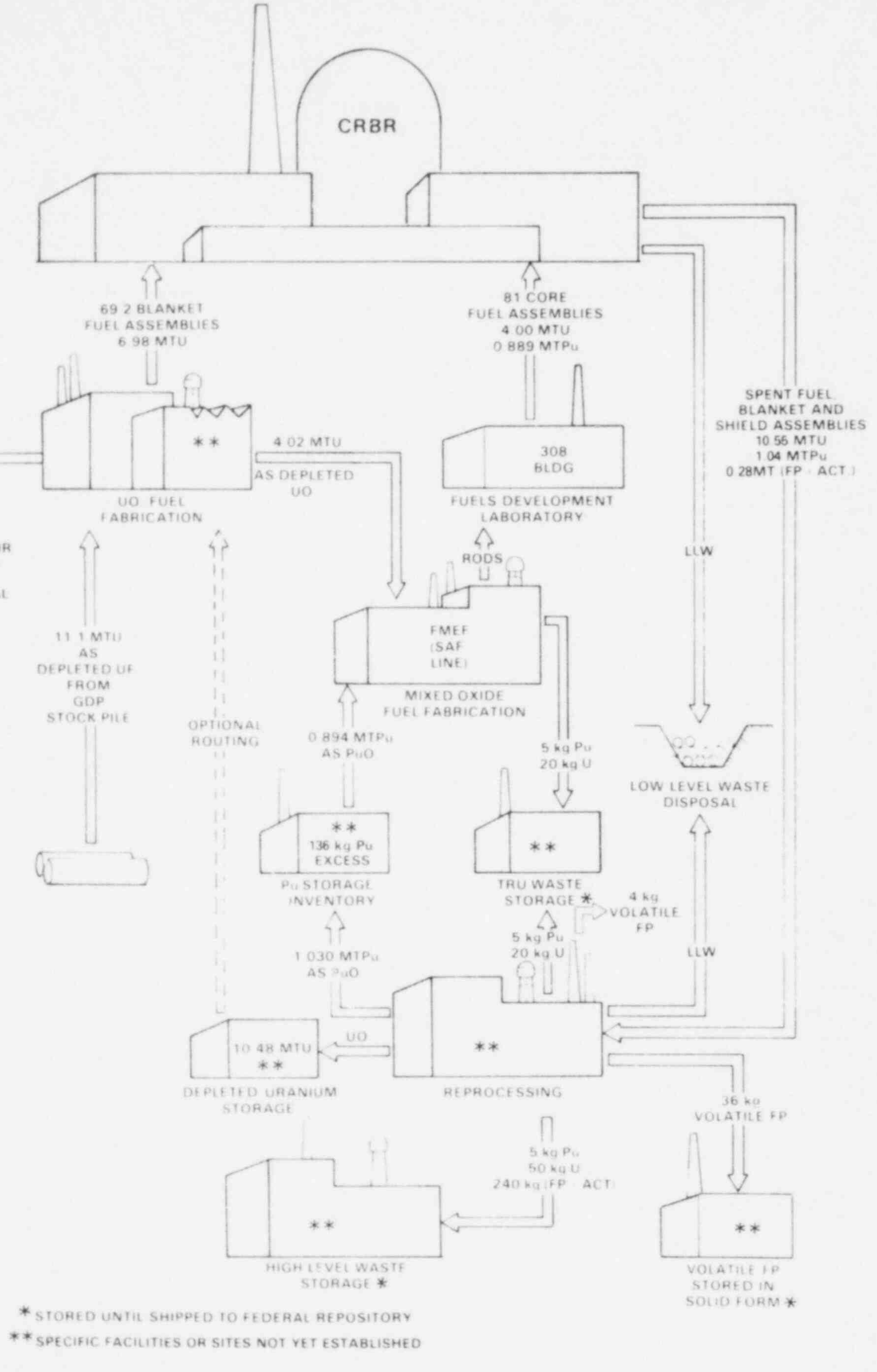

Figure D.1 Average annual fuel cycle requirements for CRBRP

The 208 radial and inner blanket assemblies would surround and be intermixed with the 156 core fuel assemblies as shown in Figure A3.3 in this FES. In the equilibrium years, on the average, as shown in Figure D.1, 81 core fuel assemblies and 69.2 blanket assemblies would be replaced annually.

The initial feed materials would consist of plutonium (obtained from DOE stockpiles) and depleted uranium (which is a by-product from the enrichment of the uranium-235 content of natural uranium). The plutonium would be converted to plutonium dioxide at a reprocessing plant while the uranium as the hexafluoride would be converted to uranium dioxide at a commercial fuel fabrication plant. Subsequently, at a mixed-oxide fuel fabrication plant, plutonium dioxide and uranium dioxide would be blended and fabricated into mixed-oxide fuel for the active middle segments of the core fuel assemblies. Uranium dioxide would be fabricated into pellets for the upper and lower axial blanket portion of the core fuel assemblies, and for radial and inner blanket assemblies of the reactor.

After exposure to neutron fluxes in the reactor, the irradiated core fuel assemblies and blanket assemblies would be stored at the reactor for a specified time. During this period the shorter-lived fission products decay and reduce the assemblies' decay-heat generation rates. Subsequently, the irradiated core and blanket assemblies would be shipped in shielded casks to a reprocessing plant where the plutonium and uranium would be separated from each other and from fission products and other actinides using chemical processes. The high-level liquid waste stream containing the separated fission products and other transuranic elements would be solidified in an acceptable form and shipped to a Federal waste-storage facility. In the equilibrium mode the plutonium would be shipped to the mixed-oxide fuel fabrication plant for recycle as fuel. The recovered uranium would either be stored for later disposition or recycled into the mixed oxide or blanket fuel assemblies. Depleted uranium from enrichment facilities would be used as necessary to make up for the uranium that would be converted to plutonium in the reactor or lost as scrap or waste in the fuel cycle process steps.

An analysis of the conservatively predicted environmental impact from the fuel cycle associated with the CRBRP and the transport of radioactive materials between the supporting facilities is provided in this appendix. This analysis is based on the quantities of materials required in a fuel cycle to maintain the CRBRP's operation and is summarized in Figure D.1. The physical characteristics and detailed description of the reactor fuel assemblies and fuel regions are shown in Tables D.2 and D.3. While the quantities of materials and the material shipments for the CRBRP fuel cycle might be larger during pre-equilibrium operation, irradiation (i.e., burnup) of assemblies and their radioactivity level would be substantially more during the equilibrium mode. Therefore, the staff has based its evaluation on the equilibrium mode, with burnups shown in Table D.3.

D.2 ENVIRONMENTAL CONSIDERATIONS

The following sections evaluate the environmental effects from the overall CRBRP fuel cycle, including releases from each processing step (Section D.2.1), waste management (Section D.2.2) and the transportation steps (Section D.2.3). A summary of effects of these operations is presented in Table D.4.

Table D.2. Physical characteristics of CRBRP fuel assemblies*

	Core & axial blanket	Inner & radial blankets
Assembly component lengths, cm		
Upper end hardware	30.4	30.4
Gas plenum	124.5	124.5
Upper axial blanket	35.6	
Core or radial blanket	91.4	162.6
Lower axial blanket	35.6	
Lower end hardware	109.2	109.2
Overall total	426.7	426.7
Fuel element total	290.6	291.5
Assembly shape	hexagonal	hexagonal
Assembly flats, cm	11.62	11.62
Fuel element arrangement	triangular	triangular
Fuel elements per assembly	217.	61.
Fuel element OD, cm	0.584	1.285
Fuel pellet OD, cm		
Core	0.491	
Axial blanket	0.483	
Inner and radial blanket		1.194
Fuel pellet density, % of theoretical		
Core	91.3	
Axial blanket	96.0	
Inner and radial blanket		95.6
Fuel element pitch, cm	0.731	1.378
Cladding thickness, cm	0.038	0.038
Channel thickness, cm	0.305	0.305
Channel height, cm	314.	314.
Circumscribed volume/assembly cubic meter	0.0607	0.0607
Heavy metal/assembly, kg	60.35	100.85
Heavy metal oxide/assembly, kg**	68.45	114.39
Stainless steel/assembly, kg	135.5	122.6
Assembly total weight, kg	204.	237.

*NRC 1982a.

**(Pu,U) dioxide in the core with uranium oxide in the axial blanket and in the inner and radial blankets.

Table D.3 Summary characteristics for CRBR (a)

Parameter	Fuel Region(s) (b)					
	Fuel	AB	Fuel + AB	IB	RB (c)	Fuel + AB + IB + RB
Electric power, MW(e) net	267.4	6.1	273.5	46.9	29.6	350.0
Thermal power, MW(t)	745.0	17.0	762.0	130.5	82.5	975.0
Average specific power, (d) MW(t)/MTIHM (e)	140.9	3.95	79.4	16.4	6.49	32.21
Average fuel burnup, MWd/MTIHM	76,031	2,133	42,870	8,693	7,977	22,600
Effective irradiation duration, full-power days	540	540	550	530	1,229	
Refueling cycle length, full-power days	275	275	275	275	275	275
Average number of assemblies charged per cycle	81	81	81	41	28.2	
Average charge, kg/refueling cycle (f)						
U-235	3.6	4.4	8.0	8.3	5.7	22.0
Total uranium	1,805.5	2,193.5	3,999.0	4,134.9	2,843.9	10,978
Fissile plutonium (g)	783.0	0	783.0	0	0	783.0
Total plutonium	889.4	0	889.4	0	0	889.4
Total (U + Pu)	2,694.9	2,193.5	4,888.4	4,134.9	2,843.9	11,867
Average discharge, kg/refueling cycle (f)						
U-235	2.6	3.6	6.2	5.9	4.0	16.1
Total uranium	1,715.8	2,149.0	3,864.8	3,960.2	2,726.9	10,552
Fissile plutonium (g)	627.2	38.5	665.7	131.6	89.1	886.4
Total plutonium	766.7	39.6	806.3	138.3	94.9	1,039.5
Total (U + Pu)	2,482.5	2,188.6	4,671.1	4,098.5	2,821.8	11,591

(a) NRC 1982a.
(b) Fuel = 36 inch (Pu,U) dioxide region, AB = uranium dioxide axial blankets associated with fuel, IB = entire inner blanket, RB = entire radial blanket.
(c) Weighted average of inner radial blanket (4 cycle residence) and outer radial blanket (5 cycle residence).
(d) Based on rated power level.
(e) MW(t)/MTIHM - Megawatt thermal per Metric Ton Initial Heavy Metal.
(f) Averaged over 4 cycles.
(g) Pu-239 + Pu-241 + Np-239.

Table D.4 Summary of environmental considerations for the CRBRP fuel cycle annual requirements

	Fuel Fabrication					
	Uranium Dioxide (Blanket)	Mixed Oxide (Core Fuel)	Reprocessing	Waste Management(a)	Transportation	Total
Natural Resource Use						
Land (ha)						
Temporarily committed	0.02	-	36	0.08	-	36
Undisturbed area	0.02	-	32	-	-	32
Disturbed area	0.004	-	4	0.08	-	4
Permanently committed	-	-	-	0.05	-	0.05
Total land	0.02	-	36	0.13	- (b)	36
Water (millions of gal)						
Discharge to air	-	-	9.6	-	-	9.6
Discharged to water bodies	1.6	0.3	5.1		-	7.0
Total water	1.6	0.3	14.7	0.2 (c)	-	17
Fossil Fuel						
Elect. energy (MJ)	1.9E+6	3.2E+7	4.1E+7	3.1E+6	-	7.8E+7
Equivalent coal (MT)	2.0E+2	3.6E+3	8.0E+3	4.7E+2	(d)	1.2E+4
Effluents-Chemicals (MT)						
Atmospheric (e)						
Sulfur Oxides	7.	130.	280.	21 (f)	1.1	440.
Nitrogen Oxides	2.	35.	80.	12	15.4	140.
Hydrocarbons	0.02	0.4	0.8	0.7	1.5	3.4
Carbon Monoxide	0.05	0.9	2.	23	9.4	35
Particulates	2.	35.	80.	4.9	0.5	120
Fluoride	0.006 (g)	-	-	-	-	0.006
Ammonia	6.7 (g)	-	-	-	-	6.7
Liquid						
Nitrate	7.3	-	-	-	-	7.3
Ammonia	3.2	-	-	-	-	3.2
Fluoride	1.3	-	-	-	-	1.3
Solids						
Calcium fluoride	11. (h)	-	-	-	-	11.00
Water treatment sludge	-	-	800.	-	-	800.
Effluents - Radiological (Ci)						
Atmospheric						
U-235	8E-7	9E-12	7.8E-11	- (b)	-	8E-7
U-238	6E-5	6.9E-10	7.4E-9	-	-	6E-5
Pu-236	-	4.5E-10	3.3E-9	-	-	3.8E-9
Pu-238	-	9.6E-7	8.5E-5	-	-	8.6E-5
Pu-239	-	5.9E-7	2.7E-5	-	-	2.8E-5
Pu-240	-	4.9E-7	2.2E-5	-	-	2.2E-5
Pu-241	-	6.7E-5	2.6E-3	-	-	2.7E-3
Pu-242	-	6.7E-10	4.7E-8	-	-	4.6E-8
Am-241	-	7.9E-8	2.1E-5	-	-	2.1E-5
H-3	-	-	5.9E+3	-	-	5.9E+3
C-14	-	-	1.4E+1	-	-	1.4E+1
Kr-85	-	-	5.1E+3	-	-	5.1E+3
I-129	-	-	3.7E-4	-	-	3.7E-4
I-131	-	-	3.9E-2	-	-	3.9E-2
Ru-103	-	-	2.9E-2	-	-	2.9E-2
Ru-106	-	-	1.2E-1	-	-	1.2E-1
Cs-134	-	-	7.6E-5	-	-	7.6E-5
Cs-137	-	-	1.7E-4	-	-	1.7E-4
Particulate FP	-	-	6.5E-3	-	-	6.5E-3
Radon and decay products	-	-	-	0.5	-	0.5
Liquid						
U-235	8E-5	-	-	- (b)	-	8E-5
U-238	6E-3	-	-	-	-	6E-3
Thermal (MJ)	3.2E+6	1.0E+8	2.2E+.	2.8E+5	2.1E+5 (i)	3.2E+8

(a) Upper value of range which depends upon geology chosen See Table D.13. Lifetime impacts prorated to annual requirements.
(b) - means not reported, or the staff believes these values would be zero or negligible by comparison. For waste management this footnote applies to all radiological effluents except radon and decay products.
(c) Water consumed in repository construction.
(d) 92,000 gallons of diesel fuel would be used in transport
(e) Based upon combustion of equivalent coal for power generation or of fuel for machinery.
(f) Chemical effluents from waste management operations include estimates of releases from operation of machinery during construction of the repository (see Table D.11) and from the burning of equivalent coal to produce the electrical energy.
(g) Based on NRC 1977b.
(h) Calcuim fluoride is isolated in settling ponds from liquid effluent.
(i) Based on heat load of major contributors (spent fuel, blanket and HLW).

D.2.1 Fuel Cycle Impacts

The fuel cycle operations, as shown in Figure D.1, would include (1) fuel fabrication operations at two different facilities, a commercial fuel fabrication plant (for blanket assemblies and for producing the uranium dioxide for core assemblies) and a government-owned mixed oxide facility (for core fuel assemblies); (2) reprocessing operations at a government-owned reprocessing facility (there are currently no commercial reprocessing plants available in the United States for processing CRBRP spent fuels, and the staff is unable to project when or whether such facilities would be available for handling the spent fuels in the time frame of interest for the CRBRP); and (3) conversion of recovered plutonium and possibly uranium from nitrate solutions to fuel grade plutonium dioxide and uranium dioxide, also at a government-owned reprocessing facility.

There are no requirements for the front end uranium steps of mining, milling, conversion and enrichment to be charged to the CRBRP fuel cycle, since these operations have already been incurred as a result of other fuel cycles, i.e., defense programs and/or commercial fuel cycles such as those supporting LWRs. Accordingly there are no environmental effects from such operations attributable to the CRBRP fuel cycle.

D.2.1.1. Blanket Fuel Assemblies

Depleted uranium dioxide for both blanket and core fuel assemblies would be obtained by converting uranium hexafluoride from the enrichment tailing stockpiles associated with DOE gaseous diffusion enrichment plants.

DOE proposes that the fabrication of blanket fuel assemblies, which would include the conversion of depleted uranium hexafluoride to uranium dioxide for both blanket and core fuels, would be carried out in existing commerical facilities. The specific facility for the conversion has not yet been selected. However, environmental considerations for this portion of the CRBRP fuel cycle can be projected from similar operations for the LWR uranium fuel cycle. Therefore, most of these in Table D.4 were obtained by multiplying the impacts of the model fuel fabrication plant as reported in Column E, Table S-3A of WASH-1248 (AEC 1974b) by a factor of about one-third. This factor is the ratio of 11.1 MTU, annual fuel requirement for CRBRP, to 35 MTU, model annual fuel requirement for an LWR. In addition, this approach overestimates the release of U-235 (and, hence, the consequence radiological impact), since the releases for these nuclides reported in WASH-1248 are based on the processing of low enriched uranium for LWRs, while depleted uranium is used for the CRBRP.

D.2.1.2. Core Fuel Assemblies

There are currently no commercially operated facilities producing fuel assemblies containing mixed oxides (uranium dioxide - plutonium dioxide). DOE proposes that the Secure Automated Fabrication (SAF) Line to be built in the Fuel and Materials Examination Facility (FMEF) on the Hanford Reservation would be used for making mixed-oxide fuel materials and core fuel rods. The uranium dioxide in powder form would be received from the commercial uranium dioxide fuel fabrication plant that produces the blanket assemblies. The plutonium dioxide in powder form would be received from DOE stockpiles or from plutonium conversion facilities at a reprocessing plant. The uranium and plutonium oxide powders would be blended, formed and sintered into mixed-oxide pellets for core fuel in the SAF line. The axial blanket uranium dioxide pellets would be included in the upper and lower segments of the core fuel rods in the SAF Line. After the core fuel rods are loaded, sealed and externally decontaminated, they would be fabricated into core fuel assemblies in the Fuels Development Laboratory (Building 308) located approximately 13 km from the FMEF.

DOE completed an environmental assessment of the FMEF (DOE 1980a), and it was supplemented to include impacts resulting from the addition of the SAF Line (DOE 1981b). Based on these assessments DOE estimated resource requirements and effluent releases relating to mixed-oxide core rod fabrication for the CRBRP. In Amendment XIV of its Environmental Report, DOE included its analysis in Table 5.7-1, which summarizes the environmental considerations for CRBRP fuel cycle. The staff considers these data acceptable for an environmental assessment since, in its views, the quantities are overestimated, and therefore conservative, because (1) DOE used data relating to the whole of FMEF, of which SAF Line requirements and releases are only a part, and (2) comparisons with staff assessments made for GESMO (NRC 1976a) show requirements and releases per ton of mixed-oxide fuel substantially lower than those in Amendment XIV. The staff also finds acceptable DOE's assessment of natural resources uses and thermal releases for core fabrication as follows:

- land use is insignificant since the SAF Line and building 308 are on existing government properties located in areas devoted to other activities,
- water use is 3.4E+5 gals per gal (750 gal/day at 72% overall time efficiency),
- thermal releases are 1.0E+8 MJ/yr (9.5E+10 BTU/yr).

For its assessment of radiological effluents, the staff took a more realistic approach to estimating radioactive releases from the SAF Line by using the throughput required in support of the CRBRP as follows.

The annual process throughput capability for the SAF Line would be 4 MTPu. The annual fuel requirement for the CRBRP (see Figure D.1) would be 0.889 MTPu. The staff assumed a nominal plutonium composition of plutonium-240 content of 12 wt%, and aged approximately 2 years before fabrication into core assemblies. During this period plutonium-241 decays with a 14.7-year half-life to americium-241. The composition of the plutonium assumed by DOE in its calculations was a nominal 20 wt% plutonium-240, unaged. The isotopic composition of the feed plutonium to the SAF Line projected by NRC and DOE is listed in Table D.5.

Exhaust gases from the SAF Line would pass through a series of three High-Efficiency Particulate Absolute (HEPA) filters. HEPA filters are required to have an efficiency of at least 99.95% each (ERDA/RL 1976). Three HEPA filters in series would therefore have a theoretical minimum overall efficiency of removing all but 1.25E-10 of particulates reaching the filter bank. The DOE assessment conservatively used as a cleanup factor of 1.25E-8 (two orders lower than theoretical) and the staff finds this to be an acceptably conservative approach.

The radionuclides projected to be released annually to the atmosphere from the SAF Line in support of the CRBRP fuel cycle are shown in Table D.6. The releases projected by DOE for the total SAF Line operation (DOE 1981b) have been adjusted downward by the staff from the full capacity of 4 MTPu/year to the 0.889 MTPu annual throughput required for CRBRP.

Table D.5 Isotopic composition of feed to SAF Line

Radionuclide	Assumed by NRC Staff, wt% (NRC 1982a)	Assumed by DOE wt% (DOE 1980a)
Pu-236	6.1E-7	8.0E-6
Pu-238	6.0E-2	5.0E-1
Pu-239	8.6E+1	7.2E+1
Pu-240	1.2E+1	2.0E+1
Pu-241	1.7E+0	6.0E+0
Pu-242	2.0E-1	1.5E+0
Am-241	3.5E-1	(not reported)

Table D.6 Annual releases of plutonium from the SAF Line in support of the CRBRP

Radionuclide	NRC Staff Estimate (Ci/yr)	DOE Estimate (Ci/yr) (a)
Pu-236	9.3E-11	4.5E-10
Pu-238	1.2E-7	9.6E-7
Pu-239	5.9E-7	4.9E-7
Pu-240	3.0E-7	4.9E-7
Pu-241	2.2E-5	6.7E-5
Pu-242	8.7E-11	6.7E-10
Am-241	7.9E-8	(not reported)

(a) Adjusted to 0.889 MT Pu throughput.

Based upon this analysis the staff used the higher values from Table D.6 for each isotope in its assessment (Table D.4).

Using essentially the same bases, DOE calculated that releases of uranium isotopes from the SAF Line processing 6 MTU/yr (maximum capacity) would be 1.1E-10 Ci/yr. The staff considers this quantity to be a conservative estimate with regard to both quantity and radionuclides of concern since the DOE calculation is based on natural uranium. Depleted uranium to be used in the CRBRP contains only 0.2 wt% uranium-235 (versus 0.72 wt% for natural uranium) and essentially no uranium-234. Adjusting for these differences the staff estimates annual uranium atmospheric releases as 9.0E-12 Ci of uranium-235 and 6.9E-10 Ci of uranium-238.

DOE conservatively calculated doses from the SAF Line by attributing all releases from the FMEF to the CRBRP core fabrication. This calculation is conservative (over estimated) in that only about 15 months SAF Line operation in each 2-year period would be devoted to CRBRP fuel fabrication. Thus, an average annual dose attributable to uranium releases would be approximately 65% of that attributed to the SAF Line at full capacity, and the annual dose attributable to plutonium releases would be roughly one-fourth of that attributed to the SAF Line at full capacity.

Since the core fuel rods would be sealed, welded, tested and externally decontaminated after fabrication at the SAF Line and prior to shipment to the Fuels Development Laboratory (Building 308), no releases would be expected from Building 308 due to the assembly of CRBRP core assemblies.

D.2.1.3. Fuel Reprocessing

Both core and blanket fuel assemblies would be removed from the CRBRP, would be transported to the reprocessing plant and would be processed to separate uranium and plutonium from each other and from the fission products formed in the fuel during CRBRP operation. Recovered uranium as a uranyl nitrate solution would be calcined to uranium trioxide and stored for recycle or alternative future uses. Recovered plutonium nitrate solutions would be processed to produce plutonium dioxide, most of which may be used to produce replacement core fuel rods at the SAF Line in the FMEF. Any excess Pu would be stored for future use.

D.2.1.3.1 Developmental Reprocessing Plant (DRP).

As a basis for evaluating the environmental impacts of the reprocessing step of the CRBRP fuel cycle, DOE used the proposed DRP which has been under development since about 1977. This plant is still in the formative stages and is represented by preliminary design concepts (DOE 1981a).

According to the Conceptual Design Report (DOE, 1981a), the facility would have a capability of processing 150 MTHM/yr (0.5 MTHM/day). The reference site for the facility would be near the proposed site of the CRBRP near Oak Ridge, Tennessee. DOE states in Amendment XIV to its Environmental Report that reprocessing of LMFBR-type fuels would be supplemented by reprocessing of LWR fuels in the DRP. Since, however, the major purpose of the DRP is the reprocessing of LMFBR fuels, of which the CRBRP fuels are the only ones known to the staff, for the purposes of this supplement, the staff has allocated the total land requirement for the DRP to the CRBRP fuel cycle. Ninety acres (36 ha) are included in the reference site. The staff assumes that approximately 10 acres (4 ha) would be disturbed by the construction of facilities, roads, parking lots, etc.

However, consumable utilities and services have been allocated on a basis of plant throughput of fuels processed. For the purposes of this supplement to the environmental report, the staff has charged about eight percent (11.86 MTHM of CRBRP spent fuels, compared to 150 MTHM/yr capacity of the DRP) of the consumable utility and services requirements to the CRBRP fuel cycle.

Normal power supply to the DRP would be 20 MVA (equivalent to 5.2E+8 MJ per 300 day year at full power). A standby power supply of 8000 kW would be provided. Emergency diesel oil storage would be 30,000 gal, the quantity required for 7 days of uninterrupted operation. Process steam would be provided by two coal-fired boilers, each sized to deliver 75,000 lb/hr of saturated steam at 350 psig, and each consuming 3.5 tons/hr of coal. Normal cooling water would be supplied by using two of three pumps each rated at 14,500 gpm at 150 ft head, driven by 700-HP electric motors. Other requirements would include emergency cooling water, demineralized water, sanitary water, compressed air and instrumentation. Non-contaminated waste water treatment would be 202,000 gpd of cooling tower blowdown, 20,000 gpd of boiler blowdown, 7000 gpd of laboratory drainage and 10,000 gpd of regenerate/rinse solutions. Treatment of this waste would produce 25,000 gpd of sludges (equivalent to roughly 10,000 MT of solids per year, assuming the fraction of solids in the sludge is 0.25) to be disposed offsite and 215,000 gpd (6.5E+7 gallons per year for 300 days/yr operation) for disposal in an effluent pond. The staff assumes cooling tower evaporation would be twice the cooling tower blowdown (1.2E+8 gallons per year).

On the bases indicated above, annual water use in support of reprocessing CRBR spent fuel would be 5.1 million gal of water discharged to water bodies and 9.6 million gal discharged to air. Electrical energy use would be 4.1E+7 MJ. Water treatment sludge produced from processing CRBRP fuels would be about 800 MT/yr.

Independent data on the radionuclide content of CRBRP spent fuel were developed by ORNL (NRC 1982a) using the ORIGEN 2 code (Croff 1980). Major assumptions and parameters used by the staff in the development of data on radionuclide content of spent fuel and comments comparing that data with data used by DOE as reported in Amendment XIV of its Environmental Report follow:

- Plutonium to be used in the core fuel was assumed by the staff to be nominally 12% Pu-240. The staff understands that 12% Pu-240 is the likely candidate for CRBRP fuel. DOE, however, assumed 20% Pu-240 in the calculations reported in its Amendement XIV.

- The plutonium was assumed by the staff to be aged a total of 4 years after separation (2 years prior to core fuel fabrication and another 2 years prior to charging to the CRBRP). Thus, americium-241 was present in the new fuel as a decay product of plutonium-241.

- The uranium to be used with the plutonium in the core and in the blanket fuels was assumed by the staff to be enrichment tails with 0.2% U-235. DOE assumed natural uranium with 0.72% U-235 in its calculations.

As a result of the differing assumptions on the nuclide distribution in the fuels, the contents of spent fuel as calculated by ORNL differ somewhat from the DOE calculations. The results are compared in Table D.7. Minor differences are noted in the fission product distributions. Somewhat more significant differences are noted in some of the actinide components, principally because of the different isotopic composition of plutonium and of the growth of americium-241. However on the basis of radioactivity, thermal power and ingestion toxicity, CRBRP spent fuel would be very much like PWR spent fuel for about 100 years after discharge and would increase by about one order of magnitude in these properties after that time (NRC 1982a).

Table D.7 Comparison of CRBRP spent fuel data* contained radioactivity, Ci/yr

Nuclide	NRC-ORIGEN2	DOE-Am XIV, Table 5.7-8
H-3	5.9E+03	5.51E+03
C-14	8.3	1.44E+01
Kr-85	5.1E+04	4.75E+04
Sr-90	3.2E+05	3.70E+05
I-129	3.7E-01	3.26E-01
I-131	3.9E+01	3.61E+01
Ru-103	1.9E+06	1.84E+06
Ru-106	8.0E+06	7.09E+06
U-232	1.9E-01	3.11E-02
U-234	1.6E-01	8.12E-01
U-235	3.5E-02	3.92E-02
U-236	9.4E-02	7.91E-02
U-238	3.5	3.68
Pu-236	6.6	3.07
Pu-238	1.6E+04	1.69E+05
Pu-239	5.4E+04	4.27E+04
Pu-240	3.4E+04	4.40E+04
Pu-241	1.7E+06	5.10E+06
Pu-242	1.0E+01	9.40E+01
Cs-134	3.8E+05	2.80E+05
Cs-137	8.3E+05	7.99E+05
Th-228	1.2E-01	5.98E-03
Th-231	3.5E-02	3.92E-02
Th-234	3.5	3.68
Am-241	1.2E+04	1.03E+05
Np-237	8.7E-01	1.04
Pa-234	3.5	3.68
Cm-242	3.7E+05	2.71E+06
Cm-244	7.0E+02	3.58E+03

*150 days after reactor discharge.

Assumptions used by ORNL (NRC 1982a) in calculating the radionuclide content of high-level waste (HLW) obtained as a result of reprocessing the spent fuel include:

- 0.5% of the uranium and plutonium is not recovered by reprocessing and is lost to the HLW.
- 0.05% of non-volatile fuel material is retained with the cladding.
- 0.69% of the fuel assembly structural material is assumed to dissolve and go to the HLW.

o 0.1% of the halogen elements and none of the noble gases, tritium, and carbon-14 is assumed to be in the HLW.

These assumptions are consistent with those used by DOE in the development of HLW data reported in Amendment XIV of its Environmental Report.

Atmospheric releases from the DRP have been projected by the staff, using data from the ORIGEN 2 codes (NRC 1982a) and the confinement factors for all radionuclides proposed by DOE, except for ruthenium isotopes. For the ruthenium isotopes, the staff chose the more conservative release factors reported by DOE in its technical support document for the management of commercial radioactive wastes (DOE 1979). The results of these estimates are summarized in Table D.8 and included in Table D.4 as Column 4. The staff believes that the estimated releases reported in the last column of Table D.8 will be achievable by any of the potential alternatives for the DRP that are discussed below. This view is consistent with that expressed by DOE in Amendment XIV.

The DRP or the model FRP would convert liquid high-level waste (HLW) to solids such as borosilicate glass. The solid HLW would be sealed in canisters and shipped to either storage or disposal.

D.2.1.3.2 Alternative Reprocessing Plants.

DOE is considering alternatives to the DRP for reprocessing of the fuel. One alternative would be the licensed operation of such a facility by private industry which would have to meet NRC requirements. Other alternatives being considered are (1) the modification of existing DOE reprocessing facilities at Hanford or Savannah River and (2) construction of new DOE facilities. In any instance, offsite environmental impacts ascribed to atmospheric releases from these alternatives are considered by the staff to be enveloped by the impacts estimated for the DRP. In Amendment XIV DOE provides the philosophy upon which the DRP design is based. The staff understands that these design parameters would be applied to any of these DOE alternatives in the event that one is selected instead of the DRP for reprocessing CRBRP fuel.

The staff notes that neither the DRP nor the model reprocessing plants assumed by DOE for reprocessing would release any liquid radioactive wastes to the environment. If the alternative of using existing DOE facilities were selected, both the Hanford and Savannah River plants release very low levels of radioactivity in liquids to the environs (ERDA 1975b; ERDA 1977). The impacts of all releases from these plants, including atmospheric releases and liquid releases, have been very small as indicated in the referenced documents. Accordingly, and since the radionuclide throughput of CRBRP fuels would be not more than approximately 25%* of the throughput for processing other fuels, the impact of liquid low-level releases would be a fraction of these small releases.

Neither the Hanford nor the Savannah River reprocessing plants presently have the capability of solidifying acidic HLW. Liquid HLW is neutralized to high pH and stored in underground steel tanks. Plans for final processing and

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*Based, for example, on the annual discharge rate from N reactor through the Purex Plant at Hanford (assumed by the staff to be about 500 MTU/yr irradiated to approximately 2000 MWd/MTU), compared to the discharge rate and irradiation level of the CRBRP fuels.

Table D.8 Source term selection for dose calculation reprocessing releases from CRBRP fuel cycle

Nuclide	Source Term (Ci/yr)		
	NRC-ORIGEN2 Basis(a)	DOE-Amend. XIV	NRC-Selected(b) (c)
H-3	5.9E+03	5.5E+03	5.9E+03
C-14	8.3	1.4E+01	1.4E+01
Kr-85	5.1E+03	4.8E+03	5.1E+03
Sr-89	2.0E-04	--	2.0E-04
Sr-90	6.3E-05	7.4E-05	7.4E-05
Y-90	6.3E-05	--	7.4E-05
Y-91	3.6E-04	--	3.6E-04
Zr-95	7.6E-04	--	7.6E-04
Nb-95	1.4E-03	--	1.4E-03
Ru-103	2.9E-02	1.8E-03	2.9E-02
Rh-103m	2.6E-02	--	2.6E-02
Ru-106	1.2E-01	7.1E-03	1.2E-01
Rh-106	1.2E-01	--	1.2E-01
Sb-125	4.9E-05	--	4.9E-05
Te-125m	1.2E-05	--	1.2E-05
Te-127	2.4E-05	--	2.4E-05
Te-127m	2.4E-05	--	2.4E-05
I-129	3.7E-04	3.3E-04	3.7E-04
I-131	3.9E-02	3.6E-02	3.9E-02
Cs-134	7.6E-05	5.6E-05	7.6E-05
Cs-137	1.7E-04	1.6E-04	1.7E-04
Ba-137m	1.6E-04	--	1.6E-04
Ce-141	1.8E-04	--	1.8E-04
Ce-144	1.5E-03	--	1.5E-03
Pr-144	1.5E-03	--	1.5E-03
Pr-144m	1.8E-05	--	1.8E-05
Pm-147	4.1E-04	--	4.1E-04
Pm-148m	1.9E-05	--	1.9E-05
Sm-151	6.4E-06	--	6.4E-06
Eu-154	5.2E-06	--	5.2E-06
Eu-155	2.5E-05	--	2.5E-05
U-232	3.9E-10	6.2E-11	3.9E-10
U-234	3.1E-10	1.6E-09	1.6E-09
U-235	7.0E-11	7.8E-11	7.8E-11
U-236	1.9E-10	1.6E-10	1.9E-10
U-237	8.4E-08	--	8.4E-08
U-238	7.1E-09	7.4E-09	7.4E-09
Pu-236	3.3E-09	1.5E-09	3.3E-09
Pu-238	8.1E-06	8.5E-05	8.5E-05
Pu-239	2.7E-05	2.1E-05	2.7E-03
Pu-240	1.7E-05	2.2E-05	2.2E-05
Pu-241	8.5E-04	2.6E-03	2.6E-03
Pu-242	5.2E-09	4.7E-08	4.7E-08
Am-241	2.5E-06	2.1E-05	2.1E-05
Am-242m	2.3E-07	--	2.3E-07
Cm-242	7.5E-05	5.4E-04	5.4E-04
Cm-243	3.3E-08	--	3.3E-08
Cm-244	1.4E-07	7.2E-07	7.2E-07
Np-237	1.7E-10	2.1E-10	2.1E-10
Pa-234	7.0E-10	7.4E-10	7.4E-10
Th-228	2.4E-11	1.2E-12	2.4E-11
Th-231	7.0E-12	7.8E-12	7.8E-12
Th-234	7.0E-10	7.4E-10	7.4E-10

(a)These calculated source terms use the ORIGEN 2, Basis (NRC 1982a) for isotope composition in spent fuel. Amendment XIV (DOE 1982) confinement factors were used except for ruthenium (and daughters), for which the release factor of the Data Sheet No. 25b of DOE/ET-0028 (DOE 1979) was used since these release factors appear to be more realistic for the near term and were more conservative, i.e., larger.

(b)The highest source term from the two approaches was chosen. The ORIGEN 2 data were used where there were none reported in Amendment XIV. This approach is the most conservative in that it gives the highest releases, thereby bounding the expected routine releases.

(c)Some isotopic values based on radiological equilibrium values.

disposal of these wastes at Savannah River include conversion of the sludges containing fission products and actinides to an immobile solid form in canisters for disposal in a Federal repository. After the radioactive cesium is removed, the supernate containing salts would be disposed of as low-level waste (LLW). The radioactive cesium might be used as radiation source or would be combined with the sludge containing the rest of the fission products and actinides. Disposal of HLW at the Hanford facility could be similar, although other alternatives are being considered. In either case the volume of HLW added to the existing and projected waste systems from the processing of CRBRP spent fuel would be small. Thus the environmental effects of CRBRP HLW processing and handling at Hanford or Savannah River Plant are not judged to be significantly different from those for the DRP alternative.

D.2.2 Waste Management Impacts

Sources of waste streams and impacts associated with storage and disposal of radioactive wastes that would be produced by the CRBRP fuel cycle are addressed and summarized in this section.

D.2.2.1 Waste Stream Sources

Radioactive wastes produced as a result of the CRBRP fuel cycle would include those from the blanket fuel fabrication plant, the core fuel fabrication facility, the reactor plant, and the fuel reprocessing plant. Estimated waste quantities produced by the CRBRP fuel cycle are presented in Table D.9. The cumulative waste quantities are based on a 30-year operating life of the proposed CRBRP and assume material flows as outlined in Figure D.1.

D.2.2.1.1 Blanket Fuel Fabrication Plant

Conversion of depleted UF_6 to UO_2 for the CRBRP blanket is planned to be performed at the blanket fuel fabrication facility. During UF_6 conversion, calcium fluoride (CaF_2) would be formed at a rate of 11 MT (5.5 cubic meters) per year (1 MT CaF_2/MTU). This low level waste, containing about 0.01 microcuries per gram of uranium, would be disposed of at the blanket fuel fabrication facility in bulk form.

D.2.2.1.2 Core Fuel Fabrication Facility

Core fuel for the CRBRP would be expected to be produced in the SAF Line which is proposed as part of the FMEF. Approximately 65% of the SAF Line capacity would be required annually to fabricate CRBRP core fuel. This would result in roughly 130 cubic meters of TRU waste (64 Ci/m^3) being generated annually from production of CRBRP fuel. These wastes would be compacted, packed in approximately 145 55-gal drums and stored in a retrievable mode for a maximum of 20 years at the Hanford Reservation. These TRU wastes would be less than 3% of the TRU waste already at the Hanford facility and should have an insignificant incremental environmental impact. Eventually DOE anticipates disposing of these TRU wastes in a Federal repository.

D.2.2.1.3 Clinch River Breeder Reactor Plant

The CRBRP would generate LLW, metallic sodium and sodium-bearing solids in the course of producing electrical energy. LLW would be generated at a rate of 67

Table D.9 Radioactive wastes from the CRBR fuel cycle (a)

Facility	Waste Type	Waste Form	Waste Container	Avg. Ann. Vol (m^3)	Cumulative Vol (m^3)	Cumulative Containers	Activity Concentration (Ci/m^3)
Blanket Fuel fabrication plant	LLW (U)	Calcium fluoride	Bulk	5.5 (b)	170 (b)	NA (c)	2E-2
Core fuel fabrication plant	TRU (U, Pu, TRU)	Solid, compacted	55-gallon drums	130 (d)	3900 (d)	4350	6.4E+1
CRBRP plant	LLW	Solid, concrete	55-gallon drums	67	2000	9570	< 1E+2
	Evaporator bottoms, derived from metallic sodium treatment	Solid, concrete	55-gallon drums	0.4	12	60	< 1E+2
	Solids containing sodium compounds	Solid, concrete	55-gallon drums	21	630	2940	< 1E+2
Fuel reprocessing plant	LLW (FP, AP) (f)	Concrete	55-gallon drums	25	750	3600	1E+1
	TRU (FP, TRU) (f)	Concrete	55-gallon drums	10	300	1500	E+3 - 1E+6
	Metal scrap (TRU)	Metal	10" Dx10' H canisters	14	420	3060	4E+5
	HLW (FP, AP, TRU) (f)	Glass	12" Dx10' H canisters	3.3 (e)	100 (e)	180	1.5E+7
	Kr-85	Metal	9" Dx65" H canisters	0.01	0.3	1-2	3.4E+6
	I-129 (barium iodate)	Concrete	55-gallon drums	0.01	0.3	1-2	1.4E+2

(a) Based on ER Amendment XIV (DOE 1982).
(b) Assuming a bulk, settled density of about 2 g/cubic centimeter for calcium fluoride.
(c) Not applicable.
(d) This 130 cubic meters could be reduced to 30 cubic meters by compaction, for a cumulative volume of 900 cubic meters.
(e) Includes volume of overpack. Volume of glass is 1.1 cubic meters annually for a cumulative volume of 33 cubic meters of glass.
(f) FP - fission products; AP-activation products.

cubic meters per year, sodium-bearing solids at 21 cubic meters per year, and metallic sodium at 0.4 cubic meters per year. This would result in the generation of approximately 425 55-gal drums annually at the CRBRP of which about 320 would contain LLW, about 100 would contain treated sodium bearing solids, and the rest would contain unreactive sodium compounds converted from two drums of metallic sodium. The LLW containing < 100 Ci/m^2 fission and activation products would be packed in 55-gal drums and disposed of at a commercial shallow-land burial site. Metallic sodium waste and sodium-bearing solids would be stored on site until they can be treated to convert sodium to unreactive forms such as oxide or nitrate. It is assumed that the unreactive forms would be solidified and/or packaged for shipment to and disposal in a commercial shallow-land burial site. The metallic sodium be would converted to aqueous nitrate and concentrated by evaporation. The evaporator bottoms will be solidified and shipped to a commercial shallow-land burial site.

D.2.2.1.4. Fuel Reprocessing Plant

Several types of wastes would be generated by the fuel reprocessing plant which supports the CRBR fuel cycle. LLW, containing short-lived fission and activation products at a total activity level of approximately 10 Ci/m^3, would be generated at a rate of 25 cubic meters annually. This waste would be fixed in concrete and packaged in 120 55-gal drums for disposal in a commercial shallow-land burial ground.

Approximately 10 cubic meters of transuranic wastes would be produced per year. These wastes containing fission products and TRU would range from 10^3 Ci/m^3 to 10^6Ci/m^3 in total activity. These wastes would be fixed in concrete, packaged in 50 55-gal drums and eventually disposed of in a Federal repository.

Approximately 14 cubic meters of metal scrap having a total activity of about 4×10^5 Ci/m^3 would be generated each year. The metal scrap from disassembly of fuel, blanket and shield assemblies and control rods would be partially compacted and packaged in 25.4-cm (10-in.) diameter by 3.1-m (10-ft) high canisters. One hundred and two canisters would be used annually. Final disposal would be in a Federal repository.

Approximately 1 cubic meter of solidified HLW (3.3 cubic meters with overpacks) containing 1.5×10^7 Ci/m^3 of fission products and traces of fuel would be produced per year. The HLW would be fixed in a low leach rate matrix and packaged in six 30.5-cm (12-in.) diameter by 3.1-m (10-ft) high canisters and eventually transported to a Federal repository for disposal.

Some Kr-85 would be captured during reprocessing and, using a sputtering process, the Kr-85 would be implanted in a metal matrix. This material, with a specific activity of 3.4×10^6 Ci/m^3, would be loaded into a 22.9-cm (9-in.) diameter by 165-cm (65-in.) high canister. One of these canisters would be required for every 28 years of CRBRP operation. These canisters are assumed to be disposed of in shallow dry wells at a Federal repository.

Iodine-129, as barium iodate (specific activity of 1.4×10^2 Ci/m^3), would be fixed in concrete and placed in 55-gal drums. Roughly one drum would be generated during 20 years of CRBRP operation. This material is assumed to be shipped eventually to a Federal repository for disposal.

D.2.2.2 Storage Impacts

Transuranic waste would be stored for a period of time prior to disposal. Approximately 6,000 55-gal drums and 3,000 canisters of metal scrap would be generated as a result of the 30-year CRBRP fuel cycle operation. It is assumed that the drums would be stored retrievably in trenches and stacked 12 deep by 12 across and 4 high (Rockwell 1982). Using the Rockwell configuration for the drums, and assuming an equivalent requirement for the canisters, the total land area required for TRU waste storage is estimated at 0.4 ha (1 acre). This land is considered temporarily committed since, after the 20 years of storage, the waste could be transferrred to a Federal repository and the storage site could be decommissioned and made available for other purposes.

D.2.2.3 Burial Ground Impacts

LLW from both the fuel reprocessing plant and the CRBRP would be disposed of at a commercial burial ground. It is assumed that eventually the reactive sodium components would be converted to a nonradioactive form, and that these wastes would also be disposed by burial. Three types of impacts were identified at the burial site: commitment of land, consumption of fuel, and long-term radiological population exposure.

Over the 30-year period for the CRBRP fuel cycle, approximately 17,000 55-gal drums (3500 cubic meters) would require burial. As perspective, a typical disposal trench (NRC 1981a) has a capacity of 17,000 cubic meters. Thus, for its lifetime the CRBRP would require about one fifth of a typical LLW disposal trench. Currently, 2 million cubic meters of space is estimated to be available in existing LLW disposal sites (EG&G 1980). Thus, the LLW from the CRBRP fuel cycle, which is similar to other commercial LLW, represents 0.2% of the current LLW disposal capacity.

Based on the reference burial ground (NRC 1981a), it is estimated that 0.1 ha (0.25 acres) of trench area would be necessary to dispose of CRBRP low-level wastes. If support areas at the burial ground were also allocated to the CRBRP fuel cycle based on the ratio of CRBRP wastes to the burial ground capacity, then an additional 0.1 ha (0.25 acres) would be considered committed. The total burial ground area committed as a result of the disposal of LLW wastes from the CRBR fuel cycle would then be approximately 0.2 ha (0.5 acres). This land would be considered permanently committed.

Fuel consumption requirements were developed based on parameters in NRC 1981a. Estimates of fuel use were made for burial ground construction, waste loading, and post-operational monitoring. The fuel requirements for the reference burial ground (described in NRC 1981a) were prorated to that portion of the site which would be occupied by CRBRP LLW wastes. The fuel requirement for the life of the CRBRP is estimated at approximately 10 cubic meters (2700 gallons).

Long-term radiological exposures from radioactive waste disposal are discussed in Section D.2.4.4.

D.2.2.4 Repository Impacts

It is assumed that TRU waste from the core fuel fabrication plant and all non-LLW from the fuel reprocessing plant would be disposed of in a Federal repository. Impacts from a repository can be grouped into three general areas: radiological releases, non-radiological effluents, and resource requirements.

Radiological releases in the near term are associated with construction of the repository and consist of increased releases of naturally occurring radon and its decay products at the construction site. For the longer term DOE states that the Federal repository is to be designed such that there will be reasonable assurance that wastes will be isolated from the accessible environment for a period of at least 10,000 years with no prediction of significant decreases in isolation beyond that time (DOE 1980c).

DOE has projected Federal repository characteristics for the disposal of LWR fuel and/or high level wastes for four geologic media (DOE 1980b). This information is used in some portions of the following NRC review. A qualitative comparison between LWR HLW and CRBRP HLW to be disposed of in a repository (DOE 1979) results in the following findings:

- The expected generation rate per GWe-yr of HLW for LWRs (DOE 1979) is approximately equivalent to that predicted for the CRBRP fuel cycle on a volumetric basis.

- The isotopic composition of CRBR HLW (NRC 1982b) would be similar to that of LWR HLW (DOE 1980b), as shown in Table D.10. While some of the plutonium isotopes from the CRBRP fuel cycle have a higher activity level, these constitute a small fraction of the entire HLW inventory.

- The radioactivity, thermal power and ingestion toxicity for CRBRP HLW and PWR HLW would be essentially similar for their entire decay lifetimes (NRC 1982b).

The staff concludes from this comparison that the LWR assessment (DOE 1980b) provides a qualitative measure of the impact of CRBRP HLW in a Federal repository. This conclusion is consistent with that reported by DOE in ER Amendment XIV.

The total repository disposal requirements of the CRBRP fuel cycle over its projected lifetime (approximately 30 years) include approximately 100 cubic meters of HLW in overpacked containers and 4,600 cubic meters of TRU waste (including metal scrap from the fuel reprocessing plant). Impacts from the disposal of CRBRP wastes were estimated by prorating the disposal impacts outlined in DOE (1980b) to that portion of the reference repositories in candidate geologic media (salt, granite, shale or basalt) which would be allocated to CRBRP waste. On the basis of the equivalent area required to dispose of the canisters sent to a repository from the CRBRP fuel cycle 6,000 55-gal drums of TRU, 3,000 canisters of metal scrap TRU; 180 canisters of HLW, not more than 1/100th of a reference repository (DOE 1979) would be occupied by wastes from the CRBRP fuel cycle. As discussed in more detail in Section D.2.4.4, releases of radioactive materials from a repository would be limited to generic values specified in the environmental radiation protection standards currently being developed by the U.S. Environmental Protection Agency. While these standards have not yet been published, they are expected to limit total repository impacts to levels which are smaller than the impacts from natural radiation sources, unmined uranium ore, or the balance of the uranium fuel cycle. The impacts attributable to the CRBRP wastes are projected to be less than 1/100th of the

Table D.10 Comparison of high-level waste from CRBRP with high-level waste from LWRs

	Curies/MTHM	
Radionuclide	CRBR	LWR[a]
H-3	0	4.2E+2
Sr-90	2.6E+4	6.1E+4
Ru-103	2.6E+2	7.4E+1
Ru-106	3.4E+5	1.9E+5
Cs-134	2.3E+4	1.2E+5
Cs-137	1.3E+4	9.3E+4
Ce-144	2.6E+5	2.4E+5
U-234	6.6E-5	1.7E-3
U-236	4.0E-3	1.3E-3
Np-237	7.3E-2	4.0E-1
Pu-238	1.3E+2	2.8E+1
Pu-239	2.3E+1	1.8
Pu-240	1.4E+1	3.7
Pu-241	6.8E+2	8.7E+2
Pu-242	4.3E-3	2.0E-2
Am-241	1.0E+3	7.1E+2
Cm-242	6.8E+3	9.9E+3
Cm-244	5.7E+1	7.2E+3
Total	1.6E+6	1.4E+6

(a) From Reference DOE 1980b, Tables 3.3.9 and 3.3.14, at about 1.5 year after reactor discharge.

total impacts of a high-level waste repository, and therefore would be expected to be insignificant compared to natural sources of radiation.

In the case of waste disposal in a geologic repository, construction of the repository would involve extractions of rock in a manner comparable to other underground mining operations. In the process of mining, release to the atmosphere of naturally occurring radionuclides from the rock would be increased. This increased release of radionuclides can be typified by the release of radon and its decay products from the mine. It is estimated that for CRBRP these releases would range from about 6×10^{-5} Ci/yr from a repository in salt to about 0.5 Ci/yr from a repository in granite (1/100th of values reported in DOE 1980). The resulting annual dose to the regional populations in the vicinity of the repository would range from about 7×10^{-5} person-rems for a repository in salt to about 1 person-rem for a repository in granite. For perspective the same population would annually receive about 2×10^{5} person-rems from other naturally occurring sources.

Non-radiological effluents released from repository construction and operation result from generation of dust and effluents from machinery and are presented in Table D.11. These projected releases would not exceed Federal Air Quality Standards, as outlined in 40 CFR 50, at the repository boundary (1.6 km from the point of emission). These quantities are developed from emission factors and estimates of fuel requirements (OWI 1978; URS 1977).

Table D.11 Annual release of nonradiological effluents from repository construction and operation attributable to CRBR fuel cycle wastes.*

	Geological Medium			
	Salt	Granite	Shale	Basalt
Effluent (MT)				
Sulfur Oxides	21	21	14	19
Nitrogen oxides	11	12	9.4	11
Hydrocarbons	0.52	0.65	0.42	0.57
Carbon Monoxide	4.1 - 13	6.4 - 23	3.8 - 13	6.1 - 21
Particulates	4.9	4.9	3.3	4.5
Heat (MJ)	2.5E+5	2.8E+5	1.4E+5	2.3E+5

*Construction and operation periods vary with geologic media; values shown are largest annual releases.

For purposes of providing perspective on such effluents, annual emissions from oil-burning space heaters in a town of about 30,000 are estimated to be 11 MT of CO, 6 MT of hydrocarbons, 27 MT of nitrogen oxide, 300 MT of sulfur oxides, and 23 MTs of particulates. In all cases these effluents are in the range of or greater than the repository releases.

Thus, the staff judges that the non-radiological impacts from the construction and operation of a repository in support of the CRBRP fuel cycle are insignificant when compared to effluents from other routine type activities.

Annual resource requirements associated with CRBRP fuel cycle wastes at a geological repository are given in Table D.12.

The lifetime land requirements are based on CRBRP wastes requiring about 1% of both the area occupied by surface facilities and the area underneath excess rock storage piles at the repositories. The land occupied by surface facilities (1.8 ha for salt and shale, and 2.2 ha for granite and basalt) could be considered temporarily committed because after the repository is decommissioned and any post-closure monitoring activity is completed, the surface land could be used for other purposes. However, land underlying the excess rock storage pile (0.7 ha for salt, 0.5 ha for shale, and 1.2 ha for granite and basalt) would be considered permanently committed.

Table D.12 Annual resource requirements for CRBR fuel cycle waste disposal in a repository*

Resource Requirement	Geological Medium			
	Salt	Granite	Shale	Basalt
Land (ha)				
Temporary	0.06	0.07	0.06	0.07
Permanent	0.02	0.04	0.02	0.04
Total	0.08	0.11	0.08	0.11
Water (millions of gal)	0.1	0.2	0.1	0.2
Fuel				
Electricity (MJ)	2.5E+6	3.1E+6	1.7E+6	2.8E+6
Diesel fuel (cubic meters)	90	100	67	90
Coal (MT)	470	420	310	430
Materials				
Concrete (cubic meters)	160	300	170	270
Steel (MT)	26	47	27	43
Steam (MT)	5000	5300	3300	4700
Staffing (person-years)	10	150	87	160

*Annual requirements vary between construction and operation; values shown are the largest annual requirements.

For perspective, the approximate annual U.S. production of some of the resources identified in Table D.12 is shown below. Staffing is that expended in the construction and mining industries (DOE 1980b).

Thus, the resource requirements for the CRBRP contribution to a repository are small in comparison with the annual U.S. production or use of such resources for other purposes, i.e., in the range of 0.0001 to 0.01%.

Resource	Annual U.S. Production or Use
Concrete (cubic meters)	7E+7
Steel (MT)	1E+8
Electricity (MJ)	7.2E+12
Diesel fuel (cubic meters)	4E+8
Staffing (person-years)	4E+6

D.2.2.5 Summary of Overall Waste Management Environmental Considerations

Annual waste management environmental considerations associated with the CRBR fuel cycle for LLW, TRU waste and HLW are presented in Table D.13. The range in impacts reflects differences which might be observed depending upon whether the Federal repository would be in salt, granite, shale or basalt. In the staff's estimation, CRBRP waste management requirements do not constitute a significant environmental impact. In all cases (i.e., storage, burial ground, repository), the relatively small amount of wastes from the CRBRP fuel cycle that would be stored and/or disposed of at facilities being planned for other nuclear requirements would constitute a very small increment to those facilities' other needs. Thus, the contribution of CRBRP fuel cycle wastes would be minor by comparison to the total waste management activities occurring at these facilities.

D.2.3 Transportation Impacts

Operation of the CRBRP would require the transportation of a variety of radioactive materials between the power plant and the supporting fuel cycle facilities. Although the exact location of some of the supporting facilities is not yet known, it is anticipated that they would be situated in different parts of the country. In terms of potential environmental impacts, it thus becomes important to quantify the many transportation steps required to support the CRBRP.

Radioactive materials transported in the CRBRP fuel cycle involve a variety of physical and chemical forms, but basically can be divided into three categories: fresh fuel materials and assemblies, irradiated materials, and radioactive wastes. The first category includes depleted uranium hexafluoride, depleted uranium oxide, plutonium dioxide, fresh core rods and fresh core and blanket assemblies. These materials would constitute the basic fuel for the reactor. Irradiated fuel and blanket assemblies, as well as exhausted radial shield and control rod assemblies, are transported from the reactor to the reprocessing plant. Radioactive wastes from the reprocessing plant, from the fuel fabrication plants and the CRBRP would have to be transported eventually to either a shallow-land burial ground or to a geologic repository. The estimated number of shipments and the quantities of these materials that would be generated in the operation of the CRBRP fuel cycle, the general characteristics of these materials, and the number of shipments per year required during CRBRP equilibrium operations are summarized in Tables D.14 and D.15.

Commercial packaging and transport of radioactive materials are regulated at the Federal level by the Department of Transportation (DOT). Shipment by the DOE is done in accordance with DOE Orders. The regulations for package design and control of shipments are designed to protect the public and transport workers from external radiation and exposure to the contained radioactive materials during shipment. Primary reliance for safety in transport of radioactive material is placed on the packaging. The packaging must meet applicable Federal and state regulatory standards, which provide that the packaging shall prevent 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., design basis accidents). Package contents must also be controlled so

Table D.13 Annual waste management environmental considerations from the CRBRP fuel cycle

Effect	Range (a)
Land (ha) (b)	
Temporarily Committed (ha)	0.07 - 0.08
Permanently Committed (ha)	0.03 - 0.05
Total	0.10 - 0.13
Water (millions of gal)	0.1 - 0.2
Fuel	
Electricity (MJ)	1.7E+6 - 3.1E+6
Coal (MT)	310 - 470
Effluents-Chemical (MT)	
Sulfur Oxides	14 - 21
Nitrogen Oxides	9 - 12
Hydrocarbons	0.42 - 0.65
Carbon Monoxide	3.8 - 23
Particulates	3.3 - 4.9
Effluents-Radiological (Ci)	
Radon and decay product	6E-5 - 5E-1
Other radionuclides	(c)
Thermal (MJ)	1.4E+5 - 2.8E+5

(a) Values shown are the range over geologic media and the periods of repository construction and operation.
(b) Land commitments include that required for storage of TRU wastes at Hanford, for LLW burial and land associated with the repository.
(c) The staff believes these values to be negligible by comparison with similar effects from other fuel cycle steps.

that standards for external radiation levels, temperature, pressure and containment are met.

D.2.3.1 Heat Load Impacts

The heat load per shipment for all fresh fuel materials would be expected to have essentially no impact on the environment. The temperature of the outer

Table D.14 Summary of fuel materials and quantities shipped for the CRBRP equilibrium annual fuel cycle

Type of Shipment	Mode of Transport	Quantity Shipped Per Year(a) (kg)	Quantity Shipped Per Shipment(a) (kg)	Heat Generation Rate Per Shipment (W)	Estimated Activity Per Shipment (Ci)	Avg. No. of Shipments Per Year	Est. Avg. Shipping Distance (km)	Shipment Destination(b)
				Fresh Fuel Material				
Uranium hexafluoride	Truck	11,100	8,430	--	3.73	1.3	4,000	BFP
Uranium dioxide	Truck	4,020	4,020	--	1.35	1	4,000	FMEF
Plutonium dioxide	Truck	890	64	--	6.4E+3	14	4,830	FMEF
Fresh Core Rods	Truck	4,889	360	--	6.6E+3	14	16	FDL
Fresh Core Assembly	Truck	4,889	360	--	6.6E+3	14	4,000	CRBRP
Fresh Blanket Assembly	Truck	6,980	600	--	0.20 (c)	12	4,000	CRBRP
						56.3		
				Irradiated Material				
Spent Core Assembly	Rail	4,670	330	2.0E+4	4.8E+6	14	4,000	DRP
Spent Blanket Assembly	Rail	6,920	580	5.4E+3 (c)	1.4E+6 (c)	12	4,000	DRP
Radial Shield and Control Rod Assembly	Rail	NA (d)	NA	NA	NA	4.5	4,000	DRP
						30.5		

(a) Quantities of materials shipped are given in kilograms of heavy metal.
(b) BFP: Blanket fabrication plant.
(c) Weighted average of inner and outer radial blankets.
(d) N/A: not available.

Table D.15 Summary of radioactive solid waste and quantities shipped for the CRBRP equilibrium annual fuel cycle

Type Shipment	Mode of Transport	Quantity Shipped Per Year (Cubic Meters)	Quantity Shipped Per Shipment (Cubic Meters)	Number of Containers Per Year	Heat Generation Rate Per Shipment (W)	Estimated Activity Per Shipment (Ci)	Avg. No. of Shipments Per Year	Est. Avg. Shipping Distance (km)	Shipment Destination(a)
				Waste From Fuel Preparation and Fabrication Plants					
TRU waste	Truck	30	6	145	--	1,660	5	4,000	FR
				Waste from CRBRP					
LLW	Truck	67	8.4	320	--	840	8	4,000	BG
Evaporator bottoms (b)	Truck	0.4	8	2	--	NA	0.05	4,000	BG
Treated sodium containing solids	Truck	21	10	100	--	NA	2.1	4,000	BG
				Waste from Reprocessing Plant					
LLW	Truck	25	12.6	120	--	130	2	4,000	BG
TRU waste	Truck	10	1.4	50	--	7.0E+5	7.1	4,000	FR
Metal scrap	Truck	14	0.8	102	--	3.4E+5	17	4,000	FR
HLW	Rail	1	0.3	6	2.6E+4	6.0E+6	3	4,000	FR
Noble gases	Truck	0.01	0.3	0.035	--	1.0E+6	0.035	4,000	FR
Iodine	Truck	0.01	0.3	0.05	--	< 50	0.03	4,000	FR
							45 (c)		

(a) FR: Federal repository; BG: Burial ground.
(b) From treated sodium coolant
(c) 42 Truck and 3 rail.

surfaces of these packages would be no higher than 50F° above the average ambient air temperature. With regard to the irradiated materials and wastes that would be transported in the CRBRP fuel cycle, the spent core and blanket assemblies and HLW shipments would release somewhat more heat to the environment. The heat load per shipment for these materials is shown in Tables D.14 and D.15.

Thermal releases would result from shipping spent core and blanket assemblies and HLW by rail. Based on the data on heat generation shown in Table D-14 and D.15 and data provided by DOE on length of travel time (DOE 1982), the thermal releases would be estimated to be about 2.1E+5 MJ annually.

With regard to the heat impacts of spent fuel and HLW, this analysis has been based upon the heat generated from these materials at their assumed shipment times of 100 days and 1 year after discharge, respectively, since these times represent maximum or bounding conditions. The design rate of release of heat to the air from casks for transport of irradiated materials and HLW is stated by the applicant to be about 26 kW, or about 90,000 Btu/hr. This rate can be compared with the rate of 50 kW or 180,000 Btu/hr released as waste heat from a 100-hp truck engine operating at full power. With the cask coolant system operating normally, the temperature of the cask surface would be less than 50F° above ambient temperature. Federal regulations (49 CFR 173.393) restrict the temperature of accessible cask surfaces to a maximum of 180°F. 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.

D.2.3.2 Traffic Density Impacts

Radioactive materials in the CRBRP fuel cycle are transported primarily by truck or train. Except in the case of plutonium containing materials and HLW which must be safeguarded against theft and sabotage (see Appendix E), shipments in the CRBRP fuel cycle would be made using commercial shipping systems. As shown in Tables D.14 and D.15, operation of the CRBRP would require approximately 56 shipments by truck per year of fresh fuel material, 33 shipments by rail per year of irradiated fuel components and wastes and 42 shipments by truck per year of radioactive wastes.

The shipments in support of the CRBRP would be over public roads via truck for fresh fuel material and some waste shipments. The number of these shipments would be very small compared with normally expected traffic density on highways. Irradiated material shipments to the reprocessing plant and shipments of HLW from the plant would be made by rail car. Shipping irradiated assemblies and HLW would involve about 30 rail car shipments annually. This is very small compared with commercial rail shipments annually. Thus the total number of shipments would be too small to have any measurable effect on the environment as a result of increased traffic density.

According to DOE, approximately 720,000 truck km (450,000 truck miles) would be required annually for shipping CRBRP fuel and waste materials (DOE 1982). The staff finds this is a reasonable estimate based on data in Tables D-14 and D-15. At 4.9 miles/gal (NRC 1976c), approximately 92,000 gal of diesel fuel would be used annually to ship these materials by truck. An additional small increment of diesel fuel would be used in rail shipment of spent assemblies and HLW. The staff concludes that the fuel attributable to the car carrying a spent fuel or HLW cask would be but a small fraction of the fuel required for the total train and is within the error of estimate of diesel fuel required for truck shipment. On the basis of emission yields for diesel engines of 102, 16.8, 168, 12.3, and 5.9 kg/1000 gal of diesel fuel respectively for CO, hydrocarbons, nitrogen oxides, sulfur oxides and particulates (NRC 1976c), combustion of 92,000 gal of diesel fuel would release about 9.4, 1.5, 15.4, 1.1, and 0.5 MT respectively of these emissions.

D.2.4 Radiological Impacts

The staff has estimated the dose commitment to the U.S. population (hereafter referred to as the population dose) from exposure to annual releases of radioactive effluents from normal operation of fuel cycle facilities and from transport of radioactive materials supporting the CRBR fuel cycle.

D.2.4.1 Dose Commitments from Blanket Fuel Fabrication

Radiological doses resulting from the conversion of depleted uranium hexafluoride to uranium dioxide and the fabrication of blanket fuel assemblies would depend, to some extent, on the commercial facility chosen to perform these functions. However, such effects can be projected on a generic basis from the environmental impact assessments of existing commercial U.S. uranium fuel fabrication plants (NRC 1977b, 1981b, and 1982b). On this basis, the population doses to the whole body from exposure to radioactive effluents from the fabrication of blanket assemblies for the CRBRP would be expected to be less than 0.1 person-rem annually.

D.2.4.2 Dose Commitments from Core Fuel Fabrication (FMEF and Building 308)

Population dose estimates for the fabrication of mixed oxide core fuel rods for the CRBRP are based on the annual releases listed in Table D.4 for the SAF Line, using an environmental dose commitment (EDC) time of 100 years.* The computational code used for these estimates is the RABGAD code originally developed for use in the "Generic Environmental Impact Statement on the Use of Mixed Oxide Fuel in Light-Water-Cooled Nuclear Power Plants," i.e., GESMO (NRC 1976a).

The following environmental pathways were considered in estimating doses: (1) inhalation and submersion in the plume during its initial passage; (2) ingestion of food; (3) external exposure from radionuclides deposited on soil; and (4) atmospheric resuspension of radionuclides deposited on soil. Radionuclides released to the atmosphere are assumed to be transported with a mean speed of 2 m/sec over a 4,000 km pathway from the State of Washington to the northeast corner of the United States, and deposited on vegetation (deposition velocity of 1.0 cm/sec) with subsequent uptake by milk and meat producing animals. No removal mechanisms are assumed during the first 100 years (radioactive decay is negligible) except normal weathering from crops to soil (weathering half-life of 13 days).

The following agricultural and population characteristics were used in computing doses:

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*The environmental dose commitment (EDC) is the integrated population dose for a specific time period (e.g., 100 years); it represents the sum of the annual population doses for the total time period specified.

- Annual food crop production is 100 kg/day/square mile.
- Annual milk production is 90 liters/day/square mile
- Annual meat production is 65 kg/day/square mile.
- Population density (based on the U.S. census for 1970 and allowing for about a 50% increase in the population) increases exponentially from 75 people/square mile in the State of Washington to 1500 people/square mile at the east coast (NRC 1979).

The bases for the agricultural characteristics are described in GESMO (NRC 1976a).

Using the above bases the U.S. population doses to the whole body and critical organs from exposure to radioactive effluents from the core fuel fabrication plant are estimated to be less than 0.1 person-rem. The staff projects that there will be no radiological releases from the core fuel assembly plant (Building 308), and thus doses to the population from the core assembly operation will be negligible.

D.2.4.3 Dose Commitments from Fuel Reprocessing

Population dose estimates for the reprocessing plant for irradiated CRBRP fuel assemblies are based on the annual releases listed in Table D.8 for the DRP. The RABGAD computer code was used to estimate doses using the preceding parameters, except for the following due to the likelihood of an eastern site for the DRP: (1) the radionuclide releases were assumed to be transported over a 2,400 km pathway, to the northeast corner of the United States, and (2) the population density was assumed to be 235 people/square mile. On this basis the U.S. population dose to the whole body from exposure to radioactive effluents is estimated to be about 140 person-rems. Over 90% of this dose would be due to exposure to tritium and carbon-14. Conservative (high side) estimates were used for source terms; consequently, the preceding dose is also conservative. Despite this bounding assessment, the dose commitment from the reprocessing plant would be less than 0.001% of the annual natural background dose to the U.S. population.

D.2.4.4 Dose Commitments from Waste Management

The radioactive wastes from the CRBRP and its supporting fuel cycle would be similar to other wastes that have been generated in the past and are projected to be a small fraction of such wastes that would be generated in the next 30 years from commercial nuclear power operations. For low-level wastes, the CRBRP wastes would represent less than 1.3 percent of the total curie content of the low-level wastes that will be disposed of at the reference disposal site assumed in the DEIS for 10 CFR 61 (NRC 1981a). The DEIS for 10 CFR 61 shows that the environmental effects of the reference disposal facility are small. Thus, the radiological effects of disposal of CRBRP low-level wastes would be negligible when compared to the total effects of low-level waste disposal.

The CRBRP high-level wastes are projected to occupy less than 1 percent of the total inventory of a typical high-level waste repository. The CRBRP wastes would not be not significantly different from other wastes that would be disposed of in a Federal repository (see Section D.2.2.4.) DOE has stated that high-level waste management facilities are to be designed in such a manner that there will be reasonable assurance that wastes will be isolated from the accessible environment for a period of at least 10,000 years with prediction of no significant decreases in isolation beyond that time.

DOE is currently conducting design studies for a HLW repository. However, until the design is finalized and a repository site has been selected, it would not be possible to quantify the long-term radiological impacts from HLW disposal at a specific site. Furthermore, the design of a repository (and the resulting impacts) would be strongly dependent on the generic performance standards with which the repository must comply. The U.S. Environmental Protection Agency (EPA) has the statutory responsibility for and has been working for 6 years to develop generic environmental radiation protection standards for disposal of HLW, but has not yet published these standards. In the absence of these standards, the radiological impacts of generic disposal of HLW cannot be quantified in a meaningful manner.

It is anticipated, however, that the EPA standard would limit the impacts of a HLW repository to levels small in comparison with natural radiation sources, unmined uranium ore, and the balance of the uranium fuel cycle. Since the HLW from the CRBRP would contribute less than 1/100th of the total inventory of a HLW repository, the radiological impacts from disposal of these wastes are expected to be insignificant compared to natural radiation sources.

D.2.4.5 Dose Commitments from Transportation

The principal radiological impacts from transport of radioactive materials are the direct radiation dose to the transport workers and bystanders. Persons along the transport route are also exposed during passage of the transport vehicle. In most cases, exposures are small and for a relatively short duration, but the number of persons who can be exposed may become large during a trip of considerable distance. Additional doses may result from exposure to the public during stops for meals, crew rest and vehicle servicing and refueling.

Estimates of the doses to transport workers and the general population from the shipment of radioactive materials in the CRBRP fuel cycle must be estimated in a generic manner because the locations of some fuel cycle operations and the storage or disposal site(s) for the radioactive wastes have not been firmly established. Using assumptions similar to those above for specific fuel cycle steps and based on average, conservative model conditions for 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 conservatively (high side) derived using the methodology detailed in NUREG-0170 (NRC 1977c). These are summarized in Table D.16. As noted in the table, the cumulative radiation dose to transport workers and the general population would be approximately 24 person-rems per year for the CRBRP and its related fuel cycle. This dose would be uniformly distributed along the route among approximately 750,000 people. Due to average nominal natural background radiation (about 0.1 rem per person per year), these same people receive about 75,000 person-rems 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 and its related fuel cycle facilities would be negligible

Table D.16 Estimated whole-body doses to transport workers and the general public from shipment of radioactive materials in the CRBRP fuel cycle*

	Person-Rems Per Year	
	Transport Workers	General Pop.
A. Fresh fuel Materials		
Plutonium dioxide	3.2	0.67
Fresh Fuel Core Assemblies	2.7	0.56
Spent Blanket Assemblies	0.11	0.0075
B. Irradiated Materials		
Spent Fuel Core Assemblies	5.8	0.74
Spent Blanket Assemblies	0.018	0.63
Control Rod and Radial Shield Assemblies	0.007	0.0024
C. Waste Materials		
Fuel Fab. Plants TRU waste	0.95	0.31
CRBRP Solid Radwaste	1.5	0.50
Reprocessing		
TRU Waste including Metal Scrap	4.6	1.5
LLW	0.382	0.13
HLW	0.005	0.18
D. Total	19	5
E. Total General Population and Transport Workers	24	

*Packages are assumed to meet DOT limits on external dose rates.

(within the range of variation of natural radiation at a given location) and indistinguishable from the doses attributable to natural sources.

D.2.4.6 Summary of Radiological Impacts

The population dose to the total body of the U.S. population that would result from the CRBRP fuel cycle operations us summarized in Table D.17. From the table the staff estimates that the dose to the total body from the annual operation of the CRBRP supporting fuel cycle would be about 170 person-rems. Most of this dose is from exposure to radioactive effluents released from the fuel reprocessing plant. For perspective, annual background radiation dose to the U.S. population (28 million person-rems) is included in Table D.17. The population dose to the total body of the entire U.S. population from exposure to radioactive effluents from routine operations of the CRBRP fuel cycle facilities and operations would be a small fraction (less than 0.001%) of the corresponding population dose from 1 year of exposure to natural background radiation. Potential health impacts from exposure to radioactive effluents from routine operation of CRBRP and its supporting fuel cycle are discussed in Section 5.7.3.

Table D.17 U.S. population doses due to annual releases of radioactive effluents from routine operations of the CRBRP supporting fuel cycle

Source of Exposure	Annual Whole Body Dose (person-rems)
Blanket Fuel Assembly Fabrication Plant	<0.1 (a,b)
Core Fuel Assembly Fabrication Plant	<0.1 (a)
Fuel Reprocessing Plant	140
Transportation	24
Storage and Disposal of Radioactive Waste	small (c)
Total (rounded)	170
Natural Background (d)	28,000,000

(a) The annual population doses to the bone, lung, kidney and GI tract are also less than 1 person-rem.
(b) Based on environmental impact appraisals for existing commercial fuel fabrication plants of Westinghouse, General Electric and Exxon, adjusted for CRBRP throughput.
(c) Expected to be very small compared with the annual releases of the other fuel cycle steps.
(d) Based upon a U.S. population of 280,000,000 persons (projected population for the year 2010) receiving a background dose of about 0.1 rem/yr.

D.2.5 Socioeconomic Impacts

Socioeconomic impacts of the CRBRP fuel cycle would relate principally to the need for new facilities or operations or additional needs to already planned operations or nuclear facilities that would cause increases or changes in levels of employment and public services requirements. These impacts have been assessed with regard to:

1. population effect - changes in population resulting from the influx of workers and their families during the construction and operational stages of the facilities.

2. economic effect - induced changes in income and expenditures, including demands for services, both public and private.

The equilibrium CRBRP fuel cycle would include new facilities for mixed oxide (MOX) fuel fabrication and fuel reprocessing as well as additional needs for uranium element fabrication, management of LLW, HLW and TRU waste generated by facilities in the fuel cycle, and the transport of products and wastes between such activities. Most facilities are expected to be DOE owned and operated and to be substantially smaller than were postulated for a commercial breeder reactor economy (ERDA 1975a). While the CRBRP is in advanced stages of design a proposed site selected and the facility for fabrication of the core fuel for the reactor is under construction, the same cannot be said for some of the other portions of the fuel cycle. Most of the other fuel cycle facilities are in the conceptual stage and potential socioeconomic effects can only be considered qualitatively.

The staff has considered the socioeconomic impacts of the additions to already planned nuclear operations as noted below.

The plant for the fabrication of the blanket materials and assemblies, yet to be selected, would likely be one of several commercial uranium fuel fabrication facilities already in operation. It is expected that the existing normal production capacity of the facility would be many times that required for CRBRP. Any impacts of blanket fuel and material production would be a small and undifferentiable component of existing effects. Thus this CRBRP operation has essentially no socioeconomic impacts.

Both the Federal high level waste repository and the specific commercial low level waste disposal facility that would be used for management of CRBRP fuel cycle wastes are not established at this time. Regardless, the waste from CRBRP would contribute only a small portion to the total capacity of such planned facilities; thus any socioeconomic impacts associated with CRBRP waste management would be a small increment to overall U.S. waste management socioeconomic impacts. In addition, socioeconomic effects of a geologic repository were assessed (DOE 1980b) and found not to be limiting in terms of a cost/benefit balance.

The materials to be transported are not unlike materials already planned to be transported to sites of several fuel cycle operations that are planned but yet to be specifically established. Thus, socioeconomic effects of transportation of radioactive materials to and from the various fuel cycle operations are assessed on a generic basis. Assumed distances between facilities were such that the analysis would tend to overestimate rather than underestimate consequences. Further, it is noted that transportation required for the CRBRP would be a small fraction of that required for the commercial nuclear fuel cycle. The volume of transportation of radioactive materials associated with the CRBRP fuel cycle would be insignificant in comparison with transport of materials for total U.S. nuclear energy production.

Socioeconomics of construction and operation of specific fuel cycle facilities principally associated with CRBRP requirements appear to be manageable as in the case of other similar significant new projects as discussed below. These socioeconomic effects include those associated with the MOX fuel fabrication plant and a reprocessing plant. Therefore, the staff's assessment considered these special CRBRP facilities.

The SAF Line, one such special facility to be used for CRBRP core fuel fabrication, will be built as part of the FMEF which is currently under construction on DOE's Hanford Reservation near Richland, Washington. Construction will take about 20 months and have a peak employment of 250 persons. Peak operational employment will be about 100 persons. The Hanford Reservation employs about 10,000 persons and the metropolitan Richland area has a population of about 125,000 persons. The relatively small magnitude of the project compared to the Hanford complex and the small size of FMEF work force compared to the relatively large population and work force in the area would result in little socioeconomic impact during either construction or operation of the facility.

The facility for reprocessing CRBRP fuel is still in the formulative stage and several alternatives are still under consideration by the DOE. The one selected by NRC for this assessment, the Demonstration Reprocessing Plant (DRP), has been selected as a bounding alternative (high side) for impact assessment purposes, but its site is yet to be established and thus can only be considered generically. On the other hand, the facility would be expected to be smaller than the reference commercial reprocessing plant for LWR fuel reprocessing where socioeconomic effects in a hypothetical but reasonable environment were not found to be large.

The DRP, although principally designed for processing CRBR fuel, could also reprocess light water reactor fuel (LWR). The designed capacity will be about 150 MT/year. Approximately 12 MT/year of this capacity will be used for reprocessing CRBRP fuel. The location of the DRP has not yet been decided but it is likely that the location will be on a Federally owned site with large local work forces. The peak construction force is projected to be 3,700 and the full operation work force about 750. Of this, about 8% would be attributable to the CRBRP fuel cycle. Assuming that the plant would most likely be built in a relatively urbanized area such as the Oak Ridge or Hanford sites, significant socioeconomic impacts would not be expected because of the availability of local labor and the ability of an urbanized area's services and facilities to absorb additional temporary population increases. In the event that the Oak Ridge reservation is the site for both the DRP and the CRBRP, then the CRBRP construction force would be decreasing as the DRP work force is increasing, thus the socioeconomic aspects of the DRP would tend to be a stabilizing factor for the additional construction period.

In summary, for those parts of the CRBRP fuel cycle that are specifically associated with that project, the socioeconomic impacts have been considered qualitatively and at most would appear to be small (e.g. equivalent to any large capital project). For those portions of the fuel cycle that are similar to the commercial nuclear reactor fuel cycle, the incremental effect of the CRBRP would be very small (approximately 1%) and is not considered to be measurable or a significant increment. Thus, it is the staff assessment that the socioeconomic impact of the CRBRP fuel cycle would not be a significant factor in the cost/benefit balance for decisions regarding the CRBRP.

REFERENCES - APPENDIX D

Code of Federal Regulations. Title 10, Part 51.

Code of Federal Regulations. Title 40, Part 50.

Croff, A. G. et al. 1980. ORIGEN2 - A Revised and Updated Version of the Oak Ridge Isotope Generation and Depletion Code. ORNL-5666, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

EG & G Idaho (EG&G). 1980. Managing Low Level Radioactive Waste. LLWMP-1, Idaho Falls, ID.

Office of Nuclear Waste Isolation (OWI). 1978. Technical Support for GEIS: Radioactive Waste Isolation in Geologic Formations. Y/OWI/TM-36/23, Oak Ridge, Tennessee.

Rockwell Hanford Operations. 1982. Support Documentation for the Hanford Defense Waste Environmental Impact Statement. RHO-HS-ST, Richland, Washington.

URS Company (URS). 1977. Air Quality Impacts Due to Construction at LWR Waste Management Facilities. URS 7043-01-01, San Mateo, California.

U.S. Atomic Energy Commission (AEC). 1974a. Clinch River Breeder Reactor Plant Environmental Report. Docket No. 50-537, Project Management Corp. for U.S. AEC, Washington, D.C.

U.S. Atomic Energy Commission (AEC). 1974b. Environmental Survey of the Uranium Fuel Cycle. WASH-1248, Washington, D.C.

U.S. Atomic Energy Commission (AEC). 1974c. Proposed Final Environmental Statement - Liquid Metal Fast Breeder Reactor Program. Washington, D.C.

U.S. Department of Energy (DOE). 1979. Technology for Commerical Radioactive Waste Management. DOE/ET-0028, Vol. 5, Washington, D.C.

U.S. Department of Energy (DOE). 1980a. Environmental Assessment for the Fuels and Materials Examination Facility, Hanford Site, Richland, Washington. DOE/EA-0116, Washington, D.C.

U.S. Department of Energy (DOE). 1980b. Final Environmental Impact Statement Management of Commercially Generated Radioactive Waste. DOE/EIS-0046F, Washington, D.C.

U.S. Department of Energy (DOE). 1980c. Statement of Position of the United States Department of Energy in the Matter of Proposed Rulemaking on the Storage and Disposal of Nuclear Waste (Waste Confidence Rulemaking). DOE/NE-0007, Washington, D.C.

U.S. Department of Energy (DOE). 1981a. Conceptual Design Report, Hot Experimental Facility. ORNL/CFRP-81/4, Washington, D.C.

U.S. Department of Energy (DOE). 1981b. FMEF Environmental Assessment Supplement for Secure Automated Fabrication (SAF). Washington, D.C.

U.S. Department of Energy (DOE). 1982. Amendment XIV to Environmental Report on Clinch River Breeder Reactor Plant. Docket No. 50-537, Washington, D.C.

U.S. Energy Research and Development Administration (ERDA). 1975a. Final Environmental Statement Liquid Metal Fast Breeder Reactor. ERDA-1535, Washington, D.C.

U.S. Energy Research and Development Adminstration (ERDA). 1975b. Final Environmental Statement Waste Management Operations at Hanford Reservation. ERDA-1538, Washington, D.C.

U.S. Energy Research and Development Adminstration (ERDA). 1977. Final Environmental Impact Statement Waste Management Operations at Savannah River Plant. ERDA-1537, Washington, D.C.

U.S. Energy Research and Development Administration, Richland Operations Office (ERDA/RL). 1976. Mechanical Standard, High Efficiency Particulate Air Filters. HPS-151-M, Richland, Washington.

U.S. Nuclear Regulatory Commission (NRC). 1976a. Final Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light Water Cooled Reactors. NUREG-0002, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1976b. Draft Supplement 1 to the Final Environmental Statement on Barnwell Nuclear Fuel Plant. NUREG-0082. Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1976c. Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle (Supp. to WASH-1248). NUREG-0116, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1977a. Final Environmental Statement Related to the Construction and Operation of the Clinch River Breeder Reactor Plant. NUREG-0139, Office of Nuclear Reactor Regulation, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1977b. Environmental Impact Appraisal of the Westinghouse Nuclear Fuel Columbia Site Commercial Nuclear Fuel Fabrication Plant, Columbia, South Carolina. Docket No. 70-1151, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1977c. Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes. NUREG-0170, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1979. Demographic Statistics Pertaining to Nuclear Power Reactor Sites. NUREG-0348, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1981a. Draft Environmental Impact Statement on 10 CFR 61 - Licensing Requirements for Land Disposal of Radioactive Wastes. NUREG-0782, Washington, D.C.

U.S. Nuclear Regulatory Commisssion (NRC). 1981b. Environmental Impact Appraisal of the Exxon Nuclear Company Nuclear Fuel Fuel Fabrication Plant. Docket No. 70-1257, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1982a. An ORIGEN2 Model and Results for the Clinch River Breeder Reactor. A. G. Croff and M. A. Bjerke. NUREG/CR-2762 (ORNL/NUREG-5884), Washington, D.C..

U.S. Nuclear Regulatory Commission (NRC). 1982b. Environmental Impact Appraisal of the General Electric Nuclear Facility Nuclear Fuel Fabrication Plant, Wilmington, North Carolina. Docket no. 70-1113, Washington, D.C.

APPENDIX E

SAFEGUARDS RELATED TO THE CRBRP FUEL CYCLE AND TRANSPORTATION OF RADIOACTIVE MATERIALS

The material in this appendix replaces the material in Appendix E in the original issuance of the FES.

E.1. INTRODUCTION

The CRBRP was originally projected to be supported by a commercial fuel cycle where all the facilities would be NRC-licensed. There are no plans for such commercial operations at the present time; hence the Department of Energy (DOE) would support the CRBRP with its own fuel cycle facilities. Accordingly, DOE amended the CRBRP Environmental Report (AEC 1974) to cover the CRBRP fuel cycle, including DOE's proposed safeguards measures for all fuel cycle and transportation activities.

This appendix describes and assesses DOE's proposed safeguards for the CRBRP fuel cycle. To aid in the assessment, three general safeguards criteria are used:

1. Do DOE's proposed safeguards systems provide a potential for deterring attempts at theft or diversion of plutonium and attempts at sabotage of facilities or materials to be used in the CRBRP fuel cycle?

2. Are DOE's proposed safeguards systems likely to detect attempts at sabotage, theft, or diversion?

3. Do DOE's proposed systems for responding to attempted theft, diversion, or sabotage provide reasonable assurance that such attempts would not be successful?

Each fuel cycle facility and transport activity can be assessed by comparing its safeguards design features with the general safeguards criteria. A typical safeguards system contains both physical security systems and material control and accounting systems, and may contain the following features: access controls, intrusion detection systems, delaying mechanisms (fences, barriers, etc.), response systems, systems to detect unauthorized removals of plutonium, material measurement systems and records systems.

The assessment is based on Amendment XIV of DOE's CRBRP Environmental Report (DOE 1982)* and on literature expressly referenced in the Environmental Report. At this stage of the licensing process, only a general description of the fuel cycle components and their proposed safeguards systems is required. The proposed fuel cycle with plutonium material types** and the expected modes of material transportation is shown in Figure E.1.

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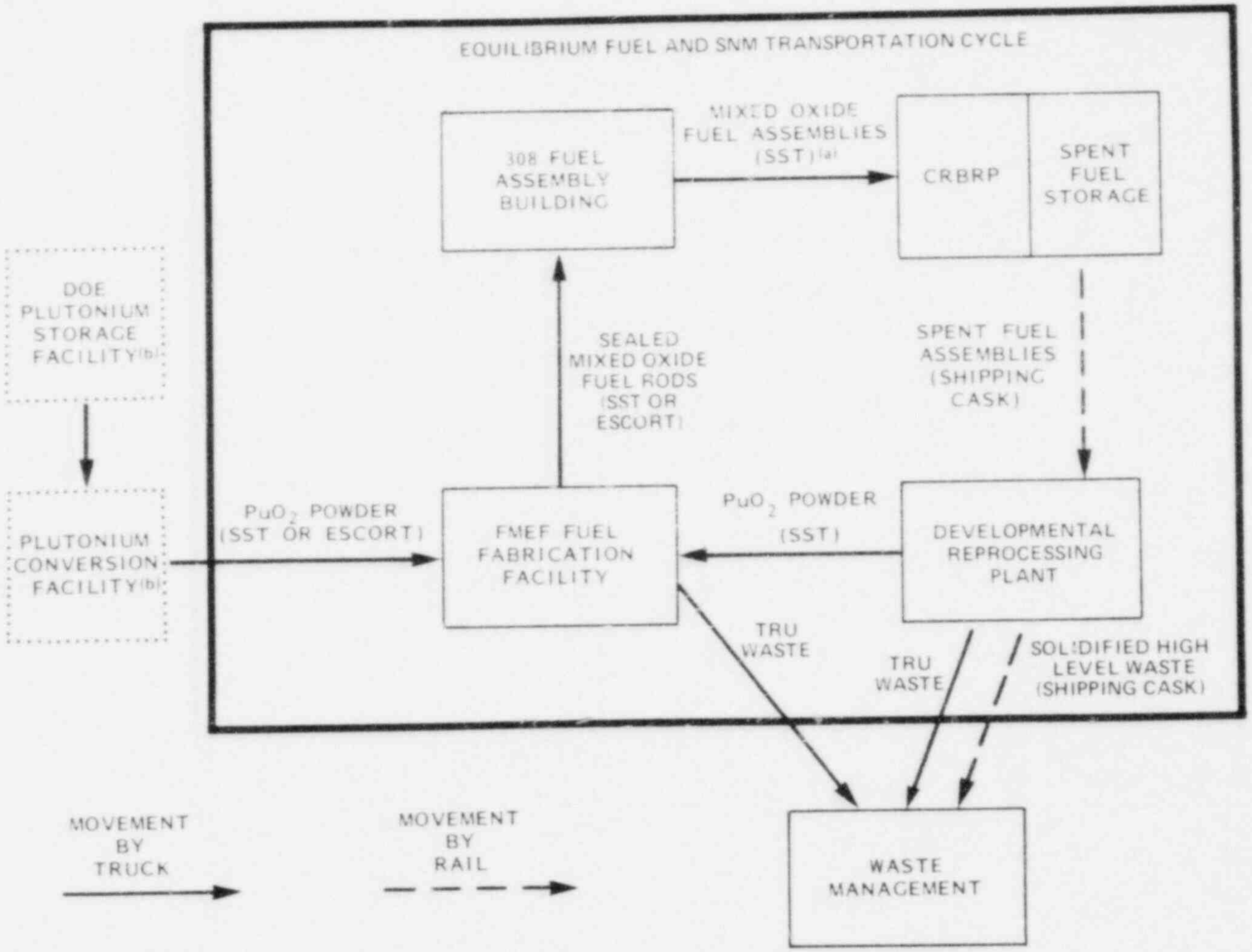
*Also referred to as "the applicants' ER" in the main body of this report.
**Plutonium is the only SNM type in the CRBRP fuel cycle.



(a) Safe Secure Transport (SST), (See Section E.8)

(b) Alternative for Initial 5 yr Demonstration Period Only

Figure E.1 CRBR Fuel Cycle, Plutonium Material Types and Transportation Links

The CRBR fuel cycle environmental review is unlike a similar review for light-water reactors for several reasons. The principal difference is that most of the fuel cycle facilities are to be owned and operated by DOE and would not be licensed. Similarly the transportation activities performed by DOE would not be subject to NRC regulation. Another difference is that most of these facilities are still conceptual and detailed safeguards systems are not yet designed for some of them. Of the CRBRP fuel cycle facilities, only Building 308 on the Hanford Reservation is operational today.

The remainder of this appendix is organized principally by fuel cycle activity. The design basis threats for the safeguards systems are described in Section E.2, followed by sections with descriptions of the DOE's proposed safeguards systems for plutonium conversion, MOX fuel fabrication, the CRBRP, fuel reprocessing, and waste storage facilities. Section E.8 describes the necessary transportation links in the fuel cycle and related safeguards measures. Each section considers the estimated cost of CRBR fuel cycle safeguards and assesses the potential for the proposed safeguards systems to meet the objectives stated above.

E.2. SAFEGUARDS DESIGN BASIS THREATS

E.2.1 NRC-DOE Threat Comparison

The safeguards systems described in this appendix are designed to counter design basis threats. The design basis threats contained in NRC's regulations (10 CFR 73.1(a)) would be used by DOE to protect against acts of radiological sabotage and to prevent the theft of plutonium at the proposed CRBRP. Safeguards systems for the associated, nonlicensed fuel cycle facilities would be designed in accordance with DOE's 1976 threat guidance. DOE threat guidance was revalidated in 1978 and remains in effect today.

NRC and DOE design basis threats are similar. The staff believes that safeguards programs designed in accordance with DOE's threat guidance will provide a level of protection against theft and sabotage that is at least as high as that provided by programs designed in accordance with NRC's design basis threats.

E.2.2 Summary of NRC Design Basis Threats

NRC design basis threats are detailed in 10 CFR 73.1(a). The threats are intended to provide guidance in the design of safeguards systems to protect against acts of radiological sabotage and to prevent theft or diversion of formula quantities* of special nuclear material. The safeguards system for sabotage shall be designed to protect against a determined violent external assault, attack by stealth, or deceptive action by several persons who are well trained and dedicated, aided by a knowledgeable insider, and equipped with suitable weapons and hand-carried equipment.

The safeguards system for theft or diversion shall be designed to prevent a determined violent external assault, attack by stealth, or deceptive actions by a small group who are well trained and dedicated, aided by a knowledgeable

*A formula quantity is defined in 10 CFR 73.2(bb).

insider, equipped with suitable weapons and hand-carried equipment, and capable of operating as two or more teams.

In addition, the safeguards systems shall be designed to protect against sabotage by a single insider and to prevent theft or diversion by a single insider and by a conspiracy between insiders.

E.2.3 NRC Policy on Clandestine Fission Explosives (CFE)

When designing safeguards systems to counter the design basis threat described above, the NRC does not assume any reduction in risk to the public due to difficulties that a non-national group might encounter in designing and building a CFE after obtaining two or more kilograms of plutonium. The staff recognizes that such risk reductions, although not quantifiable, are real, particularly in the case of a non-national group lacking necessary technical competence. Nevertheless, the staff concludes that such risk reductions are appropriately considered as an extra margin of conservatism. This staff policy on risk from clandestine fission explosives is based upon the following statement, contained in a memorandum from the NRC Executive Director of Operations on August 8, 1977: "Operating Assumption: It is assumed that a small non-national group of people could design and build a crude nuclear explosive device which would produce a significant nuclear yield, that is, a yield much greater than the yield of an equal mass of high explosive. To accomplish this, they would need an amount of special nuclear material which is at least equal to the five-kilogram formula quantity, and they would have to possess the appropriate technical capabilities." NRC regulations for protection against theft or diversion of formula quantities of SNM are consistent with this premise.

E.3. DOE SAFEGUARDS SYSTEM FOR PLUTONIUM CONVERSION

E.3.1 Physical Security System Description

Physical security systems for all DOE CRBRP fuel cycle facilities must have the objective of providing high assurance that activities involving SNM would not adversely affect national defense and security or constitute an unacceptable public health and safety hazard. In this context physical security systems are designed to protect against SNM theft or diversion and sabotage. For DOE facility physical security systems, standards for protection of SNM are outlined in DOE Order 5632.2, "Physical Protection of Special Nuclear Materials" (DOE 1979). These standards outline a protection-in-depth concept which is implemented by providing multiple barriers and detection systems between individuals and SNM.

During the first 5 years of CRBRP operation, plutonium for the core fuel would be obtained from DOE stockpiles. The conversion of plutonium to PuO_2 for fabrication of core fuel during the demonstration period would be done either at the Purex Plant on the Hanford Reservation or at another DOE facility having similar processing and safeguards capabilities. Physical security at this type of facility would include provisions for intrusion detection, adversary delay, alarm assessment, alarm response, and normal access control.

At the facility perimeter, two chain-link fences topped with barbed wire would identify the Protected Area boundary. Unauthorized access would be detectable using an intrusion detection system and a facility access control system. The perimeter would be illuminated, and assessment of alarms could be accomplished by closed-circuit television or security force visual surveillance. The guard station would limit access to the facility to personnel and vehicles necessary to perform facility functions.

All personnel, packages, and vehicles entering or leaving the Protected Area would be subject to search for contraband and plutonium. All personnel entering the Protected Area would be required to have DOE security clearances authorizing access to the facility or would be escorted by security-cleared employees. Further personnel access control would be achieved at the process building and subsequently at the plutonium conversion material access area.* Only facility personnel required for plant operations would be allowed access to these areas. All entrances to the building and material access areas would be monitored by an intrusion detection system.

Barriers at the Protected Area perimeter, building exterior, and interior portals to material access areas would be designed to delay intrusion long enough to provide sufficient time for intrusion situation assessment and alarm response actions.

All alarm and assessment systems would be monitored at a central alarm station, and redundantly monitored at a secondary alarm station located nearby.** All alarm equipment and transmission lines would be failure- and tamper-indicating. Both stations would have redundant communication links to the onsite security response force and to offsite local law enforcement agencies.

E.3.2 Material Control and Accounting System Description

All DOE CRBR fuel cycle facilities would be operated under the material control and accounting (MC&A) requirements given in DOE Order 5630, Parts 1 through 7, "Material Control and Accounting...(DOE 1979-81)" Under these requirements, the facility management would establish a system for the control and accounting of plutonium bearing materials. This would include subsystems for:

- containment
- surveillance
- internal control
- measurement
- statistics
- records and reports
- inventory certification.

The MC&A system, in conjunction with the physical security system, would provide capabilities to detect and deter the illicit diversion of plutonium and would provide assurance that no diversion has occurred.

Physical inventories would be performed on a bimonthly basis. DOE has stated that the limit of error on a 1-month material balance for facilities of this

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*Material access area is defined in 10 CFR 73.2(j).

**DOE requires central and secondary alarm stations at all facilities to be continuously manned.

type should be about 0.5% of throughput, and that the limit of error for a 2-month balance should be a slightly lower percentage of throughput.

Based on the expected plutonium throughput of the conversion facility, the limit of error for the inventory difference will be 1 kg or less for 2-month period. Items, including feed, product and scrap materials, would be stored in a vault and their contents verified by non-destructive analysis as frequently as desired.

Safeguards for the conversion facility would include a prompt accounting system which would allow material balances to be performed as frequently as desired and inventory differences estimated with sufficient accuracy to detect abrupt losses of significant quantities at high confidence levels and to detect small recurring losses before a cumulative loss could reach a significant quantity. The prompt accounting system should be able to detect the diversion of less than 1 kg of plutonium over a period as long as a week.

E.3.3 Costs of Plutonium Conversion Safeguards

DOE has not reported data concerning the cost of plutonium conversion facility safeguards.

E.3.4 NRC Assessment of Plutonium Conversion Safeguards

The safeguards systems proposed by DOE for the plutonium conversion facility meet the assessment criteria described in the Section E.1. The physical security system contains features that provide for detection of unauthorized activities and for a reasonable level of deterrence of theft of plutonium, as well as for protection of the facility against sabotage. The proposed MC&A measures, which include prompt accounting as well as systems required by DOE Orders (DOE 1979; DOE 1979-81), should provide reasonable assurance that theft or diversion of a significant quantity of plutonium will be detected in a timely manner. Communication systems would enable onsite and offsite forces to respond in such a fashion as to deter and prevent attempted adversary actions. The safeguards systems at this facility could assure that risks from the design basis threat are no greater than at other currently operating U.S. nuclear facilities handling significant quantities of SNM.

Although no cost data for safeguards at the conversion facility have been provided, it is anticipated that the costs would be comparable to the safeguards costs at other similar DOE facilities. Since the candidate facility for the initial plutonium conversion has already been built for other purposes and is only scheduled for CRBR conversion operations during the 5-year demonstration period, the plutonium conversion safeguards costs attributable to the CRBRP operations would be small compared to the other CRBR fuel cycle costs.

E.4 DOE SAFEGUARDS SYSTEM FOR FUEL FABRICATION FACILITIES

E.4.1 Physical Security System Description

The Fuels and Materials Examination Facility (FMEF), where the CRBRP fuel material would be fabricated into fuel rods, and the Fuel Development Laboratory (308 Building), where the fuel rods would be fabricated into assemblies, are located on the DOE Hanford Reservation. Both facilities would have comparable physical security features as described below.

A Protected Area would be established at the facility perimeter to control personnel and vehicle access. This area would be defined by two chain-link fences topped with barbed wire and would utilize intrusion detection systems to alert the security force to possible intrusion attempts. The perimeter would be sufficiently illuminated to permit effective alarm assessment by both closed-circuit television and security personnel. Normal access to the Protected Area would be gained by DOE security-cleared personnel and escorted visitors through a guard station. All persons, packages, and vehicles entering or leaving the area would be subject to search for contraband and plutonium.

The building portals would be security-hardened and alarmed when not in use. The main building entrance would be controlled to allow only authorized individuals access to the building. Search procedures similar to those performed at the Protected Area perimeter would be in effect.

Plutonium in the facility would be located in Material Access Areas (MAA) where access would be further limited to personnel necessary to perform authorized activities in those areas. At the FMEF the plutonium in process would be contained within the Secure Automated Fabrication (SAF) Line, which would be remotely operated from behind isolation walls that function as a secondary confinement barrier. When an MAA is unoccupied, an intrusion detection system would be activated.

Security alarm and assessment systems would sound in a central alarm station. Redundant alarm annunciation would be provided at a secondary alarm station. All alarm equipment and transmission lines would be failure- and tamper-indicating. Both stations would have redundant communication links with security response forces and local law enforcement agencies. Security for the Hanford Reservation is provided by the Hanford Patrol. Sufficient response personnel with appropriate armament are available to protect the facilities and plutonium against the design-basis threats.

E.4.2 Material Control and Accounting System Description

The CRBRP MOX fuel rod fabrication would consist of a multistep process of preparing mixed-oxide pellets and fabricating them into stainless steel fuel rods. The feed to the process would be high purity PuO_2 and UO_2 powders. The fabrication of MOX fuel rods would be done in the SAF Line, which would be built in the FMEF. The SAF Line and the fuel assembly operations in Building 308 would be operated by the DOE under the MC&A requirements given in DOE Order 5630 (DOE 1979-81). The SAF product rods would be shipped as sealed rods to the 308 Building for assembling into finished fuel assemblies.

Shipments and receipts for the SAF Line would be based on measured quantities. For material of well-known composition transfers within the SAF Line would be based on weight measurements and item identification. Elemental or isotopic analyses would be performed on transfers of scrap and waste materials.

Physical inventories would be performed on a bimonthly basis. DOE estimates that the limit of error on a 1-month inventory difference would be about 0.5% of throughput for a facility of this type, and that the error on the inventory difference for bimonthly inventories should be a slightly lower percentage of throughput. Based on the expected throughput of the fuel fabrication facilities, the limit of error on the inventory difference should be no more than one kilogram per 2-month balance.

The MC&A system for the SAF Line also would employ a prompt accountability system. The entire process would be divided into multiple unit-process accountability areas (UPAA). Plutonium quantities entering and leaving a UPAA would be measured, enabling a material balance to be calculated for each UPAA approximately every 24 hours.

The effectiveness of material control would be further enhanced by the automation of the SAF Line, which eliminates the need for routine direct handling of the plutonium. Access to plutonium can be limited to maintenance work and other nonroutine activities that can be carried out under the surveillance of authorized material custodians.

All significant amounts of plutonium in Building 308 would be in the form of sealed assembled rods. Bimonthly inventories and daily checks for missing rods would be performed as required by DOE Order 5630 (DOE 1979-81).

E.4.3 Costs of Fuel Fabrication Safeguards

The costs of safeguards for fuel fabrication are summed for the FMEF and Building 308, and include costs for physical security and material control and accounting for each facility. A summary of DOE-reported costs is shown below.

DOE Costs for Safeguards-Fuel Fabrication
(FMEF and Building 308)
(in millions of $)

	Capital Investment	Annual Operating
Physical Security System	$2.2	$0.3
Material Control and Accounting	1.6	0.9
Security Force	--(a)	0.8
Total	$3.8	$2.0

(a)Information not provided by DOE. However, the staff believes these costs would be negligible by comparison.

E.4.4 NRC Assessment of Fuel Fabrication Safeguards

The safeguards systems proposed by DOE for the FMEF fuel rod fabrication line meet the assessment criteria described in Section E.1. The physical security system would contain features that provide for detection of unauthorized activities, reasonable deterrence of theft of plutonium, and protection of the facility against sabotage. The SAF Line's MC&A system using prompt accounting would contribute to the capability of detecting diversion, and would provide assurance that diversions have not occurred. Communication of alarm conditions to onsite and offsite forces would provide reasonable assurance that both plutonium theft and sabotage can be prevented. Building 308's safeguards system would provide similar levels of safeguards protection. The proposed safeguards systems at these facilities would assure that risks from the design basis threats would be no greater than those at other currently operating U.S. nuclear facilities handling significant quantities of SNM.

The costs of fuel fabrication safeguards reported by DOE appear to be realistic, and represent a small fraction of the total projected costs of the facilities.

E.5. DOE SAFEGUARDS SYSTEM FOR CRBRP

E.5.1 Physical Security System Description

The CRBRP would be a U.S. government facility constructed, licensed, and operated in accordance with NRC regulations. The applicable regulations for physical security are found in 10 CFR 11, 25, 50, 73, and 95. The CRBRP's design features and physical security measures would be developed to meet the performance objectives and requirements as stated in the 10 CFR 73.20 and 73.55, thus providing protection against both the sabotage and theft design basis threats. According to the CRBRP Preliminary Safety Analyses Report (PSAR) (PMC 1975) the physical security system for the CRBRP would:

- control entry to the CRBRP and specific areas within the plant,
- deter penetration of facility barriers by unauthorized persons,
- detect penetrations should they occur, and
- apprehend in a timely manner all persons (including insiders) attempting acts which constitute a threat to the plant.

The CRBRP PSAR lists design features that are considered necessary to accomplish the above. These include perimeter security barriers identifying a Protected Area boundary equipped with an intrusion detection system, an isolation zone between perimeter barriers void of all structures and vegetation to facilitate intrusion alarm assessment, and adequate perimeter and building lighting to permit visual surveillance and closed-circuit television alarm assessment. There would also be strict access control at the CRBRP, which would be accomplished by an access control facility at the Protected Area perimeter containing security personnel and equipment to search persons and vehicles for contraband, a minimum number of exterior plant doors with access to security-hardened vital areas and an intrusion detection system for portals used to gain access to vital areas. Personnel access to vital equipment and material access areas would be controlled by an electronic system in accordance with levels of authorization. Intrusion detection devices and access control equipment would annunciate in central alarm stations and redundantly in a secondary alarm station. All alarm equipment and transmission lines would be failure- and tamper-indicating. The security force would provide for routine surveillance, access control, alarm response, situation evaluation and threat neutralization. There would also be a communication system between security officers and the central alarm station and the secondary alarm station with redundant communication links between these stations and local law enforcement agencies.

The CRBRP Physical Security Plan and the Safeguards Contingency Plan, which describe measures that would be used to minimize the potential for sabotage and to protect against theft or diversion, are to be provided later in the licensing process and will be reviewed in detail by the NRC staff. The Security Personnel Training and Qualification Plan following the criteria in 10 CFR 73 Appendix B will also be provided.

E.5.2 Material Control and Accounting System Description

The MC&A system for the proposed CRBRP will meet NRC requirements as described in 10 CFR 70. The material accounting will be based entirely on item control. Records showing receipts, internal transfers, and shipments will be maintained for inventory purposes. All movements of fuel would be monitored and the computerized inventory record would show the location of all fuel assemblies.

Material control would be enhanced by the design of the facility. There would be only a limited number of storage locations for fresh and spent fuel assemblies. After visual inspection upon receipt, the fresh assemblies would be placed in a secure location such as the sodium-filled fuel handling system or the reactor core until irradiation is completed. Then they would be loaded into shielded shipping casks for transport to the reprocessing facility after an appropriate cooling time.

E.5.3 Cost of CRBRP Safeguards

DOE reports the cost of safeguards at the CRBRP as shown below.

DOE Costs of Safeguards - CRBRP
(in millions of $)

	Capital Investment	Annual Operating
Physical Security System	$3.86	$0.17
Material Control and Accounting	0.0*	0.0*
Security Force	0.05	2.1
Total	$3.91	$2.27

*DOE's reported fuel management and handling system would provide the necessary MC&A data; thus there will be no incremental cost attributable to safeguards accountability.

E.5.4 NRC Assessment of CRBRP Safeguards

The safeguards system proposed by DOE for the CRBRP must meet all NRC safeguards regulations for operating a nuclear reactor licensed under 10 CFR 50.

The physical security measures described in the CRBRP PSAR are reasonable for fulfilling these regulations and include provisions to detect unauthorized activities and deter theft or sabotage. The material control and accounting provisions described in the CRBRP PSAR meet the intent of the NRC regulations in 10 CFR 70.

The costs of safeguards as reported by DOE appear to be realistic and they are a small fraction of the total cost of the CRBRP.

E.6 DOE SAFEGUARD SYSTEM FOR REPROCESSING

E.6.1 Physical Security System Description

DOE has stated that the most likely alternative for the reprocessing of spent fuel from the CRBRP would be the Developmental Reprocessing Plant (DRP). Multiple barriers would be provided at the DRP to exclude unauthorized individuals. A Protected Area would be defined around the DRP to control personnel, vehicle, and rail access to the area. The boundary would consist of two chain-link fences topped by barbed wire. A guard station would control all traffic entering and exiting the Protected Area. The DRP building itself would provide another barrier since it must be substantially constructed to provide a ventilation confinement barrier, radiation shielding, and tornado resistant features (see the DOE ER for additional DRP design information). A limited number of building entrances would be provided, each with access controls to assure that only authorized personnel gain access. Inside the DRP, spent fuel, plutonium processing, and plutonium storage operations would be contained within material access areas (MAA). These areas would also be protected with access control features designed to limit personnel to only those necessary to perform authorized activities. Vital areas containing equipment or materials which protect the health and safety of the public would be controlled in a manner similar to that for MAAs.

Unauthorized penetrations of these barriers would be detectable using multiple intrusion detection systems. At the Protected Area perimeter, electronic devices would be installed to detect any movement and the perimeter would be sufficiently illuminated that closed-circuit television could be used to assess any alarm condition. All persons, packages, and vehicles entering or leaving the Protected Area or the process building would be subject to search for contraband or plutonium. The DRP building entrances, when not in use, would be protected by an intrusion detection system, as would the entrances to MAAs and vital areas. Closed-circuit television, guard force posts and patrols, and supervisory observation would provide surveillance measures to assure that only authorized activities are performed. They would also provide alarm assessment when necessary.

All alarms, assessment systems, and response communications would be coordinated at a central alarm station. Alarm transmission and the computerized alarm monitoring system would be tamper- and failure-indicating to prevent tampering and unauthorized access. Redundant capabilities would exist at a secondary alarm station should the central alarm station be compromised. Both stations would have capabilities for redundant, continuous, and rapid communication with onsite and offsite response forces.

DOE has stated that the DRP would be protected by a dedicated security force selected, trained, and equipped in a manner consistent with requirements established in 10 CFR Part 73, Appendix B. The size of the force would be sufficient to impede and neutralize the design basis threats, and contingency plans for unauthorized acts would be prepared. Response forces would be in communication with offsite local law enforcement agencies who would assist as necessary.

E.6.2 Material Control and Accounting System Description

For purposes of material accounting, the DRP would be divided into six material balance areas (MBAs) for which plutonium balances could be performed periodically. The proposed MBAs are:

- spent fuel storage pool
- chemical separations area
- plutonium nitrate storage area
- plutonium nitrate conversion area
- plutonium oxide product storage vault
- analytical laboratory area

During equilibrium operations, an annual average of approximately 81 fuel and axial blanket, 41 inner blanket and 28 radial blanket assemblies would be received, having a total content of approximately 1000 kg of plutonium. The assemblies would be accounted for as discrete items. The book inventory value would be based on reactor calculations. The first measured value would be available after the assemblies are disassembled and the pellets are dissolved. The measured value would serve as the input accounting measurement. In addition, prompt accounting would be used throughout the facility based on continuous monitoring of the uranium and plutonium contents of process streams and intermediate storage vessels.

The final product of the facility destined for use at the proposed CRBRP use would be packaged PuO_2, and would be measured and temporarily stored in a vault onsite. Most of this ultimately would be shipped to the Hanford Reservation for fabrication into fuel assemblies. Any excess would be stored for future use. Accounting in the vault area would be on an item basis. Substantial passive material control would be achieved by limiting personnel access to any significant quantity of plutonium and through the remote operation and maintenance features of the plant. In addition, the massive shielding and the highly radioactive nature of solutions of plutonium in the chemical separations area would present serious obstacles to diversion or theft of plutonium. Active material control would be applied by use of monitoring systems to detect any unauthorized movement of plutonium from the process or storage areas.

For a yearly material balance, the accounting system limit of error is stated to be in the range of 0.7% of throughput for the DRP. This is equivalent to 7 kg of plutonium per year based on an annual CRBRP discharge rate of 1000 kg of plutonium. For the prompt accounting system, DOE has referenced studies that indicate that 5-day balances in controlled experiments have shown a limit of error of about 2 percent.

E.6.3 Costs of Reprocessing Safeguards

DOE based its safeguards cost estimates for reprocessing on the assumption that CRBRP spent fuel would utilize only a fraction (approximately 8%) of the DRP capacity. Since the DRP has no additional identified LMFBR near-term applications, the staff believes that the staff's CRBRP fuel cycle review should consider all costs of DRP safeguards. The total costs of safeguards (not adjusted for the 8% factor) for the DRP are shown below.

DOE Costs of Safeguards for the DRP
(in millions of $)

	Capital Investment	Annual Operating
Physical Security System	$35	$ 1.5
Material Control and Accounting	15	5.0
Security Force	--(a)	3.5
Total	$50	$10

(a)Information not provided by the DOE. However, the staff believes these costs would be negligible by comparison.

E.6.4 NRC Assessment of Reprocessing Safeguards

The proposed DOE facility design is conceptual in nature; hence the safeguards system is also conceptual. However, the concepts and technologies for physical security systems for this type of facility are sufficiently developed to assure that the DRP can be effectively protected. Alarm response capabilities are expected to be incorporated into the safeguards design to deter and prevent design basis threat acts.

The MC&A system for this facility is expected to be designed to assure that plutonium losses or diversion would be detected in a timely manner. To achieve the accountability measurement capability stated by DOE would require a sophisticated MC&A system with a level of performance not yet demonstrated in a large reprocessing plant. However, significant progress in MC&A technology has been made through research and development on reprocessing safeguards. Thus the staff believes that, in the time frame of design and construction of the DRP, the safeguards system, as described by the DOE, can meet the assessment criteria. DOE costs of DRP safeguards appear to be realistic and represent only a small fraction of the total fuel cycle cost.

E.7 DOE SAFEGUARDS SYSTEM FOR WASTE MANAGEMENT

E.7.1 Safeguards Description

Based on level of radioactivity or concentration of SNM, there are two types of radioactive waste generated by the CRBR fuel cycle that may require safeguards. These are (1) high-level waste (HLW), and (2) transuranic (TRU) waste.

The HLW generated by reprocessing spent fuel is to be fixed in a solid matrix and packaged in cylinders for disposal at a Federal repository. A physical security program would be incorporated at the site. This program would include access control, means of detecting unauthorized activities, and a response program to resolve abnormal situations.

TRU wastes generated at the reprocessing and fuel fabrication facilities are to be stored according to existing storage policies and procedures at an existing TRU waste storage site located on the DOE Hanford Reservation until disposal at a Federal repository. The site is isolated and protected from public access, with surveillance maintained by the Hanford Patrol.

E.7.2 NRC Assessment of Safeguards Measures

Protection of the waste generated by the CRBRP fuel cycle would be commensurate with the small amount and low concentration of plutonium involved and the generally well protected status of the material as a possible target for sabotage. The protection afforded by interim storage facilities and Federal repository disposal will provide additional assurance that sabotage attempts would not be successful. Attempted theft of stored waste materials is considered improbable due to inaccessibility, high radiation levels, and low concentrations of plutonium involved.

The amount of HLW and TRU waste generated by the CRBRP fuel cycle would be small compared to the total volume of similar waste generated by the nuclear industry. Thus any costs associated with the safeguards for CRBR fuel cycle wastes would be expected to be small by comparison with overall waste safeguards costs for the nuclear power industry.

E.8 TRANSPORTATION SAFEGUARDS

E.8.1 Shipment by Truck

The operation of the CRBRP fuel cycle would require the transportation of radioactive material, including plutonium powders, fresh fuel and radioactive wastes. The DOE Order 5632.2 (DOE 1979) requires that all shipments of two or more kilograms of separated plutonium be made in Safe Secure Transport (SST) vehicles except for movement of materials between Protected Areas on the same DOE site. These DOE onsite movements may be made by SST or other security-approved conventional vehicle escorted by armed security personnel in a vehicle equipped with a two-way radio. Such onsite transportation links for the CRBRP fuel cycle would include movements between the conversion facility (PUREX-200 East Area) and fuel rod fabrication (FMEF-400 Area) for PuO_2 powder, the rod fabrication (FMEF-400 Area) and fuel assembly (Building 308-300 Area) for sealed fuel rods, and the rod fabrication (FMEF) and the waste storage area (Hanford Reservation) for transuranic wastes (TRU).

The SST is equipped with active and passive barriers to protect against theft and sabotage attempts. Trained, equipped, and armed drivers and escorts are provided with a radio communication link to a dispatcher and local law enforcement agencies. Offsite SST plutonium movements would include plutonium from the DOE storage facilities to the conversion plant, CRBRP fuel assemblies to the CRBRP, and plutonium oxide from the reprocessing facility to the FMEF. Truck shipments of plutonium materials are summarized in Table E.1.

E.8.2 Shipments by Rail

DOE has stated that rail shipments of spent CRBRP fuel and high-level waste (HLW) would be in containers that are designed in accordance with Department of Transportation and NRC regulations. Such transportation activities would include spent fuel shipments from the CRBRP to the reprocessing plant, HLW shipments from the reprocessing plant to a waste storage facility, and HLW shipments from a waste storage facility to a Federal geologic repository.

Spent fuel assemblies and HLW are both thermally hot and highly radioactive, and would be transported and protected in large casks weighing many tons. The casks will be designed for transport on 100-ton capacity flatcars and afford considerable protection against sabotage acts. Escorts would maintain continuous surveillance of the casks and would be provided with communication capability to local law enforcement agencies in case of emergencies. Rail shipments are summarized in Table E.1.

E.8.3 Costs of Transportation Safeguards

The transportation costs attributable to safeguards can be fairly easily separated from general transportation costs. The special shipping containers that contain irradiated materials or wastes are considered fuel cycle costs since they are required due to radiological protection needs. Escorts that accompany the shipments and the necessary communications represent the major transportation safeguards costs. Transportation of spent fuel and spent blanket assemblies will have two escorts and a communication network. The cost per escort is expected to be $50,000 per year.

DOE has indicated that the SST system, which would be used for highway shipments of fresh materials containing plutonium, is principally intended to provide protection from theft or diversion. Thus, it is considered a part of safeguards costs. Based on DOE information, the system has sufficient additional availability and communication capabilities to accommodate CRBRP transportation requirements. Operating costs for the SST are reported to be $18,000 per 4000 km (2500-mile) shipment.

Two areas not addressed by DOE that may have a minor effect on transportation safeguards costs are movements of material between facilities on the Hanford Reservation and shipments of HLW from the reprocessing facility to the storage facility. Escorting material on the Hanford Reservation may result in the hiring of an extra guard at an annual cost of about $50,000. DOE states that HLW would be transported in a similar fashion to spent fuel, which implies that escorts may be used. The annual cost of escorting HLW would be $21,000, based on the ratio of the number of shipments of spent fuel to HLW. Estimated annual costs of transportation safeguards are summarized in Table E.1.

Table E.1 CRBRP plutonium transportation links and safeguards costs

Transportation Link	Plutonium Form	Transport Mode	Shipments per Year	Safeguards Costs
DOE Storage to Pu Conversion[1]	Storage form	SST	NA[2]	NA
Pu Conversion to Rod Fabrication[1]	PuO_2 powder	SST or Escort	NA }	$ 50,000
Rod Fabrication to Fuel Assembly	MOX pellets in sealed rods	SST or Escort	14 }	
Fuel Assembly to CRBRP	MOX Fuel assemblies	SST	14	252,000
CRBRP to Reprocessing	Spent Fuel assemblies	Casks-Rail	14	100,000
	Spent Blanket assemblies	Casks-Rail	12	100,000
Reprocessing to Rod Fabrication	PuO_2 powder	SST	14	252,000
Rod Fabrication to Waste Storage	TRU waste	Truck	5	NA
Reprocessing to Waste Storage	TRU & Metal Scrap	Truck	∼24	NA
Reprocessing to Waste Storage	HLW in matrix in canisters	Casks-Rail	3	21,000
TOTAL				$775,000

[1]These links exist only for the 5-year demonstration period.
[2]Data not available.

E.8.4 NRC Assessment of Transportation Safeguards

The transportation safeguards systems proposed by DOE meet the general assessment criteria described in Section E.1. Use of the SST system for highway shipments of separated plutonium would provide reasonable protection against theft and sabotage, as there would be armed escorts, and the vehicle would be equipped with immobilization features. Unauthorized access to the vehicle would be prevented by following strict loading procedures at the facility, providing carefully selected, specially trained, equipped, and armed couriers and drivers, and including active and passive barriers to protect the cargo. Timely response to theft or diversion and sabotage attempts would be provided by constant communication through a central dispatcher (with a redundant system available), and cooperative efforts of local law enforcement and other Federal agencies.

For the cases where the SST system would not be utilized (transfers around the Hanford Reservation and rail shipments for spent fuel and blanket assemblies and HLW), security-approved vehicles with communications and escorts would be used. The rail casks would be massive enough to provide radiological protection, and would also provide substantial theft and sabotage protection. Armed escorts would provide a further level of assurance, as would the communications system which would permit timely local law enforcement agency response to emergencies.

The costs estimated by DOE for transportation safeguards appear to be realistic and do not represent a major contribution to the CRBRP fuel cycle costs.

E.9 ENVIRONMENTAL IMPACTS OF SAFEGUARDING NORMAL OPERATIONS OF THE CRBRP FUEL CYCLE

The staff believes that the environmental impact of the safeguards measures necessary to minimize the risk of a successful act of theft or sabotage will be negligible. The safeguards systems that DOE proposes to employ for the CRBRP fuel cycle would involve minimal construction beyond that required for the operation of the fuel cycle facilities themselves. No new construction will be required for transportation safeguards. The number of operating personnel required for safeguards and the amount of equipment required for their support would be small compared to the overall personnel and equipment requirements of the CRBRP fuel cycle. The operation of the safeguards systems would not impact the environment beyond the immediate vicinity of the fuel cycle activities.

REFERENCES

U.S. Atomic Energy Commission (AEC). 1974. Clinch River Breeder Reactor Plant Environmental Report. Docket No. 50-537, Project Management Corp. for U.S. AEC, Washington, D.C.

U.S. Department of Energy (DOE). 1979. DOE Order 5632.2, Office of Safeguards and Security, Washington, D.C.

U.S. Department of Energy (DOE). 1979-81. DOE Order 5630, Part 1 through 7, Office of Safeguards and Security, Washington, D.C.

U.S. Department of Energy (DOE). 1982. Amendment XIV to Environmental Report on Clinch River Breeder Reactor Plant. Docket No. 50-537, Washington, D.C.

Project Management Corporation (PMC). 1975. Clinch River Breeder Reactor Plant Preliminary Safety Analysis Report (PSAR). NRC Docket No. 50-537.

APPENDIX F

LETTER FROM ERDA RE IN LIEU OF TAX PAYMENTS

No changes have been made to this Appendix.

APPENDIX G

LETTER FROM ERDA RE NEED FOR SOCIOECONOMIC MONITORING PROGRAM

No changes have been made to this Appendix.

APPENDIX H

DRAFT NPDES PERMIT

PERMIT NO. TN0028801

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IV

345 COURTLAND STREET
ATLANTA, GEORGIA 30365

DRAFT 6/24/82

AUTHORIZATION TO DISCHARGE UNDER THE
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Clean Water Act, as amended, (33 U.S.C. 1251 et. seq; the "Act"),

U. S. Department of Energy
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

in accordance with effluent limitations, monitoring requirements and other conditions set forth in Parts I, II, and III hereof. The permit consists of this cover sheet, Part I 11 pages(s), Part II 12 pages(s), Part III 5 page(s), and Attachments 4 .

This permit shall become effective on

This permit and the authorization to discharge shall expire at midnight,

Date Signed

Paul J. Traina
Director
Water Management Division

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 - Common Plant Discharge (includes Sewage Treatment Unit effluents during construction and all plant wastes during operation).

Such discharges shall be limited and monitored by the permittee as specified below:

DRAFT JUN 24 1982

Effluent characteristic	Discharge Limitations		Monitoring Requirements	
	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow - m^3/Day (MGD)	N/A	N/A	Daily	Calculation
Temperature	See Part III.D. 1/		See Part III.D.	
Additional Monitoring	See Part III.C.		2/	24-hour composite

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): plant discharge prior to entry into the Clinch River. Monitoring shall not be applicable until start of discharges other than OSN 002.

1/ The receiving water shall not exceed (1) a maximum water temperature change of 3C°(5.4F°) 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 2C° (3.6F°) per hour as measured at a depth of five feet or mid-depth which ever is less, outside of a mixing zone as defined in Part III.D.

2/ Starting six months after commercial operation date, frequency shall be two per month for the first 12 months and once per month thereafter.

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 1/ - Sewage Treatment Unit effluents to OSN 001 during construction and operation.

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent characteristic	Discharge Limitations Other Units (mg/l except as noted)		Monitoring Requirements	
	Daily Average	Daily Maximum	Measurement Frequency	Sample Type
Flow - m^3/Day (MGD)	N/A	2/	5/week	Grab
BOD_5	30	60	3/week	Grab
Total Suspended Solids	30	60	3/week	Grab
Settleable Solids (ml/l)	1.0	1.0	5/week	Grab
Dissolved Oxygen	See Below		5/week	Grab
Chlorine Residual	N/A	N/A	5/week	Grab
Fecal Coliform 3/ (organisms/100 ml)	N/A	N/A	3/week	Grab

DRAFT
JUN 24 1982

Effluent shall contain a minimum of 1.0 mg/l of dissolved oxygen at all times.

H-3

NOTE: Additional units may be added (or subtracted) provided that each individual unit does not exceed the above limitations or its individual design flow. A process modification may be made during the construction phase to the existing system to allow increased flow; however, all other discharge limitations shall apply. In either case, proper application must be made to EPA and the State of Tennessee prior to institution of any changes.

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 not 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): Individual Sewage Treatment Unit effluents prior to mixing with any other waste stream.

1/ Internal serial number for identification and monitoring purposes.
2/ Flow shall not exceed 49 (0.013) for the smaller unit nor 197 (0.052) for the larger unit.
3/ Geometric Mean

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 through 008 - Point source runoff from areas of construction and yard drainage to unnamed ditches to the Clinch River. (003, 004 and 006 may also receive dewatering wastes and/or other small sources and 007 may also receive overflow from the Concrete Wash Settling Pond and the Aggregate Washing Settling Pond during abnormal rainfall periods.)

Such discharges shall be limited and monitored by the permittee as specified below:

DRAFT
JUN 24 1982

Effluent characteristic	Discharge Limitations	Monitoring Requirements	
	Instantaneous Maximum	Measurement Frequency	Sample Type
Flow - m^3/Day (MGD)	N/A	1/week 1/	Grab
Total Suspended Solids (mg/l)	2/	1/week 1/, 3/	Grab
Oil and Grease (mg/l) 5/	55/	1/week 5/	Grab 5/
Detention Volume	See Below	1/six months	Calculation(s)

The runoff treatment ponds shall be capable of processing the 10-year, 24-hour rainfall event plus all accumulated silt without overflow of the standpipe. Not less than once per six months for the first year, permittee shall ascertain that available settling volume meets this requirement and shall report this finding when submitting Discharge Monitoring Reports. Frequency during subsequent years shall be determined based on assessment of the information for the first year.

Permittee shall maintain or obtain records of rainfall representative of site conditions. All periods of rainfall which exceed the 10-year, 24-hour event or cause discharge from any overflow shall be reported to EPA.

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored 1/week 4/.

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): points of discharge from treatment ponds A, B, C, D, E and the quarry pond, respectively, prior to mixing with any other waste stream 3/.

CONTINUED

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 through 008 - Point source runoff from areas of construction and yard drainage to unnamed ditches to the Clinch River. (003, 004 and 006 may also receive dewatering wastes and/or other small sources and 007 may also receive overflow from the Concrete Wash Settling Pond and the Aggregate Washing Settling Pond during abnormal rainfall periods.) Continued

1/ Sampling and inspection of the sand filter and water level shall be conducted at least two times per week during periods when the water level is within 36 inches of the top of the overflow pipe. All periods of overflow shall be reported and representative samples collected and analyzed, with the first sample collected within 12 hours of start of overflow.

2/ In the event that effluent concentration exceeds 50 mg/l, permittee shall evaluate system performance to assure that the system is operating as designed and that on-site controls are effective. Permittee shall take appropriate corrective action as required.

3/ All periods of discharge from the Concrete Wash and Aggregate Washing Settling Ponds to OSN 007 shall be reported and monitored 1/day for total suspended solids, total dissolved solids and pH on grab samples at the individual Settling Pond discharge points.

4/ Applicable to any flow up to the flow resulting from a 24-hour rainfall event with a probable recurrence interval of once in ten years.

5/ Applicable to OSN 003 only.

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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/ - Waste Water Treatment System effluent to OSN 001 or to the cooling tower system as make-up.

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)			
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow - m^3/Day (MGD)	-	-	N/A	N/A	Continuous	Recorder
Total Suspended Solids	20(45)	68(150)	30	100	1/week	Grab
Oil and Grease	10(23)	14(30)	15	20	1/week	Grab

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored 1/week 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): Waste Water Treatment System effluent prior to mixing with any other waste stream.

1/ Internal serial number for identification and monitoring purposes.

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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 effluent to OSN 001.

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent characteristic	Discharge Limitations kg/day (lbs/day)		Discharge Limitations (mg/l) (except as noted)		Monitoring Requirements	
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow - m^3/Day (MGD)	-	-	N/A	N/A	1/batch	Calculation
Total Suspended Solids	0.05(0.11)	0.28(0.63)	15	20	1/batch	Grab
Oil and Grease	0.05(0.11)	0.28(0.63)	15	20	1/batch	Grab

NOTE: The radioactive component of this discharge is regulated by the U.S. Nuclear Regulatory Commission under the requirements of the Atomic Energy Act and not by the U.S.E.P.A. under the Clean Water Act

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/ Internal serial number 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) 01] 1/ - Cooling Tower Blowdown to OSN 001.

Such discharges shall be limited and monitored by the permittee as specified below:

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Effluent characteristic	Discharge Limitations			Monitoring Requirements	
	Daily Avg	Daily Max	Inst Max	Measurement Frequency	Sample Type
Flow - m^3/Day (MGD)	N/A	N/A	-	Continuous	Recorder/Totalizer
Total Residual Chlorine - mg/l	-	-	0.14	Continuous	Recorder
Total Residual Chlorine - mg/l	-	-	0.14	1/week	Multiple Grabs
Temperature - °C(°F)	-	32.8(91)	-	Continuous	Recorder

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 build-up of which would cause concentrations or amounts exceeding limits established by best engineering practice. A report showing how conformance with this requirement will be met, including operational procedures, shall be submitted during the system design stage. Additionally, annual reports shall be submitted along with the first quarterly monitoring report submitted after January 1 of each year. Discharge temperature shall not exceed the lowest temperature of the recirculating cooling water prior to the addition of make-up.

There shall be no discharge of detectable amounts of materials added for corrosion inhibition (including but not limited to zinc, chromium or phosphorus) or any chemicals added which contain any of the 129 priority pollutants.

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored by continuous recorder.

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 cooling towers prior to mixing with any other waste stream.

1/ Internal serial number for identification and monitoring purposes.

During the period beginning on start of discharge and lasting through expiration the permittee is authorized to discharge from outfall(s) serial number(s) 012 1/ - Pre-operational and other metal cleaning wastes to OSN 003.

Such discharges shall be limited and monitored by the permittee as specified below:

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Effluent characteristic	Discharge Limitations			Monitoring Requirements	
	kg/batch(lbs/batch)	Other Units (mg/l)			
		Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow - m^3/Day (MGD)	2/	N/A	N/A	1/day	Determination(s)
Oil and Grease	2/	15	20	2/	Grab
Total Suspended Solids	2/	30	100	2/	Composite
Copper, Total	2/	1.0	1.0	2/	Composite
Iron, Total	2/	1.0	1.0	2/	Composite
Phosphorus as P 3/	2/	1.0	1.0	2/	Composite
Chemical Oxygen Demand 4/	2/	N/A	100	2/	Composite

Metal cleaning wastes shall mean any cleaning compounds, rinse waters, or any other waterborne residues derived from cleaning any metal process equipment.

Permittee shall notify EPA and the State of any chemicals proposed for use in metal cleaning operations which have not been previously reported and shall indicate the levels of organics, phosphorous and priority pollutants expected in the discharge from OSN 012. Such notification shall be not less than 90 days prior to use. Additional limitations and/or monitoring may be required after notifiction.

In the event that any metal cleaning wastes are disposed of either on site or off site, disposal shall be in an environmentally acceptable manner. Details of such disposal shall be submitted to EPA and the State not later than 90 days prior to any such disposal.

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored on representative grab samples.

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 metal cleaning wastes treatment facility prior to mixing with any other waste stream.

CONTINUED

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) 012 1/ - Pre-operational and other metal cleaning wastes to OSN 003. Continued

1/ Internal serial number for identification and monitoring purposes.
2/ The total quantity of each pollutant discharged shall be reported. In no case shall the quantity discharged exceed the quantity determined by multiplying the volume of the batch of metal cleaning waste generated times the concentrations noted above (i.e., 3.8 kg (8.3 lbs) of iron, copper and phosphorus; 57 kg (125 lbs) of oil and grease; and 114 kg (250 lbs) of total suspended solids per million gallons of metal cleaning waste generated). The permittee shall also report the frequency of measurement used to adequately quantify the pollutants discharged. Total volume of wastewater generated and discharged shall be reported.
3/ Applicable to preoperational cleaning wastes and other metal cleaning wastes with high initial concentrations of phosphorus.
4/ Applicable to any cleaning operation containing organic acids, chelating compounds or other compounds with high oxygen demand.

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A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on start of intake operation and lasting through expiration the permittee shall monitor serial number(s) 013 1/ - Plant Intake.

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Characteristic	Limitations		Monitoring Requirements	
	Daily Average	Daily Maximum	Measurement Frequency	Sample Type
Flow - m^3/Day (MGD)	N/A	N/A	Continuous	Pump logs
Temperature	N/A	N/A	Continuous	Recorder
Additional Monitoring	See Part III.C.		2/	24-hour Composite

Discharge of intake backwash is permitted without limitation or monitoring requirements.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): Plant intake

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1/ Serial number assigned for identification and monitoring purposes.
2/ Starting six months after commercial operation date, frequency shall be two per month for the first 12 months and once per month thereafter.

B. SCHEDULE OF COMPLIANCE

1. The permittee shall achieve compliance with the effluent limitations specified for discharges in accordance with the following schedule:

   a. Compliance with effluent limitations (001-012) - on start of discharge.

   b. Blowdown reports (011)
      (1) Initial report - during system design stage
      (2) Operating reports - annually with first DMR of each year.

   c. Metal cleaning waste disposal report (012) - submit 90 days prior to any off site disposal.

   d. Discharge plume verification (Part III.D.) - submit report by 15 months after commercial operation date.

   e. Flow evaluation (Part III.E.) - submit report by 15 months after commercial operation date.

   f. Chlorine minimization (Part III.F.) - submit reports quarterly with DMR's.

   g. Priority pollutant data (Part III.G.) - submit data by 12 months after commercial operation date.

   h. Erosion and sedimentation control program (Part III.J.)
      (1) Implement - on start of construction.
      (2) Reports -
         (a) First year - semiannually with first report due on the 28th day of the 8th month after start of construction.
         (b) After first year - annually

   i. Striped bass thermal assessment (Part III.M.)
      (1) Submit report(s) and obtain EPA approval prior to start of intake construction.

   j. Preoperational non-radiological monitoring program (Part III.N.)
      (1) Study plan - submit by six months before implementation
      (2) Implement - by two years before scheduled fuel loading
      (3) Reports - annually with first report submitted 15 months after implementation.

   k. Operational non-radiological monitoring program (Part III.O.)
      (1) Study plan - submit by six months before implementation
      (2) Implement - on start of operation
      (3) Reports - annually with first report submitted 15 months after implementation

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.

A. MANAGEMENT REQUIREMENTS

1. Discharge Violations

All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant more frequently than, or at a level in excess of, that identified and authorized by this permit constitutes a violation of the terms and conditions of this permit. Such a violation may result in the imposition of civil and/or criminal penalties as provided in Section 309 of the Act.

2. Change in Discharge

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 at least 180 days prior to commencement of such discharge. Any other activity which would constitute cause for modification or revocation and reissuance of this permit, as described in Part II (B) (4) of this permit, shall be reported to the Permit Issuing Authority.

3. Noncompliance Notification

a. Instances of noncompliance involving toxic or hazardous pollutants should be reported as outlined in Condition 3c. All other instances of noncompliance should be reported as described in Condition 3b.

b. If for any reason, the permittee does not comply with or will be unable to comply with any discharge limitation specified in the permit, the permittee shall provide the Permit Issuing Authority with the following information at the time when the next Discharge Monitoring Report is submitted.

(1) A description of the discharge and cause of noncompliance;
(2) The period of noncompliance, including exact dates and times and/or anticipated time when the discharge will return to compliance; and
(3) Steps taken to reduce, eliminate, and prevent recurrence of the noncomplying discharge.

c. Toxic or hazardous discharges as defined below shall be reported by telephone within 24 hours after permittee becomes aware of the circumstances and followed up with information in writing as set forth in Condition 3b. within 5 days, unless this requirement is otherwise waived by the Permit Issuing Authority:

(1) Noncomplying discharges subject to any applicable toxic pollutant effluent standard under Section 307(a) of the Act;
(2) Discharges which could constitute a threat to human health, welfare or the environment. These include unusual or extraordinary discharges such as those which could result from bypasses, treatment failure or objectionable substances passing through the treatment plant. These include Section 311 pollutants or pollutants which could cause a threat to public drinking water supplies.

d. Nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance.

4. Facilities Operation

All waste collection and treatment facilities shall be operated in a manner consistent with the following:

a. The facilities shall at all times be maintained in a good working order and operated as efficiently as possible. This includes but is not limited to effective performance based on design facility removals, adequate funding, effective management, adequate operator staffing and training, and adequate laboratory and process controls (including appropriate quality assurance procedures); and

b. Any maintenance of facilities, which might necessitate unavoidable interruption of operation and degradation of effluent quality, shall be scheduled during noncritical water quality periods and carried out in a manner approved by the Permit Issuing Authority.

c. The permittee, in order to maintain compliance with this permit shall control production and all discharges upon reduction, loss, or failure of the treatment facility until the facility is restored or an alternative method of treatment is provided.

5. Adverse Impact

The permittee shall take all reasonable steps to minimize any adverse impact to waters of the United States resulting from noncompliance with any effluent limitations specified in this permit, including such accelerated or additional monitoring as necessary to determine the nature of the noncomplying discharge.

6. Bypassing

"Bypassing" means the intentional diversion of untreated or partially treated wastes to waters of the United States from any portion of a treatment facility. Bypassing of wastewaters is prohibited unless <u>all</u> of the following conditions are met:

a. The bypass is unavoidable-i.e. required to prevent loss of life, personal injury or severe property damage;

b. There are no feasible alternatives such as use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment down time;

c. The permittee reports (via telephone) to the Permit Issuing Authority any unanticipated bypass within 24 hours after becoming aware of it and follows up with written notification in 5 days. Where the necessity of a bypass is known (or should be known) in advance, prior notification shall be submitted to the Permit Issuing Authority for approval at least 10 days beforehand, if possible. All written notifications shall contain information as required in Part II (A)(3)(b); and

d. The bypass is allowed under conditions determined to be necessary by the Permit Issuing Authority to minimize any adverse effects. The public shall be notified and given an opportunity to comment on bypass incidents of significant duration to the extent feasible.

This requirement is waived where infiltration/inflow analyses are scheduled to be performed as part of an Environmental Protection Agency facilities planning project.

7. 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 waters of the United States.

8. Power Failures

The permittee is responsible for maintaining adequate safeguards to prevent the discharge of untreated or inadequately treated wastes during electrical power failures either by means of alternate power sources, standby generators or retention of inadequately treated effluent. Should the treatment works not include the above capabilities at time of permit issuance, the permittee must furnish within six months to the Permit Issuing Authority, for approval, an implementation schedule for their installation, or documentation demonstrating that such measures are not necessary to prevent discharg of untreated or inadequately treated wastes. Such documentation shall include frequency and duration of power failures and an estimat of retention capacity of untreated effluent.

9. Onshore or Offshore Construction

This permit does not authorize or approve the construction of any onshore or offshore physical structures or facilities or the undertaking of any work in any waters of the United States.

B. RESPONSIBILITIES

1. Right of Entry

The permittee shall allow the Permit Issuing Authority and/or authorized representatives (upon presentation of credentials and such other documents as may be required by law) to:

a. 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;

b. Have access to and copy at reasonable times any records required to be kept under the terms and conditions of this permit;

c. Inspect at reasonable times any monitoring equipment or monitoring method required in this permit;

d. Inspect at reasonable times any collection, treatment, pollution management or discharge facilities required under the permit; or

e. Sample at reasonable times any discharge of pollutants.

2. Transfer of Ownership or Control

A permit may be transferred to another party under the following conditions:

a. The permittee notifies the Permit Issuing Authority of the proposed transfer;

b. A written agreement is submitted to the Permit Issuing Authority containing the specific transfer date and acknowledgement that the existing permittee is responsible for violations up to that date and the new permittee liable thereafter.

Transfers are not effective if, within 30 days of receipt of proposal, the Permit Issuing Authority disagrees and notifies the current permitttee and the new permittee of the intent to modify, revoke and reissue, or terminate the permit and to require that a new application be filed.

3. Availability of Reports

Except for data determined to be confidential under Section 308 of the Act, (33 U.S.C. 1318) 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 Permit Issuing Authority. 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 (33 U.S.C. 1319).

4. Permit Modification

After notice and opportunity for a hearing, this permit may be modified, terminated or revoked for cause (as described in 40 CFR 122.15 et seq) 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;

c. A change in any condition that requires either temporary interruption or elimination of the permitted discharge; or

d. Information newly acquired by the Agency indicating the discharge poses a threat to human health or welfare.

If the permittee believes that any past or planned activity would be cause for modification or revocation and reissuance under 40 CFR 122.15 et seq, the permittee must report such information to the Permit Issuing Authority. The submission of a new application may be required of the permittee.

5. Toxic Pollutants

a. Notwithstanding Part II (B)(4) above, if a xic 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 authorized herein and such standard or prohibition is more stringent than any limitation for such pollutant in this permit, this permit shall be revoked and reissued or modified in accordance with the toxic effluent standard or prohibition and the permittee so notified.

b. An effluent standard established for a pollutant which is injurious to human health is effective and enforceable by the time set forth in the promulgated standard, even though this permit has not as yet been modified as outlined in Condition 5a.

6. Civil and Criminal Liability

Except as provided in permit conditions on "Bypassing", Part II (A) (6), 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 (33 U.S.C. 1321).

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 thereby.

11. Permit Continuation

A new application shall be submitted at least 180 days before the expiration date of this permit. Where EPA is the Permit Issuing Authority, the terms and conditions of this permit are automatically continued in accordance with 40 CFR 122.5, provided that the permittee has submitted a timely and sufficient application for a renewal permit and the Permit Issuing Authority is unable through no fault of the permittee to issue a new permit before the expiration date.

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 each calendar month shall be summarized for each month and reported on a Discharge Monitoring Report Form (EPA No. 3320-1). Forms shall be submitted at the end of each calendar quarter and shall be postmarked no later than the 28th day of the month following the end of the quarter. The first report is due by the 28th day of the month following the first full quarter after the effective date of this permit.

Signed copies of these, and all other reports required herein, shall be submitted to the Permit Issuing Authority at the following address(es):

Water Permits Branch
Environmental Protection Agency
Region IV
345 Courtland Street, N.E.
Atlanta, Georgia 30365

3. Test Procedures

Test procedures for the analysis of pollutants shall conform to all regulations published pursuant to Section 304(h) of the Clean Water Act, as amended (40 CFR 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants").

4. 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 person(s) who obtained the samples or measurements;

c. The dates the analyses were performed;

d. The person(s) who performed the analyses;

e. The analytical techniques or methods used; and

f. The results of all required analyses.

5. 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.

6. Records Retention

The permittee shall maintain records of all monitoring including: sampling dates and times, sampling methods used, persons obtaining samples or measurements, analyses dates and times, persons performing analyses, and results of analyses and measurements. Records shall be maintained for three years or longer if there is unresolved litigation or if requested by the Permit Issuing Authority.

D. DEFINITIONS

1. Permit Issuing Authority

The Regional Administrator of EPA Region IV or designee.

2. Act

"Act" means the Clean Water Act (formerly referred to as the Federal Water Pollution Control Act) Public Law 92-500, as amended by Public Law 95-217 and Public Law 95-576, 33 U.S.C. 1251 et seq.

3. Mass/Day Measurements

a. The "average monthly discharge" is defined as the total mass of all daily discharges sampled and/or measured during a calendar month on which daily discharges are sampled and measured, divided by the number of daily discharges sampled and/or measured during such month. It is, therefore, an arithmetic mean found by adding the weights of the pollutant found each day of the month and then dividing this sum by the number of days the tests were reported. This limitation is identified as "Daily Average" or "Monthly Average" in Part I of the permit and the average monthly discharge value is reported in the "Average" column under "Quantity" on the Discharge Monitoring Report (DMR).

b. The "average weekly discharge" is defined as the total mass of all daily discharges sampled and/or measured during a calendar week on which daily discharges are sampled and/or measured divided by the number of daily discharges sampled and/or measured during such week. It is, therefore, an arithmetic mean found by adding the weights of pollutants found each day of the week and then dividing this sum by the number of days the tests were reported. This limitation is identified as "Weekly Average" in Part I of the permit and the average weekly discharge value is reported in the "Maximum" column under "Quantity" on the DMR.

c. The "maximum daily discharge" is the total mass (weight) of a pollutant discharged during a calendar day. If only one sample is taken during any calendar day the weight of pollutant calculated from it is the "maximum daily discharge". This limitation is identified as "Daily Maximum," in Part I of the permit and the highest such value recorded during the reporting period is reported in the "Maximum" column under "Quantity" on the DMR.

4. Concentration Measurements

a. The "average monthly concentration," other than for fecal coliform bacteria, is the concentration of all daily discharges sampled and/or measured during a calendar month on which daily discharges are sampled and measured divided by the number of daily discharges sampled and/or measured during such month (arithmetic mean of the daily concentration values). The daily concentration value is equal to the concentration of a composite sample or in the case of grab samples is the arithmetic mean (weighted by flow value) of all the samples collected during that calendar day. The average monthly count for fecal coliform bacteria is the geometric mean of the counts for samples collected during a calendar month. This limitation is identified as "Monthly Average" or "Daily Average" under "Other Limits" in Part I of the permit and the average monthly concentration value is reported under the "Average" column under "Quality" on the DMR.

b. The "average weekly concentration," other than for fecal coliform bacteria, is the concentration of all daily discharges sampled and/or measured during a calendar week on which daily discharges are sampled and measured divided by the number of daily discharges sampled and/or measured during such week (arithmetic mean of the daily concentration values). The daily concentration value is equal to the concentration of a composite sample or in the case of grab samples is the arithmetic mean (weighted by flow value) of all samples collected during that calendar day. The average weekly count for fecal coliform bacteria is the geometric mean of the counts for samples collected during a calendar week. This limitation is identified as "Weekly Average" under "Other Limits" in Part I of the permit and the average weekly concentration value is reported under the "Maximum" column under "Quality" on the DMR.

c. The "maximum daily concentration" is the concentration of a pollutant discharged during a calendar day. It is identified as "Daily Maximum" under "Other Limits" in Part I of the permit and the highest such value recorded during the reporting period is reported under the "Maximum" column under "Quality" on the DMR.

5. Other Measurements

   a. The effluent flow expressed as M^3/day (MCD) is the 24 hour average flow averaged monthly. It is the arithmetic mean of the total daily flows recorded during the calendar month. Where monitoring requirements for flow are specified in Part I of the permit the flow rate values are reported in the "Average" column under "Quantity" on the DMR.

   b. Where monitoring requirements for pH, dissolved oxygen or fecal coliform are specified in Part I of the permit the values are generally reported in the "Quality or Concentration" column on the DMR.

6. Types of Samples

   a. Composite Sample - A "composite sample" is any of the following:

      (1) Not less than four influent or effluent portions collected at regular intervals over a period of 8 hours and composited in proportion to flow.

      (2) Not less than four equal volume influent or effluent portions collected over a period of 8 hours at intervals proportional to the flow.

      (3) An influent or effluent portion collected continuously over a period of 24 hours at a rate proportional to the flow.

   b. Grab Sample: A "grab sample" is a single influent or effluent portion which is not a composite sample. The sample(s) shall be collected at the period(s) most representative of the total discharge.

7. Calculation of Means

   a. Arithmetic Mean: The arithmetic mean of any set of values is the summation of the individual values divided by the number of individual values.

   b. Geometric Mean: The geometric mean of any set of values is the N^{th} root of the product of the individual values where N is equal to the number of individual values. The geometric mean is equivalent to the antilog of the arithmetic mean of the logarithms of the individual values. For purposes of calculating the geometric mean, values of zero (0) shall be considered to be one (1).

c. Weighted by Flow Value: Weighted by flow value means the summation of each concentration times its respective flow divided by the summation of the respective flows.

8. Calendar Day

a. A calendar day is defined as the period from midnight of one day until midnight of the next day. However, for purposes of this permit, any consecutive 24-hour period that reasonably represents the calendar day may be used for sampling.

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OTHER REQUIREMENTS

A. If the permittee, after monitoring for a least 18 months, determines that he is consistently meeting the effluent limits contained herein, the permittee may request of the Director, Water Management Division that the monitoring requirements be reduced to a lessor frequency or be eliminated.

B. There shall be no discharge of polychlorinated biphenyl compounds (PCB's). Such as those commonly used for transformer fluid. The permittee shall notify EPA of any equipment placed on site which contain PCB's and take appropriate measures to assure that there is no release of PCB's to the environment.

C. Additional monitoring of the main plant discharge (001) and the plant intake (013) shall be conducted to assure conformance with applicable water quality standards. Parameters shall include ammonia (as N); chloride; sulfate; total hardness; total, dissolved, settleable and suspended solids; and total cadmium, chromium, copper, iron, lead, mercury, nickel and zinc. Data shall be submitted quarterly with DMR's. After monitoring for at least 12 months, permittee may request of the Director, Water Management Division that the monitoring requirements be reduced to a lesser frequency or be eliminated.

D. Effluent discharge structure for outfall serial number 001 shall be designed to assure a minimum dilution factor of 14 within 20 meters (66 feet) from the point of discharge for all plant discharge conditions at no-flow reservoir conditions. Subsequent to commercial operation date, field measurements (suplemented as necessary with modeling results) shall be conducted to assure conformance with this requirement and to determine three-dimensional configuration(s) of thermal and chemical plumes. A report showing compliance with the assigned mixing zone shall be submitted by 15 months after the commercial operation date.

E. Subsequent to the commercial operation date, the permittee shall conduct a detailed evaluation of actual water use and inplant waste discharges to confirm design flow data. A report of this evaluation shall cover a one-year period after startup and shall be submitted not later than 15 months after the commercial operation date. In the event that flow data is significantly different from design data, permit may be modified by the Director, Water Management Division.

F. Permittee shall implement a program to minimize the discharge of total residual chlorine by the start of cooling tower chlorination. Reduction of makeup and discontinuation of blowdown subsequent to chlorination shall be specifically evaluated. Reports shall be submitted quarterly with DMR's after start of chlorination. At such time as permittee determines that reasonable minimization has been achieved, he may request that this program be eliminated.

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G. Not more than 12 months after the commercial operation date, permittee shall submit representative data as included in 40 CFR Part 122.53(d)(7)(ii), (iii), and (iv). In the event that any pollutant is present at an unacceptable level, this permit shall be modified, or alternatively, revoked and reissued, to comply with any applicable provisions of the Clean Water Act.

H. In accordance with Section 306(d) of the Clean Water Act (33 USC Section 1251, et seq.) effluent limitations based on standards of performance contained in this permit shall not be made any more stringent during a ten-year period beginning on the date of completion of such construction or during the period of depreciation or amortization of such facility for the purposes of Section 167 or 169 (or both) of the Internal Revenue Code of 1954, whichever period ends first. The provisions of Section 306(d) do not limit the authority of the Environmental Protection Agency to modify the permit to require compliance with a toxic effluent limitation promulgated under BAT or toxic pollutant standards established under Section 307(a) of the Clean Water Act, or to modify, as necessary, to assure compliance with any applicable state water quality standard. If an applicable standard or limitation is promulgated under Sections 301(b)(2)(C) and (D), 304(b)(2), and 307(a)(2) and that effluent standard or limitation is more stringent than any effluent limiation in this permit or controls a pollutant not limited in this permit, this permit shall be promptly modified or revoked and reissued to conform to that effluent standard or limitation.

I. The permittee shall notify the Director, Water Management Division and the State Director in writing not later than sixty (60) days prior to instituting use of any additional biocide or chemical in cooling systems, other than chlorine, which may be toxic to aquatic life. 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. quantities to be used,
4. frequencies of use,
5. proposed discharge concentrations, and
6. EPA registration number, if applicable.

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J. An Erosion and Sediment Control Plan shall be submitted not later than September 30, 1982. Site preparation activities shall not be implemented until 90 days following approval of the plan by EPA, unless EPA waives this provision following a showing by the permittee that the plan can be fully instituted in a shorter period of time. The plan shall be implemented at the commencement of site preparation activities. Consecutive reports shall be submitted covering periods of six months each during the first year of construction. During subsequent years of construction, reports shall be sumitted covering 12 month periods. The reports will be due within two months of the end of the reporting period with the first report due by the twenty-eighth day of the eighth month following commencement of construction.

K. A 25-foot buffer zone will be provided between the Clinch River and the site-preparation activities except in the following areas:

1. The railroad spur going underneath Highway 58, Gallaher Bridge at RR Station 31 + 00 (RM 14.0).

2. The 48-inch corrugated metal pipe for drainage underneath the railroad spur, RR Station 29 + 39 (RM 14.0).

3. The 36-inch corrugated metal pipe for drainage underneath the railroad spur, RR Station 50 + 00 (RM 14.25).

4. The extension of the 6-foot concrete culvert underneath the railroad spur and access road, Rd. Station 1 + 84 (RM 14.5).

5. The 14-foot corrugated metal pipe underneath the railroad spur and access road, Rd. Station 5 + 35 (RM 14.6).

6. Road and railroad embankment closer than 25 feet to the Clinch River between Rd. Station 5 + 35 and Rd. Station 19 + 50.

7. The barge unloading facility (RM 14.75).

8. The water discharge outfall (RM 16.0).

9. The water intake (RM 17.9).

10. The corrugated metal pipe for the quarry treatment pond discharge (RM 18.25).

11. Where existing River Road and appurtenances are presently closer than 25 feet to the Clinch River.

L. In the event that it is determined that treatment ponds are no longer functionally required, the following steps will be taken:

   1. Reestablish natural drainage patterns, and

   2. Restore the area to an acceptable state of natural vegetation.

M. Permittee shall conduct studies to assure that thermal discharges will have minimal impact on striped bass (Morone saxtilis) during extended periods of zero flow as described in Section 4.1.2 of the "Update to the CRBRP Alternative Siting Analysis Within the TVA Power Service Area" (dated May 28, 1982).

   Permittee shall not start construction of the plant discharge structure prior to submittal of reports on these studies (see Part III.P.) and receiving approval by the Director, Water Management Division to start such construction. Such studies and reports shall include (1) coordination with TVA studies on lethal temperatures for adult and juvenile striped bass, (2) statistical analysis of streamflow during the months of July through September, (3) reevaluation of the thermal plume dispersion, and if necessary, (4) a review of alternative diffuser designs and thermal modeling. In the event that the above studies fail to demonstrate that the CRBRP thermal discharge will have no significant impact on the striped base thermal refuge, this NPDES permit shall be modified to impose more stringent thermal limitations on plant discharges.

N. Permittee shall implement an approved preoperational non-radiological aquatic monitoring program to reestablish baseline data on water quality and biotic conditions in the Clinch River not less than two years prior to the scheduled date for fuel loading. Not less than six months prior to the scheduled date for implementation, the permittee shall submit to the Director, Water Management Division, EPA, Region IV, for review and approval, a detailed monitoring plan. Reports shall be submitted annually, not more than three months following completion of the reporting period with the first report due 15 months after implementation of the program. The program shall continue for a period of not less than two years, unless mutually agreed to by EPA and CRBRP.

O. Permittee shall implement an approved operational non-radiological aquatic monitoring program on the first day of operation. Not less than six months prior to scheduled implementation date, the permittee shall submit to the Director, Water Management Division, EPA, Region IV, for review and approval, a detailed monitoring plan. Reports shall be submitted annually, not more than three months following completion of the reporting period with the first report due 15 months after implementation of the program. The program shall continue for a period of not less than two years, unless mutually agreed to by EPA and CRBRP.

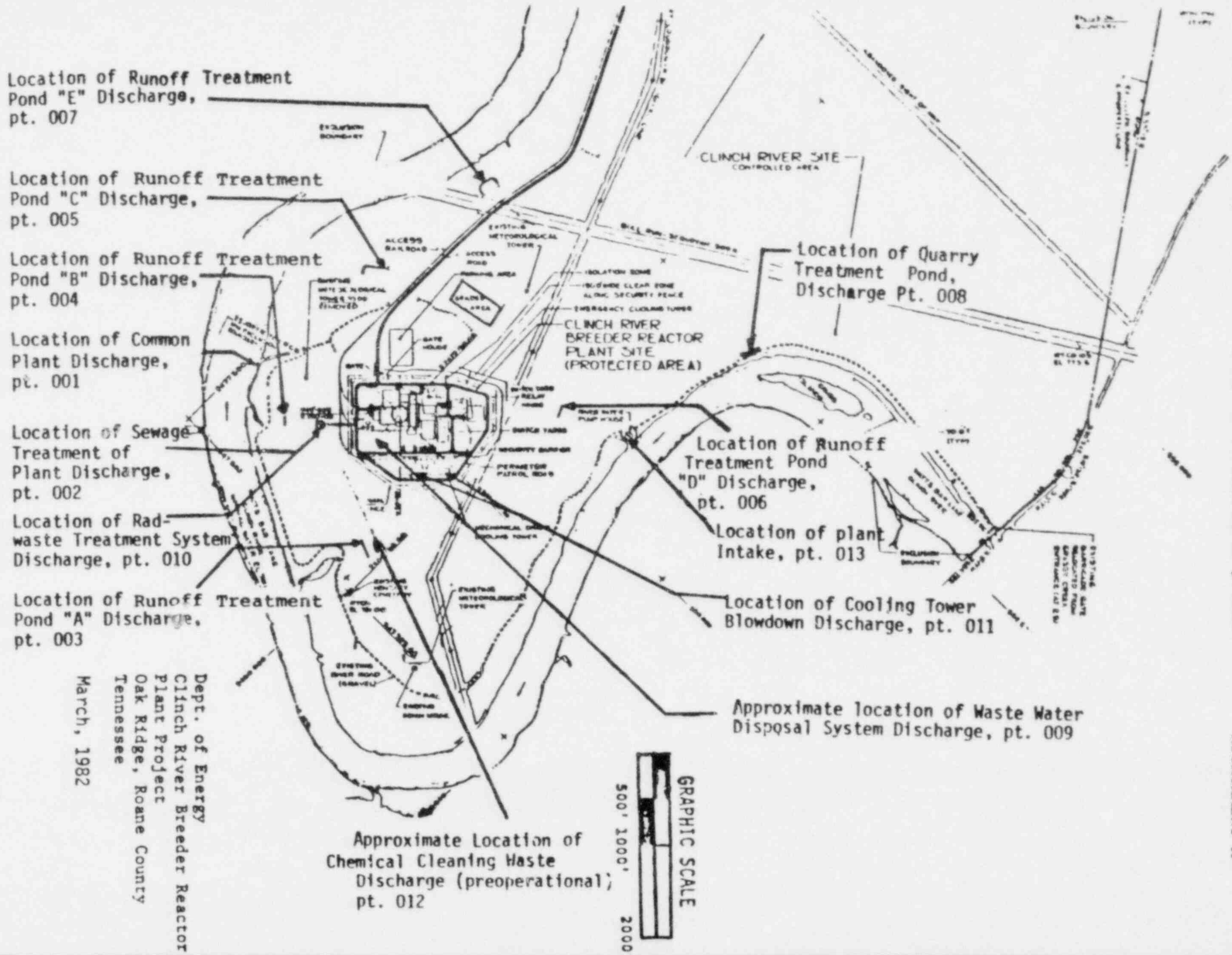
P. Copies of all plans, assessments, and reports submitted in accordance with Parts III. J, M, N, and O herein shall be forwarded by the permittee as follows:

Number of Copies	Addressee
2	Director, Water Management Division, EPA (Atlanta)
1	Chief, Ecology Branch, EPA (Athens)
2	Director for Environmental Projects, NRC (Washington)
1	Regional Director, Fish and Wildlife Service (Atlanta)
1	Director, Tennessee Division of Water Quality Control (Nashville)
1	Regional Engineer, Tennessee Division of Water Quality Control (Knoxville)

Q. The State of Tennessee has certified the discharge(s) covered by this permit with conditions (see Attachment D). Section 401 of the Act requires that conditions of certification shall become a condition of the permit. The monitoring and sampling shall be as indicated for those parameters included in the certification. Any effluent limits, and any additional requirements, specified in the attached State Certification which are more stringent supersede any less stringent effluent limits provided herein. During any time period in which the more stringent State Certification effluent limits are stayed or inoperable, the effluent limits provided herein shall be in effect and fully enforceable. (Note: Certification to be provided prior to permit issuance.)

LOCATION OF DISCHARGE POINTS

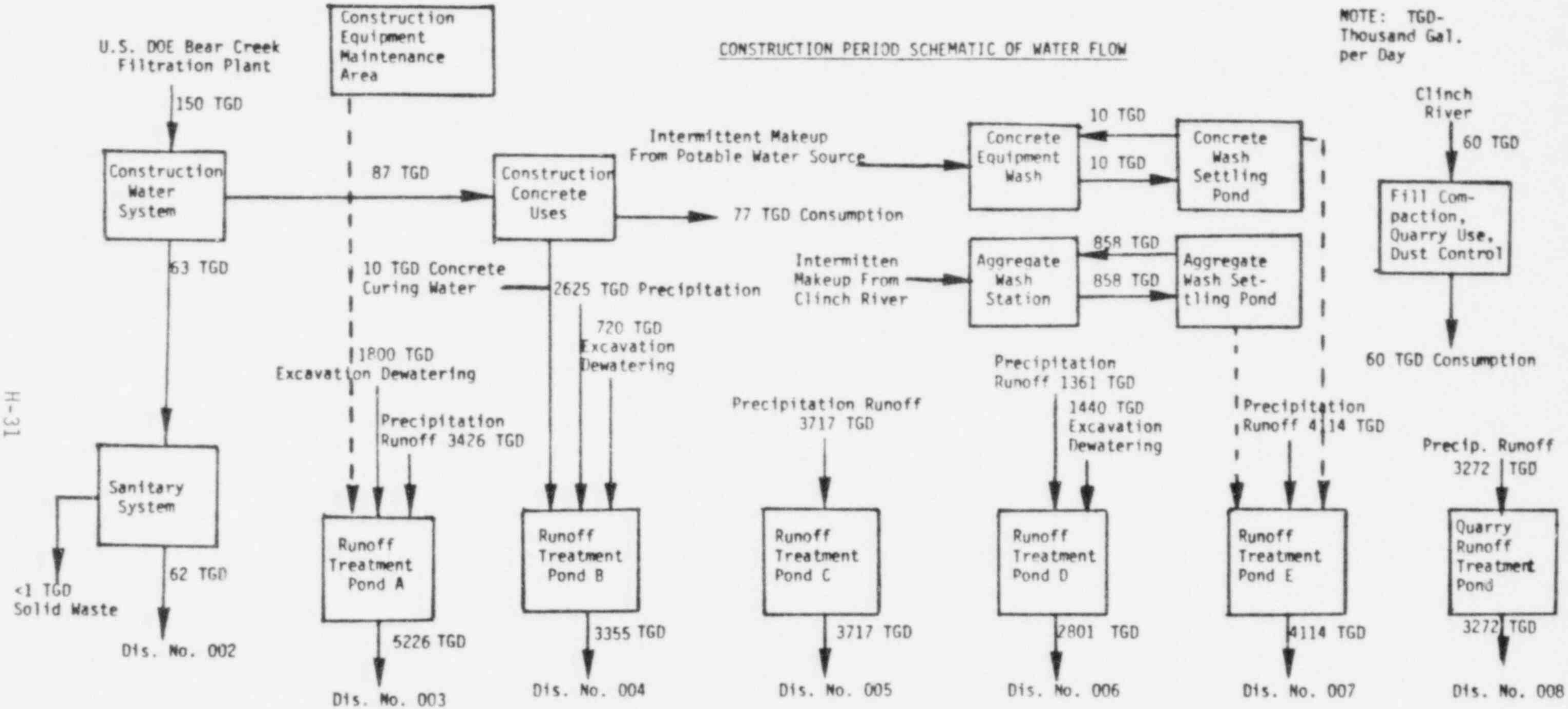
Permit No. TN0028801
ATTACHMENT A



Dept. of Energy
Clinch River Breeder Reactor
Plant Project
Oak Ridge, Roane County
Tennessee

March, 1982

CONSTRUCTION PERIOD SCHEMATIC OF WATER FLOW

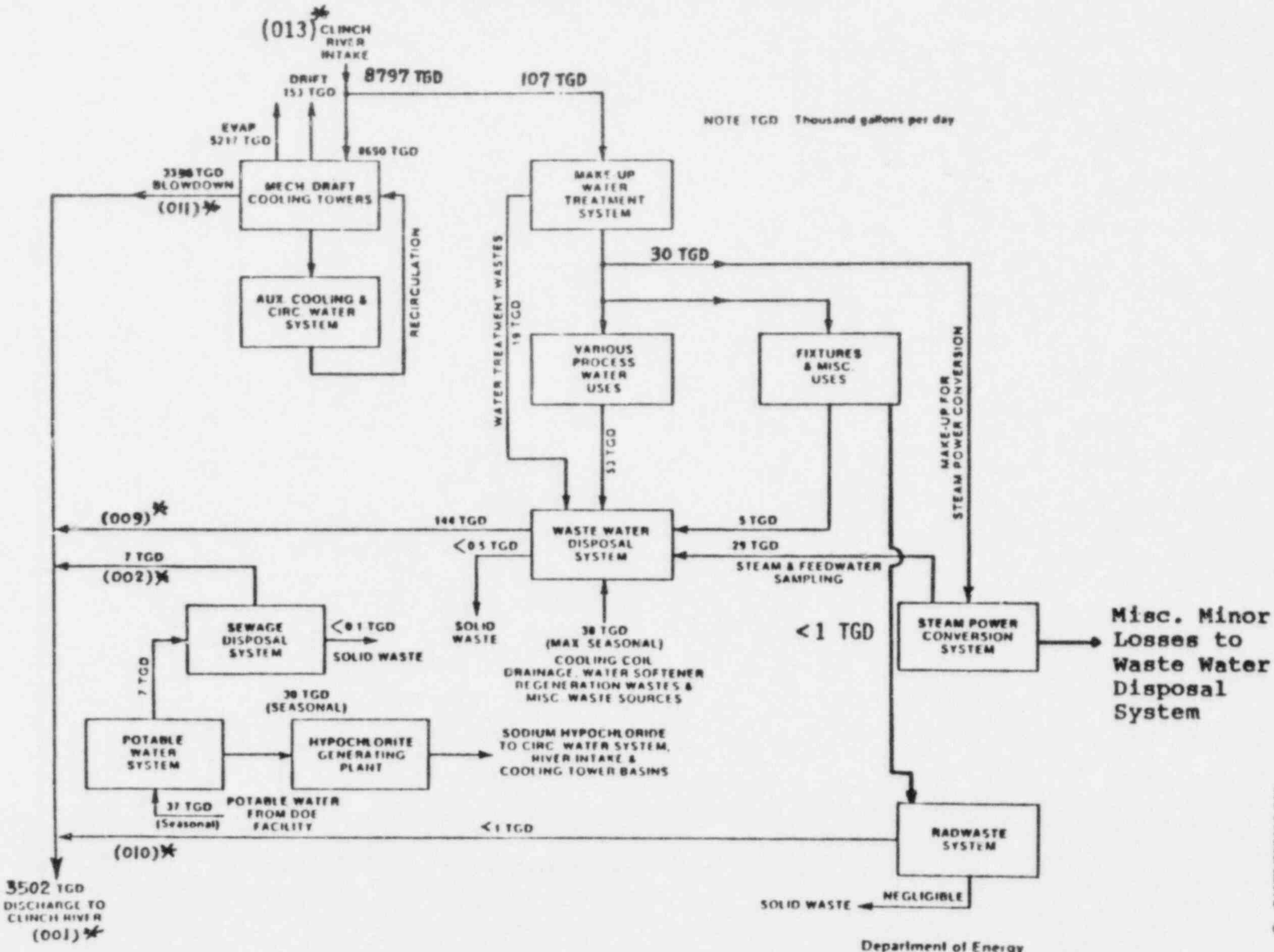


DEPARTMENT OF ENERGY
CLINCH RIVER BREEDER REACTOR PROJECT
OAK RIDGE, ROANE COUNTY, TENNESSEE

March 1982

Permit No. TN0028801
ATTACHMENT B

SCHEMATIC OF WATER FLOW — OPERATING PERIOD



*NPDES Outfall serial number

Department of Energy
Clinch River Breeder Reactor Plant Project
Oak Ridge, Roane County, Tennessee

March, 1982

Permit No. TN0028801
ATTACHMENT C

TENNESSEE DEPARTMENT OF PUBLIC HEALTH
Environmental Management and Quality Assurance Administration
T.E.R.R.A. BUILDING
150 NINTH AVENUE, NORTH
NASHVILLE, TENNESSEE 37203

June 9, 1982

CERTIFIED MAIL

RECEIVED
JUN 11, 1982

Mr. Percy Brewington, Jr.
Acting Director
CRBRP Project
P.O. Box U
Oak Ridge, Tennessee 37830

Re: Notice of Intended Action - State Certification
Clinch River Breeder Reactor Project
NPDES No. TN0028801

Dear Mr. Brewington:

Pursuant to Section 401 of the Federal Water Pollution Control Act (as amended by the Clean Water Act of 1977), 33 U.S.C. 1251, 1341, the State of Tennessee is obligated to process a certification for your discharge of wastewater, an activity which requires a National Pollutant Discharge Elimination System (NPDES) Permit from the U.S. Environmental Protection Agency. In accordance with this Statute, the Division of Water Quality Control requires as a part of the processing of certification that the wastewater discharge comply with appropriate provisions of State law, and with the appropriate sections of the Federal law.

You are hereby advised that the Division of Water Quality Control intends to issue a certification of your NPDES Permit subject to the following conditions:

1. Permittee is in no way relieved from any liability for damages which might result from the discharge of wastewater.

2. Permittee must additionally comply with all requirements, conditions, or limitations which may be imposed by any provision of the Tennessee Water Quality Control Act (T.C.A. Sections 70-324 through 70-342) or any regulations promulgated pursuant thereto.

3. The State of Tennessee reserves the right to modify or revoke the certification or to seek revocation or modification of the NPDES Permit issued subject to the certification should the State determine that the wastewater discharge violates the Tennessee Water Quality Control Act, or any of the applicable Water Quality Criteria, or any rules or regulations which may be promulgated pursuant to the Clean Water Act of 1977, Public Law 95-217.

4. The draft permit limitations on the sewage treatment unit effluents, discharge 002, must be revised as follows:

   a. Daily maximum BOD_5 must be 45 mg/l.
   b. Daily maximum Total Suspended Solids must be 45 mg/l.
   c. Daily maximum Chlorine Residual must be 2.0 mg/l.
   d. The wastewater discharge must be disinfected to the extent that viable coliform organisms are effectively eliminated. The concentration of the fecal coliform group after disinfection shall not exceed 200 per 100 ml. as the geometric mean based on a minimum of 10 samples, collected from a given sampling site over a period of not more than 30 consecutive days with individual samples being collected at intervals not less than 12 hours. For the purpose of determining the geometric mean, individual samples having a fecal coliform group concentration of less than one (1) per 100 ml. shall be considered as having a concentration of one (1) per 100 ml. In addition, the concentration of the fecal coliform group in any individual sample shall not exceed 1,000 per 100 ml.
   e. The waste treatment facilities shall be operated under the supervision of a certified operator in accordance with the Tennessee Public Water and Wastewater Environmental Health Act of 1971.

5. For discharge 003 through 008, all periods of rainfall which exceed the 10-year, 24-hour event or cause discharge from any overflow shall be reported to the State and to EPA.

6. The permittee must submit to the State, for review and approval, the following:

   a. The construction phase erosion and sediment control plan. This plan is to incorporate best available technology for control of erosion and sediment, as well best management strategy for control of oil and grease and other pollutants from the construction equipment maintenance area. This plan must be approved 90 days before the start of construction.
   b. The engineering report for the collection, treatment, and discharge of all wastewater. This report must quantify the concentration and total mass of dissolved solids to be released on a daily basis from this facility during commercial operation.
   c. The construction plans and specifications.

7. The permittee must submit to the State, for review and approval, a plan for toxicity screening of discharge 001. This plan is to be approved no later than 90 days prior to commerical operation.

If you disagree with the action intended by the Division, you may appeal the action to the Water Quality Control Board, and you will receive a hearing. The hearing will be held in accordance with Section 70-332, Tennessee Code Annotated, and with the Rules and Regulations, Chapter 1200-4, on file in the office of the Secretary of State. If you elect to exercise your right to appeal the action, you should file a Petition requesting a hearing before the Board within thirty (30) days after receipt of this Notice of Intended Action. Such Petition must be prepared on 8½-inch by 11-inch paper, addressed to the Water Quality Control Board, and filed in duplicate with the Commissioner of the Tennessee Department of Public Health. In such Petition you must state your contention in numbered paragraphs, describing how the intended action of the State is inappropriate.

Very truly yours,

Paul E. Davis

Paul E. Davis
Manager, Permits Section
Division of Water Quality Control

cc: Environmental Protection Agency, Region IV
Nuclear Regulatory Commission

NPDES Permit Rationale
Clinch River Breeder Reactor Plant
Permit No. TN0028801

JUN 24 1982

I. Applicable Regulations

A. Federal performance standards for new sources: Chemical wastes (40 CFR 423.15) and area runoff (40 CFR 423.45) as promulgated on October 8, 1974, with proposed revisions published on October 14, 1980.

B. Tennessee Water Quality Standards: Rules of the Tennessee Department of Public Health, Bureau of Environmental Health Services, Division of Water Quality Control, Chapter 1200-4. The Clinch River in this reach has been classified for Domestic and for Industrial Waste Supply, Fish and Aquatic Life, Recreation, Irrigation, and Livestock Watering and Wildlife.

II. Effluent Limitations

A. Outfall Serial Number (OSN) 001 - Common Plant Discharge. Only monitoring requirements are included since effluent limitatons have been applied to individual waste streams which discharge through this OSN.

B. OSN 002 - Sewage Treatment Unit effluents to OSN 001. Limitations are based on secondary treatment requirements (40 CFR 133.102) for domestic waste, Tennessee Standards requirements, and best professional judgements.

C. OSN 003 through 008 - Point sources of runoff from areas of construction (including dewatering and other minor wastes) and yard drainage to ditches to the Clinch River. Requirements are based on 423.45 and best professional judgements. Use of runoff collection ponds combined with sand filtration is considered to be a best management practice for control of site runoff. Equipment maintenance in the Construction Equipment Maintenance Area will result in the generation of waste oil which will be collected in two dry sump collection basins. These basins are to be cleaned of waste oil for disposed offsite. In the event that oil is not collected at an adequate frequency, rainfall could cause overflow to treatment pond A (OSN 003). Sufficient oil discharge to this pond could cause sealing of the sand filter with significant maintenance problems for the permittee. Administrative procedures to minimize this problem are proposed by the permittee, including frequent inspection and cleanout of the dry pits. An oil and grease limitation and monitoring requirement is included for OSN 003.

D. OSN 009 - Wastewater Treatment System effluent to OSN 001. Limitations are as required by promulgated and proposed 423.15(c) for low volume wastes.

   1. Concentration Limitations: Total suspended solids limitations of 30 mg/l as a 30-day average ("daily average") and 100 mg/l as a 24-hour average ("daily maximum"). Oil and grease limitations are 15 and 20 mg/l as daily average and daily maximum concentrations, respectively.

2. Quantity limitations: Based on expected monthly summer discharge rate of 125 gallons per minute (gpm). Calculations are based on the following formula:

   pounds per day = mg/l x MGD x 8.345
   where, 8.345 is the appropriate conversion factor
   0.454 pound/day = 1.0 kilogram/day (kg/day)
   MGD = Million gallons per day = gpm x 0.00144.

E. OSN 010 - Liquid Radwaste effluent to OSN 001. Limitations are based on best professional judgement. NOTE: THE RADIOACTIVE COMPONENT OF THIS DISCHARGE IS REGULATED BY THE U.S. NUCLEAR REGULATORY COMMISSION UNDER THE REQUIREMENTS OF THE ATOMIC ENERGY ACT AND NOT BY THE U.S.E.P.A. UNDER THE REQUIREMENTS OF THE CLEAN WATER ACT.

   1. Concentration limitations: Total suspended solids and oil and grease limitations of 15 and 20 mg/l, respectively, as daily average and daily maximum concentrations.

   2. Quantity limitations: Limitations are based on a 15 mg/l concentration with the following flows:

      a. Daily Average - 850 gallons per day (one batch every three days).

      b. Daily Maximum - 5000 gallons per day (two batches in one day).

F. OSN 011 - Cooling Tower Blowdown to OSN 001. Limitations are based on requirements of promulgated 423.15(i) and (j) and proposed 423.15(j) and (k), Tennessee Standards requirements, and best professional judgement.

G. OSN 012 - Metal Cleaning Wastes discharged to unnamed ditch to the Clinch River. Appl: ant presently proposes to dispose of metal cleaning wastes off-site by contractor. The permit requires that any off-site disposal be conducted in an environmentally acceptable manner and that details of such disposal must be submitted to EPA and the State not later than 180 days prior to off-site disposal. Additionally, limitations and monitoring requirements have been included in the Permit to allow the applicant to discharge treated metal cleaning wastes to the Clinch River in the event that on-site treatment is desired. Limitations are as required by promulgated 423.15(f) and proposed 423.15(d), except that best professional judgement limitations for phosphorus and chemical oxygen demand have been included.

H. OSN 013 - Plant Intake. Monitoring requirements have been included for comparison with discharge parameter concentrations to assure compliance with Tennessee Water Quality Standards criteria. EPA has tentatively determined that the proposed intake design will meet the requirements of Section 316(b) of the Clean Water Act, i.e. "...the location, design, construction and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact". No post-operational biological monitoring is considered necessary for the intake.

III. Proposed Permit Period - 5 years.

The NPDES permit limitations insure compliance with the most stringent requirements of either the promulgated (October 8, 1974) or proposed (October 14, 1980) standards of performance for new sources (40 CFR 423.15). Data in the application and best professional judgements based on information available for other power plants indicates that additional treatment is not likely to be necessary for priority pollutants. However, to assure that this judgement is correct, the permittee will be required to submit priority pollutant data not later than one year after the commercial operation date (NPDES Permit Part III.G.). Additionally, a reopener clause is included in the permit (NPDES Permit Part III.H.) in the event that excessive levels of priority pollutants are subsequently found. Monitoring of selected parameters (including heavy metal priority pollutants) will be required after the plant becomes operational (NPDES Permit Part III.C.) also. Therefore, it is proposed that a full five-year permit be issued.

APPENDIX I

LETTER TO MR. L. W. CAFFEY FROM MR. RICHARD DENISE, MAY 6, 1986

No changes have been made to this Appendix.

APPENDIX J

ADDENDUM TO SECTION 7.1: PLANT ACCIDENTS INVOLVING RADIOACTIVE MATERIALS

APPENDIX J

ADDENDUM TO SECTION 7.1: PLANT ACCIDENTS INVOLVING RADIOACTIVE MATERIALS

The staff has examined Section 7.1 of the CRBRP FES with a view to updating it to reflect any plant-site-feature or regulatory framework changes that have occurred since the FES was issued in February 1977. The staff finds that no plant-site changes have occurred that are significant to accident risk environmental concerns, nor is there significant new information relevant to environmental concerns that bears on the environmental impacts or risks of accidents as reported in the FES. Since the publication of the FES, however, the Commission has issued a Statement of Interim Policy (June 13, 1980) that provides guidance on the considerations to be given to nuclear power plant accidents under NEPA. Among other things, the Commission's statement indicated: "this change in policy is not to be construed as any lack of confidence in conclusions regarding the environmental risks of accidents expressed in any previously issued (Environmental Impact) statements, nor, absent a showing of... special circumstances, as a basis for opening, reopening, or expanding any previous or ongoing proceeding."

The staff in its environmental review of the CRBRP application concluded that the CRBRP did constitute a special circumstance that warranted consideration of Class 9 accidents in the Environmental Statement. Because the CRBRP reactor was very different from the conventional light water reactor (LWR) plants for which the safety experience base is much broader, the staff included in the CRBRP FES a discussion of the potential impacts and risks of such accidents. As noted in the Statement of Interim Policy, the fact that the staff had identified this case (CRBRP) as a special circumstance was one of the considerations that led to the promulgation of the June 13, 1980 Statement.

In examining the FES, the staff has considered that the Interim Policy Statement provides guidance for future NEPA reviews, and the staff has concluded that the discussion of accidents in the FES meets the guidance, except for consideration of the risks due to liquid pathways. A discussion of the liquid pathway risks is in Section J.1.2.

J.1.1 DESIGN-BASIS ACCIDENTS

The results of the staff's analyses of the realistic consequences of design-basis accidents were presented in the FES Table 7.2. The reported values appear to the staff to be reasonable. This conclusion is based upon comparison of realistic dose consequences of the CRBRP design-basis accidents with the corresponding doses for some recently evaluated LWRs such as the Comanche Peak, Callaway, and Palo Verde plants, as shown in Table J.1. The CRBRP doses are within the range of dose values of some of the LWRs, and the radiological health effects and the environmental impacts of such postulated accidents would be comparable to those from postulated LWR accidents.

Table J.1 Comparison of design-basis accident (Classes 2-8) site boundary doses reported in the CRBRP FES with corresponding doses reported in the environmental statements of some recent LWR operating license reviews

Accident	CRBRP FES	Comanche Peak FES	Callaway FES	Palo Verde FES
Fuel-handling accidents				
Rems thyroid	0.4	2.0	4.0	0.002
Rems whole body	0.5	0.05	1.0	0.07
Large-break LOCA or site suitability source term				
Rems thyroid	1.0	85.0	91.0	8.0
Rems whole body	0.1	1.2	2.2	0.4
Rems lung	0.2	-	-	-
Rems bone	1.2	-	-	-

Although the staff analysis of the design-basis accidents does not treat in detail the probabilities of accident occurrence except as implied in a general way in the development of the accident classification scheme of the previously proposed annex of Appendix D to 10 CFR 50, the estimated doses are so small that in the staff's judgment no unreasonable radiological risk to the public health and safety and to the environment would arise as a result of these design-basis accidents.

Included in this judgment is acknowledgment that accidents of the types represented by those described in FES Table 7.2 for Classes 2-8 have a finite and relatively larger likelihood of occurrence during the operating lifetime of the CRBRP than the occurrence of Class 9 accidents. Furthermore, their consequences are required not to exceed the dose guideline values of 10 CFR 100. An assessment of the adequacy of the engineered safety features and operating requirements to mitigate and limit the consequences of such accidents will be considered in the safety evaluation of the CRBRP. Such considerations at all contemporary LWRs have resulted in a combination of engineered safety features and operating procedures so that the contribution of these accidents to the total risk to the environment is judged to be negligible. The staff will reexamine the radiological risk contribution of the design-basis accidents at both the construction permit stage and the operating license stage of CRBRP, giving consideration to the probabilities of occurrence of accidents and to their consequences. The purpose of this reexamination at each stage of licensing will be to require that the plant safety and mitigation systems be designed and operated to offset adequately the uncertainties arising from a limited national and international LMFBR operating experience base, and to ensure that the radiological risks of accidents are not greater than those of the LWRs.

J.1.2 EVALUATION OF CLASS 9 ACCIDENTS

The staff has also performed further calculations to provide additional perspective on the risk associated with hypothetical Class 9 accidents at the CRBRP. Presented below is a discussion of the Class 9 accident sequences, estimates of accident probabilities, release of radioactive material to the environment, risks due to the atmospheric and liquid pathway exposures, economic costs of the loss of the facility, the uncertainties in predictions, and conclusions.

(1) Frequencies of Severe Accidents

The Class 9 accident discussed in the FES involved a sequence and release representative of possible core disruptive accidents (CDAs). Additional sequences are included here to provide better perspective regarding the risks of CRBRP severe accidents.

The frequencies of severe (Class 9) accidents at the CRBRP involving potential core disruption and containment failure are related to three phases of such accidents. First, initiation of core disruption must be considered, and this typically requires simultaneous failures of redundant safety systems. Secondly, there are variations in the release to containment that are dependent on the energy associated with core disruption and the nature of the response of the primary coolant boundary. Finally, the potential for containment failure must be considered. The probabilities of such events are discussed below.

- Initiators of Core Disruptive Accidents

Core disruption could be initiated by: (1) failure to adequately cool the fuel as exemplified by a loss of heat sink (LOHS), loss of coolant accident (LOCA), or massive flow blockage; (2) failure to terminate the fission chain reactions when necessary, as exemplified by a failure to scram during a loss of flow event (ULOF) or a transient overpower event (UTOP); and (3) core-wide fuel failures as exemplified by propagation of local fuel faults (FFP).

As discussed on pages 7-2 and 7-7 of the FES, requirements for prevention of severe accidents will be imposed on the CRBRP design to ensure that initiation of core disruptive accidents is made very improbable. Consequently such accidents are not included in the CRBRP design-basis accident spectrum.

LOHS events at the CRBRP would have to involve simultaneous loss of availability of the main condenser-feedwater train, of all three trains of the steam generator-auxiliary heat removal system (SGAHRS), and of both trains of the direct heat removal system (DHRS). The CRBRP SGAHRS system, which is similar in many respects to the steam generator/auxiliary feedwater systems included in PWR designs, consists of one steam-driven and two electrically driven auxiliary feedwater trains. The DHRS employs a diverse heat removal concept. Although the staff review of these systems is not complete, it is the judgment of the staff that there is sufficient inherent redundancy, diversity, and independence in the SGAHRS and DHRS systems to achieve a core degradation frequency due to LOHS events of less than 10^{-4} per reactor year. This estimate is based on a general consideration of typical achievable PWR auxiliary feedwater system reliabilities, the potential for common cause failures, and the potential for achieving high reliability in final design and operation through an effective reliability program. A significant contributor to the LOHS probability for the CRBRP would be from simultaneous loss of offsite and onsite ac electrical power and the steam-driven auxiliary feedwater train.

Because of the high boiling point of sodium, the CRBRP primary coolant system would operate at significantly lower pressures than LWR primary coolant systems. This reduces the frequency of large ruptures in the primary coolant system. To further ensure that large breaks cannot occur and cause core damage, implementation of preservice and inservice inspection of the primary coolant boundary and a leak detection system will be required. In addition, a guard vessel will be included to prevent unacceptable leakage from large portions of the primary coolant system. For these reasons LOCAs are not considered credible (i.e., design-basis) events at CRBRP. The frequency assumed for LOHS adequately bounds the LOCA contributions to core disruption frequency.

The coolant inlet region of the CRBRP core is being designed to prevent large sudden flow blockage such as that which led to extensive damage to two subassemblies in the Enrico Fermi reactor. Multiple inlet ports at different planes with interposed strainers will prevent large pieces of debris from significantly reducing coolant flow to a subassembly module. Although sources of particulate debris in sufficient quantity to produce significant flow blockage have not been mechanistically identified, it may be postulated that this might occur. Such debris would be expected to be distributed rather generally throughout a large region of the core and would be detectable by the core outlet thermocouples if significantly reduced core flow were to result. The frequency assumed for LOHS core degradation sequences adequately bounds the flow blockage contribution to core disruption frequency.

UTOP and ULOF events involve simultaneous failure of both of the reactor shutdown systems. Each of these systems will be required to meet the high standards normally applied to LWR shutdown systems. For example, as specified by IEEE Standard 279, each shutdown system will be automatically initiated, will meet the single failure criterion, and will be tested regularly. Each system consists of three independent electrical actuation channels of diverse logic and diverse components. The mechanical portions of the two systems employ diverse mechanisms and materials. Although the staff review of these systems is not complete, it is the judgement of the staff that there are sufficient inherent redundancy, diversity, and independence in the overall shutdown system designs to expect an unavailability of less than 10^{-5} per demand. This estimate is based on a general consideration of LWR shutdown system unavailability rates, ATWS precursors, potential for common cause failures, and the feasibility of implementing an effective reliability program to achieve high reliability in the final design and in operation. Using the assumption, based on LWR experience, that an average of about 10 transients (requiring scram) might occur per year of operation over the life of the plant, the staff concludes that the combined frequency of degraded core accidents initiated by ULOF and UTOP events is less than 10^{-4} per reactor year.

The CRBRP fuel design will be required to have an inherent capability to prevent rapid propagation of fuel failure from local faults. Systems to detect more slowly developing faults will also be required. Each of these features is considered feasible and in fact has been achieved on fuel designs similar to that of CRBRP. Therefore, the frequency of fuel failure propagation is considered very low. The frequencies attributed to LOHS, UTOP, and ULOF events adequately bound the contribution to core disruption frequency from fuel failure propagation.

In summary, the frequencies of core disruption from LOHS, UTOP, ULOF, LOCA, and FFP events are all considered to be less than 10^{-4} per reactor year. Even when combined, the overall combined probability of these types of events is estimated to have a net frequency of 10^{-4} per reactor year or less. This net frequency does not reflect the variations in response of the primary coolant system that might be associated with the various initiators. Some initiators may result in more severe response than others. This is taken into account as described in the following paragraphs.

- Response of the Primary Coolant System

The response of the primary coolant system to core disruption depends on the amount of energy associated with the disruption. Four categories have been identified and are listed here in order of increasing potential threat to containment integrity and increasing release of radioisotopes into containment:

I. Primary system remains intact; no significant release of radioactive materials to the containment atmosphere.

II. Primary system initially intact, but later fails due to ineffective long-term decay heat removal (of the order of hours or more). The release of core debris and sodium would be initially into the reactor cavity; eventually radionuclides and sodium would reach the containment atmosphere through the reactor cavity vents, but at a slow rate relative to the initial releases of Categories III and IV below.

III. Primary system seals experience partial failure due to excessive mechanical and thermal loads. A limited release of core Pu, solid fission products, noble gases, and volatile material into the upper containment would occur immediately.*

IV. Primary system sealing fails open by excessive mechanical and/or thermal loads. A large release of noble gases, volatile material, solid fission products, and core Pu could occur immediately. Continuous open venting to the upper containment through failed seals is available for subsequently vaporized sodium and radionuclides.*

Most core disruptive accidents are expected to be nonenergetic and to culminate in effects such as described for Categories I and II above.

The applicants have proposed to incorporate features to mitigate the above behavior indicated in Categories II, III, and IV to reduce the probability of subsequent containment failure. These include a filtered vent system to relieve containment pressure, a containment purge system to reduce the potential for hydrogen explosions, fans in the annulus between the steel containment shell and the

*Note: Longer term release to containment via the reactor cavity and vents would be as in Category II.

confinement structure to cool the two structures, and vents to relieve pressure from gases generated behind the reactor cavity cell liners. These provisions are currently under review by the staff.

The Class 9 accident releases described in Categories III and IV correspond to core disruption of sufficient energy, due to recriticality, to cause mechanical damage to the primary coolant system. The staff is reviewing the potential for energetic recriticalities to determine the magnitude of energy release anticipated. If the conclusion of this review is that an energy release beyond primary system capability cannot be precluded, the staff will require some action be taken (e.g., that the vessel be strengthened or that head restraints and sodium spray deflectors be installed) to prevent early containment failure from missiles or spray fires. The staff believes that the technology exists to design and build such devices; similar devices and/or measures were utilized in the design of the Fermi reactor, as well as in Atomics International's design studies of a 500-MWe LMFBR demonstration plant.

Assuming that a core disruptive accident occurs, the conditional frequencies of event Categories I through IV subsequently occurring are estimated as follows:

Primary System Failure - Category I, II, and III combined: $\sim$ 0.9 per CDA
Primary System Failure - Category IV: $\sim$ 0.1 per CDA

These estimates reflect the lower frequencies expected for core disruption accidents of increasing energetics. Because of the difficulty of estimating separate probabilities for Categories I, II, and III, they are combined; for the risk analysis, they are conservatively treated together as if all were Category III.

- Response of Containment

For the purpose of estimating risk given the threats to containment identified above, the following two containment failure modes leading to airborne releases are identified:

(A) Failure of Containment Caused by Overpressure

(B) Failure of Containment to Isolate

The frequency and consequences of releases to the ground by basemat penetration are considered to be overshadowed by airborne releases, as discussed under the subsection entitled "(4) Liquid Pathways" below.

The staff will require that the containment annulus cooling and vent/purge systems be designed with sufficient redundancy and quality and be tested and inspected during operation with sufficient frequency so that it can be assumed that their unavailability for anticipated mission times will not exceed 10^{-2} per demand. Such systems will not be needed to prevent overpressure conditions until many hours after initiation of a CDA, and would not be expected to be affected by loss of offsite and emergency onsite power unless such power loss should be a long-term outage. Should the containment systems be required after a temporary loss of all ac power initiating event, failure to recover ac power before containment failure occurs is estimated to have a frequency of about 10^{-2} per demand.

Containment isolation would be an engineered safety feature at the CRBRP. Such systems are designed to high quality standards and with redundancy. An unavailability of less than 10^{-2} per demand is feasible for such systems and is expected to be attained at CRBRP given that implementation of an adequate reliability program would be required.

In summary, the conditional unavailabilities for the containment failure modes are as follows:

Containment Failure Mode A (Mitigating System Failure): $\leq 10^{-2}$ per demand

Containment Failure Mode B (Containment Isolation Failure): $\leq 10^{-2}$ per demand.

(2) Release of Radioactive Material

Estimates of the release fractions of the various isotopes that can escape from the CRBRP are made using the isotope groups defined in WASH-1400. As shown in Table J.2, four release classes are considered and releases to the environment are defined for three containment modes:

- Design leakage and filtered venting
- Overpressure failure, Failure Mode A (at about 24 hours)
- Containment isolation failure, Failure Mode B (24-in. diameter ventilation line)

Releases from the primary system to the RCB can potentially occur either by leaking through the vessel head seals immediately following an energetic CDA or by release from the sodium pool (which forms in the reactor cavity after reactor vessel and guard vessel meltthrough) through the reactor cavity vent system.

Chemically inert noble gases (Xe-Kr) are not removed from the RCB other than by decay and leakage or filtered venting to the environment. The remaining fission products can be removed from the RCB atmosphere by decay, leakage, filtered venting, and by naturally occurring depletion mechanisms such as:

- Aerosol agglomeration and settling
- Thermophoretic deposition on cooler surfaces
- Plate-out

The fraction of airborne material that leaks to the environment in the long term depends on the ratio of the leakage rate to the total removal (leakage, filtration, decay, and deposition) rate. Removal by aerosol agglomeration and settling, considered the dominant deposition mechanism, is modeled as an exponentially varying time-dependent process.

Primary system sodium would play an important role in removing fission products in CRBRP. First, sodium chemically combines with fission products such as iodine and bromine to form less volatile compounds. Second, sodium is maintained well below its boiling point during normal operation, and thus fission

Table J.2 CRBR CDA sequence classes

CDA class	Initiation	Primary system failure category	Containment failure mode	Bounding estimate of containment release frequency (per reactor year)	Percent of core inventory released to environment[1,2]						
					Xe-Kr	I	CS-Rb	Te-Sb	Ba-Sr	Ru[3]	La[4]
1	Generic Core Disruption	I and II or III[5] or IV	None[6]	10^{-4}	100	0.01	0.01	0.01	0.01	0.001	0.001
2	Generic Core Disruption	II, III or IV[5]	A (Overpressure)	10^{-6}	100	1.0	1.0	0.6	0.6	0.08	0.08
3	Generic Core Disruption	II, III[5]	B (Containment Isolation)	10^{-6}	100	1.3	1.3	0.8	0.8	0.06	0.06
4	Generic Core Disruption	IV	B (Containment Isolation)	10^{-7}	100	4.0	4.0	1.7	1.7	0.35	0.35

[1]Background on the isotope groups and release mechanism is presented in Appendix VII of "Reactor Safety Study," WASH-1400, NUREG-75/014, October 1975.

[2]Indicated release percentages do not include decay; decay is accounted for in the consequence calculations.

[3]Includes Ru, Rh, Mo, Tc.

[4]Includes Y, La, Zr, Nb, Ce, Pr, Nd, Np, Pu, Am, Cm.

[5]Primary system failure Categories I, II, and III are treated together due to the difficulty of estimating probabilities for each separately; for the risk analysis, they are conservatively treated together as if all were Category III.

[6]CDA Class 1 assumes filtered venting as needed to prevent containment failure.

product release to the RCB is retarded by the liquid sodium. Third, sodium vapor, after it becomes airborne, becomes an aerosol. When sodium vapor enters the RCB, for example, a sodium oxide aerosol is formed. Because there are more than 1 million pounds of primary coolant sodium, a dense aerosol (10-100 μg/cc) could be airborne in the RCB. The airborne fission products can interact with and essentially respond as sodium oxide aerosols. For the purpose of analysis, therefore, the airborne fission products (less noble gases) are considered to be removed at the same rate as the sodium aerosols.

Referring to Table J.2, the variation in release fractions among isotope groups and CDA classes depends on the magnitude of competing, concomitant, rate processes (leakage from the RCB, release to the RCB, and deposition in the RCB). It should be emphasized that the indicated release fractions do not include removal by decay; this is accounted for in the consequence calculations.

- Leakage From the RCB

Leakage from the RCB considering CDA Class 1 involves design leakage at rates of 10^{-4} to 10^{-5} per hour and filtered venting which is 97% to 99% efficient. In CDA Class 2, approximately 57% of the RCB atmosphere will be released soon after failure by overpressure because the RCB pressure drops from about 2.3 atmospheres (abs) to 1 atmosphere (abs). Thereafter leakage through the RCB breach is about equal to the release rates of fission products and other gases into the RCB (10^{-1} to 10^{-2} per hour). The leakage rate to the environment considering failure of the containment to isolate a ventilation supply or exhaust line (CDA Classes 3 and 4) is estimated to be on the order of 10^{-1} to 10^{-2} per hour, similar to the rates after overpressure failure. Thus, for each release class several exchanges will occur during the estimated 100-200-hour period in which the sodium pool boils.

- Release to the RCB

For the purposes of this analysis head release fractions were selected as indicated in Table J.3.

Table J.3 Head release selected for source term analysis

Primary system failure category	Percent of core inventory* released from the head (%)						
	Xe-Kr	I	Cs-Rb	Te-Sb	Ba-Sr	Ru	La
III	100	3	3	1	1	0.1	0.1
IV	100	30	30	10	10	3	3

*See footnotes to Table J.2

The fission product inventory remaining in the vessel after the head release constitutes the pool inventory after vessel meltthrough. Pool releases were estimated by considering the relative volatilities of the fission products compared to sodium. Alkali metals such as cesium, for example, boil off at 10 to 20 times the rate of sodium vaporization. Halogens such as iodine form compounds with sodium and, thus, are released from the sodium pool at a slower rate than the sodium. The remaining semivolatiles and solids are released considerably more slowly than sodium. Insignificant amounts of the nonvolatiles (including fuel) are released to the RCB before cavity dryout.

Once the sodium pool has boiled off, the remaining dry debris will increase in temperature and attack the concrete basemat. Additional release of a fraction of the remaining fission products and fuel is then possible and may be exacerbated by sparging effects caused by the release of gases from the concrete during thermal decomposition.

- Deposition in the RCB

Deposition rates for particulate airborne fission products are a function of the particle shape and size as well as concentration. Typical analysis for similar sodium aerosol conditions indicate deposition rates in a single chamber of between 0.5 and 1.0 per hour. Considering leakage rates between 10^{-2} and 10^{-1} per hour, therefore, indicates that between 1% and 20% of the particulate airborne fission products may eventually be released to the environment.* The overpressure failure mode drops the containment pressure to 1 atmosphere, thereby releasing 57% of its atmosphere. Because this release would not occur until about 24 hours after the head release and about 14 hours after pool boiling begins, considerable deposition of the airborne material would occur. The remaining releases after overpressure relief are similar to those occurring after containment isolation failure.

In addition to that in the RCB, further deposition would occur in the reactor cavity and its vent system, in the annulus between the containment and confinement (overpressure failure), and in the ventilation system (containment isolation failure). Each of these features presents a tortuous flow path and appreciable surface area enabling condensation, plate out, and settling. The noble gases are conservatively estimated (decay not included) to completely escape to the environment for each CDA class. This is deemed appropriate because no deposition would occur and several exchanges of the RCB atmosphere would occur.

After considering the above factors, releases to the environment for each CDA class were estimated for vessel head releases, pool releases, and dry cavity releases. These three release components for each CDA class were then combined into a single set of releases for input into the consequence model. The results of this analysis are shown in Table J.2.

- Comparison of Accident Sequence Frequencies

The most probable class of CDA accident sequences is that in which containment systems function as designed, CDA Class 1. Releases to the environment would occur because of design leakage and controlled, filtered venting at about

*Design leakage rates of 10^{-4} to 10^{-5} per hour correspond to 10^{-5} to 10^{-7} long-term release fractions. Filtered venting is 97% to 99% efficient.

24 hours after CDA initiation. The likelihood of this accident class is estimated to be less than 10^{-4} per reactor year. The doses associated with this accident class are not expected to exceed 10 CFR 100 guidelines. The primary system failure mode is unimportant for this sequence.

The two most probable classes of CDA accident sequences for which the doses are expected to exceed 10 CFR 100 guidelines are as follows. First, in CDA Class 2, a CDA is initiated (less than 10^{-4} per reactor year), a primary system failure of Category II, III, or IV (combined conditional frequency $\sim$ 1) occurs, and containment failure mode A, containment cooling or vent/purge failure (leading to overpressure failure) at approximately 24 hours (less than 10^{-2} per demand) follows. This class of CDA accident sequences corresponds to the FES Class 9 accident. In the other of these classes, CDA Class 3, a CDA is initiated (less than 10^{-4} per reactor year), a primary system failure of Categories II and III (combined conditional frequency $\sim$ 1) occurs, and containment failure mode B, failure to isolate (less than 10^{-2} per demand) follows. Both of these classes of CDA accident sequences would therefore have an estimated bounding frequency of less than 10^{-6} per reactor year. Furthermore, the frequency of 10^{-6} per reactor year bounds each CDA accident class sufficiently such that the combined frequency of the two classes is estimated to be less than 10^{-6} per reactor year.

A less probable class of CDA sequences for which doses could exceed 10 CFR 100 guidelines, CDA Class 4, would be initiation of a CDA (less than 10^{-4} per year), primary system failure Category IV (about 0.1 per demand) and containment failure mode B, failure to isolate (less than 10^{-2} per demand). The event has an estimated combined frequency of less than 10^{-7} per reactor year.

These CDA sequence classes correspond to releases to the environment of four different magnitudes, and their probabilities represent an estimate of the frequency of each release mode.

The CDA sequence classes and their releases to the environment are summarized as percentages of the core inventories in Table J.2. Table J.4 gives the inventory of activity of radionuclides in the CRBRP core at the time of shutdown. The first class in Table J.2, which involves no containment failure, is expected to produce doses not exceeding the guidelines of 10 CFR 100.* The second class in the table corresponds to the FES Class 9 accident sequence. Although the sequences represented by the third and fourth classes would involve earlier releases than the FES Class 9 accident, it is not expected that they would involve risks (product of probability and consequences) significantly different from the FES Class 9 accident risk.

(3) Atmospheric Pathway Risks

The potential atmospheric pathway radiological consequences of these accidents have been calculated by the consequence model used in the RSS (NUREG-0340)

*The comparison to 10 CFR 100 guidelines is made to indicate that this class of CDA does not have such severe consequences as other Class 9 accidents. The 10 CFR 100 guidelines were developed for siting analysis and are often applied in design basis accident analysis. They were not intended to apply to Class 9 accidents.

Table J.4 Activity of radionuclides in the CRBR reactor core at 1121 MWt

Group/radionuclide	Radioactive inventory in millions of curries	Half-life (days)
A. NOBLE GASES		
Krypton-85	0.1	3,950
Krypton-85m	5.0	0.183
Krypton-87	8.0	0.0528
Krypton-88	11.4	0.117
Xenon-133	52.3	5.28
Xenon-135	56.5	0.384
B. IODINES		
Iodine-131	30.0	8.05
Iodine-132	40.8	0.0958
Iodine-133	51.5	0.875
Iodine-134	54.7	0.0366
Iodine-135	50.4	0.280
C. ALKALI METALS		
Rubidium-86	0.14	18.7
Cesium-134	0.66	750
Cesium-136	2.7	13.0
Cesium-137	1.7	11,000
D. TELLURIUM-ANTIMONY		
Tellurium-127	3.7	0.391
Tellurium-127m	0.54	109
Tellurium-129	9.7	0.048
Tellurium-129m	2.7	34.0
Tellurium-131m	4.5	1.25
Tellurium-132	40.0	3.25
F. NOBLE METALS		
Molybdenum-99	46.6	2.8
Technetium-99a	40.3	0.25
Ruthenium-103	52.6	39.5
Ruthenium-105	38.5	0.185
Ruthenium-106	19.6	366
Rhodium-105	38.5	1.50
G. RARE EARTHS, REFRACTORY OXIDES, AND TRANSURANICS		
Yttrium-90	0.71	2.67
Yttrium-91	20.4	59.0
Zirconium-95	36.2	65.2

Table J.4 (Continued)

Group/radionuclide	Radioactive inventory in millions of curies	Half-life (days)
Zirconium-97	40.9	0.71
Niobium-95	34.8	35.0
Lanthanum-140	42.2	1.67
Cerium-141	42.9	32.3
Cerium-143	34.8	1.38
Cerium-144	20.2	284
Praseodymium-143	34.8	13.7
Neodymium-147	17.0	11.1
Neptunium-239	1100	2.35
Plutonium-238	0.38	32,500
Plutonium-239	0.11	8,900,000
Plutonium-240	0.10	2,400,000
Plutonium-241	13.0	5,350
Americium-241	0.16	150,000
Curium-242	14.0	163
Curium-244	0.01	6,630

Note: The above grouping of radionuclides corresponds to that in Table J.2.

adapted and modified to the CRBRP site. The model used 1 year of site meteorologic data, projected population for the year 2010 extending throughout a radius of 563-km (350-mi) from the site, and habitable land fractions within the 563-km (350-mi) radius. The essential elements of the atmospheric pathways model are shown in schematic form in Figure J.1.

To obtain a probability distribution of consequences, the calculations were performed assuming the occurrence of each accident-release sequence at each of 91 different "start" times throughout a 1-year period. Each calculation utilized the site-specific hourly meteorological data and seasonal information for the time period following each "start" time. The consequence model also contains provisions for incorporating the consequence-reduction benefits of evacuation, relocation, and other protective actions, because early evacuation and relocation of people would considerably reduce the exposure from the radioactive cloud and from the contaminated ground in the wake of the cloud passage. The evacuation model used has been revised from that used in the RSS for better site-specific application. The quantitative characteristics of the evacuation model used for the CRBRP site include conservative estimates of key parameters. These estimates were made by the staff because the applicants' estimates are in a preliminary state of preparation. Included among the key parameters was the assumption of a 12-hour delay in starting evacuation after operator identification of a severe accident.

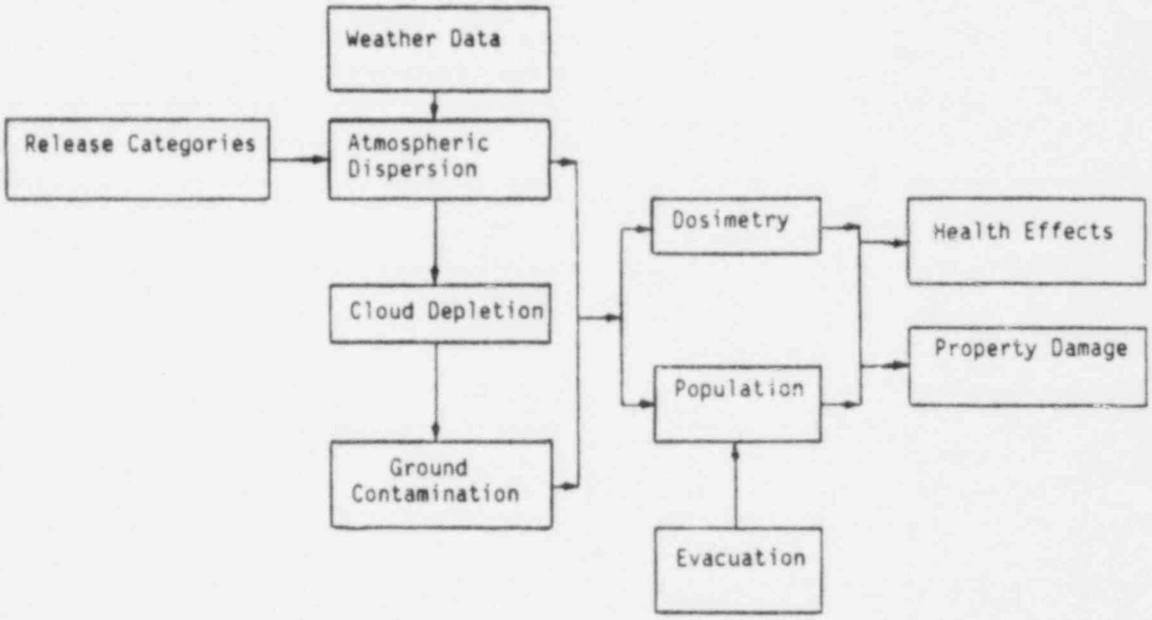


Figure J.1 Schematic outline of atmospheric pathway consequence model

There normally would be some facilities near a plant--such as schools or hospitals--where special equipment or personnel may be required to effect evacuation, and there may be some people near a site who may choose not to evacuate. Several facilities of this type have been identified near the CRBRP site, such as the Loudon County Memorial Hospital, Roane County High School, and facilities related to national security. Therefore, actual evacuation effectiveness could be greater or less than that characterized but would not be expected to be significantly less.

The other protective actions include: (1) either complete denial of use (interdiction), or permitting use only at a sufficiently later time after appropriate decontamination of foodstuffs such as crops and milk, (2) decontamination of severely contaminated environment (land and property) when it is considered to be economically feasible to lower the levels of contamination to protective action guide (PAG) levels, and (3) denial of use (interdiction) of severly contaminated land and property for varying periods of time until the contamination levels are reduced by radioactive decay and weathering so that land and property can be economically decontaminated as in (2) above. These actions would reduce the radiological exposure to people from immediate and/or subsequent use of or living in the contaminated environment.

Early evacuation of people from the plume exposure pathway zone (EPZ) and other protective actions as mentioned above are considered essential sequels to severe nuclear reactor accidents involving significant release of radioactivity to the atmosphere. Therefore, the results shown for CRBRP include the benefits of these protective actions.

There are uncertainties in each facet of the estimates of consequences (see Figure J.1) and the error bounds may be as large as they are for accident probabilities. The results of the calculations, based on conservative assumption of a 12-hour delay in evacuation, are summarized and compared with those for the Midland plant (LWR) in Table J.5 as expectation values, or averages of environmental risk per year of reactor operation. These averages are instructive as an aid in the comparison of radiological risks associated with potential CRBRP accidents and those risks calculated for recently evaluated LWRs (such as Midland) for which calculations of radiological risks were made in essentially the same manner. The table shows the average risk associated with population dose, early fatalities, latent fatalities, and costs of protective actions and decontamination.

The population doses and latent fatality risks may be compared with those for normal operation population doses given in Table 5.13 of the FES. The comparison shows that the accident risks are comparable to operating risks.

For perspective and understanding of the meaning of the early fatality risks of 6×10^{-6} per reactor-year, however, the staff notes that to a good approximation the population at risk within about 16 km (10 miles) of the plant is expected to be about 80,000 persons in the year 2010. Accidental fatalities per year for a population of this size, based upon overall averages for the United

Table J.5 A comparison of average values of environmental risks due to selected CRBRP accidents with those for the Midland plant

Environmental risk (per reactor year)	CRBRP	Midland
Population exposure		
Person-rems within 80 km	3.5	26
Total person-rems	5	130
Early fatalities	6×10^{-6}	1.5×10^{-5}
Latent cancer fatalities		
All organs excluding thyroid	0.3×10^{-3}	7.2×10^{-3}
Thyroid only	0.04×10^{-3}	1.8×10^{-3}
Cost of protective actions and decontamination	$690*	$4,800*

*1980 dollars

States,* are approximately 18 from motor vehicle accidents, 6.2 from falls, 2.5 from drowning, 2.3 from burns, and 1.0 from fire arms.

(4) Liquid Pathways

Surface water hydrologic properties at CRBRP should be similar to those used for the Liquid Pathways Generic Study (LPGS) small river site, which was based on the Clinch-Tennessee-Ohio-Mississippi Rivers system, although the river uses and populations in the LPGS (NUREG-0440) were based upon national averages and have not been directly compared to the CRBRP. The groundwater characteristics at Clinch River do not indicate any unusually adverse transport characteristics.

Additionally, the CRBRP is a considerably smaller plant than the LPGS case (CRBRP is 1121 MWt vs.3425 MWt assumed for the LPGS), and contrary to the LWR characteristics, CRBRP does not contain any large storage of water that could serve as a potential "prompt source" to the environmental liquid pathways. Therefore, only the radioactive material leached from the core debris by the local groundwater is likely to be transported to the Clinch River. This source was found in the LPGS to be considerably smaller than the "prompt source." Therefore, based on the preliminary appraisal of the liquid pathways, the staff concludes that the liquid pathways impacts of CRBRP would be probably smaller than those for the LWRs analyzed in the LPGS small river site case.

*Based on risk to individual in "CONAES Final Report," National Research Council, Chapter 9, pp. 577-534, 1979.

(5) Other Economic Risks

There are economic impacts and risk other than environmental risks that can be given a monetary value. These are accident impacts on the facility itself that result in added costs to the public, primarily taxpayers. These costs would be for decontamination and repair or replacement of the facility and for replacement power. Although it is possible that the facility would simply be decommissioned rather than restored following a serious (core-melt) accident, an assumption of restoration is considered conservative (high cost) in reflecting the cost impact of an accident. If the worth of the facility at the time of an accident is perceived to be more than the cost of restoration of the facility, then presumably the facility would not be restored and the cost impact would be less than the restoration cost, so that use of the restoration cost would represent a high side estimate. Because the worth of the CRBRP facility is primarily in the nature of research and development, the actual value cannot be quantified any more accurately than it would be perceived at the time.

Experience with such costs is currently being accumulated as a result of the Three Mile Island accident. Although CRBRP is considerably smaller in electrical output than the Three Mile Island plant, the physical size and complexity of the CRBRP is comparable and the cost of decontamination and restoration is estimated to be about the same as that for Three Mile Island. If a Class 9 accident occurs during the first full year of CRBRP operation (1990), the economic penalty associated with the initial year of the unit's operation is estimated at $2470 million for decontamination and restoration, including replacement of the damaged nuclear fuel. This is based on a $952 million value in 1980 dollars as reported to Congress by the Comptroller General (1981). The $952 million in 1980 dollars has been escalated at 10% to 1990. Although property damage insurance would cover part of this, the insurance is not credited because the insurance payment times the risk probability would theoretically balance the insurance premium.

In addition, the staff estimates average additional production costs of $27 million (1990 dollars) for replacement power during each year the CRBRP is being restored. This is based on the applicants' net projections of operating savings during the first 6 years of operation, discounted at 10% to 1990. Assuming the nuclear unit does not operate for 8 years due to shutdown, the total additional replacement power cost should be approximately $220 million in 1990 dollars.

The probability during each year of the unit's service life of sustaining a total loss of the original facility as a result of a disabling accident is taken from Table J.2 as 1.0×10^{-4}. Multiplying the previously estimated costs of $2690 million for an accident to the CRBRP during the initial year of its operation by the above 1.0×10^{-4} probability results in an economic risk of approximately $270,000 (in 1990 dollars) applicable to the CRBRP during its first year of operation. This is also approximately the economic risk (in 1990 dollars) to the CRBRP during the second and each subsequent year of its operation. Although the CRBRP would depreciate in value such that the economic consequences of an accident become less as the unit becomes older, this is considered to be offset by a higher cost of decontamination of the unit in the later years.

(6) Uncertainties

The foregoing estimates of frequencies and risks associated with the CRBRP have included allowances for uncertainties. For example, unavailability estimates for shutdown and heat removal systems have been set high enough to include allowances for potential common cause failures. However, the risks from sabotage or from external natural events such as earthquakes, tornadoes, and floods beyond design bases for such events are difficult to quantify. This situation is generic to LWRs and advanced reactors such as the CRBRP. NRC is presently devoting significant effort to developing methods for quantifying risks from such events. Compliance with current NRC siting, structural, and seismic design criteria and with 10 CFR 73 for physical security provides assurance that reactor-related risks from external events and sabotage are adequately low. The CRBRP design will be required to meet all these criteria. Risks and the uncertainties in risks from the CRBRP related to sabotage and to external events are not expected to differ significantly from such risks and their associated uncertainties at LWRs.

One additional potential containment failure mode not quantified above involves early containment failure and release caused by either a spray fire or missile generated from a very energetic CDA. The staff will review the potential for CDA energetics to ensure that necessary design enhancements of the primary coolant system are incorporated so that the probability of primary coolant system failure as a result of physically reasonable core rearrangement of sodium, cladding, or fuel will be very small. However, because it is possible to hypothesize nonmechanistic and speculative coherent and rapid core reconfigurations leading to high reactivity ramp rates, high energetics cannot be entirely precluded. Quantification of the frequency of this very improbable nonmechanistic event at this time would involve such large uncertainties that the results would have no real meaning.

It should also be noted that these results do not fully account for the effects of the sodium coolant on the radioactive source term. For example, inclusion of the effects of sodium is expected to reduce the quantity of iodine available for leakage. The large mass of sodium aerosol also contributes to the agglomeration and settling of aerosols in the primary containment. On the other hand, the sodium activation products would be released together with the primary coolant, thereby adding to the amount of radioactive material released to the containment. On balance, it is expected that the risk contribution of the presence of radioactive sodium would not invalidate the conclusions of these calculations. Further consideration of this subject will be included in the staff's review of the Probabilistic Risk Assessment for this plant, and in the staff's Safety Evaluation Report.

In summary, from the limited quantitative analyses discussed above, it is the best estimate of the staff that the frequency of individual classes of severe accidents resulting in fatalities or even doses exceeding 10 CFR 100 guidelines is less than 10^{-6} per reactor year. Compliance with current design criteria will ensure that risks from external events and sabotage are acceptably low. The risks estimated for CRBRP from a selected Class 9 accident appear in Table J.5.

The estimated probabilities of severe accidents for the CRBRP do not depend in a significant way on the Reactor Safety Study (RSS), which was published in 1975. However, the RSS has been reviewed to gain perspective regarding representative system unreliabilities and general aspects of methodology and uncertainties. For that reason the following discussion of the current status of the RSS is provided.

In July 1977, the NRC organized an Independent Risk Assessment Review Group to (1) clarify the achievements and limitations of the Reactor Safety Study, (2) assess the peer comments thereon and the responses to the comments, (3) study the current state of such risk assessment methodology, and (4) recommend to the Commission how and whether such methodology can be used in the regulatory and licensing process. The results of this study were issued in September 1978. This report, commonly called the Lewis Report, contains several findings and recommendations concerning the RSS. Some of the more significant findings are summarized follows:

(1) A number of sources of both conservatism and non-conservatism in the probability calculations in the RSS were found which were very difficult to balance. The Review Group was unable to determine whether the overall probability of a core melt given in the RSS was high or low, but it did conclude that the error bands were understated.

(2) The methodology, which was an important advance over earlier methodologies that had been applied to reactor risk, was sound.

(3) It is very difficult to follow the detailed thread of calculations through the RSS. In particular, the Executive Summary is a poor description of the contents of the report, should not be used as such, and has lent itself to misuse in the discussion of reactor risk.

On January 19, 1979, the Commission issued a statement of policy concerning the RSS and the Review Group Report. The Commission accepted the findings of the Review Group. These findings have been considered in evaluating the potential risks from CRBR.

J.1.3 CONCLUSION

The foregoing sections have evaluated the environmental impacts of severe accidents, including potential radiation exposures to the population as a whole, the risk of near- and long-term adverse health effects that such exposures could entail, and the potential economic and societal consequences of accidental contamination of the environment. The assessment of environmental risk of accidents, assuming reasonable protective action, provides perspective on the overall risk from CRBRP accidents in comparison with those from LWRs. From this comparison, the staff concluded that CRBRP accident risks would not be significantly different from those of current LWRs. The analysis confirms the FES conclusion that the accident risks at CRBRP can be made acceptably low.

REFERENCES

Comptroller General of the U.S., "Report to Congress," EMD-81-106, August 26, 1981.

Institute of Electrical and Electronic Engineers, Standard 279.

National Research Council, "CONAES Final Report," 1979.

U.S. Nuclear Regulatory Commission, NUREG-0340, "Overview of the Reactor Safety Study, October 1977.

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

---, NUREG-0564, "Draft Environmental Statement related to construction of the Seabrook Station, Units 1 and 2," August 1974.

---, NUREG-0813, "Final Environmental Statement related to the operation of the Callaway Plant, Unit 1," September 1981.

---, NUREG-0894, "Draft Environmental Statement related to the operation of the Skagit/Hanford Nuclear Plant," May 1982.

---, NUREG/CR-0400, H. R. Lewis, Chairman, "Risk Assessment Review Group Report to the U.S. Nuclear Regulatory Commission," Ad Hoc Risk Assessment Review Group, September 1978.

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

APPENDIX K

PROPOSED RULE ON ALTERNATIVE SITES

NUCLEAR REGULATORY COMMISSION

10 CFR Part 51

Licensing and Regulatory Policy and Procedures for Environmental Protection; Alternative Site Reviews

AGENCY: U.S. Nuclear Regulatory Commission.

ACTION: Proposed rule.

SUMMARY: The Nuclear Regulatory Commission is proposing to amend its regulation in 10 CFR Part 51 to provide procedures and performance criteria for the review of alternative sites for nuclear power plants under the National Environmental Policy Act of 1969 (NEPA). The proposed rule provides for (a) information requirements for applying for an alternative site review by the Commission, (b) timing of Commission review, (c) region of interest to be considered in selecting sites, (d) criteria for the selection of sites, (e) criteria for comparing a proposed site with alternative sites, and (f) requirements for reopening an alternative site decision. It is also proposed that minor amendments be made to 10 CFR Part 2 and 10 CFR Part 50 to reflect the provisions of the proposed rule. Public comment is requested on the proposed rule, on whether safety matters including emergency response capability should be admitted as issues in alternative site reviews, and on the value/impact statement supporting the proposed rule.

DATES: Comments are due on or before June 9, 1980.

ADDRESSES: Interested persons are invited to submit written comments and suggestions to the Secretary of the Commission, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Docketing and Service Branch. Single copies of the value/impact statement may be obtained on request from the Director, Division of Technical Information and Document Control. Copies of the value/impact statement may be examined in the Commission's Public Document Room at 1717 H Street NW., Washington, D.C.

FOR FURTHER INFORMATION CONTACT: Dr. Jerry R. Kline, Environmental Engineering Branch, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, telephone (301) 492-8251.

SUPPLEMENTARY INFORMATION:

I. Foreword

NEPA and NRC's environmental regulations in 10 CFR Part 51 have many provisions that shape the NRC's environmental reviews for nuclear power plants, but the basic underlying aspect is the consideration of alternatives. There are four distinct and different areas of NRC decisionmaking that involve alternatives, as described below:

1. One decision that must be made is whether additional baseload generating capacity need be provided. In other words, NRC considered the "no action" alternative, which includes consideration of conservation of energy.

2. A second decision that must be made by the NRC is whether nuclear fueled generation is an acceptable choice or whether other types of energy sources, e.g., coal, are superior.

3. A third NRC decision is whether the proposed site is acceptable. This particular decision involves the consideration of alternative sites; consideration of reasonable major mitigation measures that might be employed to make environmental impact acceptable at the candidate sites, such as the type of cooling system that should be employed at a particular site; and consideration of the costs of such major mitigation measures, as well as any major costs that might be required to make the site acceptable from a safety standpoint.

4. A fourth type of decision that is made involves whether other types of mitigation measures are warranted that normally would be of little importance to site selection, but may still be important from the standpoint of minimizing, to the extent reasonable, any residual adverse environmental impact that likely might be incurred during the construction or operation of the plant.

The proposed rulemaking focuses on the third type of NRC's environmental decisions—i.e., the question of alternative sites.

The NRC has considered the question of alternative sites in all of its NEPA reviews of applications to construct and operate nuclear power plants. As in most situations, however, the type and nature of the review has evolved over the years. Until recently, the NRC's review of the alternative site question has focused primarily on the qualities of the proposed site; i.e., a review that focuses on the "products" of an applicant's site selection process. The NRC typically did not initiate an extensive review of the applicant's site selection process and alternative site unless substantial inferior qualities were identified at the applicant's proposed site. However, the NRC has recently and dramatically expanded its review of the applicant's site selection process and procedures, as well as its review of the scope and depth of the detailed investigation of alternative sites.

The NRC believes that the experience gained in past and recent reviews of nuclear power plant sites should permit codification of the lessons learned into an intelligible, intelligent, and environmentally sensitive rule that governs the NRC review of alternative sites. While it is true that many of the issues that would be addressed by a rule on alternative site reviews could also be addressed more informally by issuance of regulatory guides and standard review plans and litigated in individual cases, some issues, particularly issues relating to notice and timing of public participation, can only be adequately addressed by rule. In addition, a comprehensive rule addressing review of alternative sites will promote public understanding of and participation in the NRC review of alternative sites. The proposed rule would:

1. Provide for more effective public participation by implementing procedural changes that: (a) require early notification of the public of an applicant's choice of a proposed site and its alternatives; (b) permit an early review of the alternative site question apart from other early site review issues; and (c) provide explicitly for consideration of candidate sites proposed by other parties that meet certain criteria and are proposed in a timely fashion.

2. Provide for greater predictability in the licensing process by (a) prescribing criteria for determining when a region of interest of sufficient size has been considered; (b) prescribing criteria for judging whether candidate sites are among the best that could reasonably be found; (c) prescribing the basic standards for comparing the proposed site to the alternative cites; and (d)

providing criteria for reopening the alternative site question after a previous NRC decision has been rendered on this subject.

The basic forces motivating the development of the proposed rulemaking are:

1. The necessity to protect the environment from unduly adverse environmental impacts, recognizing that the siting of a large, nuclear generating facility will result in some adverse impact regardless of where it is sited. Unduly adverse environmental impacts are an undersirable cost to society.

2. The realization that (a) reasonable bounds may be placed on the search for alternative sites without compromising environmental protection, and (b) the NRC's informational needs require the applicant to make a significant commitment of resources at the proposed site. As a general matter these costs are ultimately borne by the rate-payer and the taxpayer.

3. The fact that it is in the public interest to attempt to develop written, understandable NRC review and decisional criteria that provide for the necessary protection of important environmental qualities; i.e., criteria that are sensitive to the factors that would significantly and adversely impact the environment, yet still reasonably bound the consideration of alternatives to permit a rational and timely decision about the sufficiency of analysis.

Considering the above points, it should be noted that the proposed rule is environmentally based, but it does provide for other considerations (such as cost) to bound in a reasonable manner the search for candidate sites. The NRC fully realizes that an applicant does consider other factors in its site selection process. These factors are important to the applicant because they affect the economics and technical merits of the project and because many of these parameters affect reactor safety and thus must be reviewed and found acceptable by the NRC during the safety review process. The NRC sees no basic incompatibility between the environmentally-based rule proposed here and the fact that the applicant must realistically consider other, equally important, parameters in its formulation of a reasonable and effective site selection process. Also, it should be noted that the proposed rule (Section VI.2.b.(7)) includes threshold population criteria that are the same as the numerical values for population density contained in Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations." This is reflective of past staff practice. However, these criteria may be changed in accordance with an ongoing Commission review of siting policy which will be the subject of an advance notice of rulemaking in the immediate future.

To assist in the Commission's consideration of this question on population and related questions and as part of this proposed rulemaking on alternative sites, public comment is requested at this time on whether safety issues, including emergency response capability, should be admitted in the review and decisionmaking on alternative sites; and if so, how. At least two alternatives exist with regard to this question:

1. Establish, in a public rulemaking, exclusionary safety standards that must be met in order to have an acceptable site. Safety issues would not be considered in subsequent review of alternative sites, since such standards would be set sufficiently conservative that the residual radiological risk to the environment would be small and would be sufficiently similar to the residual risk at other reasonable sites in the region that an obviously superior alternative would likely not exist; i.e., these differences in residual radiological impacts would not weigh heavily in a NEPA-type cost-benefit balance. Such acceptance standards might include, for example, reasonable limits on population density, distances to towns and cities, distances to airports and other manmade hazards, and distances to capable faults.

2. Establish, in a public rulemaking, exclusionary safety standards that must be met, but also provide for inclusion of these safety issues in the consideration of alternative sites even when the sites meet these criteria. Such criteria may or may not be the same numerically as those addressed in 1 above. The rationale of this alternative rests on the view that even when a safety-related characteristic (e.g., population density) does not render a site unacceptable in any absolute sense, it may nevertheless involve sufficient residual risk to justify attempts to do better. The alternative sites evaluation process is suited to a determination of how well one can reasonably do in the particular area under consideration, since the process would illuminate specific alternatives. As an option, a second set of more conservative criteria might also be established which, if met, would not require that safety issue to be included in the consideration of alternative sites.

With respect to population density, alternative 1 above would seek to obtain a similar result as alternative 2, i.e., acceptance thresholds, set in light of population density and distribution.

The NRC realizes that implementation will not, and should not, remove the controversy over the question of alternative sites. The question rightfully is a controversial one that elicits high public interest. The purpose of the rule is not to eliminate this controversy, but to focus it on factors of critical importance to the protection of the environment.

II. Background

NEPA requires the study and development of alternatives to any major Federal action that would significantly affect the quality of the human environment. The procedure for doing this must be an integral part of the planning and decisionmaking processes of Federal agencies. 10 CFR Part 51 establishes the NRC's licensing and regulatory policy and procedures under NEPA and requires that each applicant for a permit to construct a nuclear power plant discuss in an Environmental Report "Appropriate Alternatives" to the proposed facility. Among the primary alternatives to be considered, once the need for a nuclear facility has been established, are alternative sites for the facility.

The assessment of alternative sites for proposed nuclear power plants is a complex and difficult task, for the applicant, the NRC staff, and all parties in the process. Issues related to alternative siting have been a major source of controversy in a number of cases involving construction permits for nuclear power plants. The NRC has observed that there are some recurring issues at the heart of the controversy. The Commission believes that these recurring issues can and should be resolved on a generic basis.

An NRC study group seeking to identify ways to improve the effectiveness of NRC nuclear power plant licensing procedures recommended in June 1977 (see NUREG-0292, "Nuclear Power Plant Licensing: Opportunities for Improvement") that, among other measures, rulemaking should be considered for the generic resolution of certain issues presently litigated in individual licensing proceedings. An interim policy statement on generic rulemaking was published in the Federal Register on December 14, 1978, with a 90-day period for public comment ending on March 12, 1979. Additional technical detail on the ten issues identified by the staff for possible rulemaking was provided in NUREG-0499, "Preliminary Statement on General Policy for Rulemaking to Improve Nuclear Power Plant Licensing."

One of the ten issues proposed by the staff for consideration in generic rulemaking was alternative siting methodology and information requirements. Recognizing the need for further clarification of this issue, the staff issued Supplement No. 1 to NUREG-0499, a staff report entitled "General Considerations and Issues of Significance on the Evaluation of Alternative Sites for Nuclear Generating Stations Under NEPA." The major purpose of the report was to provide additional information to members of the public, industry, and other governmental agencies who intended to comment by March 12, 1979 on issues of alternative siting.

In addition, the NRC conducted a workshop to actively seek out comments on the alternative sites issue. This workshop provided invited representatives from industry, State and Federal government, public interest groups, and others the opportunity to scrutinize and comment on the NRC staff's most recent thinking on the issue of alternative sites.

Comments and feedback received from the workshop participants and observers, and those received from the public review of Supplement 1 to NUREG-0499, have been considered in the development of the proposed rule on alternative sites.

This proposed rule sets forth the resultant NRC policy regarding the evaluation of alternative sites for nuclear power plants under NEPA. The proposed rule is intended to (1) fulfill the NEPA objectives of ensuring that environmental factors have been fully considered in NRC decisionmaking; (2) reduce uncertainty and delay in the decisionmaking process; (3) reduce Federal paperwork in NEPA statements; and (4) limit alternative site review to relevant and material issues. The basic objective of this rule is to provide for a meaningful, rationale, understandable, and stable NRC review and decisionmaking process that will both reasonably protect environmental values and yield a timely decision.

The intent of this proposed rule is to establish procedural and performance criteria for the identification and evaluation of alternative sites for nuclear power plants. Controversy with regard to the issue of alternative sites will not and should not be eliminated. This proposed rule will, however, focus the controversy on whether criteria important to environmental protection have indeed been met.

The NRC has considered the values and impacts of rulemaking and of alternative actions. These considerations have been put forth by the Commission's staff in a value/impact statement.

III. The Role of NRC and Others in the Considerations of Alternative Sites

The NRC has the statutory responsibility to review applications for the construction and operation of nuclear power plants. It must assure the accuracy and relevance of environmental information, perform the environmental analyses, and make the decision to accept or reject a site. In carrying out its responsibilities, the NRC does not select sites or participate with the applicant in selecting a proposed site. However, the NRC is the lead Federal agency under NEPA for carrying out the NEPA mandate that alternative sites be considered in connection with nuclear power plant licensing.

The NRC may give appropriate deference to other Federal agency expertise in the assessment of certain impact, e.g., U.S. Environmental Protection Agency expertise in evaluating aquatic impacts. The Commission has also stated that "the fact that competent and responsible State authority has approved the environmental acceptability of a site or project after extensive and thorough environmentally sensitive hearings is properly entitled to 'substantial weight' in the conduct of our own NEPA analysis." Public Service Company of New Hampshire, et al. (Seabrook Station, Units 1 & 2), 5 NRC 503 at 527 (1977). Additionally, consideration is given to other information developed by State, regional, and local agencies (such as land or water use plans).

The proposed rulemaking represents no change in the above stated present practice.

IV. The Proposed Rule

A rule must address those elements of the alternative siting process that are generic in nature and likely to recur in all or many of the cases likely to be encountered. In formulating the proposed rule, the staff identified six major issues associated with alternative site consideration. These are (1) information requirements, (2) timing, (3) region of interest, (4) selection of candidate sites, (5) comparison of the proposed site with the alternative sites, and (6) reopening of the alternative sites decision.

The following sections provide a statement of each element of the proposed rule, describe its relation to present practice, and discuss the need for the rule and rationale for each element of the rule. The elements of the rule are organized to reflect the logic and chronology of a normal NRC review of alternative sites in response to an actual submittal for such a review.

A. Information Requirements

A-1. Notice of Intent

1. *Statement of Rule.* An applicant is to provide the NRC staff with a notice of intent to tender an application for a construction permit (CP) for a nuclear power plant either at least three months before tendering of a CP application requesting an early review of the alternative sites issue (pursuant to § 2.101 and subpart F of 10 CFR Part 2) or 3 months prior to beginning the detailed studies on the proposed site, whichever comes first. The notice of intent will identify the location, cooling water sources, and physiographic unit of the proposed and alternative sites, as well as describe the anticipated generating capacity, the number of generating units, and the types of condenser cooling systems that would be used.

2. *Relationship to Present Practice.* Present NRC rules do not require submittal of such a notice, and present practice does not yield the information on cooling systems or alternative sites at the times specified.

3. *Need for Action.* Early public notification is needed to allow the public to become aware of the project, to identify their concerns and to express those concerns in advance of significant financial commitments by the applicant and at a time when due consideration of their concerns would not result in unacceptable schedule delays.

4. *Rationale and Discussion.* After receiving a notice of intent as required by the rule, NRC would publish the information received in the **Federal Register** and in newspapers local to the sites identified. This would assure that potential public participants have sufficient time prior to the NRC review to prepare meaningful information to be considered early in the licensing process. This provision is in direct response to a recommendation from several workshop participants.

For situations where, on the effective date of this rule, a future applicant has already begun or is about to begin detailed, long-term investigations on a site likely to be proposed subsequently to the NRC as a site for a nuclear power plant, such a future applicant must provide a notice of intent within three months following the effective date of this rule.

A.2. Reconnaissance Level Information

1. *Statement of Rule.* Reconnaissance level information, i.e., information or analyses that can be retrieved or

generated without the performance of new, comprehensive site-specific investigations, is normally adequate as a basis for identifying candidate sites and for selecting a proposed site.

Analysis of the slate of candidate sites may address other aspects of siting that are important to the applicant's decision, but must address the following subjects that are important to the NEPA reviews: hydrology, water quality and availability, aquatic and terrestrial biological resources, land use, transmission requirements, socioeconomics, population distribution and density, facility costs, institutional constraints, and public concerns where such have been provided to the applicant or NRC in writing.

2. *Relationship to Present Practice.* Present practice is that the analysis of alternative sites is normally based upon readily available, reconnaissance level information such as provided by scientific literature, reports of government and private research agencies, consultation with experts, and brief field investigations. The scope of depth of the data and analysis required are matched to the importance of possible impacts and the degree of certainty regarding their magnitude. In some cases, detailed investigations related to specific issues may be required.

While detailed site-specific baseline studies on the proposed site are required to support the remainder of the NRC's environmental review, these data normally add little to NRC's determinations regarding alternative sites. These detailed studies principally serve as a basis for decision-making regarding mitigative measures to reduce (on a practicable basis) any residual adverse environmental impacts. However, they also serve a secondary purpose in that they confirm judgments on likely adverse environmental impacts that are made using reconnaissance level data. On occasion these studies may not confirm such judgments, but may lead to a finding that the proposed site is unacceptable.

The proposed rule on reconnaissance level information represents no change in the above stated practice.

3. *Need for Action.* Present practice is sufficiently well established through licensing experience to permit rulemaking on information requirements for alternative site analysis.

4. *Rationale and Discussion.* The rationale for the rule on reconnaissance level information proceeds from the premise that major adverse environmental impacts can normally be identified using this type of information. Therefore, the added costs of requiring detailed site-specific investigations and analyses on all candidate sites normally would not be justified with respect to any marginal improvement in environmental protection. There was substantial discussion during the workshop on the applicability of reconnaissance level information to alternative site analyses. Many workshop participants emphasized that the term "reconnaissance level information" should not be interpreted to mean the reliance on limited data and subsequent superficial analyses. Such an interpretation is not intended, thus the proposed rule has been drafted to ensure that this misinterpretation will not occur.

B. Timing

1. *Statement of Rule.* Under the proposed rule an applicant may submit the proposed and alternative sites for NRC evaluation as part of a full construction permit review either early and separate from the review of plant design (an early site review) or in conjunction with the review of plant design. An early site review (ESR) of alternative sites may be in conjunction with or separate from consideration of other ESR issues. The applicant may later submit other siting issues for an early site review during the effective period of the early alternative sites partial decision.

2. *Relationship to Present Practice.* In the past, the NRC's review of alternative sites has generally occurred concurrently with the review of all other environmental issues and at the same time as the CP safety review of facility design. However, NRC regulations do provide for a single optional early site review, which may include any issues involving environmental impact or site safety that the applicant desires to address at a proposed site. While the applicant must describe the site selection process in an early site review, the review of specific alternative sites need not be addressed unless it is believed by the NRC that the consideration of other issues could prejudice the full consideration of alternative sites at a later time.

The proposed rule on timing represents a change in the above stated practice in that early review of the full question of alternative sites would be permitted in advance of the other early site review issues, and a subsequent early review would be allowed to consider the detailed baseline studies at the proposed site.

3. *Need for Action.* The option for early review of alternative sites is needed to permit a full consideration before the applicant commits substantial resources to the proposed site. If a favorable decision is made on the alternative site question, the applicant could then commit the funds necessary to perform early site-specific studies of environmental and safety matters with a greater degree of confidence that the proposed site will not subsequently be rejected in favor of an alternative.

4. *Rationale and Discussion.* A two-stage early site review process is permitted to provide incentive for an early review of the alternative site question. In this way an early decision could be arrived at on alternative sites, after which the applicant could expend the necessary resources for detailed site-specific studies and apply at a later date for the remainder of a full early site review. Thus, less of the applicant's resources would be placed at risk prior to an NRC decision on alternative sites, and yet the applicant and the public would ultimately be able to achieve all of the ultimate benefits of an early site review.

All reviews and decisions would still be performed within the effective period for the early site review decision. All that would be added would be the opportunity to receive a regulatory decision on the question of alternative sites shortly after the applicant has decided upon the proposed site, but prior to the commitment of substantial funds at that proposed site.

C. Region of Interest

1. *Statement of Rule.* The initial geographic area for determining the region of interest for NRC regulatory review purposes may be either the State in which the proposed site is located or the service areas of the applicant. The actual region of interest must be larger in accordance with Section V.3 of the rule, or may be smaller in accordance with Section V.2 of the rule, depending on the environmental diversity, institutional factors, and cost considerations set forth in those sections.

For the purpose of determining the region of interest, environmental diversity refers to the types of water bodies available within the region (upper or lower reaches of large rivers, small rivers, lakes, bays, and oceans) and the associated physiographic units.

2. *Relationship to Present Practice.* Past practice has normally been to accept the applicant's proposed region of interest which commonly is the applicant's service areas. However, the region of interest has been smaller in some situations, and in other situations an expansion of the proposed region of interest has been required. This rule preserves that practice, but it adds

specific criteria for expansion or contraction of the initial geographic area in determining the region of interest.

3. *Need for Action.* The basic forces motivating the development of this rule are:

a. The necessity to protect the environment from unduly adverse environmental impacts by providing an adequate choice of candidate sites representing reasonable environmental alternatives, and

b. The realization that reasonable bounds may be placed on the search for alternative sites without compromising environmental protection.

4. *Rationale and Discussion.* The use of service areas coupled with performance criteria for expansion or contraction is judged to be sufficient to provide a substantial range of environmental alternatives from which to choose in making the final siting decision. Unlimited expansion of the areas to be searched likely would not yield significant additional new alternatives for limiting of environmental impacts that would already be present in a reasonably bounded area. As a practical matter, utilities may initiate their searches within their service areas. In many cases this will lead to the identification of the required diversity of resources. Where service areas are small, the requirement could cause an expansion that would extend the region of interest beyond the service area boundaries. However, in very large service areas, the required diversity might be found without exploring the entire service area.

The requirements may impose a need for large regions of interest in water limited areas, particularly in the western regions of the nation. The rule is intended to ensure in all cases that all reasonable alternatives have been considered. The analysis of remote alternatives need be carried only as far as necessary to demonstrate the reasons (which include costs) for not considering them further.

The rule is intended to apply to utilities having well defined service areas as well as those that do not. In situations where the State is asking the review of the alternative sites issue or where the service areas of the applicant are not defined, the State in which the proposed site is located would be the starting point for determining the region of interest.

When considering water sources that would provide adequate water availability, the staff intends that the characteristics of the terrestrial watershed (i.e., the physiographic characteristics) also be included and considered. Under this concept, a river having adequate water for a nuclear power plant but that flows through a dedicated terrestrial area such as a national park or national forest might not qualify as an acceptable resource. It is permissible, however, to designate portions of a watershed for possible siting while excluding other portions of the same watershed.

Different portions of a watershed or coastal zone may be considered to be different physiographic units, if the environmental impacts of siting in these areas would be clearly different from one another. For example, the "head waters" region of a river watershed would be designated as a physiographic unit separate from the estuarine region of the same watershed, since the impacts on fisheries and other aspects of the environment would be clearly different in the two areas. The rule is not intended to compel the consideration of water bodies that are in similar physiographic settings, since that would not add significantly to the range of environmental choice.

In emphasizing the terrestrial components the staff intends that the search for sites should not be confined to land areas immediately adjacent to water bodies but should be expanded to include a reasonable corridor of search around the water body. Siting up to several miles from a suitable water body may be desirable to avoid land use conflicts that are often found adjacent to water bodies.

The workshop participants unanimously supported the concepts of (1) environmental diversity as a determinant in bounding the region of interest, and (2) water being the principal regional determinant of environmental diversity.

D. Selection of Candidate Sites

1. *Statement of Rule.* An applicant may submit a slate of candidate sites based on either (1) a demonstration (according to criteria for site selection procedures set forth in the rule) that the site selection methodology is a reasonable, environmentally sensitive site screening process that provides a diligent search for sites that are among the best that could reasonably be found, or (2) a demonstration that the slate of candidate sites meets the prescribed environmentally sensitive threshold criteria (set forth in the rule) and are therefore among the best that could reasonably be found. The rule states that a slate of candidate sites should contain at least four sites. The rule also provides criteria for acceptance of candidate sites proposed by any party to the proceeding.

2. *Relationship to Present Practice.* Present practice is to make a determination that candidate sites identified by the applicant are "among the best that reasonably could have been found." Until recently, the NRC's review has focused primarily on the qualities of the proposed site (a product-oriented review). However, recently the NRC has expanded its review and the staff presently reviews the demonstration of this "among the best" standard by focusing on the adequacy of the applicant's site selection procedure (a process-oriented review). The rule preserves the advantages of both the process-oriented and product-oriented approaches. The rule adds criteria for implementing an adequate site selection process demonstration and evaluation, and provides the option for a product-oriented review by specifying threshold criteria for evaluating the slate of candidate sites. Most of the workshop participants believed that the applicants should be given the option to seek either a process-oriented or a product-oriented review of the slate of candidate sites.

3. *Need for Action.* The process-oriented approach codifies the elements that govern NRC reviews of the site selection process and provides guidance for the applicant's management of that site selection process. The product-oriented approach emphasizes the environmental merits of the candidate sites rather than the process that yielded these sites, and will likely be a more environmentally sensitive approach.

4. *Rationale and discussion.* The rationale for codifying the process-oriented approach is to provide guidance to all parties regarding the elements that govern NRC reviews of that process. The general rationale for the product-oriented approach is that candidate sites that pass all of the proposed threshold standards would be unlikely to have substantial, unidentified, adverse environmental impacts. Therefore, the resulting slate of candidate sites likely would be of comparable environmental quality and should be environmentally acceptable to the NRC. While there could be a situation where the proposed site could be marginal with respect to several of the thresholds and thus might be inferior on a cumlative impact basis, it would be unlikely that all the candidate sites would be similarly inferior. Thus the proposed site's inferiority would be clearly displayed in the subsequent detailed comparison with the other candidate sites.

The rule provides that the slate of candidates sites should contain at least four sites. The reason for this is to ensure that even in regions of little diversity, there is some choice among the sites in the slate. For more diverse regions the criteria controlling how many sites would be necessary are oriented towards the diversity of environmental qualities presented, so as to give a meaningful environmental comparison of alternatives. The candidate sites would be required to be reasonably representative of all of the major diverse environmental qualities present in the region of interest, as follows:

a. Major types of water sources.

b. Major physiographic units.

c. Consideration of sites of existing electric generating facilities as well as new sites.

As an example of acceptable diversity, if a new site on a lake in a woodland area was already identified as a candidate site, a woodland site on another lake within the region of interest would not be required, unless that site also hosts an existing electric generating facility.

One of the positions adopted by the public workshop on alternative sites is that public participation in the siting process would be enhanced if parties other than the applicant were permitted to propose additional candidate sites for consideration, but that the criteria proposed for acceptance of such sites should be no more stringent than those which the applicant's sites must meet. Criteria are proposed for the acceptance of such a site that are essentially the same criteria that the applicant's sites must meet in establishing the original slate of candiates.

In addition, the proposed rule imposes time limits for proposing additional candidate sites. The time limits are a key element in achieving a timely evaluation of the alternative sites issue and, except upon a substantial showing of good cause, will not be extended.

E. Comparison of the Proposed Site With Alternative Sites

1. *Statement of Rule.* A proposed site that comes from a slate of candidate sites that are among the best that could reasonably be found will not be rejected by the NRC on the basis of the alternative site review unless a comparison with the alternative sites results in a determination that an obviously superior alternative exists. There will be a two-part, sequential test for obvious superiority. The first stage of the test will be to determine whether there is an environmentally preferred site. The second stage of the test will consider economics, technology, and institutional factors to determine whether any environmentally preferred site is obviously superior to the proposed site.

2. *Relationship to Present Practice.* Present staff practice does consider the range of factors that would be addressed by the proposed rule.

3. *Need for Action.* This proposed element of the rule will provide a more stable structure for the procedural aspects of how environmental factors should receive consideration and how these factors should be balanced with non-environmental factors to determine obvious superiority.

4. *Rationale and Discussion.* The criteria for testing the proposed site against the alternative sites comes from past practice, as reflected in individual nuclear power plant licensing reviews.

F. Reopening of the Alternative Site Decision

1. *Statement of Rule.* a. A reopening and reconsideration of the alternative site decision after a final limited work authorization or construction permit decision will be permitted only upon a reasonable showing that there exists significant new information that could substantially affect the earlier decision. Any decision to reconsider the alternative sites decision or not in these instances will consider the reasonable costs of delay and of moving to another site compared with the adverse environmental impacts that might be avoided by moving to another site.

b. For cases where the portion of the construction permit application containing facility design is filed three years or more after the effective date of this rule and where an application for an early review of alternative sites was tendered at least two and a half years prior to filing the portion of the CP application containing detailed facility design information, any reconsideration of the alternative site decision will be permitted only upon a reasonable showing that there exists significant new information that could substantially affect the earlier decision, even when allowance is made for reasonable costs of delay and of moving to another site. If such an application was not made at least two and a half years prior to filing such portion of the CP application, costs of delay and of moving to another site will not be considered in any decision to reconsider the alternative site decision or not, or in any resulting decision that there is or is not an obviously superior site.

c. If two sites are reasonably within a region of interest for a nuclear power plant site and both sites have received an affirmative NRC partial decision in an early review of alternative sites, an applicant may choose either site for an application to construct a specific nuclear power plant without reviewing the alternative site question, except on the basis of new information, as provided above.

2. *Relationship to Present Practice.* The proposed rule is generally consistent with present criteria regarding treatment of new information under the early-site-review rule, and would result in consistent criteria for the treatment of new information regarding alternative sites at the construction permit and operating license stages.

The treatment of forward costs associated with moving to another site (including costs of delay) prescribed in this element of the proposed rule would generally codify a practice that has evolved, except that it would preclude the consideration of costs of moving to another site if the applicant did not seek an early resolution of the alternative site question.

3. *Need for Action.* This proposed element of the rule will provide for consistent treatment of new information regarding alternative sites througout the licensing process.

4. *Rationale and Discussion.* The rationale for this element of the proposed rule is that after a decision has been reached regarding the alternative site question, during either an early site review or a CP review, the applicant (or licensee) will logically begin committing greater resources to that site. While such commitments are clearly at the applicant's risk, it is logical to allow the inclusion of such costs in any subsequent cost-benefit analyses, since such investments would have been made by the applicant in good faith.

Therefore, while it is possible that a reversal of the previous decision could be made based on new information (which is a risk the applicant or licensee must run), any reconsideration of the question of alternative sites and the cost-benefit analysis supporting any reversed decision should normally permit the full accounting of all reasonable forward costs to develop the new site (including costs of delay) compared to the reasonable forward costs of completing the project at the previously approved site.

At some point after issuance of the CP, the alternative of siting the nuclear power plant elsewhere likely will no longer be a reasonable alternative for the purposes of NEPA. That is, there is a point where comparative forward costs and the temporal proximity to the provision of needed (or desirably substitutable) power so favor the partially constructed site that, there likely is no real possibility that the nonsafety-related considerations at an rnative site would be obviously erior to the proposed site. At that it, the reconsideration of alternative s likely would not be required, ss the proposed site has been ged unsuitable for some safety or ironmental reason.

orward costs also could become stantial after an early site review ision, particularly as the time for a decision approaches. This means a reevaluation of alternative sites r an early site review decision likely ld not be justified on the basis of a cost-benefit analysis unless there is, example, a determination that the al use of the site (rating and number nits) would be greater than had been luated earlier, or that firm and major nges in land or water use or changes gal requirements involving the ection of species or resources have urred since the previous evaluation. unlikely that changes in the diction of environmental impacts ld be so great as to warrant a re- ew of the alternative sites decision hat basis alone.

he rationale for the third criterion of portion of the proposed rule is that o sites in the same general region of rest had been evaluated in separate ews and neither had been found to an obviously superior alternative, it is likely that neither would be iously superior to the other.

rsuant to the Atomic Energy Act of , as amended, the Energy rganization Act of 1974, and section f title 5 of the United States Code, ce is hereby given that adoption of following amendments to 10 CFR 2, 10 CFR Part 50, and 10 CFR Part contemplated. All interested ons who desire to submit written ments should send them to the etary of the Commission, U.S. lear Regulatory Commission, ntion: Docketing and Service ch, Washington, D.C. 20555 by June 80. Copies of comments received be available for public inspection at Commission's Public Document m at 1717 H Street, NW., hington, D.C.

03 [Amended]

It is proposed that § 2.603(a) be nded by adding at the end thereof ollowing:

) * * * Where an applicant has failed e the notice of intent required by endix A of 10 CFR Part 51, the ication shall be docketed in rdance with the provisions of that ndix.

§ 2.605 [Amended]

2. It is proposed that § 2.605(a) be amended by adding at the end thereof the following:

(a) * * * Where an application has been filed pursuant to Appendix A of 10 CFR Part 51 for an early alternative site evaluation separate from other early site review issues, the alternative site evaluation shall not be considered a review for purposes of this one review limitation.

Appendix Q [Amended]

3. It is proposed that the numbered paragraph 1. of Appendix Q of 10 CFR Part 50 be amended by inserting between the first and second sentence thereof the following:

"As a part of an early site review, either in conjunction with or separate from the consideration of other early site review issues, a person may submit a request for a review of the alternative site issue and for issuance of a Staff Site Report concluding that there is no obviously superior alternative to the proposed site. If the person requests an early alternative site review separate from the consideration of other early site review issues, the person may later submit other siting issues for an early site review during the effective period of the Staff Site Report on the alternative site issue, provided that any later early site review of other issues shall remain in effect only so long as the initial Staff Site Report on alternative sites remains effective."

4. It is proposed that the numbered paragraph 3. of Appendix Q of 10 CFR Part 50 be amended by adding at the end thereof the following:

"Where a person has failed to file the notice of intent required by Appendix A of 10 CFR Part 51, the request for review shall be acted upon in accordance with the provisions of that appendix."

5. It is proposed that the numbered paragraph 5 of Appendix Q of 10 CFR Part 50 be amended by deleting the last sentence thereof and substituting the following:

"The conclusions of the Staff Site Report will be reexamined by the staff where five years or more have elapsed between the issuance of the first Staff Site Report and its incorporation by reference in a construction permit application."

6. It is proposed that the first sentence of the numbered paragraph 7. of Appendix Q of 10 CFR Part 50 be amended by adding at the end thereof the following:

"However, if a person, pursuant to Appendix A of 10 CFR Part 51, has submitted a request for an early alternative site review separate from other early site review issues, the alternative site review shall not be considered a review for purposes of this one review limitation."

7. It is proposed that a new Appendix A be added to 10 CFR Part 51 to read as follows:

Appendix A.—Evaluation of Alternative Sites for Nuclear Power Plants

I. Introduction and Scope

This appendix sets forth procedures and performance criteria for the review of alternative sites for nuclear power plants under NEPA. Specifically, this appendix provides for (a) information requirements for applying for an alternative site review by the Commission, (b) timing of Commission review, (c) region of interest to be considered in selecting sites, (d) criteria for the selection of sites, (e) criteria for comparing a proposed site with alternative sites, and (f) requirements for reopening an alternative site decision.

The basic objectives of this appendix are:

1. To provide for more effective public participation by implementing procedural changes that (a) require early notification of the public as to an applicant's choice of a proposed site and its alternatives, (b) permit an early review of the alternative site question apart from other early site review issues, and (c) provide explicitly for consideration of candidate sites proposed by other parties that meet certain criteria and are proposed in a timely fashion; and

2. To provide for greater predictability in the licensing process by codification of present practice that (a) prescribes criteria for determining when a region of interest of sufficient size has been considered, (b) prescribes criteria for judging whether candidate sites are among the best that could reasonably be found, (c) prescribes the basic standards for comparing the proposed site to the alternatives sites, and (d) provides criteria for reopening the alternative site question after a previous NRC decision has been rendered on this subject.

The nuclear power plants referred to in this appendix are those facilities which are subject to § 51.5(a) of this chapter and are of the type specified in § 50.21(b)(2) or (3) or § 50.22 or are testing facilities. The submittal for review and evaluation of alternative sites shall be made in the same manner and in the same number of copies as provided in § 50.30(a), (c)(1), and (c)(3) for license applications.

II. Definitions

As used in this appendix,

1. "Region of interest" means the geographic areas considered in searching for candidate sites.

2. "Candidate sites" means those sites that are within the region of interest and are considered in the comparative evaluation of sites for a nuclear power plant and are judged to be among the best that can reasonably be found for the siting of a nuclear power plant.

3. "Proposed site" means the candidate site submitted to the NRC by the applicant, or a person requesting an early review pursuant to Appendix Q of 10 CFR Part 50, as the proposed location for a nuclear power plant.

4. "Alternative sites" means those candidate sites which are specifically compared to the proposed site to determine

whether there is an obviously superior alternative site.

5. "Slate of candidate sites" means the group of candidate sites comprised of the proposed site and all alternative sites.

6. "Environmentally preferred alternative site" means an alternative site for which the environmental impacts are sufficiently less adverse than for the proposed site that environmental preference for the alternative site can be established.

7. "Site" means the geographic area needed for the construction and operation of a nuclear power plant, including the associated transmission corridors to the first intertie.

8. "Reconnaissance level information" means any information or analyses that can be retrieved or generated without the performance of new, comprehensive site-specific investigations. Reconnaissance level information includes relevant scientific literature, reports of government or private research agencies, consultation with experts, short-term field investigations, and analyses performed using such information. The amount of reconnaissance level information and the extent of analyses conducted depend on (1) the importance and magnitude of the potential impact under evaluation and (2) whether the decision is one of identifying a region of interest, identifying candidate sites, or selecting a proposed site.

9. "Partial decision on alternative sites" means a partial decision pursuant to § 2.101 and Subpart F of 10 CFR part 2 that includes a finding that there is or is not an obviously superior alternative to the proposed site.

10. "Applicant" means a person who intends to apply, or who has applied, for a permit to construct a nuclear power plant.

11. "Notice of intent" means a notice that an application will be tendered for a construction permit for a nuclear power plant.

12. "NRC" means the Nuclear Regulatory Commission, the agency established by Title II of the Energy Reorganization Act of 1974, as amended.

13. "NRC staff" means any NRC officer or employee or his/her authorized representative, except a Commissioner, a member of a Commissioner's immediate staff, an Atomic Safety and Licensing Board, an Atomic Safety and Licensing Appeal Board, a presiding officer, or an administrative law judge.

III. Information Requirements

1.a. An applicant shall provide the NRC staff with a notice of intent to tender an application for a construction permit (CP) for a nuclear power plant either at least 3 months before tendering of a CP application requesting an early review (pursuant to § 2.101 and Subpart F of 10 CFR Part 2) of the alternative sites issue or at least 3 months before beginning detailed studies on environmental impact and site safety at the proposed site, whichever occurs earlier. The notice of intent shall identify the location, cooling water sources, and physiographic unit of the proposed and alternative sites, and shall describe the anticipated generating capacity and number and type of generating units for which a CP application will be tendered, and types of condenser cooling systems that would be used.[1]

Upon receipt of the notice of intent, the NRC will publish the information received in the **Federal Register** and in the newspapers local to the sites identified.

If an applicant fails to provide a notice of intent within the time specified, the NRC will not docket the tendered application for 3 months where no detailed studies of the proposed site have been performed or for 12 months where such studies have been performed. As soon as practicable after tendering, the NRC will publish the above specified information in the **Federal Register** and in the newspapers local to the sites identified.

b. A person requesting an early review of the alternative sites issue pursuant to Appendix Q of 10 CFR Part 50 shall provide the NRC staff with a notice of intent to submit such request at least 3 months before submitting the request for review or at least 3 months before beginning detailed studies of the proposed site, whichever occurs earlier. The notice of intent shall identify the location, cooling water sources, and physiographic unit of the proposed and alternative sites, and shall describe the generating capacity, number and type of generating units, and types of condenser cooling systems anticipated or assumed to be used.

Upon receipt of the notice of intent, the NRC will publish the information received in the **Federal Register** and in the newspapers local to the sites identified.

If the person requesting the review pursuant to Appendix Q to 10 CFR Part 50 fails to provide a notice of intent within the time specified, the NRC will not initiate the review for 3 months where no detailed studies of the proposed site have been performed or for 12 months where such studies have been performed. As soon as practicable after receiving the request for review, the NRC will publish the above specified information in the **Federal Register** and in newspapers local to the sites identified.

2. Reconnaissance level information shall normally be adequate to identify candidate sites and to select a proposed site in an alternative site analysis. In the identification of candidate sites or selection of the proposed site, the amount of data required and the extent of analyses conducted shall be appropriate to support a reasoned decision.

In some cases, reconnaissance level information may not be sufficient to support the analyses necessary to reach a reasoned decision. In these situations, new comprehensive site-specific investigations must be considered. For example, if substantial questions exist regarding the likely acceptability of a site from a geologic standpoint, substantial geotechnical investigations might be required. Also, if substantial questions exist regarding wheth a large adverse impact will occur to an important aquatic species, long-term baseli studies will be considered. The NRC staff w advise the applicant of any additional information requirements as early as practicable.

3. Where a party to a proceeding propose for consideration (according to Section VI.4 of this appendix) a candidate site not included in the applicant's slate of candida sites, it is the responsibility of that party to provide adequate information to support a decision to accept the site or not. If the site accepted as a candidate site, it is the responsibility of the applicant in the proceeding to provide the information necessary to make the final comparison of that site with the proposed site.

4. Alternative site analyses of both the identification of the slate of candidate sites and the selection of the proposed site shall, a minimum, address the following subjects:

a. hydrology, water quality, and water availability

b. aquatic biological resources, including endangered species

c. terrestrial resources and land uses, including endangered species

d. transmission corridors (approximate length and general location) and resources affected

e. socioeconomics, including aesthetics, and archeological and historic preservation

f. population distribution and density[2]

g. facility costs

h. institutional constraints, as they affect site availability

i. public concerns in the above subject areas, where such have been provided to th applicant or NRC in writing.

IV. Timing of NRC Review

1. An applicant may submit the proposed and alternative sites for NRC evaluation as part of a full CP review either prior to and separate from the review of plant design (an early site review) or in conjunction with the review of plant design.

2. As part of an early site review, an applicant that tenders an application for an alternative site review and requests a findin that there is not obviously superior alternative to the proposed site may do so either in conjunction with or separate from the consideration of other early site review issues. If the applicant applies for an early alternative site evaluation separate from the consideration of other early site review issues, the applicant may later submit other siting issues for an early site review during the effective period of the early alternative site partial decision, provided that any later early site review of other issues shall remai in effect only so long as the initial early site review of alternative sites remains effective.

V. Region of Interest

1. The initial geographic area for determining the region of interest for NRC regulatory review purposes shall be (a) the State in which the proposed site is located o (b) the service areas of the applicant. The

[1] For situations where, on the effective date of this rule, a future applicant has already begun or is about to begin detailed, long-term investigations on a site likely to be proposed subsequently to the NRC as a site for a nuclear power plant, such a future applicant must provide a notice of intent within three months following the effective date of this rule.

[2] This requirement will be modified as appropriate to conform to revisions to 10 CFR Part 100.

actual region of interest must be larger than the initial geographic area according to 3. below, or may be smaller than the initial geographic area according to 2. below.

2. The region of interest may be smaller than the initial geographic area, if (a) environmental diversity is not substantially reduced and candidate sites within the region of interest meet threshold criteria described in Section VI.2.b. of this appendix, or (b) costs of generating electricity would be exorbitant for sites located in those areas not included, or (c) siting in those areas not included would be in violation of State laws governing nonradiological health and safety aspects of utility siting, or (d) the costs would be exorbitant of developing information to demonstrate whether sites within those areas not included would likely be acceptable from the standpoint of safety.

3. The region of interest must be greater than the initial geographic area if environmental diversity would likely be substantially increased and if (a) candidate sites within the initial geographic area meet the threshold criteria in Section VI.2.b. of this appendix, and the development of sites in the added geographic areas would likely not substantially increase costs, or (b) candidate sites within the initial geographic areas do not meet threshold criteria in Section VI.2.b., and the development of sites in the added geographic areas would not require exorbitant costs.

4. For the purpose of determining the region of interest, environmental diversity refers to the types of water bodies available within the region (upper or lower reaches of large rivers, small rivers, lakes, bays, and oceans) and the associated physiographic units. A substantial increase or decrease in diversity would occur whether the region of interest includes or excludes such a water body. In areas of critical water supply, ground water and waste water are also appropriate water sources for diversity considerations.

VI. Selection of Candidate Sites

1. The candidate sites used in the subsequent site-specific comparison of alternatives must be one of the following:

a. Be identified through the use of a site selection methodology that (1) includes an environmentally sensitive site screening process (i.e., considers the same environmental parameters that are addressed by the criteria in VI.2.b., although not necessarily in the same way) resulting in a slate of candidate sites that are among the best that could reasonably be found and (2) meets the criteria presented in VI.3. below; or

b. Meet the criteria presented in VI.2. below, in which case there shall be no further review of the site selection process.

2. a. A sufficient number of candidate sites, which should include at least four sites, shall be selected from the region of interest to provide reasonable representation of the diversity of land and water resources within the region of interest. One or more of these sites should be associated with each type of water source and physiographic unit reasonably available within the defined region of interest, and one alternative site must have the same water source as the proposed site.

b. Except as noted in 2.c.(1), a site must meet the following criteria to be accepted as a candidate site without further review of the site selection process. (Technically appropriate and economically reasonable cooling system mitigative measures may be assumed for each candidate site.)

(1) Consumptive use of water would not cause significant adverse effects on other water users.

(2) There would not likely be any further endangerment of a State or Federally listed threatened or endangered plant or animal species.

(3) There would not likely be any significant impacts to spawning grounds or nursery areas of significance in the maintenance of populations of important aquatic species.

(4) Discharges of effluents into waterways would likely be in accordance with State or Federal regulations (e.g., avoidance of discharges to waters of the highest State quality designation) and would not likely adversely affect efforts of State or Federal agencies to implement water quality objectives (e.g., additional discharges to waters of currently unacceptable quality as determined by a State).

(5) There would be no preemption or likely adverse impacts on land uses specially designated for environmental or recreational purposes such as parks, wildlife preserves, State and National forests, wilderness areas, flood plains, Wild and Scenic rivers, or areas on the National Register of Historic Places.

(6) There would not likely be any significant impact on terrestrial and aquatic ecosystems, including wetlands, which are unique to the resource area.

(7) The population density, including weighted transient population, projected at the time of initial operation of a nuclear power plant, would not exceed 500 persons per square mile averaged over any radial distance out to 30 miles from the site (cumulative population at a distance divided by the area at that distance), and the projected population density over the lifetime of the nuclear power plant would not exceed 1,000 persons per square mile (simularly weighted and measured).[3]

(8) The site is not in an area where additional safety considerations (geology; seismology; hydrology; meteorology; and industrial, military, and transportation facilities) or environmental considerations for one site compared to other reasonable sites within the region of interest would result in the reasonable likelihood of having to expend substantial additional sums of money (cumulative expenditures in excess of about 5% of total project capital costs) to make the project licensable from a safety standpoint or to mitigate unduly adverse environmental impacts.

c. (1) If a site does not meet one or more of the threshold criteria provided in VI.2.b., the site may be acceptable as a candidate if it can be reasonably shown that further examination of that particular type of water source and physiographic unit would not likely identify a site that would meet those same threshold criteria.

(2) If any candidate site does not meet one or more of the threshold criteria provided in VI.2.b. to such an extent that serious adverse environmental impacts would result from its use, that site should be rejected as a candidate site.

3. If the approach of VI.1.a. above is relied upon, demonstration must be made that the site selection process incorporated the following criteria:

a. The overall objectives of the siting study and all initial constraints and limitations (including the geographic area, i.e., region of interest, which is the subject of the study) shall be explicitly stated giving the basis and rationale for all choices.

b. The proposed ways of meeting the stated objectives shall be described, including the general approach to the site selection process.

c. The study shall explicitly state factors (e.g., aquatic biology) under consideration, parameters (e.g., spawning grounds and nursery areas) by which these factors were measured, and criteria (e.g., no significant impact) that define levels of achievement.

d. The site selection study shall be interdisciplinary and shall include natural, social, and environmental sciences. The range of the responsibilities of the study team shall be clearly defined and the methods employed in resolving differences within the group or of arriving at the consensus shall be explicitly stated.

e. The process that led to the identification of candidate sites including all specific methodologies shall be explicitly stated in detail.

(1) Where preemptive screening is used, all limiting or exclusionary criteria employed shall be explicitly stated, the bases for each criterion given, and the ways in which they are applied explained.

(2) Where comparative analysis is used, all methodologies used involving importance factors, preference functions, utility functions, weighting factors, ranking scales, scoring schemes, and rating systems shall be explictly described; the basis for the selection of each methodology given; and the ways in which each is applied explained.

f. The study shall contain detailed description of administrative means used to support the site selection study, including any quality assurance program commensurate with the objectives of the study and a data management system for handling technical files, maps, and other information.

g. Definitions of terms used in the study shall be included.

4. Any intervening party and the NRC staff may propose one or more additional sites for consideration as candidate sites provided that the following conditions are met:

a. The additional sites are proposed for review within 30 days after the first special prehearing conference (i.e., the conference held pursuant to § 2.751a of 10 CFR Part 2.).

b. The proposal contains a reasonable showing that the additional sites are comparable to the applicant's slate of candidate sites in their ability to meet the criteria specified in VI.2.b. and VI.2.c. and would add to the diversity which is exhibited

[3] This requirement will be modified as appropriate to conform to revisions to 10 CFR Part 100.

by the applicant's slate of candidate sites; or where the applicant's candidate sites do not meet all the criteria specified in VI.2.b. and VI.2.c., the proposal contains a reasonable showing that the additional sites will meet these criteria.

c. Where a party identifies more than one additional site, each additional site must meet one of the tests specified in VI.4.b. above.

d. The additional sites have no physical features that would likely create substantial increases in the cost of constructing and operating nuclear power plants at the additional sites compared with the applicant's proposed site, unless there is a reasonable showing that the additional sites meet a criterion specified in VI.2.b. that is not met by the applicant's proposed site.

e. Multiple parties to NRC proceedings should consult with one another prior to proposing additional sites for consideration as candidate sites in order to reasonably limit the total number submitted.

5. A presiding Atomic Safety and Licensing Board (ASLB) may on its own initiative proposed one or more additional sites for consideration as candidate sites up to 30 days after the issuance of the Draft Environmental Statement (DES). On or after the issuance of the DES, additional sites may be introduced by the ASLB, only after a balancing of the cost of delaying the proceeding against the likelihood that utilization of the additional site would avoid significant environmental harm.

6. The 30-day time limits in VI.4.a. and VI.5. above shall not be extended except upon a substantial showing of good cause.

VII. Comparison of Proposed Site With Alternative Sites

1. After it is determined by either of the above approaches that the proposed site comes from a slate of candidate sites that are among the best that could reasonably be found, the NRC will not reject the proposed site solely based on its review of the alternative sites unless a comparision with the remaining candidate sites results in a determination that an abviously superior alternative exists. The NRC will determine obvious superiority among the candidate sites by a sequential two-part analytical test. The first part gives primary consideration to hydrology, water quality, aquatic biological resources, terrestrial resouces, water and land use, socioeconomics, and population [4] to determine whether any alternative sites are environmentally preferred to the proposed site. The second part overlays consideration of project economics, technology, and institutional factors to determine whether, if such a environmentally preferred site exists, such a site is, in fact, an obvioulsy superior site.[5] The following factors are considered in this second part of the test:

a. The environmental and safety [6] considerations in terms of technology and costs of construction and operation of nuclear power plants at the sites.

b. The forward costs [7] at the proposed site compared to the alternative sites.

c. Other considerations, such as possible institutional barriers. The applicant's proposed site will be rejected solely based on NRC review of alternative sites only when the NRC determines that, considering both parts of the test, there is an environmentally preferable alternative which also is obviously superior, i.e., the NRC is confident that the applicant's proposed site should be rejected.

2.a. If an obviously superior alternative site is identified and the proposed site is rejected by the NRC, and if the applicant submits a new application naming the identified obviously superior site as the newly proposed site, the NRC will not require review of the alternative site question for the newly proposed site, provided that the previous slate of candidate sites had been determined to be acceptable by the criteria established in this rule.

b. If more than one obviously superior alternative site is identified and the proposed site is rejected by the NRC, the applicant may request that a further finding be made in that proceeding to determine whether one of those sites is obviously superior to the others. If that finding is made and one of those sites is obviously superior to the others and the applicant submits the obviously superior site as the new proposed site, the NRC will not require review of the alternative sites question for the newly proposed site, provided that the previous slate of candidate sites had been determined to be acceptable by the criteria established in this rule. If that finding is made and none of those sites is obviously superior to the others, the applicant may propose any of the obviously superior alternative sites for review as permitted according to 2.a. above.

c. If one or more obviously superior sites are identified and the proposed site is rejected by the NRC, the applicant may submit a new proposed site that is comparable to the obviously superior sites in its ability to meet the criteria specified in Section VI.2.b. Where a new site is proposed, appropriate public notice of intent is provided, and a showing of comparability in meeting the criteria is made, the NRC will only require that the sequential two-part analytical test for obvious superiority be performed on the new proposed site and on the sites found obviously superior in the earlier proceeding.

VIII. Reopening of the Alternative Site Decision

1. A reopening and reconsideration of the alternative site decision after a final limited work authorization or construction permit decision will be permitted only upon a reasonable showing that there exists significant new information that could substantially affect the earlier decision. Any decision to reconsider the alternative site decision or not in these instances will take into account preliminary estimates of the reasonable costs of delay and of moving to another site compared with the adverse environmental impacts that might be avoided by moving to another site.

2. For cases where the portion of the construction permit containing facility design is filed three years or more after the effective date of this rule and where an applicant submits the proposed and alternative sites for NRC evaluation as part of a full construction permit review at least 2½ years prior to filing the portion of the construction permit application containing detailed plant design, any reconsideration of the alternative site decision will be permitted only upon a reasonable showing that there exists significant new information that could substantially affect the earlier decision, as described in VIII.1. above. If the proposed and alternative sites were not submitted for NRC evaluation as part of a full construction permit review at leat 2½ years prior to filing the portion of the construction permit application containing the plant design, costs of delay and of moving to another site will not be considered in any decision to reconsider the alternative site decision or nót or in any resulting decision that there is or is not an obviously superior site.

3. If two sites are reasonably within a region of interest for a nuclear power plant site and both sites have received an affirmative NRC partial decision on an early review of alternative sites, an applicant may choose either site for an application to construct a specific nuclear power plant without reviewing the alternative site question, except on the basis of new information as provided in VIII.2. above.

(Sec. 161 h., i., o., Pub. L. 83–703, 68 Stat. 948 (42 U.S.C. 2201 (h), (i), and (o)); Sec. 102, Pub. L. 91–190, 83 Stat. 853 (42 U.S.C. 4332); Sec. 201, as amended, Pub. L. 93–438, 88 Stat. 1242; Pub. L. 94–79, 89 Stat. 413 (42 U.S.C. 5841))

Dated at Washington, D.C., this 4th day of April 1980.

For the Nuclear Regulatory Commission.

Samuel J. Chilk,

Secretary of the Commission.

[FR Doc. 80-10807 Filed 4-8-80; 8:45 am]

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[4] This requirement will be modified as appropriate to conform to revisions to 10 CFR Part 100.

[5] In applying both parts of the test, the NRC will give consideration to the inherent uncertainties of cost-benefit analysis techniques and, where applicable, to the disparity in the data base between the proposed and alternative sites.

[6] There are some site safety issues for which a cost-effective means for successful mitigation is not state-of-the-art engineering. For the purposes of alternative site analysis, these site safety issues are considered in terms of site acceptability, i.e., where successful mitigation is considered outside the state of the art, the site would be considered unacceptable. However, where the mitigation of the safety issues are considered to be within the state of the art, the site would be considered acceptable but still must undergo the comparative test, which includes the impact of the mitigation on overall project cost, to determine whether there is an obviously superior alternative. Even though the proposed site successfully passes the early evaluation of alternative sites, it could still be found unacceptable in the later detailed safety review of that site.

[7] For cases where the portion of the construction permit application containing facility design is filed 3 years or more after the effective date of this rule, and an early site review application for the review of alternative sites had not been filed at least 2½ years earlier, the costs of moving to another site, including costs of delay, will be given no weight in any consideration of alternative sites or in any decision whether to reopen a previous decision on this subject.

APPENDIX L

ALTERNATIVE SITES

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TABLES

APPENDIX L

ALTERNATIVE SITES

INTRODUCTION

This appendix compares the proposed CRBRP site with seven candidate alternative sites in the context of the Commission's proposed rule on alternative sites (see Appendix K and Section 9.2.4 of this document). Four of the alternative sites are controlled by the Tennessee Valley Authority (TVA) and are within its power service area: Hartsville, Murphy Hill, Phipps Bend, and Yellow Creek (see Figure A9.1). The other three are under the jurisdiction of the Department of Energy (DOE) and are located elsewhere in the country: Hanford (WA), Idaho National Engineering Laboratory (INEL)(ID), and Savannah River (GA).

A brief description of each site is given, followed by a discussion of the following specific parameters: geology and seismology, hydrology (including water use), water quality, meteorology, aquatic ecology, terrestrial ecology (including land use), socioeconomics, population density, and nearby industrial, military, and transportation facilities. In the context of this analysis, the parameters considered include the following factors or characteristics:

Geology and Seismology--topography, surficial and bedrock geology, regional geology and seismicity.

Hydrology--water availability, flood potential, floodplain encroachment, distance to nearest downstream offsite water user that could be affected by release from the plant, potential water use within 50 miles downstream, river flow available for dilution, and groundwater transport.

The threshold criteria used to evaluate water availability is that the body of water on which the site is located have a once-in-20 year, 30-day low flow rate which is 20 times or more than the evaporative water loss caused by the plant. Because of its small size, the water loss of the CRBRP is small compared to most commercial nuclear plants. The consumptive water use by the plant is about 8 cfs, so the threshold flow rate for the alterntive sites is about 160 cfs. Most rivers in the Tennessee Valley would have an adequate water supply because of the extensive regulation provided by dams. Low flow statistics at most of these sites would not be meaningful because of the present regulation of the rivers. Minimum flow levels could probably be maintained at all sites by agreement on operating policy at upstream dams.

The potential for flooding at a site would dictate additional expenses to floodproof safety-related buildings. The plant buildings, or flood protection such as dikes or fill, might encroach on the 100-year floodplain, violating the intent of Executive Order 11988, "Floodplain Management."

The distance to the nearest water user, potential water use, and river flow rate available for dilution are the parameters which would bear on the environmental acceptability of effluents normally or accidentally released from the plant, although normal releases can generally be reduced to very low levels.

Aquatic Ecology and Water Quality--short-term or construction phase impacts, including those to any Federally recognized threatened or endangered species that might be present in the area as a result of site preparation, site runoff, erosion, and inriver construction activities associated with the intake, discharge, barge-unloading facility, and other dredging and filling; and long-term or operational phase impacts, including those to threatened and endangered species, as a result of impingement, entrainment, and thermal and other water quality effects on the receiving water. Further consideration was given to whether the discharge of effluents would require abnormal mitigative controls to comply with state and Federal regulations, or would otherwise adversely affect the efforts of state and Federal agencies to implement water quality objectives.

Meteorology--diffusion conditions (wind speed and direction, atmosphere stability) and extreme storm conditions (tornadoes).

Terrestrial Ecology and Land Use--effects on flora and vegetation, fauna, and existing and proposed uses of the land. These include possible threatened and endangered species on the site and areas specifically designated for environmental or recreational uses. Transmission lines to the sites were not reviewed in detail because none of them is likely to have significantly less environmental impact than at the Clinch River site. As indicated in FES Section 3.8, about 0.5 mile of new right of way would be cleared on site and 2.7 miles of existing right of way would be widened to accommodate the two 161-kV transmission lines that would connect the CRBRP to the TVA grid; this would affect the biota on about 58 acres of land.

Socioeconomics--displacement or disruption of onsite archeological, historic, scenic, recreational, and cultural resources; displacement of residential and economic activities; anticipated points of vehicular congestion caused by construction worker or truck traffic to and from the site; visual intrusion of station structures in offsite areas; and size and availability of the labor pool. Construction labor in sufficient quantity and within commuting distance has implications for labor migration and consequent demands on community infrastructure (that is, labor inmovement, as distinguished from commutation, is directly related to pressures on community facilities and services) and implications for regional labor shortages. For the alternative site analysis, the staff uses regional availability of labor as a gross indicator of the potential for community-level impacts. To estimate the potential labor pool for each site, 1970 census data were used to determine the percentage of construction workers in the counties within 50 miles of each site. This figure was then applied to 1985 population projections (derived using 1980 and 1990 projections and compound growth rates) to arrive at a labor pool estimate.

Population Density--the total populations within several radial distances out to 30 miles from each site and the average population densities within those distances determined from 1980 census data; projections of similar information for the years 1990 (planned year of plant startup) and 2030 (after end of plant life).

Nearby Industrial, Transportation, and Military Facilities--large industrial activities representing fixed sources of explosive or toxic materials; transportation routes in the vicinity such as railroads, highways, and waterways which may carry explosive or toxic shipments; airports within 5 miles and airline routes; and military installations and activities.

Relative Cost To Make the Project Licensable

While information is presented here on geology and seismology, meteorology, hydrology (water availability and flooding potential), and nearby industrial, military, and transportation facilities and activities which might affect a nuclear plant, these are matters considered elsewhere as site suitability aspects of safety. All of these candidate sites have been judged (Section 9.2.4.1) to meet criterion (8) in Section VI.2.b. of the Commission's Proposed Rule on Alternative Sites (Appendix K). That criterion indicates that the site should not be in an area where additional safety considerations or environmental considerations for one site compared to other reasonable sites would require the expenditure of substantial additional sums of money (cumulative expenditures in excess of about 5% of total project capital costs to make a project licensable from a safety standpoint or to mitigate unduly adverse environmental impacts). However, for this environmental comparison of alternative candidate sites to the proposed site, the staff also makes a qualitative comparison to determine whether these considerations are likely to require the expenditure of significantly different sums of money to make the project licensable at those sites.

Because TVA has "deferred" further construction of the nuclear units that were being built at the Hartsville (four units), Phipps Bend (two units), and Yellow Creek (two units) sites rather than cancelling them, the staff assumed for the purpose of this review that those units will someday be completed. Furthermore, the CRBRP could not be placed on the foundations and structures already in place because of substantial differences in design. The staff has therefore assumed that the CRBRP could be constructed on a previously undisturbed portion of each of those TVA sites, except Murphy Hill. That is probably not possible at Murphy Hill because a proposed synfuel plant would occupy most of the site. Therefore Murphy Hill is considered a surrogate for sites in that general area.

The evaluations in this analysis are based on a combination of literature review, site visits, and map analysis. Table L.1 at the end of this appendix presents a summary of the staff's conclusions.

The TVA sites are discussed first, followed by the DOE sites. Within each grouping, sites are discucsed in alphabetical order.

1 TVA SITES

1.1 Hartsville

The Hartsville site is on the north shore of the Old Hickory Reservoir, at Cumberland River Mile 285, in Smith and Trousdale Counties in north-central Tennessee. It is about 5 miles southeast of Hartsville and 40 miles northeast of Nashville. The site consists of 1400 acres of rolling terrain, with surface elevations ranging from 460 to 560 ft msl. The surrounding land is used predominantly for agriculture and forest development. Four 1205 MWe nuclear generating units are partially constructed at this site. The coordinates are 36°21'15" latitude, 86°05'10" longitude.

1.1.1 Geology and Seismology

The Hartsville site is in the Central Stable Region Tectonic Province, which is a region in which a veneer of Paleozoic sedimentary rocks overlie crystalline rocks that have been deformed into arches, domes, and basins by Paleozoic tectonic activity. The controlling earthquakes for the site are based on the postulated occurrence of an MMI VII-VIII earthquake near the site and an MMI XI earthquake 110 miles from site. The proposed safe shutdown earthquake (SSE) for the LMFBR demonstration plant (0.25 g anchoring the Regulatory Guide 1.60 spectrum) is adequate for vibratory ground motion expected for these events.

The site is on rolling topography at elevation 545 ft msl. From 10 to 20 ft of residual silts and clays overlie bedrock. Rock at the site consists of thin bedded or argillaceous limestone and thick bedded limestone of the Hermitage and Carters formations, respectively. Numerous karst features not identified during earlier investigations were encountered during excavation for Hartsville Units 1 and 2.

Because of the presence of karst features, the unpredictability of their occurrence, and the inability to locate them with standard exploratory techniques, this site is considered slightly less favorable than the Clinch River site with respect to geological considerations and costs associated with licensability. Seismology-related costs would be comparable to those at the Clinch River site.

1.1.2 Hydrology

The Hartsville site has an ample water supply from the Cumberland River; the average summer flow is about 9300 cfs. While this is somewhat more favorable than the CRBRP site, because of the small amount of water required for the demonstration plant (8 cfs), water availability is a relatively insignificant issue.

Plant grade is well above (28 ft), the probable maximum flood (PMF) level of the river, and encroachment of plant features onto the 100-year flood plain would be minimal. These parameters for Hartsville are approximately equal to those for the CRBRP site.

The site is on fractured and solutioned limestone. A conservative estimate of groundwater travel time to the river is 3 years. There are no public users of groundwater who could be affected, but contaminated groundwater could mitigate to the river.

Within 50 miles of the site, there is a sizeable population, some of which uses the Cumberland River for its water supply. The nearest surface water user is 6.5 miles downstream.

A factor that can be used by the staff to estimate the approximate potential for exposing drinking water users to radioactive liquid releases was calculated by dividing the population within 50 miles by the average annual river flow rate. For the Hartsville site, this is approximately 500,000/10,000 or 50 (people-ft^3/sec), which is higher (less desirable) than the 5.8 to 1 ratio for the Clinch River site.

Overall, the hydrologic aspects of this site are approximately equal to those of the CRBRP site, including the licensing costs to ensure adequate water supply and flood protection for the plant.

1.1.2.1 Water Quality

The Cumberland River at the Hartsville site is lower in concentration of dissolved solids than is the Clinch River. The Cumberland receives only minor additions of municipal and industrial wastes upstream, and analyses show it to be of high quality. Although the Cumberland is relatively free of the stress of pollution, the river is highly regulated both upstream and downstream by hydroelectric projects; consequently periods of zero flow or even upstream flow occur.

Because of the no-flow periods, the four nuclear units at the Hartsville site were designed to use a multiport diffuser to provide rapid dilution of station discharges. The water depth at the site is about 30 ft, providing a large pool for dilution of the station discharge during the short-duration low-flow periods. Design of the discharge system to accommodate flow from four units would result in poorer mixing when a lesser number of units are operating. Therefore, an intermittent discharge at the full four-unit flow rate is proposed during unit outages to ensure that the diffuser meets design objectives with less than four units operating. To meet water quality standards during periods of zero flow in the river, station discharge would be held in a holding pond.

The State of Tennessee developed effluent criteria specifically for the four nuclear units at the Hartsville site. In the Hartsville FES the staff conjectured that the state criterion for suspended solids would be violated regularly and that limits for concentrations of metals could be violated when the evaporative cooling system was operating at high cycles of concentration. The source of the metals is not the plant but the river itself. The assessment of impact concluded that construction and operation of the four 1205 MWe units at Hartsville would result in some small, reversible localized damage to biota. Water quality impacts attributable to the 350 MWe breeder plant would be small compared to those of the Hartsville units and would not appreciably affect the findings of the Hartsville FES.

Because both the Clinch and Cumberland Rivers are characterized by occasional periods of zero flow and might require special mitigative features to protect water quality during such periods, the Clinch River and Hartsville sites are considered comparable. Both sites are on rivers of good quality where, during normal river flow, no water quality impacts would be expected.

1.1.3 Meteorology

Although diffusion conditions at the Hartsville and Yellow Creek sites are slightly better than at the Clinch River site, the staff finds them close enough to be regarded as comparable. Because the meteorological factors for the four TVA candidate sites considered in this appendix are similar, this assessment applies to all four sites. It applies also to the proposed CRBRP site.

Diffusion conditions are generally less favorable in the TVA power service area because of the relatively higher frequency of stable, low-wind-speed conditions than in other areas of the country, based on onsite or nearby onsite meteorological data. This combination of conditions would result in more conservative relative dilution (χ/Q) values being utilized in the evaluation of consequences of routine and accidental releases from nuclear plants at these sites. Light water reactors have been found to be licensable at these sites and at sites in other parts of the country with comparable χ/Q values.

The most important and severe meteorological phenomenon which impacts plant design is the tornado. Based on the guidance in Regulatory Guide 1.76, all of the TVA sites are in Tornado Region I. Locating a nuclear power plant in this region requires a tornado design to withstand the effects of a maximum wind of 360 mph, including impact loading, pressure drop, and missiles.

The staff concluded that licensing costs with respect to meteorology considerations at all of the TVA sites would be comparable to those at the Clinch River site.

1.1.4 Ecology

1.1.4.1 Aquatic Ecology

An LMFBR demonstration plant at the Hartsville site would withdraw water from the Old Hickory Reservoir of the Cumberland River for the closed-cycle cooling system. In support of its application for the Hartsville Nuclear Plants construction permit, TVA studied fishes near the site during 1972-1974. The most abundant species were gizzard shad, carp, and bluegill. Sunfish, black and white crappie, sauger, buffalo, and freshwater drum were also common (NRC, 1975). Based on the density of larval fish in the Cumberland River adjacent to the site, the major fish spawning activity during 1974 extended from late April to mid-August. The most abundant larval taxa taken were clupeids, buffalo (Ictiobus sp.) and sunfishes (TVA, 1974). Old Hickory Reservoir is considered to be a major warm-water sport fishery in Tennessee, with the important game species being crappie, large-mouth bass, bluegill, catfish, white bass, rock fish, walleye, and sauger. A commercial fishery exists on the reservoir for buffalo, catfish, and paddlefish. Some mussel harvesting also occurs periodically in the vicinity of the site.

During the fall of 1976, a river bed survey was conducted to determine the presence of Federally protected and threatened or endangered species of freshwater mussels in the vicinity of the Hartsville site. The survey found Lampsilis orbiculata, an endangered species, in a bed adjacent to the site (Isom). The proposed discharge diffuser for the Hartsville units was relocated so it would not significantly impact the mussels in the bed. No other Federally protected threatened or endangered aquatic species is known from the site or vicinity.

Several species of freshwater fish that are considered by the State of Tennessee as endangered or threatened have been taken from the Cumberland River below the falls (TWRC, 1975). However, none have been reported from the site.

The Hartsville site was evaluated for aquatic impacts from two potential siting situations: (1) an LMFBR unit on an uncleared portion of the site of the existing deferred units and (2) an LMFBR as the only unit operating on the site.

If all four of the Hartsville units are completed, an additional intake would have to be built and the resulting impacts of construction would be comparable to those at the Clinch River site. However, if one or more of the Hartsville units are cancelled, the LMFBR could probably utilize the resulting excess intake capacity. This would cause little or no impact to aquatic biota as a result of intake construction because the present intake is substantially completed. The absence of this particular construction impact would make the Hartsville site environmentally preferable relative to intake considerations.

The discharge diffuser has not been constructed for the Hartsville units and presumably it could be sized slightly larger to accommodate the additional LMFBR blowdown flow without significant incremental impact. With respect to the impact of construction of the discharge diffuser on aquatic organisms, the Clinch River site is environmentally preferable. The potential exists for adversely impacting the freshwater mussel beds at the Hartsville site during construction of the diffuser.

The Hartsville site already has a barge-unloading facility, site preparation has been completed for the licensed units, and site runoff-holding facilities are functional. Additional impacts associated with construction of the barge-unloading facility and site preparation would be minimal. Therefore, with respect to impacts on aquatic ecology from these construction activities, the Hartsville site is environmentally preferable.

In summary, the Hartsville site would be environmentally preferable with regard to construction impacts from the breeder plant on the aquatic ecology if fewer than four Hartsville units were also completed; they would be comparable to those at the Clinch River site if all four Hartsville units were completed. If no Hartsville units were completed, the proposed site would be environmentally preferable to Hartsville with regard to construction impacts.* However, construction-related impacts are temporary, largely mitigable, and can be scheduled to further minimize effects. The applicants will be required to implement an approved erosion-control plan prior to construction. Although preferability of one site over another can be established for construction-related impacts, the staff finds, based on the above, that the importance of this preferability in the evaluation of alternatives is minor.

The impacts of plant operation on aquatic biota at the Hartsville site as a result of impingement, entrainment, and the thermal plume were also analyzed.

The Hartsville intake may result in significant losses of paddlefish, *Polyodon spathula*. TVA has experienced large numbers of young-of-the-year paddlefish impinged on the intake screens of the Gallatin steam plant, which is located downstream on the same reservoir (Pasch et al., 1980). Spawning is known to occur upstream of the Hartsville site. Entrainment losses of this species may

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*These judgments are made primarily on the basis of the intake- and diffuser-related impacts.

also be a problem. Based on this potential for impact, the staff concludes that the proposed site is environmentally preferable to the Hartsville site with respect to impingement and entrainment losses under any plant configuration at the Hartsville site.

The additional thermal loading from an LMFBR at the Hartsville site if the deferred Hartsville units are also completed would not result in an adverse impact to aquatic biota inhabiting the Cumberland River. The Hartsville site was originally reviewed for four 3579 MWt units and found acceptable (NRC, 1975), whereas the thermal discharge of an LMFBR at the Clinch River site has the potential, under low- or no-flow conditions in the Clinch River, to impact striped bass that utilize that stretch of river as a thermal refuge during the late summer and and early fall (see Sections 2.7.2 and 5.3.2.2). Should studies conducted by the applicants prior to plant operation fail to conclusively demonstrate that impact to striped bass will not occur, the applicants have committed (Longenecker, 1982) to restricting the thermal discharge from the CRBRP during periods when the river water temperature is high and zero flow conditions exist. Furthermore, EPA, in the draft NPDES Permit (III.M, see Appendix H), will require that no thermal impact to striped bass occur because of plant operation. Thus the Hartsville site is considered to be environmentally comparable to the Clinch River site with respect to the potential for impact on aquatic biota as a result of thermal discharge.

The staff concludes overall that the Clinch River site is environmentally comparable or environmentally preferable to the Hartsville site under any plant configuration with respect to the impact of construction and operation on the aquatic biota inhabiting the source and receiving water bodies.

1.1.4.2 Terrestrial Resources

There are no Federal lands or natural landmarks on or near the Hartsville site. While there are approximately 13 recreation areas within 10 miles of the site, none are on site, nor are there any privately dedicated areas on or near the site. The Old Hickory Wildlife Management Area is about 10 miles east-southeast of the site.

Before construction activities for the Hartsville units began, approximately 90% of the site was used for agricultural purposes. As a result, there was little diversity of herbaceous and woody plant species, and the site did not provide a diverse wildlife habitat. Ongoing construction activities have further reduced the desirability of this site for wildlife. No Federally listed endangered or threatened species have been known to frequent the site. Before site construction activities began, eight state endangered species were observed at or near the site. None of these species appeared to be utilizing the site for nesting activities. The staff concludes that additional construction activities associated with the possible location of an LMFBR at Hartsville would not significantly affect remaining populations on this site.

Of the 90% of the site that was used as farmland, much could be classified as "prime farmland." However, with ongoing construction activities, there are no agricultural operations on the site.

Several small wetland areas on the site are primarily the result of construction activities.

Assuming that the demonstration plant is placed on an undisturbed portion of the site, Hartsville would offer no substantial advantage over the Clinch River site in terms of impacts on terrestrial resources. This judgment recognizes that the staff has already found that the terrestrial resources on the Clinch River site are not unique and that impacts on them from construction and operation of CRBRP would be small. However, if one or more of the partially constructed units is cancelled and some cleared portion of the Hartsville site becomes available, this site would be preferable in terms of impacts to terrestrial resources.

1.1.5 Socioeconomics

No cultural, scenic, or recreational areas are located at the Hartsville site.

Only one site within 10 miles of the plant site is listed in the National Register of Historic Places. It is the Tilman Dixon house ("Dixona"), built in 1788-1789 and located less than 1 mile from the site. Two additional structures of historic interest were also originally found on site. The Wright-Oldham house is a frame house dating from the mid-19th century, and the John McGee house is a two-story brick structure from the early 19th century. The McGee house was located in an area where construction of the Hartsville nuclear units has occurred.

Archeological investigation of the Hartsville site has revealed that it is a relatively rich archeological location (TVA, 1981). Thus, building a breeder reactor there in addition to one or more commercial units would likely disrupt onsite resources. The Clinch River site is preferable in this regard.

Some residents were relocated and some agricultural land was preempted before construction began on the four commercial units. The use of additional land needed on the Hartsville site to accommodate an LMFBR would not require further displacement. Therefore, Hartsville is comparable to the Clinch River site in this respect.

Tennessee Highway 25 is the main roadway that would be used by the construction force. The lack of optional roadways indicates that the Hartsville site may be subject to more traffic congestion than would occur at the Clinch River site. Thus, the Clinch River site is preferable in this regard.

Some of the construction at the Hartsville site had proceeded considerably before work was stopped. As a result, the addition of a breeder reactor would offer less visual intrusion than at the Clinch River site.

An estimated 29,674 people will be available for construction work in 1985 in the area around the Hartsville site. This figure indicates preferability of the Hartsville site over the Clinch River site (which would have an estimated 1985 work force of 22,905) in regard to labor availability.

In summary, assuming the construction of the CRBRP on the Hartsville site, either simultaneously or not during the same time frame as one of the commercial units, the staff concludes that the socioeconomic impacts at Hartsville would be comparable with those at Clinch River. This evaluation arises because Hartsville has a favorable level of regional construction labor. However, if an LMFBR were built simultaneously with more than one of the commercial units, the Hartsville site would be less desirable than the Clinch River site because the deamnds on the regional labor force would result in construction labor inmovement.

1.1.6 Population

Population totals and projections in the vicinity of the Hartsville site are as follows:

	1980		1990		2030	
Distance from site (mi)	Total population	Density (persons/ mi^2)	Total population	Density (persons/ mi^2)	Total population	Density (persons/ $mi/^2$)
0-5	2,765	35	3,110	40	5,771	73
0-10	13,160	42	14,865	47	27,521	88
0-20	69,930	56	82,335	65	262,151	209
0-30	158,266	56	185,635	66	481,129	170

Comparable data for the proposed CRBRP site* are

	1980		1990		2030	
Distance from site (mi)	Total population	Density (persons/ mi^2)	Total	Density (persons/ mi^2)	Total population	Density (persons/ mi^2)
0-5	5,713	73	6,807	87	8,925	114
0-10	56,570	180	65,322	208	84,296	268
0-20	269,870	167	209,922	167	230,996	184
0-30	521,070	184	557,522	197	624,996	221

*Includes transient population for 0-10 miles.

Although the data indicate that population densities are somewhat lower at this alternative site than at Clinch River, the staff considers the population near both sites to be reasonably low. Neither site exceeds 500 persons/mi^2 averaged over any radial distance out to 30 miles at startup nor 1000 persons/mi^2 at the end of plant life, as stipulated in Regulatory Guide 4.7 and criterion VI.2.b.(7) of the proposed rule on alternative sites (Appendix K). Therefore, neither can be termed environmentally preferable in this regard.

1.1.7 Industrial, Military, and Transportation Facilities

There are no chemical plants or other industries processing hazardous materials in the vicinity of the site. The closest industries are several manufacturing plants located in Hartsville, approximately 5 miles northwest of the site, that produce clothing, footwear, and other fabricated products. There are no military bases or activities in the vicinity of the site.

At present, there is no barge traffic past the site on the Cumberland River. Some hazardous materials, such as gasoline, are transported on a state highway approximately 4000 ft from critical plant structures. However, the expected low frequency of hazardous material shipments, plus the separation distance from the highway to critical plant structures, is adequate to ensure that these shipments will not interfere with the safety of a nuclear plant.

There are no airports within 15 miles of the site, but there are two low-level airways which intersect within 2 miles of the site. Based on data and analysis submitted by TVA, the staff previously concluded that the probability of an aircraft crashing into a reactor at the Hartsville site is acceptably low (less than about 10^{-7} year) and within the acceptance criteria of Standard Review Plan Section 2.2.3 (NUREG-0800); thus it need not be provided for in the design of the facility.

A 22-in. natural gas pipeline traverses the exclusion area approximately 2650 ft from safety-related structures. A compressor station for this pipeline is located about 3400 ft northwest of the nearest plant structure. During the CP application for the Hartsville plant, the staff reviewed TVA's analysis and concurred that this pipeline represents no undue threat to the safe operation of a nuclear plant at the Hartsville site.

The staff concluded that no significant additional expenditures would be necessary to make the breeder plant licensable at the Hartsville site in regard to this parameter.

1.2 Murphy Hill

The Murphy Hill site is located in Marshall County, Alabama, on the southern bank of Guntersville Lake on the Tennessee River, about 25 miles southeast of Huntsville and 12.5 miles northeast of Guntersville. It consists of approximately 1200 acres, most of which has been cleared for construction of a proposed coal gasification project. Because there is probably not room for both the synfuel plant and the breeder plant on this site, the staff considered it as a surrogate for similar sites in the vicinity.

The coordinates are 34°29'00" latitude, 86°10'00" longitude.

1.2.1 Geology and Seismology

The Murphy Hill site is in the southern part of the Valley and Ridge Tectonic Province. The site is on a small peninsula in Guntersville Reservoir. The peninsula is formed by a northeast elongated hill ranging in elevation from about 595 ft msl at the lakeshore to 680 ft msl at the top of the hill.

The site is underlain by limestone, siltstone, and shale of the Ordovician Chickamauga formation. Foundations will be within approximately the same stratigraphic horizon as that of the Bellefonte plant. Like Bellefonte, Murphy Hill is on the southeast flank of the Sequatchie anticline. The Sequatchie fault is on the northwest flank of the Sequatchie anticline. The fault is a major southeast-dipping, low-angle thrust fault that formed during the Paleozoic Era along with other thrust faults throughout the Valley and Ridge Province. Several solution cavities were found in borings at the site, along with a possible northwest-trending minor fault.

The Murphy Hill site is in the same tectonic province as the proposed CRBRP site; therefore, the seismic exposure is the same. Faults in the vicinity of both sites are similar in age and physical characteristics. Foundation conditions of the Clinch River and Murphy Hill sites are similar. Thus, the Murphy Hill site is considered to be equivalent to the proposed site from the standpoint of geology and seismology; the related costs of licensing would therefore be comparable to those at the Clinch River site.

1.2.2 Hydrology

The Murphy Hill site has ample water supply from Guntersville Lake on the Tennessee River. The annual average flow at the site is estimated to be 39,000 cfs, which is more than the flow at the Clinch River site. However, because of the small amount of water required for the proposed LMFBR, water availability is a relatively insignificant issue.

Plant grade is estimated to be 621 feet msl, and the PMF is estimated to be about 3 ft below plant grade. Minimal flood protection would be needed, and there would probably be little, if any, encroachment on the 100-year flood plain because of plant construction. For this parameter, the Murphy Hill and Clinch River sites are equal.

The site is located over fracture dolomite. Groundwater occurs in fractures and solution cavities and flows toward Guntersville Lake. The potential for groundwater transport of releases does not appear to be a problem, and thus is judged to be equal to the potential at the Clinch River site.

The population within 50 miles of the site is estimated to be about 500,000. The ratio of these persons, who might drink the water, to the 39,000 cfs annual average river flow is 13 to 1, which is higher (less desirable) than the 5.8 to 1 ratio at the Clinch River site. On the basis of population served and dilution of effluents, Murphy Hill is slightly less desirable than the Clinch River site.

Overall, the Murphy Hill site is considered approximately equal to the proposed site in regard to hydrology concerns. The costs to provide adequate water and flood protection for the plant would be approximately the same for the two sites.

1.2.2.1 Water Quality

Guntersville Lake has lower concentrations of dissolved inorganics than does the Clinch River, is generally of fair quality although the reach downstream of the Murphy Hill site near the dam is highly productive, and is approaching its capacity to assimiliate organic wastes. Water temperatures in the impoundment approach the Alabama maximum criterion of 30°C, and dissolved oxygen levels below the Alabama criterion of 5.0 mg/l have been observed in the site vicinity.

Although flow into and out of the   ke is regulated for hydroelectric power generation and flow past the site may be zero for as long as 12 hours at a time, longer term flows past the site are so high (the minimum daily flow is 2900 cfs, and the 7-day, 10-year low flow is 11,000 cfs) that they ensure there will be no long-term impacts on water quality from a project the site of the CRBRP. Furthermore, the Guntersville Lake provides a large volume of dilution water for reducing effluent concentrations during the short no-flow periods.

Water quality concerns in the coal gasification plant review (TVA, 1981) were principally related to the capacity of Guntersville Lake to assimilate additional organic wastes. Additional concerns were associated with potentially toxic wastes unique to the coal gasification project. Discharge of waste heat and contaminants of the type which would result from an LMFBR posed no special concerns. The combination of the large river flow relative to the CRBRP requirements and the nature of the discharges from the CRBRP ensure that the Murphy Hill site could accommodate the project without impact.

In comparison to the Clinch River site, Murphy Hill has the advantages of greater dilution flow and somewhat lesser concern over thermal impacts. However, because impacts as a result of water quality changes at the proposed site are judged to be negligible, these Murphy Hill advantages do not weigh heavily in the comparison of alternatives.

1.2.3 Meteorology

The meteorological considerations for Murphy Hill are similar to those for the Hartsville and Clinch River sites (see Section 1.1.3 above).

1.2.4 Ecology

1.2.4.1 Aquatic Ecology

An LMFBR at the Murphy Hill site would withdraw and discharge water to Guntersville Lake for the closed-cycle cooling system.

TVA studied fishes in the vicinity of the Murphy Hill site from December 1976 through November 1977. Gizzard shad, bluegill, red-ear sunfish, yellow bass, sauger, and channel catfish were the dominant species (TVA, 1981). Abundant spawning and nursery areas were found in the overbank areas, primarily associated with thick milfoil growth. Shad comprised over 90% of all larval fish taken during the survey. Sport fishing is concentrated in milfoil beds in the coves and overbank areas and is heaviest during the spring. Bluegill and red-ear sunfish comprise approximately 80% of the total catch. Some commercial fishing in the area is known (ibid).

A number of aquatic species worthy of protection are known (Freeman et al., 1979; Boschung, 1976) or suspected at the site; they are Isoetes egelmanii, a quillivort; Elodea canadensis, also an aquatic plant; and Cambarus hamulatus, a crayfish. The status of these species has not been officially recognized by the State of Alabama, and the state currently has no legislation that provides for protection of these species.

The range of 14 species of Federally recognized threatened or endangered aquatic freshwater mussels includes the Murphy Hill site. Qualitative surveys were conducted in 1977 and 1980 to determine the distribution of molluscs in the vicinity of the site. No threatened or endangered species were found (TVA, 1981).

In this assessment of the Murphy Hill site for aquatic impacts as a result of the construction and operation of an LMFBR, it was assumed that the currently planned coal gasification plant would not be built because there is probably not sufficient room on the site for both plants. It was also assumed that the LMFBR intake would be similar to that proposed for the coal gasification project: an open channel, two vertical traveling fine-mesh screens (0.5-mm openings), and a fish return system (ibid). The discharge structure was assumed to be similar to that proposed for the Clinch River site (see Section 3.4.3).

Impacts associated with construction of the intake and discharge structures at the Murphy Hill site were judged to be potentially more harmful than at the Clinch River site. The importance of the overbank area as a nursery for fishes and the occurrence of the aquatic plant I. engelmanii along the shoreline of the Murphy Hill site have the potential for some temporary impact to aquatic species. Because site runoff-holding facilities are already in place and most of the site preparation is completed at the Murphy Hill site, the staff finds the Murphy Hill site environmentally preferable with respect to these two factors.

Overall, the staff finds that the two sites are comparable with respect to impacts on aquatic biota as a result of construction of an LMFBR. However, construction-related impacts are temporary, largely mitigable, and can be scheduled to further minimize effects. The applicants will be required to implement an approved erosion-control plan prior to construction. Although preferability of one site over another can be established for construction-related impacts, the staff finds, based on the above, that the importance of this preferability in the evaluation of alternatives is minor.

The impacts on aquatic biota as a result of plant operation at the Murphy Hill site were analyzed by TVA during the preparation of the coal gasification plant impact statement (ibid). No significant impacts on aquatic biota were determined despite facility makeup flow and blowdown rates three and four times (respectively) those anticipated for an LMFBR. A properly designed intake for an LMFBR at the Murphy Hill site would result in negligible impingement and entrainment losses. This is comparable to the losses predicted for the Clinch River site.

The additional thermal loading from an LMFBR at the Murphy Hill site would not result in an adverse impact to aquatic biota inhabiting Guntersville Lake. The thermal discharge of an LMFBR at the CRBRP site has the potential, under low- or no-flow conditions in the Clinch River, to impact striped bass that utilize that stretch of river as a thermal refuge during the late summer and early fall (see Sections 2.7.2 and 5.3.2.2). Should studies conducted by the applicants prior to plant operation fail to conclusively demonstrate that impact to striped bass will not occur, the applicants have committed (Longenecker, 1982) to restricting the thermal discharge from the CRBRP during periods when the river water temperature is high and zero flow conditions exist. Furthermore, EPA in the draft NPDES Permit (III.M; see Appendix H) will require that no thermal impact to striped bass occur because of plant operation. Thus, the Murphy Hill site is judged environmentally comparable to the Clinch River site with respect to the potential for impact on aquatic biota as a result of the discharge.

The staff concludes that an LMFBR at the Murphy Hill site would be environmentally comparable to an LMFBR at the Clinch River site with respect to the impact of construction and operation on the aquatic biota inhabiting the source and receiving water bodies.

1.2.4.2 Terrestrial Resources

There are no Federal lands or natural landmarks on or near the site, and there are no state or local parks on site. Recreation developments within 10 miles of the site are: (1) Lake Guntersville State Park and Bucks Pocket State Park; (2) two local parks (ER-CP, Appendix A, A-17); and (3) one wildlife management area. No privately dedicated areas are on or near the site, nor are there any critical habitat areas on or near the site.

Of the approximately 1200 acres on the site, one-third was farmland and two-thirds forested. The most common tree species were loblolly pine, Virginia pine, chestnut oak, and shagbark hickory. At the time of the staff site visit, the site had largely been cleared for planned construction of the coal gassification facility.

The site contained a rich diversity of fauna. It is estimated (ER-CP, Appendix A) that there were 123 terrestrial vertebrate species on the site. No rare, unique, or endangered species have been observed at the site.

Parts of the open area on the site were cultivated fields and pastures (370 acres). Based on a preliminary review by the staff, some of this acreage may be classified as "prime farmland." There are no wetlands on the site.

Although most of the clearing activities have already occurred at Murphy Hill for another planned use, the staff considered placing the LMFBR on Murphy Hill as though it were on an uncleared portion of the site, or on a nearby site possessing similar terrestrial resources. From its review of reconnaissance-level information on the terrestrial resources of Murphy Hill, the staff concludes that both this alternative and the Clinch River site have terrestrial resources characteristics that are not unique or unusual for the region. Because there are no significant differences between these sites, the staff finds that neither site is preferable to the other in terms of impacts to terrestrial resources. However, if construction of the coal gasification project does not proceed, then construction on a cleared portion of the Murphy Hill site would be preferable to clearing the Clinch River site.

1.2.5 Socioeconomics

No recreation facilities exist on the site, although two state parks are located in the vicinity (TVA, 1981). No unique or unusual scenic features have been identified on the site (ibid).

No historic resources exist on the site, although the Walker Jordan cabin (the oldest existing log cabin in Marshall County) is located about 0.5 mile southeast of the site. This cabin may be eligible for inclusion in the National Register (ibid).

A 1973 archeological survey of the site revealed four archeological sites, one of which warranted further investigation. It was concluded that no adverse impacts would occur from construction (ibid).

The Murphy Hill area does not possess abundant onsite resources. It is unlikely that siting a reactor in the general vicinity would displace or disrupt these resources. This situation is comparable to the Clinch River site.

No residents are present on the property; however, about 30% of the land at the Murphy Hill site was previously classified as prime farmland (ibid). Additional land would be required to build an LMFBR here because the coal gasification project would use most of the site. As this would likely preempt farmland, the Murphy Hill site is less desirable than the Clinch River site in this regard.

Highway access to the site is from River Road, a paved two-lane county road. No main highway leads to the area (ibid) and several miles of road improvement were needed from the site to U.S. Highway 431. Heavy congestion would be expected on State Route 227, especially in Lake Guntersville State Park during during peak construction traffic hours (ibid).

There appear to be few roads linked to the remote Murphy Hill site. Construction traffic is likely to pose more problems than at Clinch River.

If an LMFBR were built close to the gasification facility, the added visual intrusion of the reactor would be less than the intrusion that would be introduced at the Clinch River site. The Murphy Hill site is therefore preferable on that basis; however, because no construction has taken place at either site, visual intrusion would be roughly comparable at the Murphy Hill and Clinch River sites.

The staff estimates a 1985 potential labor pool of 19,058 around the Murphy Hill site. This figure is less than the number of individuals in the construction industry in the vicinity of the Clinch River site. In this regard, construction of an LMFBR at Murphy Hill would be less desirable than construction at the Clinch River site.

Overall, Murphy Hill was judged to be less desirable than Clinch River in terms of socioeconomic impacts.

1.2.6 Population

Population totals and projection in the vicinity of the Murphy Hill site are as follows:

	1980		1990		2030	
Distance from site (mi)	Total population	Density (persons/mi^2)	Total population	Density (persons/mi^2)	Total population	Density (persons/mi^2)
0-5	2,508	32	3,035	39	4,655	59
0-10	8,505	27	10,294	33	15,786	50
0-20	90,192	72	109,158	87	167,403	133
0-30	240,871	85	291,522	103	447,076	158

Comparable data for the proposed CRBRP site are given in Section 1.1.6.

Although the data indicate that population densities are somewhat lower at this alternative site than at Clinch River, the staff considers the populations near both sites to be reasonably low. Neither site exceeds 500 persons/mi^2 averaged over any radial distance out to 30 miles at startup nor 1000 persons/mi^2 at the end of plant life, as stipulated in Regulatory Guide 4.7 and criterion VI.2.b.(7) of the proposed rule on alternative sites (Appendix K). Therefore, neither can be termed environmentally preferable in this regard.

1.2.7 Industrial, Military, and Transportation Facilities

The Murphy Hill site lies on a portion of the Guntersville Lake that is a navigable waterway. The 1978 barge traffic on the Tennessee River to and from Chattanooga was over 1.5 million tons.

The closest airport is a single hard-surfaced runway at Guntersville, Alabama, approximately 9 miles southwest of the site. The closest airway is about 9 miles west of the site.

The closest industrial area to the site is the Monsanto Plant 5 miles downstream. Recreational activities within a 10-mile radius of Murphy Hill are lake oriented and include boating, water skiing, fishing, and camping.

There are no pipelines or railroads within 5 miles of the Murphy Hill site. The nearest currently used road is about 1.25 miles east of the site, across a ridge 200 ft higher than the site. State Route 79 is on the opposite shoreline of Guntersville Lake, approximately 1.5 miles west of the proposed reactor site.

Assuming that the breeder plant were built on the Murphy Hill site in lieu of the coal gasification plant, the staff concluded that no significant additional expenditures would be necessary to make the breeder plant licensable in regard to this parameter. However, if both facilities were constructed in the same vicinity, further analysis would be necessary to make a determination.

1.3 Phipps Bend

The Phipps Bend site is located in Hawkins County, Tennessee, on the right bank of the Holston River, approximately 2.5 miles east of Surgoinsville and 60 miles northeast of Knoxville. Two 1220-MWe nuclear units are partially constructed on the 1270-acre site. The coordinates are 36°27'47" latitude, 82°48'32" longitude.

1.3.1 Geology and Seismology

The site is located in the southern Valley and Ridge Tectonic Province, which consists of major northeast-trending folds and east-dipping thrust faults. The site is at a bend on the Holston River at an average surface elevation of 1180 ft msl. The area is covered by 13 to 64 ft of terrace deposits and residual soil. The plant would be founded on Sevier shale bedrock of Middle Ordovician Age. Like the CRBRP site, major thrust faults, which have been shown to be at least 240 million years old, are mapped in the site vicinity. Numerous minor faults have been mapped in excavations for the Phipps Bend Units 1 and 2 sites; these have been shown to be not capable according to Appendix A to 10 CFR 100.

Because the Phipps Bend site is in the same tectonic environment as the CRBRP site and there are no significant potential foundation problems, it is considered to be equal to the CRBRP site in regard to geology and seismology and the associated licensing costs would be comparable.

1.3.2 Hydrology

The Phipps Bend site is located on the Holston River in Tennessee, which would provide adequate water for the plant. The annual average flow rate past the site is about 3600 cfs, which is the smallest for any of the TVA candidate sites. It is less favorable than the flow at the CRBRP site, but because of the small amount of water required for the proposed plant, water availability is a relatively insignificant issue.

Plant grade would be at about 1175 ft msl, which is about 65 ft above the normal floodplain of the river. The PMF level is about 1182 feet msl. Some flood protection may be necessary at the site, but probably not in the 100-year floodplain. This is the only one of the alternative sites that might need such protection, but it could probably be accomplished, if necessary, with little difficulty and expense.

The population adjacent to the Holston River within 50 miles downstream from the site is estimated to be about 59,000. The ratio of persons served to the flow rate past the site is therefore about 59,000/3600 or 16 to 1, which is higher (less desirable) than the 5.8 to 1 ratio at the Clinch River site. Most drinking water used in the region is probably groundwater; however the nearest drinking water user is about 47 miles downstream from the site. On the basis of dilution of effluents and population served, this site is slightly less desirable than the Clinch River site.

The site is located on consolidated rocks (dolomite, limestone, shale, and sandstone). Groundwater transport to the Holston River would be slow, and, as with the other sites, the transport of radioactivity through the groundwater to adjacent rivers does not appear to be a problem.

Overall, in regard to hydrology, this site is slightly less desirable than the proposed CRBRP site and a small additional cost might be involved in making the plant licensable with respect to flood protection.

1.3.2.1 Water Quality

The FES for the Phipps Bend Nuclear Plant (PBNP) (NUREG-0168) described the water of the Holston River as having a relatively low mineral content and cool temperatures but showing signs of the stresses of heavy loadings of industrial and domestic wastes. At times upstream from the plant, low dissolved oxygen concentrations occur that are primarily attributable to organic waste loadings. The maximum average monthly temperature in the river is 82°F and it occurs in July. Short duration local maxima as high as 88°F have been reported. TVA maintains a minimum average daily flow of 750 cfs in the river, in accordance with terms of an agreement with the Tennessee Eastman Company, for dilution of waste discharges.

The small river flow relative to the water requirements of PBNP causes concern over water quality in the immediate vicinity. The two 1220 MWe light water reactors at Phipps Bend will cause a localized deterioration of water quality.

However, after complete mixing of the effluent with the river flow, the net effect of the two units will be insignificant. The additional effluent from the 350 MWe breeder plant would not alter that conclusion. The only organic loading to the river from the station, including the breeder, will be the effluent from the sanitary waste treatment system. Because of the level of treatment required by the NPDES Permit, this effluent will not add to existing water quality problems.

Because the Holston River is shallow at the site, a multiple-port diffuser was designed to disperse cooling tower blowdown quickly. With the diffuser, temperature standards could be met with an acceptable mixing zone. However, the FES concluded that, even with the diffuser, stringent limits on the discharge of copper and chlorine should be imposed. The FES further concluded that, with such limitations in the NPDES Permit, the site could accommodate the two PBNP 1233 MWe units with no significant impact to water quality. The addition of the 350 MWe breeder unit would result in a larger mixing zone but, with comparable discharge limitations, it would be accommodated with still small water quality impacts.

During construction the Holston River has been very well protected from the impact of silt. Construction impacts resulting from adding the breeder probably would also be negligible.

Water at the Clinch River site is of comparable quality to that in the Holston with regard to dissolved mineral conduct and does not have the stresses of waste loadings. Because of the slightly greater depth at the Clinch River and site because of the lower flow from the smaller breeder reactor, the problem of dispersion of the discharge with river water is more easily resolved. However, during those short time periods when flow in the Clinch River is zero, water quality in the immediate vicinity of the discharge would deteriorate. Such occurrences would be infrequent, of short duration, and highly localized. Therefore, in this regard, the Phipps Bend and CRBRP sites are comparable.

With controls in the NPDES Permit for the Clinch River site that eliminate potential impacts during abnormally low flow conditions, the Clinch River site has a slight overall siting advantage with regard to water quality.

1.3.3 Meteorology

The meteorological considerations for Phipps Bend are similar to those for the sites discussed above and the Clinch River site (see Section 1.1.3 above).

1.3.4. Ecology

1.3.4.1 Aquatic Ecology

An LMFBR at the Phipps Bend site would withdraw and discharge water from the Holston River for the closed-cycle cooling system.

TVA studied fish populations within a 10-mile stretch of the river near the site in support of the PBNP construction permit application (TVA, 1976). The dominant taxa collected were gizzard shad, suckers, sunfish, and minnows (NRC, 1977). Larvae of suckers, minnows, catfishes, sunfish, perches, and shad were collected in the vicinity of the site. A creel census found that 90% of the sport harvest is sunfish and that fishing pressure is apparently low near the site. There is no commercial fishing in the vicinity of the site. The aquatic community in the Holston River near the Phipps Bend site is probably adversely affected by a number of factors, including upsteam discharges, low dissolved oxygen, and fluctuations in water level and temperature because of an upstream reservoir.

No Federally protected threatened or endangered aquatic species are known to occur in the vicinity of the site. No aquatic species taken near the site are classified as endangered or threatened by the State of Tennessee (TRWC, 1975).

The Phipps Bend site was evaluated from the standpoint of two siting situations: an LMFBR unit with the existing two deferred units completed and an LMFBR unit as the only operating unit on the site. The Phipps Bend site was compared to the preferred site with regard to impacts to aquatic biota associated with plant construction and operation.

If both Phipps Bend units are completed, an additional intake would have to be built and the resulting impacts of construction would be comparable to those at the Clinch River site. However, if one or both of the Phipps Bend units are cancelled, then an LMFBR could probably utilize the resulting excess intake capacity. This would cause little or no impact to aquatic biota as a result of intake construction because the Phipps Bend intake is substantially completed. The Phipps Bend site would then be environmentally preferable to the Clinch River site with respect to intake construction.

The discharge diffuser has not been constructed for the Phipps Bend station and presumably it could be sized slightly larger to accomodate the additional LMFBR blowdown flow without significant incremental impact. With respect to the impact of construction of the discharge diffuser on aquatic organisms, the Phipps Bend and Clinch River sites are comparable.

Site preparation has been completed for the Phipps Bend units and site runoff-holding facilities are functional. Aquatic impacts associated with additional site preparation for the breeder at the Phipps Bend site would probably be minimal; therefore, with respect to these construction activities, the Phipps Bend site is environmentally preferable to the Clinch River site.

Overall, the Phipps Bend site was found to be environmentally preferable with respect to construction impacts to aquatic biota whether both Phipps Bend units are completed or not. However, construction-related impacts are temporary, largely mitigable, and can be scheduled to further minimize effects. The applicants will be required to implement an approved erosion-control plan prior to construction. Although preferability of one site over another can be established for construction-related impacts, the staff finds, based on the above, that the importance of this preferability in the evaluation of alternatives is minor.

The impacts on aquatic biota of plant operation at the Phipps Bend site as a result of impingement, entrainment, and the thermal plume were also analyzed. Either the current intake or a properly designed new intake at the Phipps Bend site would result in negligible impingement and entrainment losses comparable to those at the Clinch River site. However, the impact to aquatic biota in the Holston River because of the combined thermal plume from the LMFBR and both

Phipps Bend units may be unacceptable; therefore, under this siting situation, the Clinch River site is environmentally preferable.

With neither or only one of the Phipps Bend units operating, the additional thermal loading associated with an LMFBR at Phipps Bend would not result in impacts to aquatic biota, whereas the thermal discharge of an LMFBR at the Clinch River site has the potential, under low- or no-flow conditions in the Clinch River, to impact striped bass that utilize that stretch of river as a thermal refuge during the late summer and early fall (see Sections 2.7.2 and 5.3.2.2). Should studies conducted by the applicants prior to plant operation fail to conclusively demonstrate that impact to striped bass will not occur, the applicants have committed (Longenecker, 1982) to restricting the thermal discharge to Clinch River during periods when the river water temperature is high and zero flow conditions exist. Furthermore, EPA in the draft NDPES Permit (III.M; see Appendix H) will require that no thermal impact to striped bass occur because of plant operation. Thus, if the breeder were operating simultaneously with neither or only one of the commercial units, the Phipps Bend site is judged environmentally comparable to the Clinch River site with respect to the potential for impact on aquatic biota as a result of the thermal discharge.

The staff concludes that locating an LMFBR at the Phipps Bend site with neither or only one of the Phipps Bend units completed is environmentally comparable to the Clinch River site with respect to the impact of construction and operation on the aquatic biota inhabiting the source and receiving water body. If, however, both Phipps Bend units are completed, the siting of an LMFBR at the same site may result in significant impacts to Holston River biota; therefore, under this siting configuration, the Clinch River plant is environmentally preferable.

1.3.4.2 Terrestrial Resources

No Federal lands or natural landmarks are located on or near the site, and there are no state or local parks on site. Panther Creek State Park (Hamlin County) is about 35 miles southwest of the site, and Warriors Path State Park is about 20 miles to the east-northeast. There are no state forests in the area.

No privately dedicated areas are on site. There are, however, approximately 10 private recreational sites in Hawkins County (the county in which the Phipps Bend site is located).

There are no critical habitat areas on or near the site. The John Sevier Wildlife Management Area is 10 miles southwest of the site.

The vegetation of the Phipps Bend site is highly disturbed, strongly reflecting the effects of relatively intense land-use activities, including the construction of a commercial nuclear power generating facility. Previously, the land at the site was used primarily for pasture and cropland.

Some of the site wildlife habitat has been disturbed by construction activities. Terrestrial game species possibly still occurring at or near Phipps Bend include the grey squirrel, cottontail rabbit, bobwhite quail, ruffed grouse, and mourning dove. Furbearers may include red and grey fox, skunk, opossum, weasel, woodchuck, mink, and muskrat. The woodduck is the most abundantly occurring waterfowl species at the site. No Federally endangered or threatened species have been recorded on the site.

Five state listed species have been occasionally noted on the site (NUREG-0168).

There is no active agricultural operation onsite. Of the 1270 acres of the existing site, approximately 400 acres are estimated by the staff to be potentially classifiable "prime farmland."

Onsite riparian habitat exists along the Holston River. Small, productive wetland areas have been developed on the site as a result of controlled construction runoff.

The site's terrestrial resources have been impacted by construction activities related to PBNP. Thus, because of the already disturbed nature of the site and the lack of any identified unique or unusual terrestrial resources at Phipps Bend, the staff concludes that the Phipps Bend site would be slightly preferable to the Clinch River site in terms of the potential reduction of impacts to the region's terrestrial resources, although this reduction would be slight for either site.

Assuming that the LMFBR plant is placed on an undisturbed Phipps Bend site, the site would offer no substantial advantage in terms of impacts on terrestrial resources. This judgment recognizes that the staff has already found that the terrestrial resources on the Clinch River site are not unique and that impacts on them from construction and operation of the CRBRP would be small. However, if one or more of the partially constructed units is cancelled and some cleared portion of the site becomes available, this site would be preferable in terms of impacts on terrestrial resources.

1.3.5 Socioeconomics

No designated "scenic rivers" or other recreational areas are located on the Phipps Bend site. The closest cultural area is the birthplace of Davey Crockett, 20 miles away (ibid).

Several historic landmarks are located within 10 miles of the site. The closest is Stony Point, the oldest brick house in Hawkins County, which is 2 miles from Phipps Bend (ibid). No historic landmarks have been located on site. Several archeological sites have been found on site, but the Advisory Council on Historic Preservation has found that current construction will not impact them (NUREG-0365)

Onsite resources appear sufficiently limited so as to make Phipps Bend comparable to the Clinch River site in this respect.

No additional land purchases would be needed, and no displacement would occur. Therefore, the Phipps Bend site is comparable to the Clinch River site with respect to displacement of residential and economic activities.

The site is accessible from U.S. Highway 11W (NUREG-0168). Construction traffic could cause congestion, a longer period of peak traffic in Kingsport, and additional problems in Hawkins County. Assuming simultaneous construction at the Phipps Bend commercial station, breeder construction traffic would further impact an already burdened traffic network. This situation would be less desirable than the Clinch River site, which has a more extensive road system available.

If the PNBP units are not constructed simultaneously with the breeder reactor, traffic would be less but the impact would still be less preferable than at the Clinch River site.

If the PBNP units are built, an additional building on the site would add relatively little visual intrusion, and less than a reactor at Clinch River. However, because of the relatively small amount of work that has been completed at Phipps Bend, offsite visual instrusion, currently minimal, could be noticeable if one or both PBNP units are cancelled and an LMFBR is constructed. This situation is comparable to that at the Clinch River site with respect to visual intrusion.

The estimated potential construction labor force around Phipps Bend is 19,832 workers. Therefore, the demands on the regional labor force would be less favorable than at the Clinch River site where the labor force is estimated to be 22,905.

Overall, the staff judges the Phipps Bend site to be less desirable than the Clinch River site with respect to socioeconomic impacts of the LMFBR plant.

1.3.6 Population

Population totals and projections in the vicinity of the Phipps Bend site are as follows:

	1980		1990		2030	
Distance from site (mi)	Total population	Density (persons/mi^2)	Total population	Density (persons/mi^2)	Total population	Density (persons/mi^2)
0 - 5	5,737	73	6,648	85	15,315	195
0 - 10	23,297	74	30,245	96	125,296	399
0 - 20	174,342	139	216,975	173	659,864	525
0 - 30	373,617	132	468,690	166	1,455,201	515

Comparable data for the proposed CRBRP site are in Section 1.1.6.

Although the data indicate that population densities are somewhat lower at this alternative site than at Clinch River, the staff considers the populations near both sites to be reasonably low. Neither site exceeds 500 persons/mi^2 averaged over any radial distance out to 30 miles at startup nor 1000 persons/mi^2 at the end of plant life, as stipulated in Regulatory Guide 4.7 and criterion VI.2.b.(7) of the proposed rule on alternative sites (Appendix K). Therefore, neither can be termed environmentally preferable in this regard.

1.3.7 Industrial, Military, and Transportation Facilities

A small plastics manufacturing plant employing about 100 people is located approximately 1 mile north-northwest of the nearest safety-related structures.

Several other plants are located between 2.7 and 4.3 miles from the Phipps Bend plant. Because of the quantities of material and distances involved, these industries will not adversely affect the safe operation of a nuclear plant.

There is no commercial barge traffic on the Holston River in the vicinity of the site.

Chlorine and acetaldehyde have been identified as toxic materials transported near the site that would require reactor control room protection.

The nearest railroad passes the site approximately 7500 ft from the nearest safety-related structure. Munitions are shipped on this railroad to or from the Holston Army Ammunition Plant, which is approximately 3 miles northeast of the site. This separation distance is adequate to preclude adverse effects on a nuclear plant because of accidental detonations.

A small county airport with a single 3500-ft runway is 4.2 miles west of the site. There are airways and training routes located from 1.2 miles to 7 miles from the site. Based on data on aviation activities near this site and on staff analysis of similar activities at other nuclear power plant sites, the staff concludes that the probability of an aircraft crashing into the Phipps Bend plant is within the acceptance criteria of Standard Review Plan Section 2.2.3 (NUREG-0800) and is acceptable.

A 6.25-in.-diameter natural gas pipeline passes about 7500 ft northwest of the site. Because of the size of the line and the distance involved, this pipeline does not represent a hazard to the safe operation of a nuclear plant.

The staff concluded that additional expenditures necessary to make the plant licensable at the Phipps Bend site with respect to the above hazards would not be significantly greater than at the Clinch River site.

1.4 Yellow Creek

The Yellow Creek site is located in northeast Mississippi, about 9 miles north of Iuka, Mississippi, and 30 miles west-northwest of Florence, Alabama. Two 1285 MWe nuclear units are partially constructed on the 1160-acre site. The coordinates are 34°57'24" latitude, 88°12'57" longitude.

1.4.1 Geology and Seimology

The Yellow Creek site is on the boundary between the Central Stable Region Tectonic Province and the Gulf Coastal Plain Province. Structurally the site is on the east flank of the Mississippi Embayment and the west flank of the Nashville Dome. The New Madrid faulted belt is about 80 miles west of the site. The SSE is based on the postulated occurrence of an MMI VII-VIII in the vicinity of the site and an MMI XI-XII 80 miles from the site.

The site is on a dissected plateau with an average elevation of 600 ft msl. Plant structures will be founded on the Ft. Payne formation, a calcareous siltstone that does not typically support the development of cavernous or karst conditions. Bedrock is overlain by several tens of feet of residual soil, alluvial sands of the Cretaceous Eutaw formation, and sand and gravel terrace deposits.

The Yellow Creek site is considered to be equivalent to the Clinch River site for the proposed LMFBR because seismic design requirements are similar at the two sites, and the foundation rock at both sites is of high quality. The staff concluded that licensing costs with respect to these parameters would be comparable to those at the Clinch River site.

1.4.2 Hydrology

The Yellow Creek site is on the east bank of the Yellow Creek embayment of Pickwick Lake, which is on the Tennessee River. The average annual flow in the Tennessee River at this location is 56,000 cfs. Thus, this site is more favorable than the Clinch River site with respect to water availability. However, because of the small amount of water needed for the proposed LMFBR, water availability is a relatively insignificant issue.

The nearest drinking water intake is about 9 miles downstream. Approximately 100,000 people are served by water from the upstream Wilson Dam to the confluence with the Ohio River. The population adjacent to the river downstream within 50 miles is 9800. The ratio of population served to river flow rate is 9800/56,000 or 0.18 to 1, as compared to 5.8 to 1 at Clinch River. Yellow Creek is therefore preferable on the basis of population served and dilution of effluents.

Minimum plant grade is about 500 ft msl, which is about 80 ft above normal full pool on Pickwick Lake. Therefore, flooding or encroachment onto the flood plain should be minimal at this site, making it comparable to the Clinch River site in this regard.

The site is on unconsolidated materials of low permeability. Transport of radioactivity through groundwater would be relatively less at this site than at the Murphy Hill, Hartsville, or CRBRP site.

Overall, the Yellow Creek site is more favorable than the CRBRP site in regard to hydrology. However, costs relative to hydrology aspects of licensing are judged to be comparable.

1.4.2.1 Water Quality

Makeup water for the closed-cycle Yellow Creek Nuclear Plant will be drawn from Yellow Creek and station discharges will be returned directly to the Tennessee River.

Near the site the Tennessee River is of moderate hardness and relatively low in dissolved minerals. Mineral quality would be considered slightly better than that of the Clinch River. The waters of Yellow Creek would be considered very soft, but Yellow Creek tends to be higher in dissolved organics than the Tennessee River. Both water bodies are of good quality from the sanitary engineering standpoint, demonstrating that they are relatively free of stresses from municipal waste discharges. Pickwick Lake does stratify thermally in summer months and at such times the dissolved oxygen concentration decreases markedly with depth. During the dry season, which is the period of interest for assessing impact to water quality, the flow from Yellow Creek decreases to a very low rate, at times reaching zero. Thus, at such times, the makeup would essentially be Tennessee River water.

Surface temperature of the Tennessee River at times naturally exceeds the State of Mississippi maximum temperature standard. Therefore, it is necessary that alternative temperature limitations be established as prescribed in Section 316(a) of the Clean Water Act.

Because of the large flow in the Tennessee River and because of the small addition of chemicals at the Yellow Creek plant, the FES (NUREG-0365) concluded that chemical discharges would be within applicable water quality standards and in fact, that water quality in Pickwick Lake would not be changed measurably by the two 1285 MWe units, and the addition of the 350 MWe breeder unit would not alter this conclusion.

Because attainment of state water quality standards resulted in no special mitigative requirements at Yellow Creek, this site is slightly better than the proposed Clinch River site relative to impact on water quality.

1.4.3 Meteorology

The meteorological considerations for Yellow Creek are similar to those for the sites discussed above and the Clinch River site (see Section 1.1.3 above).

1.4.4 Ecology

1.4.4.1 Aquatic Ecology

An LMFBR would withdraw water from the Yellow Creek embayment and discharge into Pickwick Lake for the closed-cycle cooling system.

Based on information provided to the NRC during the Yellow Creek Nuclear Plant Units 1 and 2 construction permit review, the Yellow Creek embayment of the lake is important to the maintenance of the reservoir fishery (NRC, 1977). The embayment and Pickwick Lake proper are dominated (in terms of relative abundance) by gizzard shad, threadfin shad, bass, and sunfish. The embayment serves as an important nursery area of the reservoir, and it supports a significant commercial fishery for blue catfish, channel catfish, flathead catfish, smallmouth buffalo, and carp (ER, App F-7). The embayment also supports a significant sports fishery for bass, sunfish, white bass, and white crappie.

No aquatic species collected in the area are listed as threatened or endangered by the U.S. Fish and Wildlife Service. Cyceptus elongutus (blue sucker), collected from Pickwick Lake, is considered threatened by the State of Tennessee (TWRA, 1975).

The Yellow Creek site was evaluated from the standpoint of two siting situations: the LMFBR unit with the two light water reactor units completed and the LMFBR as the only operating unit on the site. The Yellow Creek site was compared to the Clinch River site with regard to impacts to aquatic biota associated with plant construction and operation.

If both of the Yellow Creek units are completed, an additional intake for an LMFBR would have to be built and the resulting impacts resulting from construction would be comparable to those at the Clinch River site; however, if one or both of the Yellow Creek units were cancelled, then an LMFBR could utilize the resulting excess intake capacity, thereby causing little or no impact to aquatic biota as a result of intake construction because the Yellow Creek intake is substantially completed. The Yellow Creek site would then be environmentally preferable with respect to intake construction.

The discharge pipeline has not been constructed for the Yellow Creek plant and it is presumed that it could be sized slightly larger to accommodate the additional LMFBR blowdown flow. With respect to the impact on aquatic organisms of construction of the discharge pipeline, the two sites are environmentally comparable. The Yellow Creek site already has a barge-unloading facility, site preparation has been completed for the Yellow Creek units, and site runoff-holding facilities are functional. Aquatic impacts associated with construction of the barge-unloading facility and additional site preparation for the breeder would be minimal at the Yellow Creek site. Therefore, with respect to these construction activities, the Yellow Creek site is environmentally preferable to the Clinch River site.

On balance, construction impacts at the Yellow Creek site would be environmentally preferable to those at the Clinch River site if both Yellow Creek units are completed, as well as if one or both of the Yellow Creek units are cancelled. However, construction-related impacts are temporary, largely mitigable, and can be scheduled to further minimize effects. The applicants will be required to implement an approved erosion-control plan prior to construction. Although preferability of one site over another can be established for construction-related impacts, the staff finds, based on the above, that the importance of this preferability in the evaluation of alternatives is minor.

The impacts on aquatic biota of plant operation at the Yellow Creek site as a result of impingement, entrainment, and the thermal plume were analyzed for both siting situations. Use of the existing or a new perforated pipe intake at the Yellow Creek site would result in negligible impingement and entrainment losses comparable to those expected at the CRBRP site.

For either siting situation the use of the Yellow Creek discharge pipeline would have an inconsequential impact on aquatic biota inhabiting Pickwick Lake, whereas the thermal discharge from the CRBRP at the Clinch River site has the potential, under low- or no-flow conditions, to impact striped bass that utilize that stretch of river as a thermal refuge during the late summer and early fall (see Sections 2.7.2 and 5.3.2.2). Should studies conducted by the applicants prior to plant operation fail to conclusively demonstrate that impact to striped bass will not occur, the applicants have committed (Longenecker, 1982) to restricting the thermal discharge from the CRBRP during periods when the river water temperature is high and zero flow conditions exist. Furthermore, EPA in the draft NPDES permit (III.M, see Appendix H) will require that no thermal impact to striped bass occur because of plant operation. Thus, the Yellow Creek site is judged environmentally comparable to the Clinch River site with respect to the potential for impact on aquatic biota as a result of the thermal discharge.

Overall, the staff concludes that siting the LMFBR demonstration plant at the Yellow Creek site configurations would be environmentally comparable to the Clinch River site with respect to the impact of construction and operation on the aquatic biota inhabiting the source and receiving water bodies.

1.4.4.2 Terrestrial Resources

No Federal lands or natural landmarks are on or near the site. There are no state or local parks on the site. However, two large state parks (J. P. Coleman State Recreational Area and Tishomingo State Park) are located within the area (Tishomingo County).

While there are no privately dedicated areas on the site, recreational areas oriented toward water activities are numerous in the area.

There are no critical habitat areas on or near the site.

Before the start of construction activities related to Yellow Creek Units 1 and 2, the site was predominantly forested. Only 5% of the 1160 arces had been cleared for pasture or other agricultural uses. As a result of construction activities, the staff estimates that approximately 30% of the site has been cleared or otherwise affected.

No Federally listed rare or endangered species are found on the site. Prior to construction activities, there was a rather high diversity of animals on site. This diversity still exists in the region (NUREG-0365), but construction activities have reduced both animal populations and diversity. There are no rare or endangered species on the site.

There are no agriculture activities on the site, and the staff estimates that the site contains little or no prime or unique farmland.

Two small areas of wetlands have been impacted by construction activities. Further impact by siting another facility at this site could occur, but inexpensive compensating measures can be adopted.

Assuming that the demonstration plant is placed on an undisturbed portion of the Yellow Creek site, the site would offer no substantial advantage over the Clinch River site in terms of impacts on terrestrial resources. This judgment recognizes that the staff has already found that the terrestrial resources on the Clinch River site are not unique and that impacts on them from construction and operation of the CRBRP would be small. However, if one or more of the partially constructed units are cancelled and some cleared portion of the site becomes available, the Yellow Creek site would be preferable in terms of impacts to terrestrial resources.

1.4.5 Socioeconomics

There are no historic structures located on the Yellow Creek site, although an historic cemetery is located in the immediate vicinity (NUREG-0365). TVA conducted an intensive archeological survey and found numerous archeological sites (ibid). Scenic and recreational enjoyment of the area have already been disrupted by construction at the site (ibid).

Placement of a breeder reactor on the site of the proposed Yellow Creek units would likely disrupt numerous archeological sites. This situation would be less preferable than at the Clinch River site.

Seven households were relocated when construction began at Yellow Creek, and no economic activities required relocation. It is doubtful that further displacement would be required if the LMFBR were relocated to Yellow Creek. This situation would be comparable to Clinch River because no displacement is necessary at the proposed site.

Before Yellow Creek Nuclear Plant construction began, serious doubts existed about the ability of area roadways to handle construction traffic (ibid). State Routes 25 and 365, U.S. 73, Short Road, and Old Iuka-Red Sulphur Springs Road were expected to be heavily impacted. Because of the apparently inherent deficiencies in local road systems, traffic congestion would be more of a problem at Yellow Creek than at the Clinch River site.

Because a good portion of the commercial station at Yellow Creek has been constructed (about one-third), the visual intrusion from adding a breeder reactor there would be less than at the Clinch River site.

The area within commuting distance of the Yellow Creek site is estimated to contain a construction labor force of 10,177 by 1985. By this criterion, Yellow Creek is less desirable than the CRBRP site, which would have a work force of 22,905.

Overall, the staff considers the Yellow Creek site to be less desirable than Clinch River in terms of socioeconomic impacts.

1.4.6 Population

Population totals and projections in the vicinity of the Yellow Creek site are as follows:

	1980		1990		2030	
Distance from site (mi)	Total population	Density (persons/mi^2)	Total population	Density (persons/mi^2)	Total population	Density (persons/mi^2)
0 - 5	1,040	13	1,140	14	1,354	17
0 - 10	6,180	22	7,615	24	9,487	30
0 - 20	59,115	47	69,080	55	99,253	79
0 - 30	116,815	41	135,206	48	195,073	69

Comparable data for the proposed CRBRP site are in Section 1.1.6.

Although the data indicate that population densities are somewhat lower at this althernative site than at Clinch River, the staff considers the populations near both sites to be reasonably low. Neither site exceeds 500 persons/mi^2 averaged over any radial distance out to 30 miles at startup nor 1000 persons/mi^2 at the end of plant life, as stipulated in Regulatory Guide 4.7 and criterion VI.2.b.(7) of the proposed rule on alternative sites (Appendix K). Therefore, neither can be termed environmentally preferable in this regard.

1.4.7 Industrial, Military, and Transportation Facilities

An oil storage facility is located at the Yellow Creek port, approximately 1.8 miles north and west of the Yellow Creek site. This distance is sufficient to preclude adverse effects, except for smoke effects resulting from fires, which may require control room protection.

The closest major land transportation route is State Highway 25, about 2 miles west of the site. The closest airport is at Iuka 13 miles south of the site.

The plant site is near two Federal airways and a military jet training area. Based on staff analysis of these routes, the staff concludes that the probability of an aircraft crash is acceptably low (less than about 10^{-7} per year) and need not be considered in the plant design basis.

The closest natural gas pipeline is a 6-in. line located 7.5 miles northwest of the site. The closest railroad is 7 miles to the northwest, with a spur extending to the Yellow Creek port 1.8 miles northwest. These separation distances are adequate to ensure no adverse impacts on a nuclear plant.

The main channel of the Tennessee River is 2 miles east of the site and is a major barge route. Presently, the Yellow Creek embayment is not available to commercial barge traffic. However, upon completion of the Tennessee-Tombigee Waterway, an estimated 24,000,000 tons of materials will be shipped past the site annually. Appropriate design and/or location of the plant intake structure would ensure against damage to the intake structure from barge collisions and fires. The plant itself should not be affected by such hazards.

The staff concluded that the additional costs of licensing at Yellow Creek for protection of the plant from nearby hazards are not likely to be significantly greater than at the Clinch River site.

2 DOE SITES

2.1 Hanford

The Hanford site is located in the southeast area of DOE's large Hanford reservation, about 9 miles northwest of North Richland, Washington, 1.5 miles north-northwest of the Fast Flux Test Facility (FFTF), and 5 miles southwest of the Washington Public Power Supply Systems' WNP-2 facility. The coordinates are 46°26'00" latitude, 119°23'00" longitude.

2.1.1 Geology and Seismology

The Hanford reservation is in the Pasco Basin, a structural downwarp within the Columbia River Basalt Plateau of eastern Washington and Oregon and southern Idaho. The Pasco Basin is bounded by long sinuous folds in the basalt bedrock that trend in generally east-west to northwest-southeast directions. These folds reach a maximum elevation of more than 3500 ft msl on top of Rattlesnake Mountain southwest of the site. The site surface elevation is about 450 ft msl. The Hanford area is underlain by at least 5000 ft of basalt flows ranging in age from Miocene to Pliocene. Overlying basalt in the site area are several hundred feet of dense Pliocene-Pleistocene soils of the Ringfold formation, which is overlain by glacio-fluvial sands and gravels.

he area is characterized by the infrequent occurrence of low- to moderate-intensity earthquakes, the sources of which are not known. There are indications in the geologic record within the region of relatively recent tectonic activity. The appropriate earthquake design basis for this region has not been established, although much work is being done by the Washington Public Power Supply System, Puget Power, and DOE to accomplish that goal. Other facilities n the region are designed for vibratory ground motion values of 0.25g at WNP-1, , and 4 and at FFTF, and 0.35g at the Skagit-Hanford site, based on pre-Regulatory Guide 1.60 spectra.

he staff believes a Hanford site is licensable, but because of the current ncertainty of the tectonic regime at Hanford, this site is considered to be ess desirable than the Clinch River site in regard to geological and seismological considerations and additional costs associated with these considerations are likely to be required for licensing the plant at Hanford.

.1.2 Hydrology

he Hanford reservation is adjacent to the Columbia River, which has an average nnual flow near the site of about 120,000 cfs. This is more favorable than at he Clinch River site. However, because of the small amount of water required or the proposed LMFBR, water availability is not considered a significant item.

opulation along the Columbia River downstream and within 50 miles of the site s estimated to be about 70,000. The ratio of people potentially served to iver flow rate is, therefore, 70,000/120,000 or 0.58 to 1, although some of he water supplied to this population is groundwater. Because this ratio is .8 to 1 at the Clinch River site, Hanford is preferable on the basis of ffluent dilution and population served.

he PMF at the site is estimated to be 424.5 ft msl. Flood analyses for three ther commercial nuclear plants at this site have shown that flooding will not e a problem. Floodplain encroachment will not occur. In these parameters, anford is equal to the proposed CRBRP site.

roundwater is present under the site in unconsolidated glacial-fluvial eposits. There are extensive data on the movement of groundwater and dissolved radioactivity at the Hanford site. The potential for contamination of ater supplies from accidental releases of radioactivity at the site will be mall and is considered to be equal to the Clinch River site.

verall, in regard to hydrology, the Hanford site is more favorable than the linch River site. However, costs with respect to water availability and flood rotection at the two sites would be comparable.

1.2.1 Water Quality

e Columbia River at the Hanford site has an average annual flow of 120,000 s, with a controlled minimum day flow average of 36,000 cfs. The quality of e Columbia River in that vicinity is excellent although state temperature andards are exceeded during late summer as a result of natural conditions. e concentrations of certain trace metals (cadmium, copper, iron, lead, and rcury) at times exceed EPA water quality criteria. Dilution of effluent reams with the flow in the Columbia River would virtually ensure that any FBR discharges would not be measurable. Even at the controlled minimum low flow, the river would dilute the breeder project waste stream by a factor of 7200.

The slightly better water quality in the Columbia relative to the Clinch and the substantially higher dilution flow in the Columbia would appear to give the Columbia an environmental advantage. However, because the Clinch River site can accommodate the breeder project with no significant adverse water quality impact on other uses, the apparent advantage does not weigh heavily in selecting among the alternatives.

2.1.3 Meteorology

The Hanford site is a desert-type site with diffusion characteristics that are different from nondesert sites. Based upon extensive diffusion studies, it has been found that, although there is high joint frequency of stable and low wind speeds, considerably better diffusion characteristics exist in desert regions than in nondesert regions. From a diffusion point of view, the far west sites (Hanford and INEL) have better diffusion conditions than the TVA sites. This would lead to less conservative χ/Q values being utilized for evaluation of the impacts of routine and accidental releases than are utilized for the other sites.

This site is in Tornado Region III, which would require a design to withstand the effects of a maximum wind speed of 240 mph.

The staff concludes that the Hanford site is preferable to the proposed site with regard to meteorological considerations, and somewhat lower costs for licensing would be required compared to the Clinch River site.

2.1.4 Ecology

2.1.4.1 Aquatic Ecology

The LMFBR at the Hanford site would withdraw and discharge water to the Columbia River for the closed-cycle cooling system.

A number of studies on aquatic biota have been conducted in the vicinity of the proposed site in support of the Washington Public Power Supply System Nuclear Plants 1, 2, and 4 and the Puget Sound Power and Light Company's proposed Skagit/Hanford Nuclear Plant (WPPSS; PSPLCo, 1981). The most abundant resident species of fish collected from the river near the proposed site are the large-scale sucker, bridge-lip sucker, squawfish, chiselmouth, and the red-side shiner. Important anadromous fish from the site are the chinook, coho, sockeye salmon, steelhead trout, and American shad (PSPLCo, 1981). Spawning of the fall run of chinook salmon and steelhead trout occurs in the Columbia adjacent to Hanford reservation. Shad may also spawn in the Hanford section of the river (WPPSS). No Federally recognized threatened or endangered aquatic species is known to occur in the Columbia River in the vicinity of this site.

The Hanford site was evaluated for aquatic impacts resulting the construction and operation of the LMFBR on a site near the FFTF with an intake and discharge located to the east in the Columbia River. For this comparison, intake and discharge structures of the same designs as those proposed for the Clinch River site were evaluated for the Hanford site. Impacts associated with the construction of the intake and discharge structures at the two sites were judged to be equivalent.

Because of the size of the Columbia River, the inland location of the site, the porosity of the soil, and the more arid conditions at the Hanford site, the potential for site runoff having a detrimental effect on aquatic biota is significantly less than at the Clinch River site. Overall, the staff finds that the Hanford site is environmentally preferable with respect to LMFBR construction-related impacts on aquatic biota. However, construction-related impacts are temporary, largely mitigable, and can be scheduled to further minimize effects. The applicants will be required to implement an approved erosion control plan prior to construction. Although preferability of one site over another can be established for construction-related impacts, the staff finds, based on the above, that the importance of this preferability in the evaluation of alternatives is minor.

The impacts of plant operation on aquatic biota at the Hanford site as a result of impingement, entrainment, and the thermal plume were compared to those projected for the Clinch River site.

The use of intake proposed for the Clinch River at the Hanford reservation would result in negligible impingement and entrainment losses, comparable to those predicted for the Clinch River site.

The blowdown discharge represents about 0.008% of the lowest mean monthly flow. Thus the additional thermal loading from an LMFBR at the Hanford site would not result in an adverse impact to aquatic biota inhabiting the Columbia River, whereas the thermal discharge of a plant at the Clinch River site has the potential, under low- or no-flow conditions in the Clinch River, to impact striped bass that utilize that stretch of river as a thermal refuge during the late summer and early fall (see Sections 2.7.2 and 5.3.2.2). Should studies conducted by the applicants prior to plant operation fail to conclusively demonstrate that impact to striped bass will not occur, the applicants have committed (Longenecker, 1982) to the restricting the thermal discharge from the CRBRP during periods when the river water temperature is high and zero flow conditions exist. Furthermore, EPA in the draft NPDES Permit (III.M; see Appendix H) will require that no thermal impact to striped bass occur because of plant operation. Thus, the Hanford site is judged to be environmentally comparable to the Clinch River site with respect to the potential for impact on aquatic biota as a result of thermal discharge.

The staff concludes overall that an LMFBR at the Hanford site is environmentally comparable to an LMFBR at the Clinch River site with respect to the impact of construction and operation on the aquatic biota inhabiting the source and receiving water bodies.

1.4.2 Terrestrial Resources

The Hanford reservation occupies about 365,000 acres of the southeastern part of the State of Washington. The Hanford site, owned by DOE, is primarily dedicated to nuclear activities, including research into advanced reactor designs as well as the commercial operation of nuclear power (NUREG-75/012).

There are no natural landmarks on the site; however, there are two registered sites within 50 miles--Gingko Petrified Forest and Grand Coulee. There are no state or local parks on the site; Olmstead Place State Park is approximately 0 miles from the site. No privately dedicated areas are on or near the site.

The Arid Lands Ecology (ALE) Reserve occupies about 120 mi^2 of the site. Additionally, 86,000 acres of the site are being reserved for a wildlife refuge and recreation area by the Washington State Department of Game. These areas would not be affected by construction activities. The ALE Reserve also contains several endangered plant species.

The site contains eight major kinds of shrub-steppe plant communities. The most broadly distributed vegetation type is the sagebrush/cheatgrass or sagebrush/Sanberg's bluegrass association.

Mule deer, cottontail rabbit, jackrabbit, porcupine, and a variety of small mammals are on the site. Waterfowl, especially the Canada goose and mallards, occupy the Hanford Reach of the Columbia River during peak migratory periods.

Federally listed endangered species that may use the site for a refuge are the American perigrine falcon and the bald eagle.

There are no farmlands on the site. A small portion of the site is classified as "prime farmland soil, if irrigated."

A riparian community occupies the banks of the Columbia River.

Hanford is an extremely large site with terrestrial resources characteristic of large regions in the western states. The parts of the site preserved for environmental research and wildlife would not have to be impacted by any siting activities connected with an LMFBR. Although the terrestrial resources of the Clinch River and the Hanford sites are characteristic of entirely different ecosystems (such as forested vs. rangeland), the staff cannot determine any significant reason for preferring one site or the other in terms of mitigating or impacting terrestrial resources primarily because both sites would require some clearing activities.

2.1.5 Socioeconomics

There are no scenic, historic, or recreational sites on the Hanford reservation (PMC, 1977). However, the Hanford Dunes and Arid Lands Ecology Reserve have been proposed as National Natural Landmarks. The Hanford Reach of the Columbia River has been proposed as a potential wild, scenic, or recreational river under the Wild and Scenic Rivers Act. None of these should affect the Hanford reservation as a candidate site (PMC, 1982).

Many significant archeological sites have been discovered in the Hanford area, especially along the Columbia River (PMC, 1977). Several recorded Wanapam Indian villages and campsites were located there (DOE, 1982). One archeological site is know to be located on the site, but this will not be disturbed by existing construction (PSPL, 1982).

The Hanford site is comparable to Clinch River with respect to the potential for displacing or disrupting onsite resources.

The Hanford reservation has been government property since 1943, and, thus contains no residential or economic activities. The sites are comparable with respect to displacement of such activities, because none would occur at the Clinch River Site.

Route 10, Route 4 South, and State Highway 240 would be the routes used most by construction traffic. Large construction projects have occurred on the Hanford site, and the tri-cities area road system has proven capable of handling the traffic (PSPL, 1982). Traffic near the Hanford site would increase because of additional workers, and the resulting congestion would be comparable to that at the Clinch River site.

With two nuclear reactors currently being built at Hanford, the construction of a breeder reactor would add little visual intrusion as compared to a single plant on tne undeveloped Clinch River site. Therefore, the Hanford site is preferable with respect to visual intrusion.

The staff estimates that a construction labor force of 6244 will reside near the plant in 1985. In this regard, the Hanford site is less desirable than the Clinch River site, which has an estimated labor pool of 22,905.

Overall, the staff concludes that the Hanford site is less desirable than Clinch River with respect to socioeconomic impacts.

2.1.6 Population

Population totals and estimates for the Hanford site are as follows:

	1980		1990		2030	
Distance from site (mi)	Total population	Density (persons/ mi^2)	Total population	Density (persons/ mi^2)	Total population	Density (persons/ mi^2)
0 - 5	0	0	0	0	0	0
0 - 10	13,924	44	19,432	62	37,154	118
0 - 20	87,283	69	121,807	97	232,894	185
0 - 30	133,379	47	186,135	66	355,890	126

Comparable data for the proposed CRBRP site are given in Section 1.1.6.

Although the data indicate that population densities are somewhat lower at this alternative site than at Clinch River, the staff considers the populations near both sites to be reasonably low. Neither site exceeds 500 persons/mi^2 averaged over any radial distance out to 30 miles at startup nor 1000 persons/mi^2 at the end of plant life, as stipulated in Regulatory Guide 4.7 and criterion VI.2.b.(7) of the proposed rule on alternative sites (Appendix K). Therefore, neither can be termed environmentally preferable in this regard.

2.1.7 Industrial, Military, and Transporation Facilities

The Hanford reservations consists of about 360,000 acres controlled by DOE. Land uses consist of a number of DOE nuclear production reactors and various laboratory facilities plus the Fast Flux Test Facility (FFTF). Private leases of land include the WPPSS plant at the 100-N area and leases for WPPSS Units 1 and 2 under construction.

Other than the above facilities and the onsite road and railroad system, there are no industrial or military facilities nearby of concern to a nuclear plant.

The proposed LMFBR alternative site is approximately 5 miles southwest of the WPPSS 1, 2, and 4 site and 5 miles south of the Skagit/Hanford site. The site is approximately 1.5 miles northwest of the FFTF reactor. There are no oil or gas pipelines in the vicinity of the site. The major gas pipeline is more than 15 miles from the site. There are no airports within 10 miles of the site. The closest airport is Richland Airport approximately 12 miles south-southwest.

The NOAA aeronautical chart indicates a notice that aircraft are requested to avoid the area (Hanford reservation) below 2400 ft msl for national security reasons.

The staff concludes that licensing costs with respect to protection of the plant from the above hazards would be comparable to those at the Clinch River site.

2.2 Idaho National Engineering Laboratory (INEL)

The site is on the large INEL reservation about 23 miles west-northwest of Idaho Falls, Idaho and about 13 miles east of the EBR-II plant. The approximate coordinates are 43°40'00" latitude, 112°30'00" longitude.

2.2.1 Geology and Seismology

INEL is on the eastern section of the Snake River Plain, which is a subdivision of the Columbia Plateau Province. The Snake River Plain is underlain by a thick sequence of Tertiary and Quaternary lava flows and associated interbeds of alluvial, lacustrine, and eolian deposits. The plain is rough surfaced but generally flat. Northwest and southeast of the plain are north-south trending, generally parallel mountain ranges, composed of folded and faulted Paleozoic rocks. These ranges and intervening valleys were formed by block faulting (horst and graben), which is typical of basin and range terrain. Capable faults (the Arco and Howe faults) have been mapped on the west flank of two of the north-south mountain ranges north of INEL. There is no evidence that the faults cut the Tertiary-Quaternary basalts of the Snake River Plain, but alignments of volcanic vents and rhyolitic domes, forming prominent buttes, extend across the plain along projections of the faults. These alignments are parallel to a young (2000-year old) rift zone extending southeast from the Craters of the Moon area.

The INEL area has been relatively aseismic historically, but the basin and range terrain to the north, south, and southeast are very active. The basalt bedrock would make an adequate foundation for an LMFBR. However, the INEL site is considered to be less suitable than the CRBRP site for an LMFBR demonstration plant because of the uncertainties about the tectonic regime and potential for earthquake occurrence at INEL. The applicants' estimate of 0.32g for the Loss-of-Fluid Test (LOFT) facility near the center of the reservation (FES Table 9.5) indicates that a somewhat higher cost design may be necessary at INEL than at Clinch River, where the plant is designed for 0.25g.

2.2.2 Hydrology

The INEL site is on a major aquifer, the Snake River Plain aquifer, which is a large water resource. Water for plant operation would come from this source, and construction of a 10-acre pond for normal and safety-related water storage would be necessary. The site is less desirable than the Clinch River site in this regard, although availability of water is not regarded as significant because of the small amount of water required for the LMFBR demonstration plant.

Flooding may occur locally on the Big Lost River because of spring snow melt, but is of little concern to plant siting. No floodplain encroachment is expected. In regard to these parameters, the INEL site is considered equal to the CRBRP site.

The water table at the site is deep and fast moving. While the transport of radioactivity through the groundwater would not affect any current public water supplies, it might affect a future use of this resource. In this regard, the site is less desirable than the proposed CRBRP site.

Overall, the hydrology considerations of the Idaho site are less desirable than the Clinch River site, and costs to ensure water availability would be somewhat higher than at the Clinch River site.

2.2.2.1 Water Quality

If located at INEL, an LMFBR would utilize groundwater and would ultimately return the waste streams to the groundwater. The groundwater reservoir beneath the INEL is extremely large relative to the breeder project water requirements. However, when waste streams are returned to this reservoir, they would not be diluted in the same way that wastes discharged to a surface water body would be diluted; rather, they would move with the groundwater flow, changing in quality by interaction with surrounding soil. At a distance from the site, a well that intercepts the path of the waste flow would draw water from a range of depths, which, in effect, would provide dilution at the point of use. Wastes could be returned to the groundwater in such a way that the likelihood of interference with other users would be minimum.

The behavior of waste streams introduced into groundwater is not entirely predictable and, therefore, such waste disposal is generally done intentionally only after some deliberation. The staff does not feel that this would be an insurmountable design problem at INEL, but it does present some uncertainty and a minor additional cost.

The CRBRP site has the advantage of disposal to a surface water source. However, this advantage is not considered to weigh heavily in the comparison of alternatives.

Overall, the INEL site would be less desirable than the Clinch River site with respect to water quality considerations.

2.2.3 Meteorology

The meteorological considerations for the INEL site are similar to those for the Hanford site (see Section 2.1.3 above). Therefore, from a diffusion point of view, this site has better diffusion conditions than the proposed CRBRP site. This would lead to less conservative χ/Q values being utilized for evaluation of the impacts of routine and accidental releases than are utilized for the Clinch River site.

This site also is in Tornado Region III, requiring a design to withstand the effects of a maximum wind speed of 240 mph.

The staff concludes that the INEL is preferable to the proposed site with regard to meteorological considerations, and somewhat lower costs for licensing would be required compared to the Clinch River site.

2.2.4 Ecology

2.2.4.1 Aquatic Impacts

An LMFBR at the INEL site would withdraw water from the Snake River Plain aquifer. Surface discharge to an evaporation basin is planned for the blowdown stream. Surface water at the INEL site consists of three intermittent streams that terminate in four playas in the north-central part of the reservation. No surface streams leave the reservation.

No impacts to aquatic biota as a result of construction or operation of an LMFBR at the INEL site are postulated. The staff thus concludes that the INEL site is environmentally preferable to the CRBRP site with respect to the potential for impacts to aquatic biota.

2.2.4.2 Terrestrial Resources and Land Use

The INEL consists of 572,000 acres of Federally owned rangeland set aside for the construction, testing, and operation of a wide variety of nuclear facilities. No natural landmarks are on or near the site, nor are there any state or local parks, privately dedicated areas, or critical habitat areas on or near the site.

The vegetation on the site consists primarily of sagebrush, lanceleaf rabbit brush, and a variety of grasses. The only trees are found along the Big Lost River.

The vegetation supports a variety of wildlife consisting of small mammals, birds, reptiles, and a few large mammals. Small animals include chipmunks, ground squirrels, mice, and jackrabbits. Pronghorn antelope, coyotes, and bobcats are seen at the site. The only endangered species occasionally frequenting the site are the bald eagle and perigrine falcon.

There are no active farm operations or wetlands on site, but man-made lagoons on the site do attract birds. Riparian habitat exists along the three streams that run through the site.

The INEL site is characteristic of the western arid regions and is, therefore, more similar to the Hanford site than to the Clinch River site in terms of terrestrial resources. Because of the extensive size of this site and the lack of any unique terrestrial features, including no specific areas dedicated to the preservation or research of terrestrial resources (Section 2.1.4.2), the staff believes that this site would be slightly preferable to the Hanford site, and potentially preferable to the preferred CRBRP site, in regard to impacts on

2.2.5 Socioecon[illegible]

The Experimental Breeder Reactor I (EBR-I), potentially [illegible] has been identified [illegible] as a historical site. Another historical site, potentially [illegible] in the National Register of Historic Places, has been identified [illegible] property, but will not be impacted by construction (PMC, 1982). No archeolog[illegible] resources or scenic or recreational areas are known to exist on the INEL site. Therefore, construction at tne INEL site might result in somewhat less disruption of onsite resources than at the CRBRP site, which contains several archeological findings. However, the staff views the potential impacts on such resources at INEL as preferable to those at the Clinch River site.

The INEL site area, like the Clinch River site, is Federally owned, with no private residences allowed. As no (nonnuclear) economic activities exist at these sites, no residential or economic activities will be displaced. (The INEL site does contain several nuclear facilities, but these would not be affected by the construction of a breeder reactor.) Therefore, the INEL site is comparable to the proposed site in this regard.

The site area is served mainly by U.S. Routes 20 and 26 and Idaho State Highways 88 and 22 (Eastern Idaho, 1981). Traffic congestion could be expected on the U.S. highways as traffic moves to the site from the Pocatello/Blackfoot and Idaho Falls areas. This situation would be comparable to congestion at the Clinch River site.

The INEL site area is undeveloped, desert-type rangeland, with sparse population (ibid). However, several facilities are already on site, thus minimizing the additional visual intrusion of a breeder reactor. The INEL site is therefore preferable from the standpoint of visual intrusion.

The staff estimates a potential 3346 people in the local labor pool. This is less desirable than at the Clinch River site, which has an estimated labor pool of 22,905, becuase it implies significantly more labor inmovement and greater demands on community facilities and services than at the proposed site. Overall, the staff judges the INEL site to be less desirable than the Clinch River site with regard to socioeconomic impacts.

2.2.6 Population

Population totals and estimates for the INEL site area are as follows:

terrestrial resources. This conclusion is based on the staff's opinion that the diversity or richness of the terrestrial resources at INEL is less than at the Clinch River site and, therefore, siting at INEL would be slightly preferable.

2.2.5 Socioeconomics

The Experimental Breeder Reactor I (EBR-I) area at INEL is considered an historical site. Another historical site, potentially eligible for inclusion in the National Register of Historic Places, has been identified on the property, but will not be impacted by construction (PMC, 1982). No archeological resources or scenic or recreational areas are known to exist on the INEL site. Therefore, construction at the INEL site might result in somewhat less disruption of onsite resources than at the CRBRP site, which contains several archeological findings. However, the staff views the potential impacts on such resources at INEL as preferable to those at the Clinch River site.

The INEL site area, like the Clinch River site, is Federally owned, with no private residences allowed. As no (nonnuclear) economic activities exist at these sites, no residential or economic activities will be displaced. (The INEL site does contain several nuclear facilities, but these would not be affected by the construction of a breeder reactor.) Therefore, the INEL site is comparable to the proposed site in this regard.

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2.2.6 Population

Population totals and estimates for the INEL site area are as follows:

Distance from site (mi)	1980		1990		2030	
	Total population	Density (persons/ mi^2)	Total population	Density (persons/ mi^2)	Total population	Density (persons/ mi^2)
0 - 5	0	0	0	0	0	0
0 - 10	0	0	0	0	0	0
0 - 20	5,272	4	6,989	6	10,612	8
0 - 30	77,735	27	103,060	36	156,476	55

Comparable data for the proposed CRBRP site are in Section 1.1.6.

Although the data indicate that population densities are somewhat lower at this alternative site than at Clinch River, the staff considers the populations near both sites to be reasonably low. Neither site exceeds 500 persons/mi^2 averaged over any radial distance out to 30 miles at startup nor 1000 persons/mi^2 at the end of plant life, as stipulated in Regulatory Guide 4.7 and criterion VI.2.b.(7) of the proposed rule on alternative sites (Appendix K). Therefore, neither can be termed environmentally preferable in this regard.

2.2.7 Industrial, Military, and Transportation Facilities

Other than the existing INEL facilities and the onsite road and railroad system, there are no nearby industrial or military facilities near INEL of concern to a potential nuclear power plant.

Because of the large site area for INEL, a demonstration breeder reactor such as the CRBRP could be located at the INEL site at sufficient separation distances from other facilities to preclude adverse effects upon it.

The proposed site is about 7 miles east-northeast of the EBR-II reactor.

The nearest major natural gas pipeline (24 in. or larger) passes through Pocatello, approximately 40 miles south of the proposed site. There are no major oil pipelines near the site. The nearest railroad passes through Idaho Falls in a north-south direction about 30 miles east of the proposed CRBRP alternate site.

The nearest airport is at Idaho Falls, approximately 30 miles east-southeast of the proposed CRBRP alternate site. The NOAA aeronautical chart indicates a notice that aircraft are requested to avoid the area (INEL) below 7700 ft msl for national security reasons.

The staff concludes that licensing costs at the INEL site with respect to protection against hazards to the plant would be comparable to those at the Clinch River site.

2.3. Savannah River

The site is in the northeast quadrant of the large DOE Savannah River Plant (SRP) reservation in the southwestern part of South Carolina. It is about 25 miles southeast of Augusta, Georgia, and about 7 miles west-northwest of Barnwell, South Carolina. The approximate coordinates are 33°19'00" latitude, 81°32'00" longitude.

2.3.1 Geology and Seismology

The Savannah River site is in the Coastal Plain Tectonic Province, within 20 miles of the Fall Zone, the boundary between the Piedmont and Coastal Plain Provinces. The site is underlain by approximately 900 ft of unconsolidated to semiconsolidated Coastal Plain sediments over early Paleozoic crystalline bedrock. Surface elevations on the reservation range from more than 300 ft msl to less than 100 ft msl near the Savannah River to the east. Elevations in the proposed site area range between 250 and 300 ft msl.

The northwest border fault of the Dunbarton Triassic Basin lies within a few miles southeast of the site. This fault is overlain by underformed Late Cretaceous soil that is the age equivalent of the Black Creek and Peedee Formations of South Carolina. Recent investigations by the U.S. Geological Survey (USGS) found evidence of two previously unidentified northeast-trending faults in the area. The northwesternmost fault, the Millet Fault, crosses the southern third of the SRP. The Millet Fault is interpreted by USGS investigators to be a high-angle reverse fault within the Dunbarton Basin. The Millet fault offsets the base of the Upper Cretaceous about 700 ft and Late Eocene about 20 ft. Evidence indicates that displacement on the Millet Fault has decreased through time, 9 to 3 ft per million years through Upper Cretaceous to 0.5 ft per million years in the Upper Eocene. Evidence available to date does not indicate that this fault is capable. USGS investigations are still underway.

The Savannah River site is considered to be licensable from a geological standpoint. However, because of recent concerns regarding the Charleston seismicity and the proximity of the Savannah River site to that activity, it is likely that considerable effort would have to be expended to validate the site at the proposed safe shutdown earthquake and operating basis earthquake design bases. For this reason, the Savannah River site is considered to be somewhat less suitable than the Clinch River site with regard to geological and seismological considerations, and the associated costs for licensing are likely to be higher at the Savannah River site.

2.3.2 Hydrology

The Savannah River site is adjacent to the Savannah River, which has an average flow of about 10,400 cfs. This is more favorable than at the CRBRP site; however, because of the small amount of water required for the plant, water availability is not a significant issue.

The PMF was projected for the nearby Alvin Vogtle Nuclear Plant to be about 168.2 ft msl. Establishment of an LMFBR above this flood level (as are the Vogtle plants) should be no problem. There would be no encroachment in the 100-year flood plain. In regard to these parameters, this site is equal to the Clinch River site.

The Savannah River site is in the coastal plain. Groundwater on site exists under water table conditions and flows toward the Savannah River. Transport of accidental radioactivity through the ground to the Savannah River would probably not be a problem.

The nearest public drinking water user is about 112 miles downstream, outside of the 50-mile zone used in the present comparison. Therefore, drinking water contamination is not considered to be a problem, and the site is considered to be more favorable than the proposed Clinch River site.

Overall, in regard to hydrology, the Savannah River site is more favorable than the Clinch River site. However, the licensability costs associated with water availability and flood protection would be comparable at the two sites.

2.3.2.1 Water Quality

The Savannah River upstream of the DOE facility is highly regulated for hydroelectric power generation. The guaranteed minimum daily flow past the site is 5800 cfs. The river is quite low in dissolved mineral content. It has been subjected to significant municipal and industrial waste loadings (DOE, 1982), Environmental Control has designated it as a Class B waterway, suitable for domestic water supply usage.

Construction and operation of four 1100 MWe generating units at the Alvin W. Vogtle Nuclear Plant across the river were predicted to have no significant impact on water quality of the Savannah River and no impact on downstream users or aquatic biota (AEC, 1974). Construction and operation of the 350 MWe breeder unit also would have no significant effect on water quality.

In comparison to the Clinch River, the Savannah River is of slightly better quality in terms of content of dissolved inorganics and provides a higher minimum flow to dilute discharges. However, because water quality changes were concluded to have negligible impact at the Clinch River site, these differences should not weigh heavily in the comparison of alternatives.

2.3.3 Meteorology

The Savannah River site tends to have relatively poorer diffusion conditions than in other parts of the country, but it has somewhat better conditions than those expected in the TVA area. Based on meteorological data collected near the Savannah River site, there is a relatively lower frequency of the joint occurrence of stable and low wind speed conditions. This results in relatively better χ/Q values than at the TVA sites for utilization in estimating the consequences of routine and accidental releases.

The Savannah River area is in Tornado Region I, which would require a design to withstand the effects of maximum tornado winds of 360 mph. In this regard it is comparable to the CRBRP site.

The staff concludes overall that meteorological conditions are slightly better at the Savannah River site than at the Clinch River site, and slightly lower costs for licensing licensing the plant would probably be required than at the Clinch River site.

2.3.4 Ecology

2.3.4.1 Aquatic Ecology

An LMFBR at the Savannah River site would withdraw and discharge water from the Savannah River for the closed-cycle cooling system.

The biological characteristics of the Savannah River and some of its tributaries that drain the site are contained in a series of reports issued by the Philadelphia Academy of Natural Sciences (ANSP, 1970, 1978), in an FES issued for a defense waste processing facility that is proposed for the site (DOE, 1982), and in the Vogtle Nuclear Plant FES (AEC, 1974). The aquatic biological communities of the Savannah River near the site are generally typical of those of coastal southeastern rivers. Dredging the main channel up to Augusta, Georgia, during the 1950s and completion of upstream reservoirs have affected the biological communities by reducing shallow habitat and transport of sediment and allochthonous material (DOE, 1982). The Savannah River and its associated swamp and tributaries in the vicinity of the site have a very diverse fish fauna.

Studies conducted in support of the Vogtle plant construction permit application found that the most common forage and predaceous species of fish taken from the Savannah River in the vicinity of the Savannah River site were gizzard shad and longnose gar (AEC, 1974).

The results of an egg and larval fish study conducted in 1977 found that, in the vicinity of the Savannah River plant, the most abundant larvae were blueback herring. Some Dorosoma sp. and American shad larvae were also collected. More than 90% of all fish eggs collected were American shad.

The most important game species are the largemouth bass, smallmouth bass, pickerel, crappie, sunfish, and catfish. Important commerical species taken from the river are American shad, hickory shad, and striped bass.

One semiaquatic species, the American alligator, is known from the site and is on the Federal list of endangered species. This species is known from one onsite pond, two onsite creeks, and the swamp bordering the Savannah River. The shortnose sturgeon, also Federally recognized, has been reported from the lower Savannah River (Dadswell). These species are not likely to be affected significantly by construction and operation of the breeder plant.

In addition to the two listed above, no aquatic species are listed by the State of South Carolina as endangered (State of South Carolina Code of Regulations 550-15) and none are known from the Savannah River project vicinity.

The Savannah River site was evaluated for aquatic impacts as a result of the construction and operation of an LMFBR sited in the northeast portion of the reservation. Makeup and blowdown water would be obtained from the Savannah River via a pipeline traversing the reservation in an east-west direction. For this evaluation, the LMFBR intake structure was considered to be of a design similar to that of the existing Savannah River project intake and the discharge similar to that proposed for the Clinch River site.

Considering the undisturbed nature of this alternative site, the long intake and discharge pipeline, and the necessity of inriver construction for a new intake and discharge, the staff finds that neither the Savannah River nor the CRBRP site is environmentally preferable to the other with respect to construction impacts on aquatic biota.

The impacts on aquatic biota of plant operation at the Savannah River site as a result of impingement, entrainment, and the thermal plume were also compared to those projected for the Clinch River site.

A properly designed intake at the Savannah River site would result in negligible impingement and entrainment losses, comparable to those at the proposed site.

The blowdown discharge represents about 0.1% of the minimum daily Savannah River flow. Thus, the additional thermal loading from an LMFBR at the Savannah River site would not result in an adverse impact to aquatic biota inhabiting the Savannah River, whereas the thermal discharge of an LMFBR at the CRBRP site has the potential, under low- or no-flow conditions in the Clinch River, to impact striped bass that utilize that stretch of river as a thermal refuge during the late summer and early fall (see Sections 2.7.2 and 5.3.2.2). Should studies conducted by the applicants prior to plant operation fail to conclusively demonstrate that impact to striped bass will not occur, the applicants have committed (Longenecker, 1982) to the restricting thermal discharge from the CRBRP during periods when the river water temperature is high and zero flow conditions exist. Furthermore, EPA in the draft NPDES Permit (III.M; see Appendix H) will require that no thermal impact to striped bass occur because of plant operation. The Savannah River site is therefore judged environmentally comperable to the Clinch River site with respect to the potential for impact on aquatic biota because of the thermal discharge.

The staff concludes overall that an LMFBR plant located at the Savannah River plant site would be environmentally comparable to one at the proposed site with respect to the impact of construction and operation on the aquatic biota inhabiting the source and receiving water bodies.

2.3.4.2 Terrestrial Resources

The Savannah River site is an 800-km^2 (300-mi^2) controlled area owned by the Federal government. There are no natural landmarks on or near the site, nor are there any state or local parks on site. The site has been designated as a National Environmental Research Park. As a result, extensive areas are protected to provide research opportunities into the environmental impacts of human activities. Aside from those areas, there is sufficient space for the LMFBR demonstration project.

The site is approximately 90% forested. Because the area is large and topographically variable, its floral and faunal diversity and abundance have high ecological valve.

The site contains considerable wildlife diversity because of its range of diverse habitats and its protection from the public. Four species listed as endangered or threatened by the U.S. Fish and Wildlife Service have been identified as possibly occurring on the site: bald eagle, red-cockaded woodpecker, Kirthland's warbler, and the American alligator. Only the red-cockaded woodpecker could find highly specific and suitable habitat in the area considered for a site, and observations to date have not found evidence of this species.

No agricultural operations are permitted on the site. Before it was acquired by the U.S. government, the Savannah River site was approximately one-third cropland and pasture. Some of this land may be classifiable as "prime farmland."

The site contains extensive floodplain swamp areas bordering onsite creeks and rivers. These areas would most likely not be impacted by construction or operational activities because of the large size of the site.

Both the Savannah River and the Clinch River sites are forested and would require removal of forested habitat. Although the Savannah River site has a greater variety of resources than the Clincn River site, the proposed locations on these sites are similar in most respects. Therefore, the staff concludes that the Savannah River site offers no significant advantage over the Clinch River site in terms of reduction of impacts to terrestrial resources.

2.3.5 Socioeconomics

There are no significant historic sites, public scenic attractions, or recreational or cultural areas located on the Savannah River site. Some small, prehistoric campsites have been found, but none of importance (PMC, 1977). The site was surveyed from December 1978 to January 1979, and no archeological or historic artifacts were found (DOE, 1982). Although some resources have been found on this site, no important resources would be impacted by construction, thus making the Savannah River and Clinch River sites comparable in this respect.

The Savannah River site does not contain residential or economic activities that would be displaced; it is therefore comparable in this respect to the Clinch River site.

Many state and Federal highways serve the Savannah River area. These include Interstate Highways 20, 26, and 95; U.S. Highways 321, 78, 378, 1, 178, 601, 278, and 21; and State Highways 125, 19, and 64 (NUREG-0139). Because of the multitude of nearby multilane roadways (DOE, 1982) and because of the numerous points of access to the site, traffic congestion at Savannah River is likely to be less than congestion at the Clinch River site, thus making Savannah River preferable in this regard.

Existing structures at the Savannah River site include five nuclear production reactors (three operating, two in standby), a small test reactor, two separation areas for processing irradiated materials, a heavy water extraction and recovery plant, a fuel and target fabrication facility containing two test reactors, the Savannah River Laboratory, and other buildings (PMC, 1977). The addition of a breeder reactor to a remote part of the area would indicate less visual intrusion than at the Clinch River site.

The estimated 1985 construction force around Savannah River is 11,645. Thus, the Clinch River site, with a labor pool of 22,905, is judged preferable in regard to the local labor supply.

Overall, the staff considers the Savannah River site to be comparable to the to the proposed site in terms of socioeconomic impacts.

2.3.6 Population

Population totals and estimates for the Savannah River area are as follows:

	1980		1990		2030	
Distance from site (mi)	Total population	Density (persons/mi²)	Total population	Density (persons/mi²)	Total population	Density (persons/mi²)
0 - 5	0	0	0	0	0	0
0 - 10	5,471	17	6,046	19	8,344	27
0 - 20	45,983	37	50,821	40	70,129	56
0 - 30	239,092	85	264,248	93	364,644	129

Comparable data for the proposed CRBRP site are in Section 1.1.6.

Although the data indicate that population densities are somewhat lower at this alternative site than at Clinch River, the staff considers the populations near both sites to be reasonably low. Neither site exceeds 500 persons/mi^2 averaged over any radial distance out to 30 miles at startup nor 1000 persons/mi^2 at the end of plant life, as stipulated in Regulatory Guide 4.7 and criterion VI.2.b.(7) of the proposed rule on alternative sites (Appendix K). Therefore, neither can be termed environmentally preferable in this regard.

2.3.7 Industrial, Military, and Transportation Facilities

The Savannah River reservation consists of about 192,000 acres about 15 miles southeast of Augusta, Georgia. The site contains a number of DOE nuclear production reactors, several separation areas, a heavy water plant, and several other research and administrative facilities.

The proposed site is approximately 3 miles northeast of the Savannah River 100-R area and 4 miles northwest of the Barnwell County industrial park.

Other than the existing DOE facilities and the onsite road and railroad system, there are no nearby industrial or military facilities of concern to a nuclear plant.

Because of the large site area associated with the Savannah River reservation, a demonstration breeder reactor such as the LMFBR could be located within the Savannah River reservation at sufficient separation distances from other facilities to preclude adverse effects upon it.

The nearest airport according to the Atlanta Sectional Aeronautical Chart published by NOAA is at Barnwell, approximately 11 miles southeast of the proposed alternate site for the LMFBR. This chart indicates that for national security reasons, aircraft are requested to avoid flight over an 8.5 nautical-mile radius of a specific location (the Savannah River site) below 1200 ft msl. This radius extends over the proposed CRBRP alternative site.

The nearest major gas pipeline (24 in. or larger) extends from Macon to Aiken, South Carolina. A smaller gas pipeline extends due east for approximately 25 miles and then in a southeasterly direction to Savannah. This line is about 20 miles due north of the proposed reactor site. There are no major oil lines within 20 miles of the site. The nearest railroad is the Seaboard Coastline, which passes through the Savannah River Plant site approximately 11.5 miles southwest of the proposed reactor site.

The staff concludes that licensing costs for protection of the plant from the above hazards would be comparable to those at the Clinch River site.

CONCLUSIONS

Based on the preceding assessments of the four TVA alternative sites and three DOE sites in the States of Washington, Idaho, and South Carolina, the staff has concluded that all of these alternatives are probably acceptable as nuclear power plant sites and none of them is substantially better than the proposed site at Clinch River. This conclusion is indicated by the composite ratings in Table L.1. The staff's judgments concerning each of the environmental parameters are summarized in the same table.

Table L.2 provides a qualitative comparison to Clinch River of additional costs that potentially could be incurred to make the proposed plant licensable at the alternative sites from a safety point of view. The qualitative cost differences do not take into account the fact that the CRBRP design is so far along that substantial changes would be costly. However, from inspection of Table L.1, it does not appear that taking this fact into account would result in different conclusions. The table does not include costs to mitigate unduly adverse environmental impacts because none have been found. The composite ratings of these costs are included in Table L.1 under parameter 6, and they have been considered in arriving at the overall composite ratings in Table L.1.

Table L.1 Comparison of potential environmental impacts of the CRBRP at alternative sites vs. Clinch River site

Site	Parameters Considered* 1	2	3	4	5	6	Composite Rating
Clinch River**	small	small	small	small	low	base	small
Hartsville	0	0	0	0	0	0	0
Murphy Hill	0	0	0	-	0	0	0
Phipps Bend	-	-	0	-	0	0	-
Yellow Creek	+	0	0	-	0	0	0
Hanford	+	0	0	-	0	0	0
Idaho (INEL)	-	+	+	-	0	-	0
Savannah River	+	0	0	0	0	0	0

*Parameters considered:

1 - Water use and quality
2 - Aquatic resources
3 - Terrestrial resources
4 - Socioeconomics
5 - Population density: population density near all these sites is low (i.e., under $500/mi^2$ in 1990 and under $1000/mi^2$ in 2030, averaged over any radial distance out to 30 miles)
6 - Cost of safety considerations

**Base-line impacts from FES update

Definition of "small": The impacts are expected to be such that only minor mitigative actions, if any, are necessary.

Relative Ratings:

0 = Comparable (approximately the same degree of impact)
+ = Preferable (a lesser degree of impact)
- = Less desirable (a greater degree of impact)

Table L.2 Comparison of potential additional costs of licensing the CRBRP at alternative sites vs. the Clinch River site from safety standpoint

	Considerations*					
Site	1	2	3	4	5	Composite Rating
Hartsville	-	0	0	0	0	0
Murphy Hill	0	0	0	0	0	0
Phipps Bend	0	0	-	0	0	0
Yellow Creek	0	0	0	0	0	0
Hanford	-	-	0	+	0	0
Idaho (INEL)	-	-	-	+	0	-
Savannah River	-	-	0	+	0	0

*Considerations:

1 - Geology

2 - Seismology

3 - Hydrology

4 - Meteorology

5 - Nearby industrial, military and transportation facilities

Relative Ratings:

0 = Comparable
+ = Preferable
- = Less desirable

Appendix L Bibliography

Academy of Natural Sciences of Philadelphia, "Summary of Studies on the Savannah River, 1951-1970," for E. I. du Pont de Nemours and Co., 1970.

---, "Summary Reports of Savannah River Cursory Surveys, 1961-1972, 1974, 1977," for E. I. du Pont de Nemours and Co., 1978.

Arendts, J. G. et al., "Proposed Uniform Building Code Seismic Risk Zone Revision in Southeast Idaho," for EG&G, November 1979.

Boschuz, H., ed, "Endangered and Threatened Plants and Animals of Alabama," Bulletin of the Alabama Museum of Natural History, No. II, 1976.

Dadswell, M. J., "Synopsis of biological data on the shortnose sturgeon Acipenser brevirostrum (Le Sueur, 1818)", manuscript, Fish and Oceans Canada Biological Station, St. Andrews, NB, EOG2X0.

Eastern Idaho Council on Industry and Energy, "The Idaho National Engineering Laboratory as a Site for a Large LMFBR," January 1981.

Freeman, J. D., A. S. Causey, J. W. Short, and R. R. Haynes, "Endangered, Threatened, and Special Concern Plants of Alabama," Dept. Series No. 3, Auburn University Agricultural Station, Auburn, AL, 1979.

Isom, B. J., Testimony presented before the Atomic Safety and Licensing Board in the Matter of Tennessee Valley Authority Hartsville Nuclear Plants Units 1A, 2A, 1B and 2B, Docket Nos. 50-518 through 50-521.

Longenecker, J. R., Letter to P.S. Check, NRC, May 28, 1982.

Pasch, Ronald W., Peter A. Hackney, and John A. Holbrook, "Ecology of Paddlefish in Old Hickery Resevoir, Tennessee, with Emphasis on First-Year Life History," Trans Am. Fish. Soc. 109:2, pp 157-167, 1980.

Project Management Corporation, "Clinch River Breeder Reactor Plant Environmental Report," Docket 50-537, February 1977.

---, Tennessee Valley Authority, and Energy Research and Development Administration, "Supplemental Alternative Siting Analysis Update for the LMFBR Demonstration Plant," February 1982.

Puget Sound Power and Light Company (PSPL), "Skagit/Hanford Nuclear Project, Application for Site Certification--Environmental Report," Docket No. 50-239, Amendment 4, December 1981; Docket 50-522 and 50-523, March 1982.

South Carolina Code of Regulations, Chapter 50-15, "South Carolina Nongame and Endangered Special Conservation Act," 1976.

Tennessee Valley Authority, "Final Environmental Impact Statement--Coal Gasification Project," TVA/ONR/PCS-81/3, July 1981.

---, "Hartsville Nuclear Plants, Environmental Report, Construction Permit Stage," Vols 1 through 4, September 1974.

---, "Phipps Bend Nuclear Plant, Units 1 and 2, Environmental Report," Vols 1-3 and Supplement, April 1976.

---, power system map, July 1974.

---, "Site Evaluation Report, Nuclear Units x21-22, x24-25 (Phipps Bend, Watts Bar, Bellefonte, Murphy Hill, Yellow Creek, Saltillo)," February 1975.

---, "Yellow Creek Nuclear Plant Units 1 and 2, Environmental Report," Vols 1-3 and Supplement.

Tennessee Wildlife Resources Agency (TWRA), Proclamation - Endangered and Threatened Species, Tennessee Code/Annotated Sec. 51-905 and 51-907, Proc. No. 75-15, Nashville, Tennessee, June 19, 1975.

U.S. Atomic Energy Commission, "Final Environmental Statement Related to the Construction of the Alvin Vogtle Nuclear Plant," 1974.

U.S. Coast and Geologic Survey, map of Savannah River Plant, 1963.

U.S. Department of Energy (DOE), DOE/EIS-0082, "Final Environmental Impact Statement: Defense Waste Processing Facility, Savannah River Plant, Aiken, S.C.," February 1982.

---, letter to NRC responding to staff questions 750.2R, 750.3R, and 750.4 on alternative sites, February 12, 1982.

U.S. Energy Research and Development Agency, "Environmental Impact Statement on Waste Management Operations, Hanford Reservation," ERDA 1535, December 1975.

---, "Environmental Impact Statement on Waste Management Operations, INEL," ERDA-1536, September 1977.

---, "Environmental Impact Statement on Waste Management Operations, Savannah River Plant," ERDA-1537 September 1977.

U.S. Nuclear Regulatory Commission, NUREG-75/039, "Final Environmental Statement Related to the Construction of Hartsville Nuclear Plants," June 1975.

---, NUREG-0139, "Final Environmental Statement Related to Construction and Operation of Clinch River Breeder Reactor Plant," February 1977.

---, NUREG-0168, "Final Environmental Statement Related to the Construction of Phipps Bend Nuclear Plant Units 1 and 2," February 1977.

---, NUREG-0365 "Final Environmental Statement Related to the Construction of Yellow Creek Nuclear Plant Units 1 and 2," November 1977.

---, NUREG-0555, "Environmental Standard Review Plan," May 1979; draft revision of Section 9.2, Alternative Sites, November 1981.

---, NUREG-0800, "Standard Review Plan for Nuclear Power Plants," July 1981.

Washington Public Power Supply System (WPPSS), "Supply System Nuclear Projects Nos. 1 and 4, Environmental Report, Operating License Stage," Docket Nos. 50-460 and 50-513.

APPENDIX M

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This is a supplement to the 1977 Final Environmental Statement (FES) relative to construction and operation of the proposed Clinch River Breeder Reactor Plant at Oak Ridge, Tennessee. It provides the staff's assessment of additional data relative to the site and environs and modifications of the plant design and its fuel cycle which have occurred since the FES was issued. The staff's overall conclusion is unchanged; that is, that the action called for is the issuance of a construction permit subject to certain limitations for protection of the environment.

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