UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
UNITED STATES DEPARTMENT OF ENERGY	)	Docket Nos. 50-537
PROJECT MANAGEMENT CORPORATION	)	
TENNESSEE VALLEY AUTHORITY	)	
	)	
(Clinch River Breeder Reactor Plant)	)	

NRC STAFF'S PROPOSED OPINION AND FINDINGS OF FACT ON LWA-1 MATTERS

Daniel T. Swans..
Counsel for NRC Staff

Bradley W. Jones
Counsel for NRC Staff

Geary S. Mizuno
Counsel for NRC Staff

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The Staff of the U.S. Nuclear Regulatory Commission (Staff), in accordance with 10 C.F.R. §2.754, proposes the following opinion and findings of fact with regard to the captioned proceeding.

I. INTRODUCTION AND BACKGROUND

This is a proceeding on the application of the United States Department of Energy (DOE), Tennessee Valley Authority (TVA), and Project Management Corporation (PMC), hereinafter referred to as Applicants, for a limited work authorization (LWA-1) for the proposed Clinch River Breeder Reactor Plant, (CRBR) hereinafter referred to as the facility. The facility will be located in Oak Ridge, Tennessee. The Proposed Findings of Fact will examine the Applicants' request for an LWA-1 in accordance with 10 C.F.R. § 50.10(e)(1) and (2).

On October 11, 1974, Applicants applied to the Atomic Energy Commission, (AEC) predecessor to the Nuclear Regulatory Commission (NRC),[1/] for a construction permit and a Limited Work Authorization (LWA-1) under Section 104(b) of the Atomic Energy Act of 1954, as amended, 42 U.S.C. § 2011 et seq. for the Clinch River Breeder Reactor Plant to be located in Oak Ridge, Tennessee. The Commission issued a notice of hearing on the application for the construction permit which was published on June 18, 1975, (40 Fed. Reg. 25708 (1975)).

The application sought authority to construct a demonstration plant under DOE's Liquid Metal Fast Breeder Reactor (LMFBR) Program. The proposed facility is designed to use a liquid-sodium-cooled fast breeder reactor to produce 975 megawatts of thermal energy (MWT) with a net electrical output of approximately 350 megawatts. The proposed site is owned by the United States of America and is presently in the custody of TVA and DOE. The proposed location is on the north side of the Clinch River in the town of Oak Ridge, Roane County, Tennessee, which is about 25 miles west of Knoxville (Staff Exhibit 7, p. i).

The notice of hearing set forth the requirements pursuant to the Atomic Energy Act of 1954, as amended, and the National Environmental Policy Act of 1969 which are to be met prior to the issuance of construction permits. In addition, the requirements to be met were set forth prior to the issuance of a limited work authorization. The notice of

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1/ The Energy Reorganization Act of 1974 (P.L. 93-438, 88 Stat. 1233, 42 U.S.C. § 5814) abolished the AEC, established the NRC and transferred the AEC's licensing functions under the Atomic Energy Act of 1954, as amended, to the new Commission.

hearing also provided that any person whose interest might be affected by the proceeding could file a petition for leave to intervene pursuant to 10 C.F.R. § 2.714. Additionally, the notice of hearing designated an Atomic Safety and Licensing Board (Board) for this proceeding.

According to the notice of hearing, the Board may conduct a separate hearing and issue a partial decision on issues pursuant to NEPA, general site suitability issues specified by 10 C.F.R. § 50.10(e) and certain other possible issues for a limited work authorization. A partial decision addressing the remaining radiological health and safety issues, together with this Board's ultimate decision on issuance of the construction permits, will be issued after the conclusion of public hearings on the remaining radiological health and safety aspects of the application.

Pursuant to the notice of hearing, petitions for leave to intervene were filed by the State of Tennessee on July 17, 1975, and an amendment thereto postmarked September 24, 1975; Roane County, Tennessee, on July 17, 1975, and an amended petition on August 29; the City of Oak Ridge, Tennessee, on July 17, 1975, and an amendement thereto on January 22, 1976; Natural Resources Defense Council, Inc., the Sierra Club and East Tennessee Energy Group on July 18, 1975, and a petition for leave to intervene out of time was filed by Lenoir City, Tennessee on July 7, 1976.

At the September 16, 1975 Prehearing Conference, the Staff stated that in its opinion the amended petition of the State of Tennessee met the requirements of 10 C.F.R. § 2.714,[2/] and the Applicant took a similar position in its answer filed on September 19. In the Licensing Board's

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2/ Prehearing Conference, September 16, 1975, Tr. 22.

Special Prehearing Conference Order of October 9, 1975, the State of Tennessee was admitted as a party to the proceeding. On March 29, 1982, the State of Tennessee filed a motion to withdraw as a party under 10 C.F.R. § 2.714 but would continue to participate in the proceeding as an "interested state" pursuant to the provisions of 10 C.F.R. § 2.715. The Licensing Board granted this motion on March 31, 1982.

The Applicants' answer to Roane County's amended petition was filed on September 8, 1975. The Staff's answer, filed on September 11, 1975, conceded a sufficient showing of interest and one adequate contention. In the Licensing Board's "Special Prehearing Conference Order" of October 9, 1975, Roane County was admitted as a party to the proceeding. On November 17, 1976, Roane County requested to withdraw as a party to the proceeding. The Licensing Board authorized the withdrawal of Roane County as an intervening party on December 13, 1976.

The Applicants' answer to the City of Oak Ridge's petition was filed on July 25, 1975 and the Staff's answer was filed on July 30, 1975. Both the Staff and Applicant conceded that interest was sufficiently shown, but asserted that the petition had failed to state even one contention with sufficient specificity to comply with the regulations. At the prehearing conference on September 16, 1975, the Licensing Board granted the City of Oak Ridge the leave to file an amended petition within 20 days.[3/] On January 22, 1976, the City of Oak Ridge filed its amended petition. The Applicants' answer was filed on February 2, 1976 stated two interpretations of the proposed contention. Depending upon which interpretation the City

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3/ Prehearing Conference September 6, 1975, Tr. 19.

of Oak Ridge meant, the Applicant either supported or opposed the amended petition. However, the Staff's answer, which was filed on February 4, 1976, supported the amended petition. Thereafter, the Licensing Board admitted the City of Oak Ridge as an intervening party to the proceeding in its "Memorandum and Order Regarding Amended Petition for Leave to Intervene Filed by City of Oak Ridge" of March 4, 1976. On August 20, 1982, the City of Oak Ridge requested leave to withdraw as a party to the proceeding but would continue to participate as an "interested state" under 10 C.F.R. § 2.715(c). On September 7, 1982, the Licensing Board granted the motion.

Regarding the Natural Resources Defense Council, Inc., Sierra Club, and East Tenenssee Energy Group's joint petition to intervene, the Applicants' answer filed on July 25 and the Staff's answer filed on July 31 conceded that interest was sufficiently shown by each group and at least one relevant contention was sufficiently pleaded to satisfy the requirements of 10 C.F.R. § 2.714. The Licensing Board's "Special Prehearing Conference Order" of October 9, 1975 admitted each group as a party to the proceeding. On February 8, 1982, the intervenors requested the withdrawal of the East Tennessee Energy Group as an intervening party. The request was granted by the Licensing Board on February 11, 1982.

With regard to the Lenoir City, et al. petition, to intervene, the petition was opposed both by Applicants in its Response of July 19, 1976 and by the Staff in its Response of July 20, 1976. On August 26, 1976, the Licensing Board issued an "Order Denying Motion for Leave to Intervene Out of Time and Petition for Leave to Intervene Filed by Lenoir

City et al." for no good reason shown for petitioners' tardiness in seeking intervention, for not satisfying the provisions of 10 C.F.R. § 2.714(a) for untimely intervention petitions, for not submitting a sufficient factual bases for their contentions and for unsigned supporting affidavits and unverified petition by persons who had direct personal knowledge necessary to state interests or bases for the contentions of each petitioner. In the Matter of Project Management Corp., U.S. Energy Research and Development Administration and Tennessee Valley Authority (Clinch River Breeder Reactor Plant), LBP-76-31, 4 NRC 153, (1976), aff'd, ALAB-354, 4 NRC 383 (1976).

The parties to this proceeding are the Applicants, the NRC Staff, and Natural Resources Defense Council, Inc. and the Sierra Club (Intervenors). The State of Tennessee (State) and City of Oak Ridge (City) participated as "interested states" pursuant to 10 C.F.R. § 2.715(c).

On April 22, 1977, the Energy Research and Development Administration (ERDA) predecessor to DOE, moved that all hearing procedures be suspended because the Administration had determined that the construction of the CRBRP would be indefinitely deferred. As a result, on April 25, 1977 the Licensing Board ordered the hearing procedures and schedules to be suspended. On January 11, 1982, the Applicants submitted a motion to lift the suspension of the hearing procedures and to request a prehearing conference.

The Licensing Board held a prehearing conference on April 5 and 6, 1982 and heard oral argument on the "Revised Statement of Contentions and Bases" filed by Intervenors on March 5, 1982 and the Responses of Applicants and Staff which were both filed on March 19, 1982. On April 14, 1982, the Licensing Board issued an "Order Following Conference with Parties" which ruled on the revised contentions. The following contentions were admitted for the LWA proceeding: Contention 1a dealing with core disruptive accidents; Contentions 2 and 3 dealing with core disruptive accidents, Contention 4 dealing with safeguards, Contention 5 dealing with alternative sites, Contention 6 dealing with the fuel cycle,[4/] Contention 7 dealing with programmatic objectives, alternative designs and the aspects of meterology and population concerning alternative sites, Contention 8 dealing with decommissioning[5/] and Contention 11 dealing with health effects. On April 22, 1982, the Licensing Board issued an "Order Following Conference with Parties" which addressed the issues within Contentions 1, 2 and 3 that should be deferred for purposes of discovery and litigation until after the LWA-1 evidentiary hearing and partial initial decision. After the August 2, 1982 conference with parties, the Licensing Board issued an "Order Following Conference with Parties" on August 5, 1982. United States Department of Energy Project Management Corporation Tennessee Valley Authority (Clinch River Breeder Reactor Plant), 16 NRC ____ (August 5, 1982); aff'd, ALAB-688, 16 NRC ____ (August 25, 1982). Due to the fact that the Staff's final FES Supplement was not published until October 1982, the Licensing Board ruled that the

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4/ On October 26, 1982, the Board granted summary disposition on Contention 6a, on Contention 6(b)(2), on the first two sentences in Contention 6b and deleted "not included or" in Contention 6b.

5/ After the Board admitted Contention 8 on decommissioning, the Intervenors withdrew the contention, Tr. 4955-4956 scope of the evidentiary hearing commencing on August 23, 1982 would be limited to contentions relating to site suitability. In June of 1982, the Staff had published the "Site Suitability Report in the Matter of Clinch River Breeder Reactor Plant, Docket No. 50-537," NUREG-0786. The exact wording of the contentions litigated in all phases of the hearing is included in this document in Section II, the Statement of Contentions.

On July 19, 1982, the Board issued a "Notice of Evidentiary Hearing and Prehearing Conference" setting August 23, 1982 as the date for a Prehearing Conference and for the Evidentiary Hearing at Oak Ridge, Tennessee. Evidentiary hearings were held on August 23-27, 1982 concerning the site suitability aspects of Contentions 1a, 2a-h, and 3b-d. In October of 1982, the Staff issued the "Supplement to Final Environmental Statement Related to Construction and Operation of Clinch River Breeder Reactor Plant, Docket No. 50-537," NUREG-0139, Supplement No. 1, Vols. 1 and 2. On October 13, 1982, the Board issued a "Notice of Resumption of Evidentiary Hearings" establishing November 16-19, 1982 and December 13-17, 1982 as the dates for continued evidentiary hearings. During November 16-19, 1982, evidentiary hearings were conducted concerning the environmental aspects of Contentions 4, 5a, 6, 7c and 11. Thereafter, during the week of December 13-17, 1982 evidentiary hearings concerning the environmental aspects of Contentions 1, 2, 3, 5b, 6, 7a and b, and 11 were held.

The record of this proceeding consists of the transcript of the Licensing Board's prehearing conferences of September 16, 1975 (Tr. 1-64), March 22 and 23, 1976 (Tr. 65-458), May 24, 1976 (Tr. 459-581), September 23, 1976 (Tr. 582-755), March 21, 1977 (Tr. 756-967), February 9 and 10, 1982

(Tr. 968-1233), April 5 and 6, 1982 (Tr. 1-472), April 20, 1982 (Tr. 473-684) and August 2, 1982 (Tr. 685-875). In addition, oral argument on Intervenors' Contentions 10 and 11, as proposed in 1975, were held before the Commission on July 16, 1976 (Tr. 1-102). On October 19, 1976, the Atomic Safety and Licensing Board conducted an oral argument on Lenoir City's et al.'s petition to intervene (Tr. 1-139). The evidentiary record of this proceeding consists of transcripts of hearing sessions of August 23-27, 1982 (Tr. 1234-3217), November 16-19, 1982 (Tr. 3218-4946) and December 13-17, 1982 (Tr. 4947-7105). Additionally, the exhibits which were received in evidence are listed in Appendix A, attached hereto.

In making these findings and conclusions, the Board reviewed and considered the entire record of the proceeding and all of the proposed findings of facts and conclusions of law submitted by the parties in the proceeding. All of the proposed findings of fact and conclusions of law submitted by the parties which are not incorporated directly or inferentially in this Partial Initial Decision are rejected as being unsupported in law or fact or as unnecessary to the rendering of this Partial Initial Decision.

II. OPINION

This opinion supplements, and should be read in addition to, the oral argument presented by the Staff and Applicants on December 16 and 17, 1982 and January 4 and 5, 1983. Although this argument briefly summarizes the argument that was presented on those dates, the argument contained in this submittal is largely supplemental to the oral argument advanced by Applicants and the Staff.

A. Uncontested Site Suitability Matters (Fdgs. 1 - 53)

The Board finds that the Staff and Applicants have properly described, and have given appropriate consideration to, the characteristics of the reactor design and proposed operation, the population density and use characteristics of the site environs, and the physical characteristics of the site, insofar as they were not contested in this proceeding. These matters are addressed throughout the Staff's Site Suitability Report in the Matter of Clinch River Breeder Reactor Plant, NUREG-0786, dated June, 1982 (Staff Ex. 1).

B. Site Suitability Accident Evaluation: Contentions 1a, 2a, 2b, 2c 2e and 3b-d (Fdgs. 54- 108)

The purpose of DBAs is to establish analytical tests of the safety systems and features of a reactor. Following the practice of LWR licensing, accidents involving very improbable multiple failures of safety systems or failure of conservatively designed safety features need not be included in the DBA spectrum. The Staff has identified feasible design and operational measures, including those normally applied to LWRs and those special measures needed for LMFBRs, which will be implemented at CRBR to assure that the conditions which could lead to CDAs are very improbable. Given the current state-of-the art of reliability analysis methodology for reactor systems it is more appropriate to continue to rely on established deterministic criteria and engineering judgment than on reliability analysis and goals in establishing which accidents are included in the design basis accident spectrum.

The lessons learned from previous reactor accidents have been factored into the criteria to be applied to CRBR. Although human errors could cause CDAs, this will be very unlikely based on implementation of NRC's human factors review procedure.

Taking all the above into account it is reasonable to exclude CDAs from the CRBR design basis accident envelope. For the purpose of the site suitability review, the Staff's analyses of potential accident initiators and sequences and events is sufficient.

The Staff also finds that there has been an adequate evaluation of the potential effect of human error on accidents at CRBR for the purpose of site suitability analysis, and that the detailed review to be carried out by the Staff and Applicants in subsequent reviews of CRBR will assure that it will be very unlikely that human error could affect the safe operation of the plant.

C. <u>Site Suitability and Environmental Computer Codes and Models: Contention 2f, g and h</u> (Fdg. 114)

The issues of the proper documentation, validation, and verification of the computer codes and models, as well as the input for the codes, was not contested by Intervenors in either the site suitability or environmental phases of the proceeding. Accordingly, the Board has no trouble adopting the conclusions of the Staff and Applicants that the computer codes and models, and the input to the computer codes, were adequately described and verified for the purposes of the site suitability and environmental reviews.

D. Site Suitability Containment Design: Contention 2d (Fdgs. 109 - 113)

We have concluded that for a reactor of this general size and type it is feasible to design, construct and operate an adequate containment which can maintain the leak rates assumed in the Staff's and Applicants' site suitability source term analysis. This point was not contested by any NRDC, et al., testimony.

E. Uncontested Environmental Matters (Fdgs. 115 - 186)

The Board finds that the Applicants and Staff have properly evaluated the environmental impacts of construction and operation of the proposed Clinch River Breeder Reactor, as well as the environmental measurement and monitoring programs, and the overall cost-benefit balancing of the proposed facility. This evaluation was fully in compliance with NEPA, Sections 102(A), (C) and (D), and the relevant portions of 10 C.F.R. Part 52. These matters are addressed in the Staff's Final Environmental Statement related to construction and operation of the Clinch River Breeder Reactor Plant, NUREG-0139, dated February 1977 (Staff Exh. 7), and the Final Supplement thereto, dated October 1982(Staff Ex. 8).[6/]

6/ The State of Tennessee and the City of Oak Ridge, although removing themselves as parties to this proceeding, advanced written positions regarding the socio-economic impacts of construction of the CRBR. "Position Paper of the Tennessee Attorney General on Socio-Economic Impact Matters and Other Matters Relating to the Clinch River Breeder Reactor Plant," dated November 10, 1982 and "The City of Oak Ridge's Statement Relative to the Socio-Economic Impact of the Clinch River Breeder Reactor Plant," dated November 12, 1982. Although the City and the State did not offer any evidence on the matter, and did not

(FOOTNOTE CONTINUED ON NEXT PAGE)

F. Environmental Effects of Accidents: Contentions 2c, d, f-h, and 3c and d (Fdgs. 187 - 215)

The analysis of CDAs and their consequences as described in the Supplement to the Final Environmental Statement (Staff Ex. 8) meet all the requirements for environmental impact considerations under NRC regulations and policy, and under the National Environmental Policy Act, for the description of such impacts and performing the NEPA cost/benefit analysis, and are totally adequate for such purposes. The radiological source term analysis has adequately considered the possible releases of fission products and core materials, and also the potential environmental conditions in the reactor containment building created by the possible release of substantial quantities of sodium. The Staff has adequately considered the potential release of sodium following a CDA, including

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6/ (FOOTNOTE CONTINUED FROM PREVIOUS PAGE)

participate in the hearings, they did request socio-economic monitoring, mitigation of adverse socio-economic impacts, and financial assistance from DOE on an in-lieu-of-tax basis. The Board has determined that it need not pursue the issue, since the record of this proceeding adequately supports the Staff and Applicants' conclusions that socio-economic impacts from construction are acceptable provided that the precautions set forth in the FES at pages v. and vi. are followed. The Staff has proposed license conditions which require Applicants to implement a comprehensive socio-economic monitoring program in Section 6.1.6 of the 1982 FES Supplement for CRBR (Staff Ex. 8). The Board believes that any license conditions requiring Applicants to "mitigate adverse socio-economic impacts," as requested by the State, is not warranted at this time. The Board believes that proposed license conditions (e) and (f) on page vi. of the Staff's FES Supplement (Staff Ex. 8) adequately protected the State and City against unforeseen impacts. Finally, the City's request that 42 U.S.C. Section 2391 financial assistance payments from DOE to the City be made on an in-lieu-of-tax basis, has previously been determined by the Board to be an appropriate issue in this proceeding, and should be denied. (Order of August 26, 1976; LBP-76-31, 4 NRC 153, 158).

the possible range of quantities released, and has considered the environmental conditions caused by such a release in the analysis of radiological consequences.

The Staff properly concluded that the proposed containment system, or suitable feasible modifications thereof, can adequately reduce calculated offsite doses to an acceptable level, and that it can serve adequately toward keeping the risks from the CRBRP comparable to, or better than, the risks from current LWRs. The Staff has established that the proposed primary system and containment system designs provide sufficient containment function capability, taking into consideration the feasibility of modification if further enhancement of the containment is necessary, to assure that the analyses of radiological consequences of accidents as presented in the NEPA review are valid and provide the descriptions and analyses needed to meet NEPA and other federal regulatory requirements for such purposes. The Staff has given sufficient attention to CRBR accidents other than the DBAs, i.e., that the Staff has evaluated, adequately for the NEPA review, possible CRBR accidents other than DBAs, as evidenced in the FES and its Supplement. Furthermore, as part of that effort, the Staff has given considerable attention to accidents associated with core melt-through following loss of core geometry and sodium-concrete interactions, and we have concluded that, for the NEPA review, the Staff has adequately analyzed such accidents.

In the Staff's evaluation of the full range of accidents possible at CRBR, including the initiation, control and mitigation of accidents, the Staff has, for the purposes of environmental review, adequately identified and analyzed and given due consideration to the ways in which human error can initiate, exacerbate, or interfere with the mitigation of CRBR accidents.

In support of their argument that CDAs should be DBAs, Intervenors take the ratios of doses calculated at the K-25 plant and "in the worst direction" to derive a dose calculation which results in dose values exceeding the 10 C.F.R. Part 100 dose guidelines. Upon close inspection, however, the argument is found to be not valid, because it assumes that factors for the calculations are the same for both parts of the ratio when they are not. Specifically, Intervenors argue that the probability of CDA impacts in a given sector direction of 10^{-5} is the worst case probability. Tr. 6625, Cochran. This is not supported by the record. The value calculated by Cochran accounts for the 1 in 16 chance (about 10^{-1}) of impacts in a given sector. This factor of 10^{-1} therefore accounts for an average chance of impacts in that sector. The worst sector impact, for example, a release from accidents more severe than the HCDA or SSST accident with the wind blowing toward the Y-12 or K-25 plants, would have a probability at least an order of magnitude smaller than the accident and release probability, or about 10^{-7} per year.

Although Intervenors argue that the worst case doses can be calculated by changing the realistic (50%) X/Q from one direction to another, this disregards temporal variations of X/Q. For example, the dispersion parameters (X/Q) for 7 days at K-25 that can be expected 50% of the time in one direction cannot be compared with the 30-day dispersion parameter in the same direction at the LPZ that can be expected 0.5% of the time by the simple ratios. The site suitability dose estimates by Staff and

Applicants are based on 0.5% X/Q values obtained for each of the 16 sectors over a long period of time. Dr. Cochran's assumptions neglect the spatial as well as temporal variation of X/Qs.

The Staff's and Applicants' estimates of dosages at Y-12 and at K-25 were based on realistic X/Qs. In other words realistic X/Q values were used in both locations, not the low likelihood X/Q values (0.5%) used for assessing the site suitability source term, which Intervenors used.

Intervenors then compared a realistic dose of 320 millirems at K-25, calculated for a 50% X/Q for a duration of 7 days, with the conservative site suitability dose at LPZ of 7000 millirems, which was calculated by using a 0.5% X/Q (conservative value) for a 30-day duration of exposure. This method is incorrect, since it compares doses which do not correspond to each other in terms of X/Qs and the exposure duration.

Intervenors repeat the same errors for the comparision of whole body doses and in comparing Applicants' doses.

Thus, although Intervenors argue at Tr. 6641 that they calculated the worst sector thyroid dose for realistic NEPA assumptions rather than conservative site suitability source term analysis, this is incorrect. As shown above, the dose estimates of Dr. Cochran reflect 0.5% X/Qs, and lower filter efficiencies than were assumed for the Staff's and Applicants' conservative analysis. Fifty percent X/Os and realistic filter efficiencies are needed to compare realistic LPZ doses with 10 C.F.R. Part 100 dose guidelines.

Dr. Cochran's argument at Tr. 6648 indicates that he misunderstands the functioning of the proposed CRBRP containment systems and the proposed design and the manner in which accident radioactivity releases to the containment are to be handled. He states that the "annulus filtration system takes activity from outside the containment in the annulus and pumps it back in" (Tr. 2039) whereas the record indicates that filtered atmosphere from the annulus is partially released and partially recirculated to the annulus, not back into the containment. For the handling of CDAs, the annulus filtration system is followed by and not, as Dr. Cochran asserts, simultaneous with (Tr. 6648) initiation of the annulus cooling system and the venting and purging through the TMBDB filter system (containment cleanup system).

G. Safeguards of plant and Fuel Cycle: Contentions 4 and 6(b)(4) (Fdgs. 216 - 250)

Despite Intervenors' arguments to the contrary, the Staff did consider the effects of successful acts of theft or sabotage and found them unacceptable. As a result, the Staff's analysis focused on taking the "hard look" NEPA requires to determine that the safeguards systems in the CRBR fuel cycle will be appropriate to protect against successful acts of theft or sabotage.

The Staff's methodology for the safeguards analysis employed three criteria for reviewing safeguards. Intervenors' arguments that the criteria chosen by Staff do not provide a "high degree of assurance" indicates a confusion of the requirements for meeting safeguards regulations and the requirements to meet NEPA responsibilities. A review showing that the regulations are met, which includes a showing under 10 C.F.R. § 73.20 that there is high assurance that activities do not constitute unreasonable risk to the public health and safety, is the showing required to meet NRC safeguards regulations, not NEPA. Furthermore, a finding under that regulation need not be made until the operating license stage, and even then will be applicable only to physical security. The test for NEPA, is that the analysis must take a "hard look" at the environmental effects attributable to safeguards in the fuel cycle.

The Commission has recognized the unusual circumstances of this case where two agencies, both subject to NEPA, are responsible for the same project. U.S.E.R.D.A., et. al (Clinch River Breeder Reactor Plant), CLI-76-13, 4 NRC 67,77 (1976). Further, a programmatic statement has already been issued by ERDA, now a part of DOE, which includes the CRBR project. Id. While NEPA does not specifically address to what extent a second agency should review a project for which a programmatic statement applies, the courts and the Commission have provided some analyses which can aid such a determination.

The Commission has directed that, as a result of both Congressional limitations and the programmatic statement, although an environmental analysis of the Clinch River project is required, such an analysis should be a limited one. CLI-76-13, supra, at 86. The Commission ruled that some issues were entirely precluded from NRC review as a result of ERDA's programmatic statement for the LMFBR program, while others were still subject to NRC review. Id. at 90-92.

Court decisions provide a guide for judging the extent of the limited review of CRBR which NRC should conduct. There has developed in the law a "rule of reason" in judging NEPA reviews. This principle was discussed by the D. C. Court of Appeals in Natural Resources Defense Council, Inc. v. Morton, 458 F.2d 827, 834-8 (D.C. Cir., 1972). The court noted that what is required is information sufficient to make a reasoned decision. Specifically, as to alternatives not within the control of the agency, the court noted that reference could be made to studies of other agencies. Id. It would, therefore, be entirely appropriate for the present review to place reliance on DOE analysis concerning fuel cycle alternatives which are within DOE's responsibility.

Further evidence that NRC need not perform its own independent review of DOE's fuel cycle facilities to be used for CRBR comes from discussion in the Morton case which indicates that no agency need conduct a "crystal ball" inquiry into alternatives. Rather, the agency is subject to a rule of reason in analyzing alternatives. Id.

The Commission in CLI-76-13, noted that it was appropriate, in determining the scope of a NEPA review, to take into account the practical consideration of the Congressional allocation of responsibility for the decisions involved. Id. at 90. By analogy, in discussing the table S-3 rule on the fuel cycle for LWR's, the Commission set forth a reasoned approach for analyzing fuel cycle impacts.

> Although the rule should reflect as accurate an assessment as reasonably possible of uranium fuel cycle impacts, the rule clearly does not need the detail or precision of an environmental analysis for licensing fuel cycle facilities themselves. A reasonable degree of uncertainty is unavoidable and is acceptable, given that basic decisions have not yet been made regarding reprocessing and the technology of waste disposal.
>
> A reasonable approach for determining waste disposal impacts is to focus on a system which seems likely to be deployed and to estimate its impacts conservatively, based on the best available information and analysis. 44 F.R. 45362 (August 12, 1979).

When taking the above case law and Commission pronouncements into consideration it is evident that the decision by NRC to review those fuel cycle facilities which DOE has indicated would be used for the CRBR fuel cycle, is correct. This conclusion, however, should not lead one to ignore the conservatisms built into the Staff's analyses. Moreover, in some cases, the Staff analysis bounded alternatives which might be chosen.

For example, although Staff's review focused on DOE's proposals for a specified preferred fuel cycle, it did consider the possibility that facilities other than DRP might be built for reprocessing and that there may be no reprocessing at all. DOE states in its Environmental Report that the safeguards provisions for the reprocessing plant where CRBRP fuel is eventually processed will be similar to those described earlier for the DRP. Staff assessed whether DOE could reasonably meet those commitments and concluded that DOE could. In this regard, it is important to keep in mind the fact that the balance of the CRBR fuel cycle facilities need not undergo an NRC licensing review as part of this proceeding.

The Morton case gives the directive that, so long as agencies take a "hard look" at environmental consequences, the courts should not interject themselves into the review process. Morton at 838. Further, this "hard look" would also be subject to the rule of reason discussed above. When these two points are considered in conjunction with the fact that the NRC is reviewing another agency's environmental analysis in the form of DOE's Environmental Report (ER), the correctness of the Staff's approach is evident. This is because the court in Morton, as discussed above, specifically stated that where the alternatives (in this case fuel cycle alternatives) are the responsibility of another agency, the reviewing agency may rely on the studies of the responsible agency. In this case, NRC may rely on the ER prepared by DOE. Nevertheless, the Staff performed a sensitivity analysis to qualitatively assess alternative fuel cycles.

Thus, it is apparent that the NRC Staff designed an approach to the environmental review which amounted to a "hard look" at the analyses conducted by DOE as presented in their ER and found that the radiological and sociological impacts from the CRBR fuel cycle were an insignificant factor in any cost-benefit balance for the CRBR project.

With respect to environmental effects, the Staff examined DOE's analysis to determine the reasonableness of DOE's approach, the credibility of and conservatism of DOE's assessment methods, and the use of the best available information and techniques. In some instances, the Staff independently conducted an analysis and used whichever results (Staff's or DOE's) were most conservative.

The above discussion clearly shows that both the Staff's choice of alternatives to be analyzed for the CRBR fuel cycle and the method chosen to conduct that analysis meet the requirements of NEPA as interpreted by both the Commission and the judiciary.

In order to conduct this NEPA analysis the Staff established 3 criteria, they are:

1. Do DOE's proposed safeguards systems provide a potential for deterring attempts at theft or deversion of plutonium and attempts at sabotage of facilities or materials to be used in the CRBR 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?

The Staff also considered the design basis threat and other applicable regulations.

When considered with the knowledge that: 1) the "rule of reason" applies to NEPA analyses, 2) specific facilities have not yet been completely designed, and 3) the conclusion in Morton that one agency may rely on the studies performed by another agency, this procedure for review is obviously adequate and reasonable.

Intervenors also raise issues that are generally related to the threat levels used for designing safeguards systems. The first of these is the position that CRBR is especially susceptable to sabotage or theft because of its use of plutonium as a fuel source. This position, aside from a lack of factual basis as discussed below, is also a roundabout way of attacking the Commissions threat level definitions contained in 10 C.F.R. Part 73. Such a challenge is impermissable under 10 C.F.R. 2.758 and Intervenors have not followed the procedures required to get an exemption from that provision.

Aside from the argument being legally impermissable, testimony at the hearing established that CRBR's use of formula quantities of nuclear material was not unique. Other facilities, which have operated with formula quantities of nuclear material without theft or sabotage problems, were identified at the hearing.

The second question as to threat relates to the discussion of the comparability of DOE and NRC threat guidance. Since NRC safeguards regulations are deemed adequate to protect against theft or sabotage and are not subject to challenge in individual licensing proceedings, it follows that if DOE threat guidance, to be applied to fuel cycle facilities, is comparable there should be adequate safeguards for DOE facilities to protect against theft or sabotage. As the findings show, not only are the threat levels comparable, but there is a continuing review by NRC, DOD, and DOE to assure adequacy and to transfer information from one agency to another.

Having established the comparability of NRC and DOE threat levels, the Staff analyzed the proposed safeguards at fuel cycle facilities on a systems basis to determine that the proposed safeguards contained all the systems necessary to address the threat of theft or sabotage. The Staff was then able to estimate the environmental impacts of those systems.

The above method of analyzing the environmental effects of safeguards for the CRBR fuel cycle, when considered in conjunction with that fact that fuel cycle facilities are not yet completed and that DOE will have separate NEPA responsibilties for those facilities, is both complete and reasonable under the "hard look" requirements of NEPA as interpreted in Morton.

Intervenors' witness for Contention 4 and 6(b)(4) regarding safeguards of the CBBR plant and of the fuel cycle was Dr. Thomas B. Cochran. Dr. Cochran admitted that he had never participated in the design or inspection of a physical security system or in the design or inspection of a material control and account system for a plutonium handling facility or a nuclear power reactor (Tr. 3789-3791). In addition, Dr. Cochran has never reviewed a specific physical security system plan for a nuclear power plant or a plutonium handling facility (Tr. 3790). With regard to firsthand knowledge of the fabrication and assembly of the components of the physical security system and the material control and accounting system for a nuclear power plant or a plutonium handling facility, Dr. Cochran stated that he did not even have this knowledge (Tr. 3791-3972. Security systems and material control and accounting systems involve detection devices and sensor systems.

Dr. Cochran claimed he has a limited knowledge with the current state of technology concerning exterior and interior sensor systems (Tr. 3792). However, when Dr. Cochran was questioned about specific systems he admitted that he was not familiar with the current state of technology concerning video motion detection devices, interior volumetric sensor systems, microwave sensors, infrared detectors or devices for non-destructive assay of scrap or waste (Tr. 3792-3794). With this very limited understanding of the technology involved in the safeguards area, the Board is unable to lend a great deal of credibility to Dr. Cochran's testimony on this subject.

H. Impacts of Fuel Cycle: Contention 6(b)(1), 6(b)(3) and 6(b)(4) (Fdgs. 251 - 302)

The analysis of the safeguards and the fuel cycle for the CRBR contained in the Final Environmental Statement Supplement are adequate.

This conclusion is supported by all the findings of fact related to these issues. Specifically, however, an analysis of the methodology used for the NRC Staff review of these issues reveals the appropriateness of the Staff review procedure, and an examination of the evidence presented during the hearings reveals no error in that review. This portion of the brief will first discuss the general methodology common to the analyses of both the fuel cycle and safeguards for the fuel cycle, and will then separately discuss specific issues raised by the Intervenors.

Turning to the specific issues related to the fuel cycle, we note that discussion at the hearing addressed whether the Staff's analysis of the DRP bounded any possible choices for reprocessing CRBR fuel. While the discussion above indicates that it may not be required that NRC go beyond the DOE choice of alternatives for the fuel cycle, the Staff, in fact, conducted an analysis of DRP which bounds all reasonably likely alternatives.

With respect to waste management, the Staff has considered the wastes from each step of the CRBR fuel cycle. A key conclusion to the Staff's analysis, which was not disputed by Intervenors, is that wastes from CRBR will be similar to other wastes from the commercial nuclear power industry and can be handled by similar means. When this is considered along with the very small fraction of the total commercial nuclear waste which will be attributable to CRBR, the extensive studies of similar commercial nuclear wastes, and the conservative bases of the Staff analysis, the correctness of the Staff's conclusion of no significant effects from waste management becomes apparent.

The Intervenors also questioned the ability to meet confinement factors for the DRP. Testimony at the hearing established that the attainment of the confinement factors required a small improvement over the present level of confinement factors and should not be difficult to obtain. This point was not seriously controverted by Intervenors.

The question of what fuel material would be used at CRBR was also considered at the hearing. While the Staff analysis originally considered only once through use of fuel as proposed by Applicant, the Staff also conducted a qualitative analysis which determined that a more realistic fuel cycle, using fresh fuel initially followed by recycled CRBR fuel, would not significantly change the Staff's environmental analysis. This qualitative analysis conducted at Staff initiative was eventually quantitatively confirmed by a Staff analysis of modified data from Applicants, which was instituted at Staff request. Additionally, the testimony established that the use of recycled LWR plutonium in the time frame of consideration was unrealistic. Thus, the Staff's use of 20% PU-240 for its environmental analysis was conservative and appropriate.

The Board accorded little weight to the Intervenors' testimony offerred by Dr. Johnson on the matter of impacts of the fuel cycle. Dr. Johnson has no formal training or experience with the processes that comprise the CRBR fuel cycle, nor with the components of the Rocky Flats facility with which Dr. Johnson had concerns, i.e., fire control and ventilation systems for that and other DOE fuel cycle facilities. By contrast, Staff witness Lowenberg, who was very familiar with Rocky Flats and other fuel cycle reprocessing plants by virtue of his facility design experience, testified that Rocky Flats was not comparable to the CRBR fuel cycle reprocessing facilities, but that in any event DOE has taken steps through orders, which are applicable to CRBR fuel cycle facilities, which require design features which help to prevent the reoccurrence of fires such as occurred at Rocky Flats and which require protection of the radioactivity filters, mitigation of fire sources, and the installation of fire detection and heat rise instruments. Further, although Dr. Johnson complained that the Staff's environmental analysis failed to address doses to bone and other internal organs, he testified that he had no basis to refute the Staff's testimony in its Supplement to the FES, wherein the Staff stated doses for internal organs for the CRBR blanket fuel and core fuel assembly fabrication plants, and that for the fuel cycle facility with the dominant contribution to population doses, the Staff appropriately considered doses to the whole body, rather than to any specific organs. Finally, Dr. Johnson conceded that his argument that the Staff had underestimated the radiotoxicity of plutonium is based on a study of effects on 69 dogs whereas the Staff based its assumptions on the National Academy of Sciences BEIR I and III reports, which are based on studies of thousands of humans. Moreover, the author of the article upon which Dr. Johnson relies cautions that a meaningful comparison of human and animal exposures required to produce tumors is not possible at this time.

In sum, the Staff's analysis of environmental impacts resulting from the CRBR fuel cycle activities was adequate and in compliance with applicable law.

Intervenors' witness for Contention 6 regarding the impacts of the fuel cycle was Dr. Thomas B. Cochran. Dr. Cochran stated that he nevery participated in the design of a plutonium fuel cycle facility or a radioactive effluent control systems for any plutonium fuel cycle facility (Tr. 4525-4526). Regarding Dr. Cochran's participation in the design of a nuclear power plant core, his knowledge is from college class exercise (Tr. 4526). He admitted he is not an expert reactor core designer in any business way (Tr. 4527). Intervenors contested the capabilities of HEPA filters to minimize any environmental releases. However, Dr. Cochran, a health physicist, had never seen a HEPA filter or had any familiarity with actual hands-on maintenance or operational performance of HEPA filters. Dr. Cochran's knowledge of HEPA filters was limited to his reading about the filters (Tr. 4549). The Board recognizes that Dr. Cochran is not an expert in the areas of designing a plutonium fuel cycle facility, radioactive effluent control system or a reactor core. Additionally, the Board is cautioned in attributing a greal deal of weight to Dr. Cochran's testimony on HEPA filters because of the limitation of his experience.

I. Alternative Sites: Contentions 5(a) and 7(c) (Fdgs. 303 - 390)

These contentions allege that the Staff's environmental review of alternatives in the FES Supplement for CRBR is inadequate in two respects. First, Intervenors contend that the Staff failed to adequately evaluate alternative sites to the Clinch River site, especially with regard to demographic and meteorological factors. Second, Intervenors contend that the Staff failed to consider the alternative siting concepts of co-location and underground siting. Contrary to Intervenors' claims, the Staff has shown that it has conducted a comprehensive evaluation of the Clinch River site, four alternative TVA sites and three DOE sites. In its review, the Staff considered meteorology, including atmospheric dispersion (X/Q) at each of the alternative sites, and its contribution to radiological risk. Demographic factors, including population density, were also considered by the Staff. The Staff's testimony conclusively show that the Staff did take the requisite "hard look" at alternative sites to Clinch River before concluding that there are no "substantially better" alternative sites to Clinch River. The correctness of the Staff's conclusion is bolstered by the fact that Intervenors failed to present any affirmative evidence on this aspect of the contention.

With regard to the alternative siting concept of co-location, the Staff's unchallenged evidence shows that co-location has no substantial advantage in terms of public safety and security. The Staff's evidence also shows that any hypothetical advantages of underground siting are outweighed by the disadvantages of cost, operational problems, and construction difficulties. Intervenors failed to present any affirmative evidence, and failed to cross-examine the Staff and Applicants' witnesses on underground siting or co-location.

J. Evacuation of Nearby Facilities: Contention 5(b) (Findings 391 - 433)

The effect of evacuation of the Oak Ridge National Laboratory ("ORNL"), the Oak Ridge Gaseous Diffusion Plant ("K-25"), and the Y-12 plant on the national energy supply and national security is the subject of this contention. The Staff and Applicants' witnesses testified that

ORNL plays no role in the national energy supply, and that long-term evacuation of ORNL would not affect national security. The evidence conclusively shows that while evacuation of the Y-12 plant may be necessary following the occurrence of an Hypothetical Core Disruptive Accident ("HCDA"), that evacuation is not expected to be for a long period, and that such shutdown would not significantly affect weapons production. With regard to the effect of Y-12 evacuation on the national energy supply, it is undisputed by Intervenors that Y-12 plays no role in the fuel cycle for any energy generation mode, and that evacuation of Y-12 would not affect the national energy supply. The K-25 plant may require evacuation following an HCDA, but that such evacuation would not affect national need for utility-grade uranium due to (1) the considerable under-utilized capacity and operating flexibility of the remaining two gaseous diffusion plant ("GDP") complex and (2) the construction and operation of the Portsmouth gas centrifuge plant. K-25 evacuation will have little adverse affect on national security, since the nation's supply of highly enriched weapons-grade uranium is provided by the Portsmouth GDP. Intervenors presented no evidence in this area, and the evidence conclusively supports the Staff's and Applicants' findings on the likelihood and consequences of ORNL, Y-12 and K-25 evacuation due to SSST Accidents and HCDAs at CRBR.

K. Alternative Designs and Programmatic Objectives: Contention 7(a) and (b) (Fdgs. 434 - 493)

Two related issues are raised by this contention. Intervenors contend that the programmatic objectives of the CRBR project have not been adequately demonstrated. They also allege that alternative design features which have been utilized in foreign LMFBRs have not been evaluated by Staff to determine if they are "substantially better" alternatives. No affirmative evidence was presented by Intervenors on this contention. Moreover, the Staff's and Applicants' evidence clearly supports the findings that CRBR will meet the programmatic objectives of timeliness, and that selection of an alternative site is an avoidable delay. The Staff also presented testimony showing that adoption of the General Accounting Office's ("GAO") proposed testing program represents an avoidable delay and does not represent a substantially better, technically-justified alternative. There was extensive testimony by Staff and Applicants' witnesses that CRBR will utilize design concepts most likely to be used for commercial LMFBRs; and that Applicants have implemented informational systems and programs to assure that data on CRBR cost, reliability and maintainability are collected and analyzed . There is also extensive evidence that CRBR is reasonably likely to generate information relevant to demonstrating the environmental acceptability of commercial LMFBRs. Six alternate design concepts employed on foreign LMFBRs were identified by Intervenors as alternatives which are "substantially better" than those used in the current CRBR design: flywheels on sodium pumps, self-actuated shutdown systems, core retention systems, the homogenous core, a fully-isolated containment, and the pool cooling system. Each of these alternative design concepts were evaluated by the Staff and Applicants. The Staff concluded that none of these concepts were "substantially better" alternatives which should be incorporated in the CRBR design. The record clearly demonstrates: 1) that the Staff comprehensively and objectively evaluated the CRBR design and Applicants' management and information systems, 2) the Staff's conclusions that CRBR will achieve its programmatic informational and timing objectives are correct and 3) that no substantially better design concepts exist.

L. Genetic Effects of Operation: Contention 11(b) (Fdgs. 494 - 496)

The Staff and Applicants presented convincing testimony indicating that the expected genetic effects from operation of CRBR, both to the general population and to plant workers, would be negligible. Both utilized accepted methodolgy endorsed by the BEIR III committee, of which the Staff witness was a member. Intervenors did not present testimony on the subject.

M. Cancer Risk of Operation: Contention 11(c) (Fdgs. 497 - 500)

Similarly, the Staff and Applicants adequately assessed the potential cancers that may occur from exposure of plant employees and the general public. The potential fatal cancer risk estimators that were used were based on models described in the National Academy of Sciences BEIR I Report, and are consistent with the recommendations of other national and international radiation protection organizations, which represent the views of the overwhelming majority of the scientific community. The Staff's and Applicants' estimates of potential cancers are appropriately conservative, and result in an estimate of cancer risk to the general public which is much less than natural background radiation, and a risk to the exposed work force which is a small fraction of the estimated normal incidence of cancer fatalities to that segment of the population.

N. Overall Conclusions

On the basis of the analysis and evaluation performed by Staff and Applicants, the Board concludes that, in all respects, the proposed Clinch River Breeder Reactor Plant site is a suitable location for the reactor of the general size and type proposed from the standpoint of radiological health and safety considerations under the Atomic Energy Act of 1954, as amended, and the rules and regulations promulgated by the Commission in conformance with this Act.

On the basis of the environmental evaluations performed by the Staff and Applicants, we conclude 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 alternaive TVA site using the hook-on arrnagement 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. Finally, the CRBRP would meet the demonstration plant's objectives within the LMFBR program.

The Board concludes, on the basis of the analysis and evaluation set forth in the FES and FES Supplement and the balance of the record in this proceeding, after weighing the environmental, economic, technical, and other benefits of the Clinch River Breeder Reactor Plant against their environmental and other costs, that the action called for under the National Environmental Policy Act of 1969 (NEPA) and 10 C.F.R. § 51 is the issuance of a limited work authorization subject to certain limitations to protect the environment set forth in Staff Sexhibit 7, p. iii and Staff Exhibit 8, pp. v-vi. The Board finds that the FES, as supplemented, is a comprehensive and adequate review and evaluation of the environmental impacts resulting from plant construction and operation.

III. FINDINGS OF FACT

A. SITE SUITABILITY - UNCONTESTED MATTERS

1. Site Description and Exclusion Area Control

1. The site consists of 1,364 acres on a peninsula formed by a meander in the Clinch River. The site is bounded on the east, south and west by the Clinch River and on the north by DOE's Oak Ridge reservation. The planned location of the plant structures is at an elevation of 815 feet above mean sea level (MSL) (Staff Exhibit 1, p. III-1).

2. The exclusion area is the site property and the river adjacent to the site, less 112 acres along the northern boundary which has been set aside for an industrial park. The minimum exclusion area boundary distance is approximately 670 meters (2,200 feet) measured from the center of the containment building southwest to the nearest point on the exclusion area boundary. The site property is owned by the United States of America and is presently in the custody of the TVA. TVA will transfer to DOE the custody of those portions of the site which are required for the purpose of designing, constructing and operating the CRBRP (Staff Exhibit 1, p. III-1).

3. The proposed exclusion area will not be traversed by any public highways or railroads; however, the Clinch River along the eastern, southern, and western boundary is included within the exclusion area. Movement on the Clinch River will be controlled in the event of an emergency by the Applicants in coordination with other appropriate agencies as specified in the radiological emergency plan. The river bank on the plant site will be posted to inform river users of the nearby nuclear plant. A small family cemetery is located in the southern part of the site. Access to this cemetery will be controlled by the Applicants (Staff Exhibit 1, p. III-1).

4. Based on the Applicants' custody of the site property and commitment to make arrangements to control traffic on the Clinch River in the event of an emergency, the Applicants have the proper authority to determine all activities in the exclusion area and that there is reasonable assurance that the Applicants can comply with the requirements of 10 C.F.R. Part 100 with respect to Applicants' control over the exclusion area.

2. Population and Population Distribution

5. The contested issue concerning the consideration of the aspects of population and population density with regard to the selection of alternative sites is addressed in section III.D.4 of these findings. Hereinafter, the uncontested aspects of the population and population distribution of the CRBR are discussed. The proposed site is located within the city limits of Oak Ridge, however, the residential area is located between seven and fourteen miles northeast of the site. Kingston, Tennessee, located 7 miles away in the west direction, is the largest nearby town

and had a 1980 population of 4,367. Other major nearby communities are Oak Ridge, Tennessee, (1980 population 27,522) located 9 miles northwest and Knoxville, Tennessee (1980 population 182,249) located 22 miles east-northeast of the reactor site (Id. Staff Exhibit 1, p. III-2).

6. The 1980 residential population within five miles of the site was 4,440 people (Staff Exhibit 1, p. III-1). For the year 1990, which is the projected time of plant startup, the projected resident cumulative population within five miles of the site is 4,680. In the year 2,030, which is the projected end-of-plant-life, the projected resident cumulative population within five miles of the site is 5,380. For a 30 mile radius of the site, the 1980 resident cumulative population was 516,540. By 1990 and 2030, the projected resident cumulative population for a 30 mile radius is 550,180 and 608,280 respectively (Id., p. III-2, 3). The Staff obtained an independent estimate of the 1980 population within 50 miles of the site from the U.S Bureau of the Census. The U.S Bureau of the Census estimated that the population within 50 miles of the site would be 837,300 which agreed with the Applicants' value of 830,800 (Id., p. III-2, 3). The Staff also compared the Applicants' projected population growth rate for the year 2030 of 2.5% per decade for the area within 50 miles of the site to the projected 5.6% per decade growth rate of the U.S. Bureau of Economic Analysis for Economic Area 50, an area comprising east-central Tennessee and southeastern Kentucky. Both the Applicants' 2.5% per decade growth rate and the Bureau of Economic Analysis 5.6% per decade growth rate are below the acceptance levels of Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations" (Id., p. III-2, 3). These are reasonable projections.

7. The transient population in the site vicinity, other than travelers on local roads and highways, consist of 16,900 workers at three large industrial activities on the Oak Ridge reservation which is within 9 miles of the site and 10,000 individuals at the peak hour use of the recreational facilities which are within 10 miles of the site (Staff Exhibit 1, p. III-2).

8. The Staff compared the projected population in the CRBR site vicinity with the acceptance criteria given in Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations," and Standard Review Plan Section 2.1.3. The resident plus weighted transient population density within 30 miles of the site at projected time of plant startup (taken to be year 1990) was well within 500 persons per square mile. Similarly, the resident plus weighted transient population density within 30 miles of the site at projected end-of-plant-life (taken to be year 2030) was well within 1,000 persons per square mile (Staff Exhibit 1, p. III-2). These transients (other than highway travelers) do not significantly alter the population distribution.

9. The Applicants have selected a low population zone with an outer radius of 2.5 miles. The total 1980 resident population within the low population zone is less than 1,500 persons. There are no significant transient populations within the low population zone other than highway travelers through the area (Staff Exhibit 1, p. III-2, 3). As a result of the evaluation of the low population zone proposed by the Applicants and Staff for the Clinch River Breeder Reactor site, there is reasonable assurance that the 10 C.F.R. Part 100 definition of the low population zone can be satisfied in that we have not identified any unusual characteristics

with respect to the low population zone which would prevent the development of appropriate emergency response procedures.

10. The nearest population center, as defined in 10 C.F.R. Part 100, is Oak Ridge, which contained a 1980 population of 27,522 persons. Furthermore, Staff projects that future residential development of Oak Ridge will not result in population growth closer than five miles within the operating lifetime of the proposed Clinch River Breeder Reactor facility due to present zoning restrictions. The Oak Ridge population center distance begins at a point seven miles in the north-northwest direction of the site. This distance satisfactorily meets the 10 C.F.R. Part 100 requirement that the population center distance be more than one-and-one-third times the low population zone distance (Staff Exhibit 1, p. III-3).

11. The specified minimum exclusion distance (2,200 feet) and the low population zone radius (2.5 miles) are of sufficient size because they compare favorably with the minimum exclusion distances and low population zone radii of previously licensed plants of similar size and design. Accordingly, there is reasonable assurance that adequate engineered safety features can be provided to satisfy the exposure guidelines of 10 C.F.R. Part 100 for reactors of the general size and type proposed for the Clinch River Breeder Reactor site. (Staff Ex. 1, p. III-3).

3. <u>Nearby Industrial, Transportation, and Military Facilities</u>

12. The contested issue of the impact of the CRBR on industrial facilities is addressed in section III.D.5. Hereinafter, the uncontested issue of the impact of nearby industrial, transportation and military facilities

are discussed. The nearby industrial facilities in the vicinity of the proposed site are the Oak Ridge Gaseous Diffusion Plant (ORGDP), Oak Ridge National Laboratory (ORNL), Y-12 Plant and a facility in the Clinch River Consolidated Industrial Park (CRCIP). ORGDP is located about three miles north-northwest of the site and produces enriched uraninum. Anhydrous hydrofluoric acid (AHF) has been identified as a hazardous material stored at ORGDP whose accidental release could impact on the safe operation of a nuclear plant at the Clinch River site by affecting plant operators in the control room. The Applicants evaluated a postulated accident in which AHF evolved as hydrogen fluoride (HF) gas. The Applicants have committed to install HF detectors in the control room air intakes which will alarm and automatically isolate the control room upon detection of the HF gas. In addition, communication procedures between ORGDP and CRBRP will be included in the site emergency plan. The Staff independently reviewed the Applicants' postulated accident and concluded that the release of a large quantity of HF gas at ORGDP will not preclude the acceptability of the Clinch River site on the basis that the installation of HF detectors in the control room intakes and adequate communication procedures will assure the timely isolation of the control room (Staff Exhibit 1, p. III-6). These are reasonable means to deal with an HF accident.

13. ORNL is located about four miles east-northeast of the site. Approximately 5,000 employees at ORNL are engaged in basic and applied research in activities in nuclear and other technologies. The Y-12 plant is nine miles northeast of the site and employs about 6,300 persons. Production and research and development facilities are pro-

vided at Y-12 for DOE. The Staff has determined that no activities have been identified at either ORNL or Y-12 which constitute a hazard to the safe operation of a nuclear plant at the Clinch River site (Staff Exhibit 1, p. III-6).

14. There is a small industrial facility located on a 33-acre tract in the 112-acre Clinch River Consolidated Industrial Park (CRCIP) along the northern boundary of the site approximately 1.5 miles from the proposed location of the plant structures. This industry employes 30 people and fabricates neutron absorbers for power reactors and fuel elements for test reactors. This activity is considered to be compatible with the development of the Clinch River site for a nuclear plant (Staff Exhibit 1, p. III-7). The small industrial facility will be compatible with the development of the Clinch River site.

15. The major transportation artery in the vicinity of the site is Interstate 40 which passes approximately 1.25 miles to the south. State Route 58 is about 1.5 miles to the northwest and State Route 95 about three miles east at their closest points of approach. Since hazardous materials for the nearby ORNL and ORGDF facilities are transported over these highways, the Applicants evaluated a postulated accident involving a tank truck carrying AHF. The AHF detectors in the control room air intakers, and the distances of these routes from the site, would ensure that highway accidents involving AHF will not preclude the suitability of the site. The Staff independently reviewed the analyses and concluded that the consequences of an AHF accidental release would be safety mitigated and such accidents will not preclude

the suitability of the site (Staff Exhibit 1, p. III-7). The site is suitable under accidents involving the transport of AHF.

16. The closest major rail line is approximately 10 miles northwest of the site. The Staff concluded that this distance is sufficient to eliminate potential railroad accidents as a factor in determining the suitability of the site (Staff Exhibit 1, p. III-7).

17. The nearest airports to the site are two light plane facilities located at a distance of about 10 miles from the site. The McGhee-Tyson airport in Knoxville, located 20 miles east-southeast of the site, is the closest major airport with scheduled commercial flights. The nearest flight path passes about ten miles south of the site. The Staff determined that the distances of these aviation facilities are adequate to ensure that the suitability of the site will not be adversely affected (Staff Exhibit 1, p. III-7). Air transportation will not adversely affect the site.

18. About one and one-third miles east of the proposed location of the CRBRP structures, is the nearest fuel supply pipeline. The 6-inch natural gas pipeline runs in a north-south direction. Based on the relatively small size of the pipeline and its distance from the site, the Staff concludes that this pipeline will not preclude the acceptability of the site even if in the future a more hazardous gas such as propane were added to the natural gas pipeline (Staff Exhibit 1, p. III-7). The pipeline will not adversely affect the suitability of the site.

19. There are no oil refineries or storage facilities, quarries, or mineral extraction operations in the vicinity of the site. Additionally,

there are no military bases or facilities within 10 miles of the site (Staff Exhibit 1, p. III-8).

20. In order to evaluate the potential impact on the Clinch River site of the possible future expansion of existing facilities and the development of new DOE programs, the Applicants conducted a survey for a long-range land use plan for the Oak Ridge reservation. The survey results were that potential new activities on DOE controlled land will not impose an undue risk on the safe operation of the CRBR (Staff Exhibit 1, p. III-8).

21. The Exxon Nuclear Company had requested a 2,500-acre site on the Oak Ridge reservation for storing and reprocessing spent fuel. The Exxon site was to be located approximately 2.5 miles north-northeast of the Clinch River site. Exxon had submitted an application to the Commission to construct this facility, however, since 1977 plans for that facility were terminated and the application was withdrawn (Staff Exhibit 1, p. III-8).

22. On the basis of the review of the nature and extent of potential hazards resulting from man-related activities which are conducted at nearby industrial, military, and transportation facilities, the activities in the vicinity of the Clinch River site are not likely to preclude site acceptability. Therefore, the Clinch river site is suitable for a reactor of the general size and type proposed.

4. Emergency Planning

23. The Applicants have provided a description of the preliminary plans for coping with emergencies. The Staff has completed its initial review of the plans against the requirements of 10 C.F.R. § 50, Appendix

E, Part II. The Federal Emergency Management Agency (FEMA), in its review of state and local plans for the nearby Sequoyah Nuclear Plant, found that the State of Tennessee Radiological Emergency Plans are adequate and capable of being fully implemented. FEMA will review the state and local plans for the emergency planning zones for the Clinch River site during the CRBRP operating license review for compliance to the criteria specified in NUREG-0654/FEMA-REP-1, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants" (Staff Exhibit 1, p. III-10). An effectively coordinated site, state and local radiological emergency response plan can be achieved for the Clinch River site.

5. Meteorology

24. The contested issue of the aspect of meteorology on the selection of alternative sites is addressed in section III.D.4. Herein, the uncontested aspects of meteorology are discussed. The Clinch River site is located in a broad valley of the southern Appalachian mountains and is in a region where atmospheric dispersion conditions are less favorable than average for all areas of the United States (Staff Exhibit 1, p. IV-1).

25. A description of the meteorological conditions of the site, including the climatology of the region, local meteorological conditions, and expected severe weather is presented in Section 2.6 of the Final Environmental Statement for the CRBR (Staff Exhibit 7). Section 6.3.1 of that document describes the onsite meteorological program. The onsite meteorological measurement system originally was not comparable to the

recommendations of Regulatory Guide 1.23, "Onsite Meteorological Programs," with respect to the location of wind and vertical temperature grandient measuring instrumentation. The system has been modified and it conforms to its recommendations (Staff Exhibit 1, p. IV-1).

26. All structures and equipment exposed to tornado forces and needed for safe shutdown of the plant will be designed to be consistent with the design basis tornado characteristics for Region I as recommended by Regulatory Guide 1.76, "Design Basis Tornado for Nuclear Power Plants" (Staff Exhibit 1, p. IV-2).

27. The Applicants have provided joint frequency distribution of wind speed and direction by atmospheric stability class (based on vertical temperature difference) collected on the Clinch River onsite meteorological tower during the one-year period February 17, 1977 through February 16, 1978. From these data the Staff calculated estimates of the relative concentration (X/Q) values for short-term releases from plant buildings and vents using the wind speed and direction measured at the 33 foot level and the vertical temperature difference measured between the 33 and 200-foot levels on the tower. In accordance with the methodology described in Regulatory Guide 1.145, short-term (up to 30 days) X/Q values were calculated. A direction-dependent atmospheric dispersion model with enhanced lateral dispersion during neutral and stable atmospheric conditions accompanied by low wind speeds was used. These enhanced lateral dispersion factors were based upon diffusion studies performed at several locations including the Clinch River site (Staff Exhibit 1, p. IV-1).

28. Two probablistic analyses were performed. The first analysis requires the development of the X/Q values for each of the 16 cardinal point sectors that is not exceeded 0.5% of the total time. The highest of each of these 16 sector X/Q values is defined as the maximum section X/Q value is compared with the overall site X/Q that is exceeded no more than 5% of the total time. Whichever value was higher was used to determine the consequences of accidental releases at the exclusion zone boundary of 670 meters and outer boundary of the low population zone of 4023 meters. For the Clinch River site the more conservative X/Q values were those based upon the 0.5% sector values and was thus utilized by the Staff to evaluate the consequences of design basis accidental releases. Although the atmospheric diffusion conditions at the Clinch River site are less favorable than the conditions throughout most of the United States, its X/Q values are still comparable to those which the Staff has calculated for several other nuclear power sites in the region (Staff Exhibit 1, p. IV-1, 2).

29. The Applicants have provided data which is reasonably representative of conditions at the proposed CRBRP site and is sufficient to conservatively estimate atmospheric dispersion characteristics. Additionally, the meterology at the proposed site is sufficiently characterized and there are no meteorological characteristics that would preclude the determination of site suitability in accordance with 10 C.F.R. § 100.11.

6. Hydrology

30. The proposed site for the CRBRP is located on the north shore of the Clinch River. The proposed plant grade will be about 815 feet above mean

sea level (MSL), which is about 74 feet above the normal river level of 741 feet MSL. The Clinch River drainage area is about 16,200 square miles, and the average flow is about 4800 cubic feet per second (CFS) at the site; the river is regulated by a series of dams, both upstream and downstream from the site. The site is most directly under the influence of the Melton Hill dam which is about five miles upstream (Staff Exhibit 1, p. IV-2).

31. Cooling tower makeup will be withdrawn from the Clinch River. The Staff has concluded that an adequate normal cooling water supply can be provided. Emergency cooling for safe shutdown and residual heat removal will be supplied by a mechanical draft cooling tower, which will have a sufficient supply of water available in its self-contained storage basin, consistent with the criteria suggested in Regulatory Guide 1.27, "Ultimate Heat Sink for Nuclear Power Plants" (Staff Exhibit 1, p. IV-2).

32. The potential for flooding of the site from several sources has been considered by the Applicants. The Staff performed an independent evaluation of the potential for flooding at the site consistent with the criteria of Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants." The maximum flood on record, judging from gage records and newspaper accounts, occurred in March 1886, with a reported water level of about 764 ft. MSL at the proposed site. This flood occurred before construction of the present, extensive TVA dam system. Since completion of the system of dams in March 1973, the maximum water level at the site has been about 750 ft. MSL which is about 65 ft. below plant grade. A repetition of the worst flood of record, but with the present

TVA dam system, would yield a water level of about 751 ft. MSL, 64 ft. below plant grade (Staff Exhibit 1, p. IV-2).

33. The Applicants have evaluated and the Staff has independently verified the precipitation induced Probable Maximum Flood on the Clinch River. The estimated maximum stillwater level is about 778 ft. MSL, 37 ft. below plant grade. Wind wave runup would add a maximum of about 4 ft. against vertical surfaces. These flood levels were found not be as severe as the Design Basis Flood (Staff Exhibit 1, p. IV-2, 3).

34. The Design Basis Flood for the proposed site has been determined by the Applicants to be caused by the assumed partial seismic failure of Norris Dam, about 62 miles upstream from the site, coincident with the Standard Project Flood with the attendant failures of the Melton Hill Dam and Watts Bar Dam. The Standard Project Flood is about half that of the Probable Maximum Flood and is generally representative of the maximum historical flood in the region. The maximum stillwater level at the site has been estimated by the Applicants to be about 804 ft. MSL, about 9 ft. below plant grade. Maximum wave runup would add an estimated 5 feet at vertical surfaces (Staff Exhibit 1, p. IV-3).

35. The Applicants have proposed that the site drainage facilities, including roofs, will be designed such that an occurrence of the local Probable Maximum Percipitation will not constitute a threat to safety-related facilities. These proposed design bases meet the criteria suggested in Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Report for Nuclear Power Plants," Revisison 2 (Staff Exhibit 1, p. IV-3).

36. Groundwater occurs at the site primarily in weathered joints and fractures in the surface rock, under water table conditions. All groundwater at the site flows toward the river, which is the groundwater sink. There are no groundwater users which could be affected by the unplanned release of liquid radwaste. Groundwater travel time to the Clinch River has been estimated by the Applicants to be a minimum of 28 years. Due to absorption, most radionuclides would travel more slowly than the groundwater (Staff Exhibit 1, p. IV-3).

37. There are no unique hydrological phenomena related to site flooding, that an adequate water supply can be provided for normal and emergency cooling, and that the hydrosphere offers no greater potential for surface water and groundwater contamination from unplanned releases of liquid radwaste than at other nuclear power reactor sites which have been approved. These conclusions are based on Staff's independent evaluations and comparisons by hydrologic parameters at this site with those at other approved plants. Therefore, hydrological conditions at the proposed Clinch River site are acceptable for the general size and type proposed reactor.

7. Geology

38. The proposed Clinch River site is located in the southeast section of the Valley and Ridge Physiographic Province of eastern Tennessee. Surface rocks at the site consist of two major geologic units, the Knox Group and Chickamauga Group. The former is predominantly a dolomite of Cambro-Ordovician age. The Chickamauga is the foundation rock for the site and consists of alternating layers and laminations of siltstone, limestone,

and shale with some chert. The bedrock is included in the zone of extensive thrust faulting in east Tennessee. The bedrock contains minor structures such as small faults (a few feet in length) and small folds. The strike is approximately N45°E and dips on the average about 40° southeast. The bedrock is overlain in some areas by terrace deposits of up to 40 feet thick, weathered rock, and extensive zones of clayey residual soil. The overburden thickness ranges from 8 to 56 feet deep over the site area. Most of the plant island is founded on the Chickamauga Unit A limestone and Unit A upper siltstone which do not have significant weathering except near the ground surface. Weathering and solutioning of the Unit B limestone in the site area appears to extend a maximum depth of about 100 feet primarily along jointing (Staff Exhibit 1, p. IV 3-4).

39. The foundation level of the plant island is about 15 to 80 feet below the top of continuous rock which is defined in the PSAR as rock which does not contain any significant weathered or solutioned discontinuities (Staff Exhibit 1, p. IV-4-5).

40. The closest major fault is the Copper Creek fault and its trace is located 3,000 feet from the site. At this location, the fault strikes N52°E and dips away from the site to the southeast at an approximate dip of 25 degrees. Displacement of this fault is about 7,200 feet with the Rome Formation thrust over Chickmauga Group rocks. This fault has a mapped length of 100 miles, but becomes complex and merges to the north with other faults. The Copper Creek fault is one of many Late Palezoic thrusts that developed during the Allegheny Orogency (Pennsylvanian-Permian, 330-240 million years before present, (MYBP). These structures are not considered active and are not used in determination of the Safe

Shutdown Earthquake. Radiometric dates of 290 ± 10 MYBP and 280 ± MYBP were obtained for mylonite fault gage material taken from the fault zone of the Cooper Creek thrust. This finding, coupled with lack of evidence of recent offset and an understanding of the tectonic development of the Paleozoic thrust faulting in east Tennessee, indicates that this major fault and other small faults in the site area associated with it are tectonically old. Therefore, these faults are not considered hazardous to the safe operation of a nuclear plant at this location. These faults are not capable faults as defined in "Seismic and Geologic Siting Criteria for Nuclear Power Plants," Appendix A, 10 C.F.R. § 100 (Staff Exhibit 1, p. IV-4).

41. Considerable new regional geologic and seismic information has been obtained since publication of the SSR, including new data regarding the Giles County and Charleston earthquakes and theories about their source mechanisms. The Applicants are assessing this new information relative to the proposed CRBRP site. The Staff has been following the development of new information and to date finds no reason to change its conclusions regarding the suitability of the site (Staff Exhibit 1, p. IV-4).

42. A facility for injecting radioactive waste into subsurface strata is located on the Oak Ridge Reservation approximately four miles east of the proposed CRBRP site. These injection wells have been used periodically since February 1954 to inject wastes mixed with a cement grout slurry into the Conasauga shale along cracks generated by hydrofracturing. Thus far, injections have been into units stratigraphically above the projection of the Cooper Creek thrust fault (Staff Exhibit 1, p. IV-4).

43. Many small seismic signals resembling earthquakes have been recorded on the seismograph at Oak Ridge. These occur primarily during working hours. Moreover, they do not seem to occur any more frequently when injection is in progress. The Applicants have conducted analyses of these signals and have compared these results with the data obtained from Rangely, Colorado where earthquakes have occurred due to man-made causes. The Applicants have concluded that the ORNL injection wells are not inducing seismicity in the area; the Staff also concurs in this assessment on the basis of a statistical comparison. The Applicants have committed to restrict future hydrofracture operations within a defined set of parameters (Staff Exhibit 1, p. IV-4, 5).

44. A new disposal well has recently been installed and will be utilized beginning June 1982. This new facility is located about 800 feet southwest of the well that has been used during the last few years. That well has been retired. Tests at the new location have demonstrated that the new disposal well penetrates essentially the same geologic horizon as the old well. The new well will be closely monitored using techniques that have proved successful in the past. Therefore, future waste injection will not have an adverse affect on the proposed CRBRP site (Staff Exhibit 1, p. IV-5).

45. The Staff, based on its independent analysis and evaluation of the Applicants' work to date, concludes there are no geologic problems which are not amenable to established engineering solutions (Staff Exhibit 1, p. IV-5). Therefore, the Clinch River site is suitable from a geologic standpoint for a reactor of the general size and type proposed.

8. Seismology

46. In arriving at the Safe Shutdown Earthquake (SSE), the proposed CRBRP site has been considered to be located in the Southern Valley and Ridge Tectonic Province. The epicentral intensity of the maximum historical earthquake which has occurred in the province in which the proposed CRBRP site is located has been the subject of a reevaluation by the U.S. Geological Survey (Letter to Edson G. Case, USRNC from W. A. Radlinski, Acting Director, U.S. Geological Survey, February 12, 1976). The conclusion of the reassessment of the maximum intensity of the Giles County, Virginia earthquake of May 31, 1897 was that, "Following past practice, there is no basis for revising the assigned maximum intensity of MM VIII." Following the tectonic province approach described in "Seismic and Geologic Siting Criteria for Nuclear Power Plants." Appendix A, 10 C.F.R. § 100, it is assumed that the intensity at the proposed CRBRP site due to other Safe Shutdown Earthquake could equal intensity MMI VIII. Plots of measured peak ground acceleration values versus observed intensity show a large variation (Staff Exhibit 1, p. IV-5).

47. Several authors have reported curves or correlations in the literature which in one way or another attempt to represent these data. The most frequently used curves are least squares lines which relate the logarithm of mean acceleration to intensity. Because the samples are varied from one study to another, the derived relationships have varied as well. The Staff practice is to choose values which are representative of the trend of the mean of the data for the intensity of the SSE. On this basis, the Staff considers a value of 0.25g to be appropriate for

the SSE at the CRBRP site. The Staff recognizes that the correlations relied upon in its assessment have been derived using data recorded in active seismic zones, primarily California. The Staff is independently reviewing available strong motion data in an attempt to better identify the parameters affecting the vibratory motion-earthquake size correlation and to assess any geographical dependence. Based on the preliminary results of these studies, the value of CRBRP is judged to be adequately conservative (Staff Exhibit 1, p. IV-5).

48. In accordance with 10 C.F.R. Part 100, Appendix A, the SSE is defined as the design response spectra. In the zero period limit, these spectra are normalized to the acceleration for seismic design corresponding to the design earthquake. The seismic design response spectra for CRBRP will be reviewed against the existing Staff positions and Regulatory Guides to assure that the seismic input, as defined by the design response spectra corresponding to the specified ground acceleration in acceptable (Staff Exhibit 1, p. IV-6).

49. The Staff, based on its analysis and evaluation of available seismological data, including the results of investigations performed by the Applicants concludes that there are no corresponding cosiderations that would preclude the acceptability of the site for a nuclear power plant (Staff Exhibit 1, p. IV-6). Therefore, the Clinch River site is acceptable from a seismological standpoint for a reactor of the general size and type proposed.

9. Foundation Engineering

50. The foundation rock for the proposed CRBR site consists of alternating layers and laminations of siltstone, limestone and shale with some chert. The bedrock is overlain by terrace deposits up to 40 feet thick, weathered rock, and zones of clayey residual soil. Overburden varies in thickness from 8 to 56 feet throughout the site area. The main seismic Category I structures, except for the Steam Generator Maintenance Bay, the Fuel Oil Storage Tanks, and the Cooling Tower will be founded on a single common structural mat called the Nuclear Island at elevation 715 feet located directly on a siltstone structure termed the "Chickamauga Unit A Upper Siltstone." The Steam Generator Maintenance Bay will be founded in a limestone formation termed the "Chickamauga Unit B Limestone." Two seismic Category I Fuel Oil Storage Tanks will be anchored to a common reinforced concrete mat with base at elevation 787 feet supported directly by compacted Class A structural backfill material overlying the Unit A Upper Siltstone. The seismic Category I Cooling Tower will be supproted by a single mat founded at elevation 765 feet on the Unit A Upper Siltstone. Emergency plant and underground class IE electrical ducting will be founded on compacted Class A structural backfill materials (Staff Exhibit 1, p. IV-6).

51. The Applicants have reported a total of 129 borings and 6350 linear feet of seismic refraction traverses have been accomplished to determine subsurface conditions at the site. Additional in situ-testing was accomplished including seismic up-hole surveys, seismic cross-hole surveys, continuous velocity logging and Goodman Jack testing. Laboratory testing of representative samples of the subsurface rock has been accomplished

to determine the static and dynamic properties of the materials. Other site investigative efforts reported as accomplished relevant to the geotechnical aspects of the site involved a comprehensive office review of available published data including reports, geologic maps, and previous construction data for the area (Staff Exhibit 1, p. IV-6).

52. Based upon the information presented by the Applicants, it is the finding of the Staff that the Applicants' site investigation efforts provide adequate coverage of the site area in sufficient detail to provide a high level of confidence that specific subsurface conditions have been adequately defined. The Staff's review of the data presented reveals no evidence of significant zones of solutioning, caverns, or highly weathered areas in the foundation bedrock which could produce significant subsidence under the anticipated loads to be imposed by the proposed structural mats. Therefore, there are no subsurface conditions expected which could preclude the suitability of the site for the proposed plant (Staff Exhibit 1, p. IV-6, 7).

10. Conclusions

53. On the basis of the analysis and evaluation performed, in all respects, the proposed Clinch River Breeder Reactor Plant site is a suitable location for the reactor of the general size and type proposed from the standpoint of radiological health and safety considerations under the Atomic Energy Act of 1954, as amended, and the rules and regulations promulgated by the Commission in conformance with this Act.

B. SITE SUITABILITY - CONTESTED MATTERS

1. Accident Issues: Contentions 1(a), 2(a)-(h), and 3(b)-(d)

(a) Scope of Design Basis Accident

54. Design basis accidents are a set of events used to assess the way specific systems respond to abnormal conditions. As such these events provide analytic tests of the design, selected to determine if installed or proposed safety features can cope adequately with the postulated event. "NRC Staff Testimony on Intervenor's Contentions 1a, 2b, 3b, 3c and 3d Regarding Site Suitability Accident Analysis" by Bill M. Morris, Jerry J. Swift, Richard Becker, Thomas L. King and Edmund Rumble will hereinafter be referred to as Staff Testimony of Morris, et al.) (Staff Testimony of Morris, et al, Tr. 2449).

55. Plant response to these DBAs is assessed using the guidance from 10 C.F.R. Part 50, primarily the General Design Criteria, and the Standard Review Plan, primarily Chapter 15. It is normal staff practice to require that conservative margins be demonstrated in analyses of the postulated events. In addition, the postulated events must be acceptably mitigated, i.e., meet all specified acceptance criteria, even if single failures are postulated to have also occurred in the safety systems under evaluation. (Staff Testimony of Morris, et al, Tr. 2449).

56. The design basis accidents are selected to represent a reasonable envelope of the credible events which might occur at a nuclear plant and which require mitigation by active systems or passive structures. The choice of the specific events typically depends on the type of reactor with different sets of events selected for BWRs, HTGRs, PWRs and LMFBRs. No regulatory criteria have been established for making these choices.

Instead, engineering judgment regarding the kinds of faults or phenomena which might occur for a given kind of nuclear reactor is employed. (Staff Testimony of Morris, et al, Tr. 2450).

57. Although probability is a consideration in distinguishing DBAs from Class 9 accidents, there are no specific numerical probability thresholds which are employed. The Staff's engineering judgment, based on such deterministic criteria as quality assurance, compliance with regulatory standards, redundancy, independence, and diversity is more often employed to decide that multiple failure of safety systems need not be postulated as part of the design basis for nuclear plants. (Staff Testimony of Morris, et al, Tr. 2451). Although the Staff, in a 1976 letter to Applicants, presented a goal that there should be no greater than one chance in a million per year for potential consequences greater than the 10 C.F.R. 100 dose guidelines, this standard is a design objective, rather than fixed number that must be demonstrated. (Tr. 2278; Staff Ex. 5 at 2). Applicants similarly do not utilize this objective as a criterion. (Tr. 1483).

58. For those cases for which estimates have been made of the frequency of severe accidents the frequency estimates were only part of the basis for decision. The Staff recognizes that significant uncertainties must be attributed to probability estimates related to complex systems with very low failure frequencies and for this reason has not placed major emphasis on such estimates for decisions regarding classification of accidents. (Staff Testimony of Morris, et al, Tr. 2451-52).

59. The Applicants have proposed a set of design basis accidents (DBAs) against which to test the capability of CRBR safety systems. They

are described in Chapter 15 of the Preliminary Safety Analysis Report (PSAR). The proposed events include reactivity transients, undercooling events, local fuel faults, fuel handling and storage events, sodium leaks and additional miscellaneous events. Within these classifications more than sixty specific DBAs have been postulated and analyzed by the Applicants. ("Applicants' Testimony Concerning NRDC Contentions 1, 2 and 3" will hereinafter be referred to as Applicants Testimony.) (Applicants Testimony, Tr. 1995-97, 1999-2015).

60. Based on the Staff's knowledge of the kinds of credible accidents that could occur for an LMFBR of the general size and type as CRBR and of the kinds of safety system capability for mitigating such accidents that is achievable for such a reactor the Staff believes that it is very unlikely that radiological releases from DBAs could exceed those of the very conservative site suitability source term that has been analyzed in the Site Suitability Report. Although it is possible that the Staff review of the CRBR DBAs will result in some modifications to the characterization of the DBA, or in the predicted radiological releases associated with the DBAs, it is very unlikely that any credible accident could release such large quantities of radioisotopes into containment that the health effects would exceed those of the site suitability source term. Only some Class 9 accidents such as CDAs could result in releases in excess of the site suitability source term. Such accidents are considered incredible because they could only occur upon multiple failures of safety systems. (Staff Testimony of Morris, et al, Tr. 2453-54).

61. A core disruptive accident is an accident so severe that the reactor core or more specifically the fuel geometry is significantly

modified over a significant region of the core. Among the variations in the subsequent behavior are (1) successful in-core cooling of the disrupted core, (2) thermal reactor vessel failure because of inability to cool the disrupted core, and (3) mechanical reactor vessel failure because of power bursts from reactivity excursions or fuel coolant interactions which might occur as a result of fuel and coolant relocation. All these variations could have serious consequences because of the release of radioisotopes into containment, but if containment failure were to also occur due to excessive mechanical or thermal loadings, the radiological consequences could be even more severe. (Staff Testimony of Morris, et al, Tr. 2455).

62. A core disruptive accident could occur if there is either (1) a failure to remove heat from the fuel at a sufficient rate so that fuel integrity is lost, or (2) a local failure in a fuel assembly propagates beyond that assembly to adjacent regions of the core. Failure to remove sufficient heat from the fuel could occur if any, or a combination, of the following should occur:

(a) failure to shut down the nuclear chain reaction when necessary during an over-power or a flow reduction transient,

(b) failure to maintain sufficient primary coolant inventory to keep the fuel covered with coolant,

(c) failure to maintain sufficient coolant flow to provide a heat removal path from the fuel,

(d) failure to extract sufficient heat from the coolant to maintain fuel integrity. (Staff Testimony of Morris, et al, Tr. 2455-56).

However, the Board finds that the Staff's and Applicants' knowledge of the kinds of systems and features which need to be included in an LMFBR design to fulfill these functions is complete enough to allow a conclusion that CDAs may be made sufficiently improbable that they may be excluded from the design basis accident spectrum. (Staff Testimony of Morris, et al, Tr. 2456).

63. The basis for this conclusion is the Applicant's and the Staff's judgments that the safety functions which must be fulfilled to make CDAs very improbable can be implemented for an LMFBR of the general size and type as CRBR. (Applicants Testimony, Tr. 2003; Staff Testimony of Morris, et al, Tr. 2458). This confidence is based on two points. First, those safety functions which must be achieved for an LMFBR are not fundamentally different from the safety functions successfully implemented for LWRs. Second, the special characteristics associated with design and operation of an LMFBR and how they could impact these safety functions are well understood from the general knowledge and experience gained from design and operation of fast sodium cooled reactors such as FEMRI, EBR I and II, SEFOR, FFTF, and foreign LMFBRs. (Staff Testimony of Morris, et al, Tr. 2458). The vast experience of the Staff witness panel members with numerous domestic LMFBRs was factored into the Staff's conclusions regarding the reliability, feasibility and general site suitability of the facility which is the same general size and type as the CRBR. (Testimony of Morris, et al,Tr. 2413-14, 2394). More specifically, with only a few exceptions, the Staff review procedures and the criteria and standards from 10 C.F.R. Parts 50, 73 and 100, and the NRC standard review plan normally applied to LWRs, are considered by the Staff to be applicable to an LMFBR. These criteria are

the basis for excluding core disruptive accidents from the design basis accident spectrum for LWRs, and when supplemented with the special criteria necessary to account for the characteristics of LMFBRs, contribute to the Staff's conclusion that CDAs can be made very improbable for CRBR. (Staff Testimony of Morris, et al, Tr. 2458).

64. To take into account the special nature of LMFBRs and to make the initiators of CDAs sufficiently improbable to exclude CDAs from the DBA envelope, the Staff has developed specific design features to be required of the CRBR design. These include the following features specifically highlighted in section II.C. of the Staff's Site Suitability Report (SSR, Staff Ex. 1):

(1) Redundant, independent, and diverse reactivity shutdown systems.

(2) Redundant, independent, and diverse heat removal systems.

(3) Means to detect and prevent propagation of local fuel faults.

(4) Assurance of continuing high integrity of the heat transport system. (Staff Testimony of Morris, et al, Tr. 2458-59).

65. The Staff testified that the CRBR design must include measures to protect against damage to equipment, structures, and components from chemical reactions involving sodium (sodium fires, sodium water reactions, sodium-concrete reactions), to prevent blockage of flow to fuel assemblies, and to provide necessary heating to safety systems containing sodium. (Staff Ex. 1, Sec. II.D; Staff Testimony of Morris, et al, Tr. 2459). Based on its experience and knowledge of LMFBRs, the Staff believes that the criteria

and standards discussed above can be implemented for CRBR. (Staff Testimony of Morris, et al, Tr. 2459).

66. The safety functions which must be achieved to prevent CDAs are as follows: (1) shut down the nuclear chain reaction upon initiation of transients, (2) maintain sufficient coolant inventory, (3) maintain sufficient coolant flow, (4) remove sufficient heat from the fuel, (5) avoid propagation of local fuel faults beyond an assembly. Characteristics of systems and design features to achieve these functions are described below. (Staff Testimony of Morris, et al, Tr. 2459-60).

67. High reliability of the reactivity shutdown function can be achieved by following the same design principles implemented for LWRs of various types. Dual (redundant) shutdown systems which are independent of one another and which employ diversity of design will be required for CRBR. By designing each of these dual systems to itself meet the single failure criterion, a requirement normally only applied to the total shutdown systems of LWRs, it would be necessary for four simultaneous component failures to occur before defeating the reactivity shutdown function. To minimize the possibility that such simultaneous component failures could be induced by some common cause, independence and diversity must be designed into the dual systems. IEEE Standard 279 and various regulatory guides enumerated in the Standard Review Plan have been used by the Staff in their review to assure that the single failure criterion is met for LWRs. These will be applied to CRBR also. (Staff Ex. 1 at II-6, 7; Staff Testimony of Morris, et al, Tr. 2460-61; Applicants Testimony, Tr. 2016-2024).

68. To achieve independence between the dual systems, Regulatory Guide 1.75 (separation of electrical circuits), Appendix R to 10 C.F.R.

Part 50 (fire protection), erection of physical barriers, and employment of electrical isolation devices, all of which have been successfully applied to LWRs, will be required to be applied to CRBR. Diversity may be achieved by employing different types of components, sensors, logic, reactivity insertion mechanisms, etc. or even by requiring that the design and maintenance functions be performed by different groups. However, the Staff believes that a level of reliability sufficient to exclude CDAs from the design basis can be achieved. (Staff Testimony of Morris, et al, Tr. 2461; Staff Ex. 1 at II-7).

69. CDA initiation resulting from uncovery of the reactor core can be made highly improbable by requiring high integrity of the heat transport system. The principal measures to achieve this are to perform pre-service and in-service inspection of the primary coolant boundary to verify continuing piping integrity and to install a detection system to detect small leaks, should they occur, before they grow to unacceptable size. Because LMFBR primary coolant systems operate at low pressure and below the saturation temperature of sodium, an Emergency Core Cooling System (ECCS) to rapidly inject coolant when a pipe break occurs is not necessary. Instead it would be sufficient to provide (a) guard vessels to catch hypothetical coolant leakage from portions of the system below the top of the core to ensure sufficient core coverage and (b) piping elevated above the top of the core for other portions of the coolant system to preclude siphoning. Based on successful implementation of such features at LWRs and domestic and foreign LMFBRs the Staff believes it will be possible to implement them acceptably at CRBR, and to thereby assure that CDAs related to loss of coolant inventory will be very unlikely. (Staff Testimony of Morris,

et al, Tr. 2461-62; Staff Ex. 1 at II-8, 9; Applicants Testimony, Tr. 2024-29).

70. It is necessary to assure that a clear path for coolant flow to the fuel assemblies will be maintained. This will avoid a sudden flow blockage and damage to sub-assemblies such as occurred at the FERMI reactor. It is possible to achieve this by including multiple coolant inlet ports at different planes and by interposing strainers in the flow path. Although high quality of fabrication will be required for CRBR, non-mechanistic deposits of debris or other loose parts may be postulated. Flow blockage from such sources can be avoided by employment of core outlet thermocouples or loose parts monitoring systems to aid operators in diagnosing and correcting such conditions. (Staff Testimony of Morris, et al, Tr. 2462-63; Testimony of Strawbridge, Tr. 1828-30; Applicants Testimony, Tr. 2032-34; Staff Ex. 1 at II-10). To protect against postulated loss of pumping power, natural circulation capability can be included in the design by choosing appropriate elevations of piping and heat exchangers. Based on successful implementation of such features at domestic and foreign LWRs and LMFBRs the Staff believes that CDAs from insufficient coolant flow can be made very improbable. (Staff Testimony of Morris, et al, Tr. 2463).

71. Redundant and diverse decay heat removal systems will be required by CRBR. (Staff Ex. 1 at II-12). As is commonly done for LWRs, multiple decay heat removal paths using a safety grade steam generator auxiliary feedwater system can be employed to fulfill a part of this requirement. A certain amount of diversity can be achieved by using both electrically and steam driven auxiliary feedwater pumps. Additional redundancy and diversity can be implemented by including a system employing a heat transfer

agent different from sodium and ejecting heat directly to the atmosphere without use of steam generators. Independence between the redundant systems or circuits can be achieved by adhering to standards such as Regulatory Guide 1.75, and 10 C.F.R. Part 50 Appendix R, and IEEE Standard 279 or by erecting physical barriers. (Staff Testimony of Morris, et al, Tr. 2463-64).

72. These design measures have been successfully implemented in domestic and foreign LWRs and LMFBRs and the Staff believes that they may also be implemented for CRBR to the degree needed to eliminate as credible accidents CDAs resulting from failure to remove heat. (Staff Testimony of Morris, et al, Tr. 2464; Staff Ex. 1 at II-12, 13; Applicants Testimony, Tr. 2024-29).

73. To assure that local fuel failures do not propagate so rapidly that adjacent assemblies are affected two measures must be taken. First, the fuel must be designed with sufficient inherent integrity that catastrophic failure is unlikely and that rapid propagation will not occur. This has been achieved for instance with the FFTF fuel and it is expected that similar ruggedness can be designed into the CRBR fuel. Second, a detection system must be installed to detect local faults so that reactor shutdown may be implemented before such a fault propagates to adjacent fuel. Because rapidly progressing faults appear to be unlikely, the detection system does not necessarily have to be a fast acting system and may not have to be connected to the protection system. However, this is an option which could be included for conservatism. (Staff Testimony of Morris, et al, Tr. 2464-65; Staff Ex. 1 at II-9, 10; Applicants Testimony, Tr. 2032-35).

74. The Staff believes that a system to detect delayed neutrons from fission reaction products which have been leeched into the coolant would be acceptable as a sufficiently sensitive detection mechanism for local faults. Such systems have been implemented at domestic and foreign LMFBRs. (Staff Testimony of Morris, et al, Tr. 2465; Staff Ex. 1 at II-10).

75. Certain measures specified in 10 C.F.R. and the Standard Review Plan are important in assuring high reliability for all the systems and features described above. Compliance with these measures would be verified by the Staff during its construction permit and operating license reviews for CRBR. (Staff Testimony of Morris, et al, Tr. 2465-68).

76. A review of the adequacy of control room design, operator training, utility management, plant operating and emergency procedures such as carried out for LWRs will be conducted to assure that accidents resulting from human error will be improbable at CRBR. Special emphasis on such reviews has developed subsequent to the TMI-2 accident. Furthermore, based on the Staff's experience and knowledge of characteristics of LMFBRs exemplified by SEFOR, EBR-II, FFTF, it is believed that there are no special LMFBR characteristics which require extraordinary capability on the part of operator to prevent CDAs. Rapid operator action in responding to accidents will not be necessary because the NRC criteria normally applied to LWRs, and also to be applied to CRBR, require that fast acting safety systems be installed to mitigate rapidly developing accidents. NRC criteria do not prohibit operators becoming involved in mitigating accidents which evolve more slowly. Because of the low primary coolant pressures of LMFBRs the CRBR operators would not be faced with the challenges of performing any actions related to depressurization

during small pipe breaks or loss of offsite power as would be the case for PWRs. Because of the large heat capacity margin of an LMFBR reactor coolant system there is ample time for operator action in transferring to the backup decay heat removal system in responding to loss of all primary heat transport capability. Accidents involving sodium interactions with water may be mitigated without operator action, and sodium fires progress slowly enough that rapid operator action is not required. (Staff Testimony of Morris, et al, Tr. 2468-69). For these reasons the Board agrees with the Staff that there is no requirement for extraordinary operator capability in responding to accidents at an LMFBR beyond that normally achieved by operators of LWRs, and that it is feasible to make CDAs resulting from human error at CRBR very unlikely. (Staff Testimony of Morris, et al, Tr. 2470).

77. The Experimental Breeder Reactor - I accident was caused by an intentional disconnection of automatic safety devices. (Testimony of Cochran, Tr. 2628). Similarly, the SEFOR LMFBR experienced intentional unprotected transient overpowers with delayed safety system activation, as part of an experimental program (Testimony of Becker, Tr. 2396-97), which is a valid basis for distinguishing CRBR from SEFOR, the latter which included CDAs within the design basis. (Testimony of Becker, Tr. 2397-98). Neither DOE nor the NRC considered CDAs to be within the design basis for the FFTF breeder reactor. (Testimony of King, Tr. 2395-96; Testimony of Brown, Tr. 1825-26).

78. The Staff's safety objective is a review guide such that there should be no greater than one chance in a million per year for potential consequences greater than the 10 C.F.R. Part 100 dose guidelines for

the CRBR. The goal is an aiming point, rather than a fixed number which must be demonstrated, which is kept in mind by the Staff as it makes a judgement as to when there is sufficient diversity, redundancy and independence for the CRBR. (Staff Ex. 5, p.2; Testimony of Morris. Tr. 2277-79). DOE does not believe that this objective is necessary for the CRBR review, and it is not factored into the current DOE conclusion that CDAs need not be included as DBAs. (Testimony of Clare, Tr. 1483).

79. Although all details of the CRBR design basis accidents are not known at this stage of the Staff's review, the Staff has sufficient experience and knowledge of the kinds of accidents which could occur at LMFBRs to be confident that no credible accidents could result in core melting and releases of radioisotopes in excess of the site suitability source term. (Staff Testimony of Morris, et al, Tr. 2475).

80. The Staff has evaluated the special nature of LMFBRs and has concluded that although such reactors will require training for the specific activities encountered, they do not present more difficult challenges to operators or more opportunity for human error than do LWRs. The NRC has established capabilities and procedures, many stemming from the lessons of TMI, to review those aspects of nuclear reactor design and operation for which human error is a factor in initiating or exacerbating accidents and to assure that such possibilities are unlikely. Such a review will be carried out for CRBR with appropriate levels of assurance attained as design and operational details are more fully established. (Staff Testimony of Morris, et al, Tr. 2476).

81. Based on the above, the Staff found that there has been adequate evaluation of the potential effect of human error on accidents at CRBR for

the purpose of site suitability analysis, and that the detailed reviews of CRBR will assure that it will be very unlikely that human error could affect the safe operation of the plant. (Staff Testimony of Morris, et al, Tr. 2476-77).

82. Despite the conclusion that CDAs may be excluded from the design envelope, to assure that risks from CDAs will be acceptable, analysis of potential for recriticality, fuel coolant interaction and primary system damage, and of core meltthrough and sodium concrete reactions will be carried out by the Staff and reported in the SER. The general objective of this review will be to assure that design features are adequate to assure that the risk from CRBR is not significantly greater than the risk from recently licensed LWRs. (Staff Testimony of Morris, et al, Tr. 2472).

(b) Site Suitability Source Term

83. The Staff analysis which applied 10 C.F.R. § 100.11(a) and fn. 1 to that section, correctly derived the source term by computing the source term in the non-mechanistic method provided for in the regulation and TID 14844. ("NRC Staff Testimony on Intervenor's Contention 2a, 2c, 2d, 2e, 2f, 2g and 2h Regarding Site Suitability Accident Analysis" by Larry W. Bell, Edward F. Branagan, Jr., Lewis Hulman, John K. Long, Jerry J. Swift, Farouk Eltawila and Irwin Spickler will hereinafter be referred to as Staff Testimony of Bell, et al.,) (Staff Testimony of Bell, et al, Tr. 2488-2489, 2491, 2503).

84. The Staff's non-mechanistic analysis included the assumption of releases beyond those which would be produced by any design basis accident,

and included a substantial core meltdown. (Staff Testimony of Bell, et al, Tr. 2488-2489, 2491, 2503).

85. The methodology used for computing the site suitability source term (source term) is the same as that used for light water reactors. (Staff Testimony of Bell, et al, Tr. 2492).

86. The use of the light water reactor methodology for computing the CRBR source term is appropriate because of similarities in function between the two types of reactors and because releases are based on the percent of core content (which would pick up changes in isotopic content of the core, one area where CRBR is different than an LWR) (Staff Testimony of Bell, et al, Tr. 2492).

87. As a method of conservatism in its analysis the Staff took no credit for sodium absorption of iodine, although sodium may completely absorb iodine preventing such release. (Staff Testimony of Bell, et al, Tr. 2493).

88. The Staff also assumed, although accidents which are likely to release iodine would only release 10% of the fission product inventory, that 50% of the iodine in the inventory would be released. (Staff Testimony of Bell, et al, Tr. 2494).

89. Additionally, credit was not taken for further reductions in iodine release which would occur from attenuation which occurs due to the path the iodine must follow to the containment. (Staff Testimony of Bell, et al, Tr. 2495).

90. Under the regulations (10 C.F.R. 100.11) for the site suitability analysis, the air pathway is the medium of concern for assessing doses from plutonium. (Staff Testimony of Bell, et al, Tr. 2496).

91. For reasons detailed in the Staff's testimony, the release of plutonium in particulate form is conservatively estimated at 1% for the source term. (Staff Testimony of Bell, et al, Tr. 2496-2498).

92. Because of attenuation, condensation, and oxygen limitations the staff assumption of 180,000 lbs. of sodium dispersed into the containment is conservative. (Staff Testimony of Bell, et al, Tr 2500).

93. Based on computations contained in the Staff's testimony the toxicity of plutonium in the source term is over 1200 times more radiologically toxic than the entire dispersable sodium inventory. (Staff Testimony of Bell, et al, Tr. 2501).

94. For the above reason, sodium-24's contribution to dose is negligible and would not change conclusions as to site suitability. (Staff Testimony of Bell, et al, Tr. 2501).

95. Although the Staff did assume 1,000 lbs. of sodium in computing fallout, it was determined that doses would increase by only 5% if the sodium contribution to fallout was ignored. (Staff Testimony of Bell, et al, Tr. 2502).

96. CRBR has an annulus filtration system capable of handling 200,000 lbs of sodium released to containment. (Staff Testimony of Bell, et al, Tr. 2502).

(c) Doses

97. Part 100 provides the guidelines for doses to the whole body and thyroid. (Staff Testimony of Bell, et al, Tr. 2509.)

98. As a method of conservatism dose guidelines are modified (downward) at the CP stage. (Staff Testimony of Bell, et al, Tr. 2490-2491.)

99. In addition, for CRBR, doses to several additional organs were computed. (Staff Testimony of Bell, et al, Tr. 2509.)

100. The Staff used the dose to the thyroid as a reference point, rather than to the whole body. This resulted in guidelines 3 times more limiting then if whole body dose limits were used as a reference point. (Staff Testimony of Bell, et al, Tr. 2511.)

101. The Staff considered mortality risk weighting factors from other than ICRP-26 and concluded that ICRP-26 yielded more conservative guidelines. (Staff Testimony of Bell, et al, Tr. 2511-2512.)

102. The guidelines in 10 C.F.R. Part 100 are not intended to be acceptable for doses to the public, they are for comparing sites and determining site suitability. (Staff Testimony of Bell, et al, Tr. 2512).

103. The hot particle theory has generally been rejected by the scientific community. (Staff Testimony of Bell, et al, Tr. 2514-2515; Testimony of Branagan, Tr. 2530).

104. The Site Suitability dose estimates are based on 0.5% X/Q values obtained for each of the 16 sectors over a long period of time. Dr. Cochran's assumptions neglect the spatial as well as temporal variation of X/Qs. (Staff Ex. 1 at III-11 and IV-1).

105. The Staff and Applicants used dosages at Y-12 to calculate dosages at K-25 by taking ratios of realistic X/Qs. The Staff's calculations were made by comparing the 7-day 50% X/Q at Y-12 with the 7-day 50% X/Q at K-25. In other words realistic X/Q values were used in both locations, not the low likelihood X/Q values (0.5%) used for assessing the site suitability source term. (Testimony of Thadani, Tr. 5665-66, 5672-73; Staff Testimony of Lowenberg, Soffer, et al, Tr. 5688; Testimony of

Hibbitts, Tr. 5426, 5428, 5433 fn.4). A realistic dose of 320 millirems at K-25 was calculated for a 50% X/Q for a duration of 7 days. Staff Testimony of Lowenberg, Soffer, et al, Tr. 5688). The realistic effects of a CDA Class 1 accident, as presented in the FES Supplement, were calculated with realistic filter efficiencies of 97-99%. (Staff Ex. 8 at J-9 and J-10, Fn), as compared to the conservative 95-99% filter efficiencies utilized in the Staff calculations of Site Suitability source term dose results (Staff Ex. 1 at III-11) and the effects of such an accident on K-25 and Y-12 (Testimony of Thadani, Tr. 5665). The conservative Site Suitability dose at LPZ of 7000 millirems, was calculated by using a 0.5% X/Q (conservative value) for a 30 day duration of exposure. (Id.; Staff Ex. 1 at III-11).

106. The Staff is using the new model as a means of comparison to demonstrate the differences between ICRP-2 and ICRP-30 methodology. ICRP-2 refers to only bone doses, whereas ICRP-30 differentiates between bone surfaces and bone marrow. The Staff is, however, not using the newer models for siting or safety analyses and has stood by its site suitability estimates using ICRP-2 methodology. (Testimony of Branagan, Tr. 2341-44).

107. The Staff analyzed a puff release of radioactivty 30 days after a CDA accident, as part of a sensitivty analysis performed to assess the site suitability source term accuracy. After considering various alternative scenarios assuming fallout within containment for 24 hours and for 30 days, the resulting puff release would in any event result in doses within 10 C.F.R Part 100 guidelines. (Testimony of Bell, Tr. 2400-04). Only if the extremely conservative, and upper bound assumption that there would be no depletion or fall-out during the 30-day period (Testimony of

Bell, Tr. 2403-04), would release result in a dose (Testimony of Bell, Tr. 2401) which is above that level which the Staff assumed to be the equivalent mortality risk dose corresponding to the 10 C.F.R. § 100.11 thyroid dose (See Staff Ex. 1 at III-9). Accordingly, the employed on appropriate degree of conservatism in its analysis of the puff release sensitivity analysis, which provided added assurance that the Staff's site suitability dose estimates were appropriate. (Testimony of Bell, Tr. 2354; Testimony of Hulman, Tr. 2357).

108. For accidents within the design basis, and hence less severe than the site suitability accident, filtered atmosphere from the annulus is partially released and partially recirculated to the annulus, not back into the containment. (Applicants Testimony, Tr. 2039). For the handling of CDAs, the annulus filtration system is followed by initiation of the annulus cooling system and the venting and purging through the TMBDB containment cleanup system. (Applicants Testimony, Tr. 2055, 2057, 2058).

(d) Containment Design

109. To achieve such limited leakage, first, a containment is provided that is large enough and strong enough not to fail but to contain the radioactive materials and other materials that could be released into it in any accident within the design basis envelope. Second, the containment is designed to limit the outward leakage of its airborne contents to not more than 0.1% by volume per day, at its design pressure. Third, a system is provided to capture and treat all but a small fraction of the leaked material; in this case, that small fraction (the "bypass leakage") should be not more than 0.001% of the containment

volume per day (at the design pressure). (Staff Testimony of Bell, et al Tr. 2505-06).

110. The proposed design provides for 3,600,000 cubic feet of air volume above the operating floor and a design pressure of 10 psig under DBA conditions. This design accommodates the large sodium fire (burning 179,000 lb. sodium) which is proposed as a DBA. The containment volume is similar to that of larger LWR power plants, and a number of larger LWR power plants have containments built to hold significantly higher pressures (e.g., design pressures of 45 psig); thus the size and strength are clearly within the feasibility of current practice. Containments have also been built for other sodium-cooled reactors; thus there is experience in building containment designs to withstand accidents involving sodium fires. (Staff Testimony of Bell, et al, Tr. 2506-07).

111. Current LWR containments as well as the FFTF containment are designed, constructed and tested to leak rates of not more than 0.1% by volume per day. Because the steel-shell containment of the CRBR does not have any features significantly different in this regard from such containments for LWRs, it is feasible to provide such leak tightness for the CRBRP. (Staff Testimony of Bell, et al, Tr. 2507).

112. Some current LWR containments of similar size and design as that proposed for CRBR have been designed and constructed for similar bypass leakage fractions; because of the similarities, and considering experience with containments for other sodium cooled plants, we conclude that it is feasible to do as well at CRBRP. (Staff Testimony of Bell, et al, Tr. 2507; 2040).

113. Outside of the steel-shell containment, there is a reinforced concrete confinement structure; the five-foot gap between the two is the annulus. At least ninety-nine percent of the leakage from the containment is expected to enter this annulus. The annulus filtration system draws in air from the annulus space and exhausts some to the environment, to maintain the annulus at negative pressure. If significant radioactivity is detected in the air, the annulus filtration system draws in a bigger volume of air and passes it through a prefilter bank and a HEPA filter bank before recirculating it. This filtering and recirculation cleans filterable radioactive materials out of the air, and thus greatly reduces the quantitities of such materials that might be leaked out in the event of an accident. The components of the annulus filtration system are fans and filters, duct work and accessories common in nature to those in other nuclear facilities and in use in industry. The annulus filtration system as a system is very similar to air cleaning systems in common use in the nuclear industry. Thus it is feasible to achieve the intended function of the annulus filtration system. (Staff Testimony of Bell, et al, Tr. 2507-08; 2040).

(e) Use of Computer Codes and Models

114. The Staff utilied the TACT, PAVAN and HAA-3 codes in its analysis of the site suitability source term for CRBR. (Staff Testimony of Bell, et al, Tr. 2518). The documentation and validation/verification of these codes is presented in Staff Testimony of Bell, et al, Tr. 2519-24. Input for the codes was also validated/verified by the Staff and explained. Id. The use of these codes does not depend upon an analysis of the

energetics of a CDA but rather on the quantitities of aerosols assumed airborne. Since adequately conservative and bounding values were used for the Site Suitability Source Term, these well-documented and verified codes can be used with confidence to contribute to the analysis of the radiological effects for site suitability purposes. (Staff Testimony of Bell, et al, Tr. 2524).

C. ENVIRONMENTAL - UNCONTESTED MATTERS

1. Compliance with NEPA, Section 102(A), (C) AND (D), AND 10 C.F.R. § 51

115. As required by 10 C.F.R. Part 51, the Applicants submitted, with its application, an Environmental Report (ER). The ER, as amended, was received into evidence as Applicants Exhibit Nos. 34-38 (Tr. 3241). Based on the environmental information submitted by the Applicants in the ER, as supplemented, and on its independent analysis and review, the Staff prepared a Draft Environmental Statement (DES) which was issued in February of 1976. By a Notice of Availability published on February 12, 1976, the public was invited to comment on the DES (41 F.R. 6341 (1976)). Copies of the DES were also provided to appropriate Federal, State and local agencies for their comment. In February of 1977, the Staff published its Final Environmental Statement (FES) which includes, among other things, the full text of all comments received with respect to the DES (Appendix A) as well as the Staff's responses to those comments (Chapter 11). By a Notice of Availability, published on February 14, 1977, the Final Environmental Statement was also made available to various agencies and to the public (42 F.R. 9071 (1977)). The Final Environmental Statement was

received into evidence as Staff Exhibit 7 (Tr. 3244). In July of 1982, the Staff published a Draft Supplement to the Final Environmental Statement. By a Notice of Availability published on July 30, 1982, the public was invited to comment on the Draft FES Supplement (42 F.R. 33028 (1982)). Copies of the Draft FES Supplement were also provided to appropriate Federal, State and local agencies for their comment. In October of 1982, the Staff published a Supplement to the Final Environmental Statement which includes, among other things, the full text of all comments received with respect to the FES Supplement (Appendix N) as well as the Staff's responses to those comments (Chapter 12). By a Notice of Availability, published on November 3, 1982, the Supplement to the Final Environmental Statement was also made available to various agencies and to the public (47 F.R. 49909 (1982)). The Supplement to the Final Environmental Statement was received into evidence as Staff Exhibit 8 (Tr. 3244).

116. The proper conclusion, on the basis of the analysis and evaluation set forth in the FES and FES Supplement and the entire record in this proceeding, is that after weighing the environmental, economic, technical, and other benefits of the Clinch River Breeder Reactor Plant against their environmental and other costs, the action called for under the National Environmental Policy Act of 1969 (NEPA) and 10 C.F.R. § 51 is the issuance of a limited work authorization subject to certain limitations to protect the environment. (Staff Exhibit 7, p. iii; Staff Exhibit 8, pp. v-vi). Further, the FES as supplemented is a comprehensive and adequate review and evaluation of the environmental impacts resulting from plant construction and operation. (Staff Exs. 7 and 8).

2. Impacts of Construction

(a) Impacts on Land Use

117. The primary impact of the Clinch River Breeder Reactor Plant on land use will be the utilization of about 292 acres of the 1364 acre proposed site for construction activities (Staff Exhibit 8, p. 4-1). Construction of the plant will require the clearing, grubbing and grading of approximately 292 acres of mostly forested land, whereby 113.5 acres of the total area to be cleared will be permanently disturbed (Staff Exhibit 8, p. 4-1). The 113.5 acres will be used for access roads and railroads, the meteorological tower area, a barge unloading area, river intake area, parking area, settling ponds, laydown areas, principal plant buildings and the security barrier (Staff Exhibit 8, p. 4-2). Land to be disturbed would avoid the "natural areas" discussed in Staff Exhibit 7, Section 2.7.1. The rare wildflowers (Staff Exhibit 7, Section 2.7.1.1) would not be affected since they are sufficiently distant from the area that would be disturbed by plant construction (Applicants Exhibit 35, Section 4.1.1.6). The loss of 113.5 acreas of biota would not constitute a significant impact since prime or unique land uses or special resources on the site will not be affected because the resources affected are of comparable quality to those in the vicinity (Staff Exhibit 7, p. 4-3; Staff Exhibit 8, p. 4-1).

118. Timber of commercial value will be harvested and removed in accordance with the DOE Forest Management Program. The remaining plants and brush would be burned in accordance with state and Federal air pollution regulations (Applicants Exhibit 35, Section 4.1.1); this will have a slightly adverse effect on air quality in the immediate vicinity.

Conventional garbage will be disposed of offsite (Staff Exhibit 8, pp. 4-1, 4-3).

119. The barge loading facility will occupy a 125-by-185-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 be covered with about 700 yds^3 of sand to cushion grounded barges during unloading (Staff Exhibit 8, p. 4-5).

120. 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 not be obtained from the 45-acre quarry and stockpile areas (Staff Exhibit 8, 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 on the quarry area at the end of construction (Staff Exhibit 8, p. 4-5). After completing construction, surfaces not a part of the permanently committed land would be graded and revegetated (Staff Exhibit 7, p. 4-4). Moving construction equipment and disturbing the land would result in temporary adverse effects such as erosion, siltation and interferences with some community life patterns. Based upon the Staff's review of the plans discussed above, the extent of such effects would be at a practicable minimum during the brief periods of their occurrences. The long-term effects would not be significant (Staff Exhibit 7, p. 4-4).

121. Historic and archaeological resources, except for the Hensley cemetery and the Indian Mound, are at distances sufficient to have no involvement with the construction plan. The Indian Mound was excavated and was found it no longer exists. The State's archaeologist's opinion is that the Applicants have given adequate consideration to archaeological resources. The State Historic Preservation Officer concurs that no structures of historic interest remain in the area (Staff Exhibit 7, p. 4-4 and Appendix C; Staff Exhibit 8, p. 4-5).

122. Additionally, the Applicants propose to construct transmission lines. The Staff concudes that erosion and air pollution control practices (Staff Exhibit 7, Section 3.8) would be adequate to prevent adverse impacts on terrestrial biota in the area and that historical and archaeological resources would be adequately protected. The shift in land use of nearly 61 acres from woodland to open area would have no significant impact on wildlife becuase of the large area of land with similar woodland vegetation nearby, 1289 acres of forest on the site and 29,443 acres of forest on the Oak Ridge Reservation (Staff Exhibit 7, p. 4-4; Staff Exhibit 8, p. 4-5). These aspects of land use conversion mentioned above will result in acceptable impacts, provided that preventative measures as summarized in Section 4.2 of the Staff's Final Environmental Statement and Supplement to the Final Environmental Statement are implemented.

(b) Impacts on Water Use

123. The impacts on water use will include water for fire protection, sanitary facilities, making concrete and other construction activities would be piped from the nearby Bear Creek Filtration Plant. Water for

the quarry would be pumped from the river and would be recycled from settling basins, maximum use during peak crushing would be 40,000 gpd. The maximum requirement is expected to be 210,000 gpd, representing about 0.007% of the river's annual average flow. This small withdrawal is expected to have no significant effect on navigational and recreational uses of the river or any downstream uses. 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. Tonnage barge shipments for plant construction may exceed during some years the annual commercial tonnage of recent years (Staff Exhibit 7, Section 4.3). The Applicants state that the number of shipments during the construction period would not exceed 20 and that no shipments are planned during operation (Id.). Although individual shipments of plant components, because of relatively large tonnage, may have some adverse impacts on other shipping for a few days at a time, the overall impact would be very small because of the limited number of shipments over the several-year construction period (Staff Exhibit 7, pp. 4-4 - 4-5; Staff Exhibit 8, p. 4-5).

124. For erosion control in dewatering and related activity the Applicants plan to use drainage ditches at the base of stockpiles and excavation slopes, a storm water drainage system, and a system of diversion channels leading to settling basins before discharging water to the river. Dewatering is expected to have no significant aesthetic or other effect on the river (Staff Exhibit 7, p. 4-5).

125. Transmission line construction is expected to have temporary impacts at stream crossings and these will be minor due to siltation control (Staff Exhibit 7, p. 4-5).

126. The Applicants state that 20,000 m^3 of material from the sites of the access road and railroad fills, the water intake and discharge structures, and the barge unloading facility would be placed on a land disposal site near the barge facility. About 10,000 m^3 of fill would be placed at these sites, including 950 mi^3 of riprap (Staff Exhibit 7, p. 4-5). Protective measures (Staff Exhibit 7, Section 4.4.2, par 2) and the plan to do major construction elements in sequence would give protection sufficient to insure only temprary, minor adverse impacts upon the aesthetic quality and navigational and recreational uses of the river (Staff Exhibit 7, p. 4-5).

(c) Impacts on Ecological Systems

127. Terrestrial impacts during construction will result in the harvesting of timber and the destruction of some other plant and animal life on 292 acres concerned with the plant and 58 acres in connection with the transmission lines, both on and off the site. The acres for the quarry, under the Applicants' restoration plans would probably start supporting wildlife about 10 years after restoration and provide habitat equivalent to the present habitat in another 10 years. Of this land, the acres in connection with the plant and the acres for the transmission lines, according to the Applicants' plans, would be revegetated by the end of the construction period and 73 acres would be disturbed for the life of the plant. In the forested acres, animals

would be either killed or displaced to surrounding woodland where they would compete for space and food with populations already present. None of the estimated shifts in animal populations is greater than 10% of the corresponding population on the site (Applicants' Exhibit 35, Section 4.1.1.6). No rare or endangered animal species is known to occur on the land affected by construction. Two plant species, Cimicifuga rubifolia and Saxifraga careyana, under status review by the Fish and Wildlife Service (FWS), have been identified on the proposed site (see Staff Exhibit 8, Section 2.7.1.1). Based on field studies and procedures adopted by the Applicants, safeguards have been developed to ensure protection of these critical elements (Staff Exhibit 8, Section 4.6.1.1(16)). The Staff's opinion is that the impact on terrestrial biota would be minimal in view of the fact that the amount of land affected would be less than 1% of similar available land onsite and the Oak Ridge Reservation (Staff Exhibit 7, p. 4-5; Staff Exhibit 8, p. 4-5). Additionally, the Applicants have made commitments to restrict erosion and chemical releases that would be adequate to protect the terrestrial ecosystem from significantly adverse effects from those sources. (Staff Exhibit 7, section 4.4.1).

128. The precautions to the used in contructing plant buildings, the river pumphouse with intake pipes, a cofferdam, a discharge pipe, the barge-unloading facility, a railroad and railroad spur, and transmission lines would assure minimum effects upon aquatic resources. No significant effects are anticipated in the river channel. 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 biological activity in the Clinch River, (2) construction practices to minimize impact as recommended by the Staff are followed, and (3) requirements in the Erosion and Sediment Control Plan and the NPDES Permit are met (Staff Exhibit 7, pp. 4-5 - 4-6; Staff Exhibit 8, pp. 4-6 - 4-7). These aspects of aquatic use are acceptable impacts provided that the preventive measures as summarized in Section 4.4 of the Staff's Final Environmental Statement and Supplement to the Final Environmental Statement are implemented.

(d) Impacts on the Community

129. The impacts on the community that were analyzed were the inmover construction labor force, distribution of inmover construction labor force, social effects, economic effects, aesthetic effect and dust and noise. The Applicants' analysis of the inmover construction labor force showed that 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. At an inmovement level of 26% many as 1300 direct employees might move into four-county impact area during the peak year of construction (Applicants Exhibit 36, Section 8.3.2.1). The corresponding figure at the 40% level would be 2000. 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 (Applicants Exhibit 36, Appendic C, Section 1.0; Staff Exhibit 7, pp. 4-6 - 4-8; Staff Exhibit 8, pp. 4-7 - 4-8).

130. With regard to the distribution of the 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. 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. 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. Those inmovers desiring a more urban life might choose to settle in the vicinity of Knoxville despite the 37-mile commute (each way). 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 (Staff Exhibit 8, p. 4-8 - 4-9) indicates the estimated alloca-

tion of inmoving workers and their families to communities within the nearby county area (Staff Exhibit 8, pp. 4-8 - 4-9).

131. The social effects on housing, school systems, transportation, health care, municipal water supply, waste disposal, public safety, recreation, and visual aesthetics were also analyzed. 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 problems generated by new, temporary population additions to the four-county area of Anderson, Roane, Loudon, and Knox are addressed in detail in Staff Exhibit 8, pp. 4-9 - 4-22. 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 (Staff Exhibit 8, pp. 4-9 - 4-10). Additionally, the economic effects on the private and public sector were analyzed (Staff Exhibit 8, pp. 4-21 - 4-22).

132. 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.

133. 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. 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 expeditures, although additional teachers might be required in all systems (Staff Exhibit 8, p. 4-22).

134. The Applicants' 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 (Staff Exhibit 8, p. 4-22).

135. 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 hours. In fact, the most noticeable impact on traffic would be an extension of peak from 1 to 2 consecutive communiting hours during the peak of construction. The Staff

also noted the potential for increases in accident frequency, inconvenience, and accelerated road deterioration (Staff Exhibit 8, p. 4-23).

136. 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 (Staff Exhibit 8, p. 4-23).

137. 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 (Staff Exhibit 8, p. 4-23).

138. The data indicates a $446 million direct payroll throughout the construction period. If 40% of that payroll is spent in the four-county area, the private 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 expeditures (Staff Exhibit 8, p. 4-25).

139. Dust and noise and other potentially adverse effects from blasting and heavy equipment during construction would have minor adverse effects and

they would be experienced only by the few residents immediately south of the river (Staff Exhibit 7, p. 4-17; Staff Exhibit 8, pp. 4-25 - 4-26).

140. To limit the adverse effects during construction, the Applicants have commited to various measures and controls which are in Staff Exhibit 8, pp. 4-26 - 4-28. Based on the Staff's review of the anticipated construction activities and the expected environmental effects therefrom, the measures and controls committed to by the Applicants, in Staff Exhibit 8, pp. 4-26 - 4-28, 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 (Applicants Exhibit 34, Section 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 Clich 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.

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 mitigate adverse impacts of the project.

141. The expected environmental effects from anticipated construction activities are acceptable impacts if the Applicants' commitments to

measures and controls to limit adverse effects during construction (Staff Exhibit 8, pp. 4-26 - 4-28) and the Staff's precautions to ensure that adverse environmental effects will be of the minimal practicable levels (Staff Exhibit 8, pp. 4-28 - 4-29) are implemented.

3. Impacts of Operation

(a) Impacts on Land Use

142. Use of the site for the CRBRP would be consistent with the present industrial zoning for the site and adjacent land on the Oak Ridge reservation. Results of the University of Tennessee onsite archaelogical investigations will be made available to the public (Staff Exhibits 7 and 8, Section 2.3). Family members would continue to have access to the Hensley Cemetery which is also south of the plant location. Plant operation would have essentially no impact upon other archaeological and cultural values since they are at sufficient distances away from the plant. The State archaeologist's opinion is that the Applicants have given adequate consideration to archaeological resources. The State Historic Preservation Officer concurs that no properties of historic interest remain in the area (Staff Exhibit 7, Appendix C).

143. The plant would have an insignificant adverse visual impact upon the area. Structures would be partially visible from Gallaher Bridge and scattered residences south of the river. Building finishes would harmonize with each other. Ridges and hills would provide a natural screening. The impact of the cooling tower plumes is discussed in Staff Exhibits 7 and 8, Section 5.3.3.

144. Cooling tower fogging and icing are expected to have insignificant effects upon local transportation routes (Staff Exhibits 7 and 8, Section 5.3.3). Cooling tower noise at the 2200 ft. minimum exclusion distance would be about 55 dBA (Applicants Exhibit 36, Section 5.1.8.4), about equal to the 55 dBA threshold, as a day-long average, for outdoor annoyance (EPA, 1974). There would be no noise problem and insignificant effects upon local transportation routes from the cooling towers in the surrounding areas from operation of the plant.

(b) Impacts on Water Use

145. Plant operation would result in the consumptive use of 8.3 cfs of river water, about 0.2% of the annual average river flow rate. During the infrequent periods of no flow (the most severe was 29 days, 10 years ago) the consumptive use would represent well under 0.1% of the capacity of the Watts Bar Reservoir, for a 29-day no-flow period. River water consumption by the plant would represent a small, justifiable diversion with negligible effect on downstream uses including the ORGDP intake at CRM 14.4 (Staff Exhibit 7, p. 5-1, Staff Exhibit 8, p. 5-1).

146. Chemical and sewage discharges would be regulated by the NPDES permit and the State of Tennessee 401 Certification (see Staff Exhibit 8, Appendix H). Therefore, meeting the applicable standards would have no significant effect on the river's water quality (Staff Exhibit 7, p. 5-1; Staff Exhibit 8, p. 5-1).

147. Groundwater supplies would not be affected either. Supplies on the south side of the river would not be influenced by plant operation, since groundwater flow is toward the river from both sides. There would

be no wells and, therefore, no consumptive use on the site. Liquid and solid waste would not be discharged to onsite land (Staff Exhibit 7, Sections 3.6 and 3.7), except for a small amount of cooling tower drift (Staff Exhibit 7, Section 5.3.3), resulting in no measurable effect on groundwater (Staff Exhibit 7, p. 5-1).

148. Additionally, plant operation would have no effect on fishing and navigational use of the river. Only 1% of the commercial catch from Watts Bar Reservoir was taken within 10 miles of the site in 1972. About one sport fishing party per day was observed during the base line monitoring (Staff Exhibit 7, Section 2.7.2).

(c) Heat Dissipation System

149. The factors analyzed for the heat dissipation system were the water intake; impingement; entrainment; water discharge which includes thermal plume characteristics, thermal plume effects, cold shock, and scouring; atmospheric heat transfer; threatened and endangered aquatic species. With regard to the water intake, the 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) (Staff Exhibit 8, p. 5-1). The intake system would consist of two perforated pipes submerged in the Clinch River serveral feet above the bottom and would have characteristics to reduce fish impingement (Staff Exhibit 8, p. 5-1). 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 (Staff Exhibit 8, p. 5-2).

150. 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° (30°F) 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 (Staff Exhibit 8, pp. 5-2 - 5-3). 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 of entrainable organisms would be 0.6%, assuming a uniform distribution of organisms throughout the water column. Under low flow conditions of 1000 cfrs, the loss would be only 2.2%. Even if the entrainable organisms are found to

be in higher concentrations in the vicinity 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.

151. As a result of the studies conducted by the Applicants (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 (Staff Exhibit 8, p. 5-3).

152. With regard to water discharge, the thermal plume characteristics were analyzed. To predict the river temperature rise induced by plant blowdown discharge, the Applicants constructed a physical model. Since the greatest potential thermal impact are periods of no flow, four cases were analyzed, typical cases in winter and summer and worst cases in winter and summer. Based upon physical modeling, the thermal change produced would be small. All cases suggest that the submerged jet would mix rapidly (Staff Exhibit 7, pp. 5-5 - 5-7).

153. The Staff performed an independent analysis of the submerged thermal plume using a three-dimensional model (Bacas, 1971). Three cases were modeled for the purposes of cross-checking the Applicants' predictions, namely: summer typical, winter typical, and winter worst. Winter worst would produce greater change than summer worst (Staff Exhibit 7, Table 5.5). The data used in the physical model (Staff Exhibit 7, Table 5.2) were used in preparing the model input data for the three cases. As illustrated in Staff Exhibit 7, Figure 5.4, the mathematical

model results show excellent agreement with the data developed from the physical model study, for the summer and winter typical conditions. The comparisons for the winter worst conditions show poor agreement between mathematical and physical model results; the mathematical model predicts a more rapid dilution. The gradual dilution predicted by the physical model probably is the result of thermal buildup in the flume. Thermal buildup problems commonly occur in flume experiments using relatively small cross-flow velocities, becuase of the finite size of the basin and the time required for the thermal field to reach the steady state. Consequently, the Staff believes that the physical model results for the winter worst conditions are very conservative in estimating the rate of dilution. Staff Exhibit 7, Table 5.6 presents the temperature differentials for the plume centerline and the associated volumes predicted by the Staff's mathematical models (Staff Exhibit 7, p. 5-8).

154. Based upon the small size of the thermal plume (less than 200 ft.) and the more than 1.5-mi distance between intake and discharge, recirculation would not likely occur even under extended periods of no flow or reverse flow. Recirculation with the plume from the Kingston plant, 9 miles distant, would be even less likely (Staff Exhibit 7, p. 5-8).

155. Thermal limitations have been proposed on the CRBRP diffuser discharge as follows: "The receiving water shall not exceed (1) a maximum water temperature change of 3°C (5.4°F) relative to an upstream control point, (2) a maximum temperature of 30.5°C (86.9°F), and (3) a maximum rate of 2°C (3.6°C) per hour outside of a mixing zone which shall not exceed the dimensions of a circle with a maximum diameter of 30.5 meters (200 ft)" (Staff Exhibit 7, Appendix H, page 3); blowdown "discharge temperature

shall not exceed the lowest temperature of the recirculating cooling water prior to the addition of makeup" (Staff Exhibit 7, Appendix H, page 18). Based on the results of its hydrothermal analysis, the thermal discharge will comply with these requirements (Staff Exhibit 7, p. 5-8).

156. Regarding thermal plume effects, 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 (Staff Exhibit 8, p. 5-4).

157. Therefore, the impacts from the thermal discharge upon aquatic biota for all species, during normal operation and with flow in the Clinch River are expected 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 (Staff Exhibit 8, p. 5-5).

158. Water discharge also included an analysis of cold shock and scouring. Cold shock is the thermal stress resulting from a rapid

decrease in temperature that can occur immediately after plant shutdown. The most adverse result of cold shock would occur during the winter, when Δ Ts are at their highest. Because the small area within the 2.5°C isotherm would not be able to support large numbers of fish, fish loss is unlikely to result from interruption of heated effluent (Staff Exhibit 7, p. 5-11). Physical modeling of the discharge demonstrated that the plant would produce a localized scour hole. Under the four cases analyzed, the area of the scour hole would be as follows: winter no flow, 7.2 m^2; winter average flow, 8.4 m^2; summer no flow, 6.4 m^2; and summer average flow 10 m^2. The scour hole would produce a permanent loss of habitat to the benthic macroinvertebrates. However, the impact would not be significant due to the small area affected (Staff Exhibit 7, p. 5-11).

159. Regarding atmospheric heat transfer, the plume from the cooling tower interacting with other plume sources was analyzed. The only interaction of plumes from other sources and the CRBR cooling tower plume would be from the K-25 towers. Only with a constant wind from the northern sector coupled with stable atmosphere could the K-25 plume reach lengths interacting with the plume at the site (ER, Am I, Part II, A1). Other sources are either very small (X-10 and Y-12) or at such great distance and height (Kingston and Bull Run) above the plant plume as to have negligible interaction (Staff Exhibit 7, p. 5-12).

160. Pertaining to fogging from the plant tower, it possibly could have some small effect on local transportation routes. Based on data supplied by the Applicants (ER, Am I, Part II, A4),
the potential for fogging would exist 3.6 hr/yr and 2.4 hy/yr along Interstate 40 at Caney Creek and Gallaher Bridge, respectively. Addi-

tionally, the potential for fogging due to the plant tower will exist 2.4 hr/yr at ORNL. Monitoring fog and ice impact of tower operation would be a part of the technical specifications at the operating license stage (Staff Exhibit 7, p. 5-12). Drift deposition for the cooling tower was also analyzed (Staff Exhibit 7, p. 5-12). Drift deposition from the CRBRP tower would have no important effect on vegetation or fauna. Lastly, the impacts from operating the mechanical draft towers would be regarded primarily as minor aesthetic and nuisance factors rather than health or safety problems. (Staff Exhibit 7, pp. 5-12 - 5-13).

161. In compliance with the Endangered Species Act, the NRC requested the U.S. Fish and Wildlife Service (FWS) to provide a current list of those Federally recognized threathened 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 mussles (Staff Exhibit 8, Appendix B). No critical habitat has been designated in the vicinity of the site. The Staff performed a biological assessment for the listed species. As a result, it is expected that construction and operation of the CRBRP will not have an adverse effect on any federally protected endangered or threatened species. By letter dated September 17, 1982, FWS advised the NRC that it concurred in the Staff conclusions (Staff Exhibit 8, p. 5-7).

162. 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. Staff

Exhibit 7, Section 2.7.2 summarizes the known captures of this species in Watts Bar Lake. No significant losses to this species are anticipated as a result of thermal impact, impingement, or containment are anticipated (Staff Exhibit 8, p. 5-7).

(d) Other Nonradiological Effects

163. Other nonradiological discharges from the plant are the impacts of chemical effluents, sanitary waste and other waste. These nonradiological discharges are expected to comply with the NPDES permit and the State of Tennessee Water Quality Standards requirements (Staff Exhibit 8, pp. 5-7 - 5-8).

(e) Transmission Lines

164. Insignificantly adverse visual impacts would result from 3 miles of new lines on expansions of existing rights-of-way (Staff Exhibit 7, p. 5-3). The Applicants plan to control vegetation growth by mechanical cutting and limited use of herbicides (Staff Exhibit 8, p. 5-8). With regard to corona effects and ozone production, the Staff anticipates no significant impact from operation of the 161 kV transmission lines (Staff Exhibit 7, p. 5-14). Transmission line operation creates potential for adverse effects from audible noise, corona, radio and television inter ference, and elctrostatic induction. However, experience with 161 kV lines on the TVA system shows that the effects are minimal (Applicants Exhibit 35, Section 5.6). There are no adverse impacts having any significant consequence.

(f) Impacts on Community

165. 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 (Applicants Exhibit 36, Table 8.2-1). The Applicants indicate that 75 jobs would be created as a result of the direct employment on CRBRP (Applicants Exhibit 36, Table 8.2-3). 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 (Staff Exhibit 8, p. 5-9).

166. 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 (Applicants Exhibit 36, Table 8.2-1). With respect to induced employment, 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 (Staff Exhibit 8, p. 5-9).

167. 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 (Applicants Exhibit 36, 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, there is no one jurisdiction that would have difficulty in accommodating operating phase inmovers (Staff Exhibit 8, p. 5-9).

168. 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 (Applicants Exhibit 36, Section 8.2.2.1).

169. Regarding 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. Possible revenue sources by which the project would help meet the increased public spending load in the local area as a result of the operation of the project are direct and indirect taxes from payroll and spending. Local communities now can add to the state sales tax of 4.5% on designated items

an additional tax of up to 2.5% 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 taxes, beverage taxes, fines, fees, and state transfer funds (Staff Exhibit 8, pp. 5-9 - 5-10).

(g) Radiological Impacts from Routine Releases

170. For the radiological impact from routine releases on biota other than man, depending on the pathway and radiation source (Staff Exhibit 7, Figure 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 (Staff Exhibit 8, p. 5-11).

171. 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 C.F.R. § 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 (Staff Exhibit 8, p. 5-11).

172. In analyzing the radiological impact from routine releases on humans, the factors of exposure pathways, liquid effluents, gaseous effluents, direct radiation from the facility, occupational radiation exposure, fuel cycle impacts and transportation of radioactive materials were considered (Staff Exhibit 8, pp. 5-11 - 5-20). The annual 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 consindered. Beyond 50 miles, and until the gaseous effluent reaches the north-eastern 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 troposphere. 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, and transportation, are presented in Staff Exhibit 8, Table A5.5.

173. The Staff determined and the Board agrees that 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 A5.5 for completeness of information is the annual population dose expected from the CRBRP supporting fuel-cycle facilities. Occupational radiation exposure is discussed in Staff Exhibit 8, Section 5.7.2.5.

174. With regard to evaluating the radiological impact to the general public, 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 abnormalties in the year 2010 population and in the first five generations of the year 2010 population, respectively (Staff Exhibit 8, pp. 5-20 - 5-22). On this basis, 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.

4. Environmental Measurement and Monitoring Programs

175. The Applicants have designed various preoperational and operational monitoring programs to monitor offsite radioactivity, onsite meteorology, the aquatic environs, the terrestrial environs, the chemical and physical aspects of the area, and the socioeconomic factors. Additionally, the Applicants will survey the primary work force. Since 1977, 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 (Applicants Exhibit 35, Section 6).

176. In evaluating the additional information, the Staff has not found substantial changes that would alter significantly its assessments of environmental impacts in the FES (Staff Exhibit 7, Section 6; Staff Exhibit 8, Section 6). Therefore, the monitoring programs are adequate with the precautions outlined by the Staff in Staff Exhibit 8, pp. 6-1 - 6-20).

5. Cost-Benefit Balancing

177. In balancing the costs and benefits of the Clinch River Breeder Reactor, the Staff reviewed the following benefits: 1) the LMFBR concept demonstration, 2) power produced, 3) research, 4) environmental enhancement, 5) employment and payroll, and 6) taxes. Pertaining to the costs of the CRBRP, the Staff reviewed the environmental costs and the monetary costs.

178. The principal benefit of the proposed facility would be to demonstrate the liquid metal fast breeder nuclear reactor concept for commercial use in generating electrical power. If the applicability can be demonstrated, the useable energy in our uranium resources would be extended and the country would become more self-sufficient in energy production. The electricity generated by the plant would be a secondary benefit. If the plant operates at 76.5% (based on 350 MWe) average capacity factor over the 30-year plant life, a total of slightly over 70 billion kWh could be produced. 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) (Staff Exhibit 7, p. 10-7, Staff Exhibit 8, pp. 10-9 - 10-10).

179. Regarding research the Applicants have proposed an extensive preoperational monitoring program to characterize the environment prior to construction, and a similar operational phase monitoring program to determine any adverse effects due to plant construction or operation. Surface and groundwaters, local meteorology, terrestrial and aquatic ecology, and radiological surveys would be conducted (Staff Exhibit 7, pp. 6-1 - 6-13; Staff Exhibit 8, pp. 6-1 - 6-20). The Applicants have also proposed that expenditures for research and development (R&D) by DOE in support of the CRBRP woud total $435 million between 1975 and 2020, with about $900 million more for safety-related R&D applicable to the total LMFBR program (Staff Exhibit 8, p. 10-10). In the area of environmental enhancement, the results of onsite archaeological investigations by the University of Tennessee will be made available to the public (Staff Exhibit 7, p. 10-7).

180. Employment and payroll is a secondary benefit from the CRBRP. 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 (Staff Exhibit 8, pp. 10-10 - 10-11).

181. Another secondary benefit from the CRBRP are tax revenues. 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 in Staff Exhibit 8, Table A4.13, p. 4-23. 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 (Staff Exhibit 8, p. 10-10).

182. With regard to environment costs, those were discussed in the sections entitled environmental impacts due to construction and environmental impacts of plant operation. A summary of these costs are in Staff Exhibit 8, Table A10.2, pp. 10-12 - 10-15.

183. Regarding monetary costs, the Applicants' current estimated cost of the CRBRP is \$3.196 billion for plant investment, dvelopment, and operation through 1995. 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 that amount. Accordingly, between the years of 1974 and 1995 the total costs by year of expenditure are estimated to be \$3.525 billion and by 1982 present worth are estimated to be \$3.423 billion (Staff Exhibit 8, p. 10-11). The cost of safeguards are estimated to total \$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 (Staff Exhibit 8, Appendix E, Section E.6.3).

184. Estimated costs for decommissioning would vary, depending on the decommissioning mode chosen, from about $21 million to about $43 million in 1978 dollars (see Staff Exhibit 8, Section 10.2.4.5) (Staff Exhibit 8, pp. 10-11 - 10-17).

185. The Staff reviewed Applicants' proposed plant (Staff Exhibits 7 and 8, Chapter 3) and made an independent evaluation of the environmental effects of its construction and operation (Staff Exhibits 7 and 8, Chapters 4 and 5) at the proposed site (Staff Exhibits 7 and 8, Chapter 2). Further consideration was given to technical alternatives (Staff Exhibits 7 and 8, Chapter 8) and the environmental and monetary factors associated with alternative plant-site combinations and plant system alternatives (Staff Exhibits 7 and 8, Chapter 9).

186. On the basis of its evaluation, it can be concluded 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 CRBPR 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 CRBRP would meet the demonstration plant's objectives within the LMFBR program (see Staff Exhibit 8, Chapter 8).

D. ENVIRONMENTAL - CONTESTED MATTERS

1. Accident Analysis: (Contentions 1(a), 2(a), 2(b), 2(c) and 3(b)-(d)

187. The FES and its Supplement describe CDAs and the general classes of events potentially leading to CDAs. A comparison of selected CRBRP accident sequences was made with those in the Reactor Safety Study (WASH-1400) to gain perspective on risks of very severe accidents in CRBRP. Our discussion of accidents in the FES and its Supplement, particularly appendix J thereto, is in keeping with the guidance of the Commission's Statement of Interim Policy on Nuclear Plant Accident Considerations Under the National Environmental Policy Act of 1969 (45 F.R. 40101, June 13, 1980). ("NRC Staff Testimony of Bill M. Morris, Jerry J. Swift, John K. Long, Edmund T. Rumble, III, Mohan C. Thadani, Lewis G. Hulman on Intervenors' Contention 2 and Its Subparts 2c, 2d, 2f, 2g and 2h and Contention 3 and Its Subparts 3c and 3d" will hereinafter be referred to as Staff Testimony of Morris, Swift, et al) (Staff Testimony of Morris, Swift, et al, Tr. 5752).

188. CDA initiation frequencies have been determined by judging the feasibility of achieving a specific level of performance. This judgment was based on three points. First, the Staff considered general characteristics of the CRBRP system design as proposed including its inherent redundancy, diversity, and independence and its perceived interfaces with support systems such as electrical power, operators and maintenance personnel.

Secondly, the Staff considered the potential for achieving high reliability in the design through implementation of an effective reliability program. Finally, quantitative bounding CDA initiation frequencies for the CRBR design were estimated based on the above and on relevant LWR operating experience including the pertinent information available from reliability oriented studies of LWRs and LMFBRs. (Staff Testimony of Morris, Swift, et al, Tr. 5753-54).

189. The Staff's specific CDA initiation frequency estimates attributed to ATWS events were based on NUREG-0460, "Anticipated Transients Without Scram for Light Water Reactors," Vol. I, Section 4.3, where an estimate of the frequency of ATWS for typical LWRs was given as 2×10^{-4} per year. In Volume 4 of NUREG-0460, the Staff found that the risks of ATWS were unacceptable for light water reactors. Estimates in this same range were subsequently quoted by the Commission in its statement regarding ATWS rulemaking. These ATWS frequency estimates were based on operating LWR experience including a variety of designs and plant ages. (Staff Testimony of Morris, Swift, et al, Tr. 5754). For the CRBR, however, for reasons of redundancy, diversity, and independence of shutdown systems, the same conclusion with respect to unacceptability does not apply. (Testimony of Hulman, Tr. 5539-40).

190. Against this background the Staff evaluated the CRBR shutdown system design criteria. The most important factor considered was the extra redundancy, independence and diversity of the proposed CRBR shutdown systems. The currently proposed design of the CRBR shutdown system includes two independent and diverse systems, each of which is comparable to an LWR shutdown system. Each of these systems will meet the single

failure criterion, the criteria for independence between redundant channels and will include measures for diversity such as diverse logics, circuitry, actuating mechanisms, and sensors. The Staff also took into consideration the nature of the ATWS percursors from LWR experience to determine if there were any special lessons related to the CRBR design. Some LWR ATWS percursors seem relevant to CRBR but others do not. The Staff considered the potential frequency of occurrence of transients at CRBR, the potential for achieving high reliability through implementation of a formal reliability program, and the possibility of common mode failures of the two shutdown systems. (Staff Testimony of Morris, Swift, et al, Tr. 5754-55).

191. Without common mode failures, an estimate of the CRBR ATWS frequency could be arrived at by direct multiplication of the failure frequencies of the two shutdown systems as though they were totally independent. However, because of the potential for common mode failure it is not appropriate to attribute ATWS frequencies to CRBR as low (about 10^{-7} per year) as might be obtained by multiplication of the unreliabilities possible for the primary and secondary shutdown systems. Instead, to be conservative, a range of 10^{-5} to 10^{-4} per year was selected by the Staff as a preliminary estimate for CRBR. Although the Staff concluded that the most likely CRBR ATWS frequency was on the low end of this spectrum, it used 10^{-4} per year as the bounding value for the purpose of risk estimates in Appendix J. (Staff Testimony of Morris, Swift, et al, Tr. 5755).

192. The Staff arrived at the specific CDA initiation frequency estimates attributed to loss of heat sink (LOHS) events based in part on the redundancy and diversity of the CRBR decay heat removal systems and in

part on the reliability of PWRs, which have redundancy and diversity in their auxiliary feedwater system (AFWS) similar to that of the CRBR. Evaluations of PWR AFWS reliabilities including that in WASH-1400 and more recent studies, suggest that failure frequencies in the range of 10^{-5} to 10^{-4} per demand may be achieved. The general trend of these studies is the basis for the conclusion that the CRBR AFWS can achieve similar reliability. Because CRBR also has a Direct Heat Removal Service (DHRS) to back up its three main loops of heat transport systems, LOHS failure frequency will be below 10^{-4} per year. (Staff Testimony of Morris, Swift, et al, Tr. 5756).

193. The CDA initiation frequency from fuel failure propagation in CRBR would be bounded by the ATWS and LOHS frequencies. This conclusion is based in part on the fact that the sodium coolant used to cool the CRBR core will operate far below its saturation temperature, and has a high thermal conductivity. Furthermore the coolant will move with a relatively high velocity through the assemblies. This means that local perturbations such as gas bubbles or debris particles will most likely be swept through the assembly instead of collecting and manifesting themselves as initiators for fuel pin cladding failures. Also if there are such perturbations, even including a release of fission gas from a pin with breached cladding, the efficient heat transfer and high subcooling provide protection against local fault propagation. (Staff Testimony of Morris, Swift, et al, Tr. 5756-57). Additional inherent safety features in the design of the CRBR cooling system are discussed at (Staff Testimony of Morris, Swift, et al Tr. 5757-59), which supported the conclusion that fuel failure propagation would be very unlikely. If in fact failures do

occur, however, they would be detected early enough to prevent propagation into a CDA.

194. Additional support for the conclusion that the probability of a CDA from such events is low derives from the fact that the design features of the fuel and coolant are inherent, passive measures, and because only a simple and inherently reliable detection system is employed. (Staff Testimony of Morris, Swift, et al, Tr. 5759). The CDA initiation frequency from loss of coolant accidents would be bounded by the LOHS frequency at CRBR. CDA initiation resulting from uncovering the reactor core can be made highly improbable by requiring high integrity of the heat transport system. The principal measures to achieve this are to perform pre-service and in-service inspection of the primary coolant boundary to verify continuing piping integrity, and to install a detection system to detect small leaks, should they occur, before they grow to unacceptable size. Because LMFBR primary coolant systems operate at low pressure and below the saturation temperature of sodium, an Emergency Core Cooling System (ECCS) to rapidly inject additional coolant when a pipe break occurs is not necessary. Instead, it is sufficient to provide (a) guard vessels to catch coolant leakage from portions of the system below the top of the core to ensure sufficient core coverage and (b) piping elevated above the tope of the core for other portions of the coolant system to preclude draining the reactor vessel. Based on successful implementation of such features at LWRs or domestic and foreign LMFBRs, it will be possible to implement these design features acceptably at CRBR, and thereby assure that CDAs related to loss of coolant inventory will be very unlikely. (Staff Testimony of Morris, Swift, et al, Tr. 5759).

195. Because the design features such as guard vessels and leak detection systems required to assure that unacceptable loss of coolant will not occur are passive and/or do not require complex active components and systems, their failure is very unlikely, in comparison to the estimated failure frequency for the shutdown system or decay heat transport system. Furthermore, the likelihood of a leak in the CRBR piping is also low. Therefore, the contribution of loss of coolant events to the frequency of CDAs is small compared to the contribution due to LOHS. (Staff Testimony of Morris, Swift, et al, Tr. 5760. The conditional frequencies of containment isolation failure and containment annulus cooling and vent-purge system failure are based on the feasibility of the general CRBRP design achieving a specific level of reliability considering environmental factors, common mode failure and an appropriate level of reliability of required supporting systems and functions. In the case of the containment isolation system, LWR containments incorporate systems of similar function and design, thus bounding frequency estimates for CRBRP including environmental, support, other interacting factors, can be made with sufficient confidence. In the case of the annulus cooling and vent-purge system, an equivalent level of LWR experience is not available. Thus confidence in the bounding frequency estimate is based upon the systems' inherent redundancy, diversity and independence as well as the feasibility of improving system performance, should this be deemed necessary, coupled with a reliability program and a testing and inspection program of sufficient frequency to provide the required reliability. (Staff Testimony of Morris, Swift, et al, Tr. 5762).

196. The pipe rupture probabilities for CRBR are estimated to be 10^{-8}/plant-year for the cold leg, and 10^{-7}/plant-year for the hot leg. (Staff Ex. 20 at 4, Harris). The failure rate of primary piping in CRBR is 0.1 to 1 times the corresponding value for a PWR. (Tr. 6271, Harris).

197. It is very unlikely that a previously undetected interdependence exists between various elements of the CRBR which could lead to an accident. (Tr. 2256, Morris). The systems proposed for CRBR are sufficiently understood such that an unknown system interaction is unlikely to increase the likelihood that human error could cause a CDA. (Tr. 2468, Morris, et al). In this regard, a key systems review was performed to assure consideration of common cause failures, in support of the above conclusion. (Tr. 5270-71, 5247-49, Clare; Staff Ex. 8 at 12-77 and 12-78).

198. The Staff did not rely on design-specific reviews of the proposed CRBR in performing its accident analysis review. Tr. 5638-40; 5496-5505. Although the document CRBRP-1 provided some background information for Dr. Rumble's understanding of CRBR, the detailed review contained in that document were not relied on for the Staff's analysis of CRBR. (Tr. 5640, 5486, 5495, 5503; Rumble).

199. Staff witness Rumble briefly participated in the early planning of methodology for the development of CRBRP-1. His work was limited to the scoping out of some preliminary qualitative event trees, but he did not perform any calculations. Some vestiges of the initiator work performed by Dr. Rumble, as modified by others, subsequently became part of the CRBRP-1 document, but consisted solely of general methodology which is not specific to CRBR, and is generally applicable to any power reactor.

(Tr. 5641-42, Rumble). Dr. Rumble did not rely on any of his preliminary CRBRP-1 work as part of his preparation of testimony for the Staff in the current hearing, and has not done any work for Applicants on CRBR since he completed the preliminary work on CRBRP-1. (Tr. 5642-43; Rumble). A sufficient review of the involvement of Dr. Rumble's firm, SAI, in the preliminary work on CRBRP-1 was performed by the Staff to ensure that this preliminary work was not of such significance as to prevent SAI from providing independent advice to the Staff regarding CRBR. Tr. 5643-44; Morris).

200. The releases of fission product and core-materials, including halogens, iodine, and plutonium, from CDAs which have been evaluated by the Staff are presented in Table J.2, Appendix J of the FES Supplement (Staff Ex. 8). Release fractions are specified for CDA Classes 1 through 4 as indicated in Table J.2 of the FES Supplement (Staff Ex. 8). Each of these four sets of release fractions is based upon a specific accident scenario with regard to containment response and phenomenological events which occur after initiation of a CDA; however, for all CDAs it is assumed that the total noble gas inventory would be released from the containment building. (Staff Testimony of Morris, Swift, et al, Tr. 5763).

201. Estimates of the fraction of the core radionuclides released to the outside environment are made for each nuclide group identified in Table J.2 of the FES Supplement (Staff Ex. 8). These release fractions depend upon the fraction of each nuclide group released from the fuel, the primary system via the reactor vessel head, the sodium pool and subsequently the dry reactor cavity. (Staff Testimony of Morris, Swift, et al, Tr. 5763.

202. Release fractions of the fission products from the fuel after a CDA were conservatively selected by the Staff considering core disruption phenomena and analysis of radionuclide releases in WASH-1400, Appendix 7, pp. 1-15, and the data provided in the document "Nuclear Aerosols in Reactor Safety, tne State of the Art Report," Nuclear Energy Agency, OEC, CSNI/SOAR, No. 1 June 1979, p. 228. The reactor vessel head release fractions were conservatively selected on the basis of judgment from consideration of general LMFBR research on energetic CDAs taking into account the relative volatilities of the different radionuclide species and other materials. (Staff Testimony of Morris, Swift, et al, Tr. 5764).

203. The accident processes and assumptions made by the Staff in estimating the thermodynamic conditions in the reactor containment building and the reactor cavity following the initiation of a CDA are conservatively described in Staff Exhibit 7, as well as the resulting release fractions of fission products. (Staff Testimony of Morris, Swift, et al, Tr. 5763-68).

204. Using the estimates of RCB source terms and leakage rates of the containment atmosphere out of the RCB, the ratio of leakage rates to leakage plus fallout rates, as discussed in the FES Supplement, Appendix J at J-7 through J-11 (Staff Ex. 8) were estimated by the Staff for each CDA Class and RCB source term. This ratio, when multiplied by the inventory fraction of each isotope in the RCB, results in an estimate of the fraction of each isotope released from the RCB. If filtering is operative, the filtering inefficiency (1 minus filter efficiency) was also multiplied by the release fraction to obtain the environmental release fraction. (Staff Testimony of Morris, Swift, et al, Tr. 5769).

205. Once the release fractions to the environment are calculated for each isotope group of each RCB source term, they are combined to form a total release fraction for each isotope group of each CDA class. Each CDA class environmental release represented by a set of isotope group release fractions is then used as input into the consequence model. (Staff Testimony of Morris, Swift, et al, Tr. 5769). These releases were then conservatively characterized for input into the Staff's computer consequence model (CRAC), as described at (Id., Tr. 5770-78). The Staff utilized conservative estimates of height and energy content of releases (Id., Tr. 5770), sodium aerosol deposition rates (Id., Tr. 5771) and concentration rates (Id., Tr. 5771-72) and leakage rates to the environment (Tr. 5773-75).

206. The realistic doses of CDA Class-1 accident releases (the site suitability source term accident) would meet the dose guidelines of 10 C.F.R. Part 100. Staff Ex. 8 at J-11.

207. The present body of information regarding the energetics resulting from physically reasonable core arrangements of sodium, cladding, or fuel indicates that the magnitude of such energetics is well within the containability range of the primary system. If after completion of the Staff review of the potential for core associated energetics, a conclusion is reached that energy releases beyond the primary system capability to maintain sufficient integrity cannot be precluded, the Staff will require design modifications to prevent early containment failures from such effects as missiles or spray fires. Such modifications are clearly feasible and not so costly as to significantly affect the overall cost-benefit balance. Thus the releases from CDAs as indicated in Table J.2 of the FES Supplement (Staff Ex. 8) do not include early containment failures

from extremely energetic CDAs since they will be of sufficiently low likelihood that their contribution to the risk of the public will not be significant. (Staff Testimony of Morris, Swift, et al, Tr. 5779-80).

208. Head releases for those CDA Classes analyzed in the FES Supplement are presented in Table J.3 (Staff Ex. 8). These releases are selected to approximate potential bounding head releases for two different levels of energetics, given the design of the primary containment system and potential variations thereof. While these releases are not derived from specific analyses of the CRBR, they have been selected on the basis of the ranges of such releases that have been estimated for CRBR and other plants. Further, the releases of different isotope groups were set relative to each other to account for the spectrum of volatile species present in the core inventory. (Staff Testimony of Morris, Swift, et al, Tr. 5780).

209. From the background information available regarding energetics and from a design feasibility standpoint, these release values presented in Table J.2 (Staff Ex. 8) are appropriate and probably conservative (based upon NUREG-0772). The sensitivity of these values was tested by considering variations in these head release fractions, using the CDA classes as defined in Table J.2. This sensitivity test did not significantly affect the risk with regard to its impact on the NEPA cost/benefit analysis. (Staff Testimony of Morris, Swift, et al, Tr. 5781).

210. The Staff's analyses properly assumes that less than one in ten CDAs are energetic enough to cause primary coolant system seal failure. This assumption is based on the present body of knowledge and the capacity of the primary system to withstand mechanical damage. The frequency of one in ten is set conservatively as a reflection that some uncertainty remains

with regard to energetic recriticalities. (Staff Testimony of Morris, Swift, et al, Tr. 5783). The specific factors supporting this conclusion are set forth at Tr. 5784.

211. As is the case regarding the site suitability analysis, it is conservative to assume, as the Staff did, that in analyzing accident risk for the CRBRP, which has equal or better conditions versus comparable LWR situations, the same level of human error induced unavailability estimates should be used. (Staff Testimony of Morris, Swift, et al, Tr. 5786). The Staff used the consequence model described in the Reactor Safety Study, RSS, (WASH-1400, NUREG-75/014) and associated computer code "CRAC", adapted and modified to treat the CRBRP reactor core characteristics and the CRBRP site features in the Staff's environmental analysis. This model, and the input for it, were adequately documented and validated/verified, and uncertainties regarding its use were properly accounted for in its use. (Id., Tr. 5787-92). The risks to the public from the postulated CRBRP accidents would be comparable to the risks calcuated by the Staff for light water reactors. The bases for this conclusion include sensitivity studies involving CRAC calculations for a PWR or BWR at the CRBR site, and CRAC generated risk estimates incorporated in Environmental Statements for contemporary LWRs at other sites. (Id., Tr. 5792).

212. The radioactive sodium release does not significantly increase the calculated CRBRP accident risks to the public. The aerosol agglomeration effects of sodium, however, are expected to further reduce the quantity of radionuclides released to the offsite environs in an accident involving sodium release, over what was estimated by the Staff. Because there is limited information on the behavior of sodium aerosols in the outdoors

atmosphere, it is conservative to not include the reduction of risk that could result from the agglomeration characteristics of sodium. If sodium-24 were included in the postulated accident, radionuclide releases would not increase the risks to the public significantly. The computed early fatality risks increased only slightly, and the latent fatalities did not change. The small increase in early fatalities is not considered significant in view of the conservative assumptions regarding release fractions and the radiotoxicity of sodium used in the analysis. (Staff Testimony of Morris, Swift, et al, Tr. 5793).

213. There is an approximately equal likelihood that about 1 or 10 early fatalities would occur as a result of a severe accident. The probability of substantial more fatalities, however, drops by order of magnitude and there would probably be 1 chance in 10 billion per year that 30 or more early fatalities might occur. Similarly, there is about one chance in a billion per year that there would be about 1000 latent fatalities as a result of a severe accident. At the extreme end of the offsite mitigation costs spectrum, the costs could be as high as several hundred million dollars. (Staff Testimony of Morris, Swift, et al, Tr. 5794).

214. The CDA Class 1 analysis by the Staff assumed that the contain-
214.ment system functions as designed, similar to the postulated site suitability source term accident. (Staff Ex. 8 at J-5; Staff Testimony of Morris, Swift, et al, Tr. 5782). For comparison purposes, this accident is not expected to result in doses which exceed 10 C.F.R Part 100 guidelines. (Staff Ex. 8 at J-11).

215. A full probabilistic risk assessment is not considered necessary at the construction permit stage, nor has it been Staff practice to perform such assessments for other environmental impact statements since the Commission issued its policy statement of June 1980. (Testimony of Hulman, Tr. 5644).

2. Safeguards of Plant and Fuel Cycle: Contentions 4 and 6(b)(4)

216. The health and safety consequences of successful acts of sabotage or theft of plutonium, which could be used in either explosive or dispersal devices, would be unacceptable and the Staff analysis, therefore, analyzed the environmental impacts of the systems necessary to render successful acts of sabotage or theft unlikely. ("NRC Staff Testimony of Robert J. Dube, Robert Davis Hurt, John W. Hockert, Charles E. Gaskin and Harvey B. Jones, Jr., Regarding Contentions 4 and 6(b)(4)" will hereinafter be referred to as Staff Testimony of Dube, et al, Tr. 3737-38; Testimony of Hockert, Tr. 3591).

217. The basis for the Staff's analysis was the Applicants' supplement to the CRBR Environmental Report, Amendment No. XIV to the Environmental Report for the Clinch River Breeder Reactor Plant, Docket No., 50-537, June 1982. This supplement provided a description of the safeguards systems that the Applicant proposes to employ. The safeguards systems for the CRBRP will be required to be designed to satisfy the NRC requirements of 10 CFR 50, 70, and 73. The safeguards system for the mixed-oxide fuel fabrication facility, the reprocessing facility, and transportation activities would comply with the requirements of DOE Orders 5630, 5631, and 5632. (Staff Testimony od Dube, et al, Tr. 3736).

218. The systems described in Amendment No. XIV cover each activity in the proposed CRBR fuel cycle, including material transportation. The descriptions include both physical protection and nuclear material control and accounting (MC&A) capabilities, thus providing defense in depth. (Staff Testimony of Dube, et al, Tr. 3739; Testimony of Hockert, Tr. 3591.

219. For all the CRBR fuel cycle activities the Staff considered the combined effectiveness of physical protection and MC&A. The physical protection systems would include such features as security zones, facility architectural and design features, personnel and vehicle access controls, intrusion detection and assessment systems, automated alarm reporting, surveillance, communications, and computer security. Material control and accounting systems would include both passive and active features. Passive material control would be accomplished by placing barriers or impediments between special nuclear material and an inside adversary. Active material control would be accomplished by using the latest advances in remotely-controlled automated processing and rapid accounting techniques, in addition to traditional longer-term physical inventories. PuO2 and fresh fuel in transit would be protected by the DOE Safe Secure Transport System. (Staff Testimony of Dube, et al, Tr. 3738-3739)

220. The Staff's assessments were performed on a systems level. Operating procedures, equipment specifications, and other details were not considered. The Applicants' proposals were judged in terms of whether the safeguards systems would cover all necessary fuel cycle activities, are appropriate for the types of activities to which they would be applied, and are likely to be able to protect against theft, deversion and sabotage. (Staff Testimony of Dube, et al, Tr. 3739, 3744-45)

221. The systems level assessment is appropriate for an environmental impact review, a detailed review of a safeguards and security plan not being required until the operating license stage. See 10 C.F.R. § 50.34(c)(d). (Staff Testimony of Dube, et al, Tr. 3739, 3744-45.

222. The Staff's assessment method was to evaluate DOE's proposed safeguards systems against three general performance criteria. The evaluation took account of the safeguards design basis threats and, when necessary, depended on comparisons between DOE's proposals and specific NRC regulations. The Staff's assessment is discussed in detail in the CRBR Final Environmental Statement Supplement (FESS), Section 7.8 and Appendix E. (Staff Testimony of Dube, et al, Tr. 3741).

223. In accordance with NRC's safeguards mandate, the NRC Staff conducted analyses of the potential theft and sabotage threat to licensed nuclear activities. Because the incidence of nuclear sabotage and theft is very low, such analyses relied primarily on the study of evidence in non-clear, high value, or high risk environments. Some nuclear events have also been included in the analysed. These studies analyzed the characteristics of potential adversaries to nuclear programs, including their degree of motivation, equipment, tactics, and organization. The design basis threats contained in 10 C.F.R. Part 73.1(a) represent the Staff's best judgment of the characteristics of potential adversaries nuclear activities. (Staff Testimony of Dube, et al, Tr. 3743).

224. Formula quantities of PU will be present at the CRBR, reprocessing plant, and the fuel fabrication facility. (Staff Testimony of Dube, et al, Tr. 3742).

225. In order to conduct the systems level review deemed appropriate for analyzing the environmental effects attributable to the CRBR fuel cycle, the Staff compared the DOE and NRC safeguards regulations and determined that there were no differences at the systems level between the two agencies requirements. (Testimony of Hurt, Tr. 3605, Tr. 3744-45).

226. The Applicants have commited to meet DOE safeguards orders. (Testimony of Dube, Tr. 3683-84)

227. Further, the Staff determined that DOE Orders (which would apply to other DOE facilities if chosen over those proposed) can, from a technical standpoint, reasonably be complied with for fuel cycle facilities. (Testimony of Dube, Tr. 3706, Testimony of Hurt, Tr. 3680).

228. As part of the review to determine whether DOE regulations and Orders would protect against acts of sabotage or theft, directed against fuel cycle facilities, to the same or greater extent as the NRC regulations do, the Staff did a side by side comparison, concluding that the DOE regulations and Orders did provide for safeguards adquate to repell acts of sabotage or theft equal to or greater then the NRC design basis threats. No evidence was presented disputing this conclusion. (Testimony of Jones, Tr. 3627-32).

229. In discussion of the material control and accounting (MC&A) systems, which will be used during the CRBR fuel cycle, both the Staff and Dr. Cochran agreed that the MC&A system must be considered in conjunction with physical security measures in determining that the ability to detect divergance of formula quantities of PU is adequate. (Testimony of Dube, Tr. 3725-26; Testimony of Cochran, Tr. 3827).

230. Although Dr. Cochran cites an IAEA (International Atomic Emergency Agency) report for the proposition that there is uncertainty in the ability to achieve certain MC&A performance levels, he also admitted that the IAEA does not consider physical security measures along with MC&A. Thus, the material cited is not evidence that the CRBR fuel cycle facilities can not achieve MC&A performance levels since Dr. Cochran himself admitted that physical security and MC&A systems should not be considered independently. (Testimony of Cochran, Tr. 3820-3821, 3827; Testimony of Dube, Tr. 3725-26).

231. With respect to MC&A technology, it was established that in only one area is research and development (R&D) needed to establish technological capability to meet performance goals can be met. (Testimony of Hurt, Tr. 3689-90, Testimony of Dube, Tr. 3697 and 3721).

232. In spite of the fact that prompt accountability systems, as discussed above, have been proposed and are technically within a reasonable time frame for achievability, NRC regulations do not, at present, require such a system. (Testimony of Hurt, Tr. 3694. Testimony of Dube, Tr. 3646 and 3688).

233. A system with capabilities of the MC&A system proposed by Applicant for the Demonstration Reporcessing Plant (DRP) can detect the theft of as little as .6 kilograms of Plutonium with a 90% probability of detection. (Testimony of Dube, Tr. 3681).

234. Dr. Cochran presented a list of events which he believed were empirical evidence supporting his conclusion that successful theft or sabotage was credible, however, upon cross examination, he admitted with respect to each of those events that they did not involve material

subject to the level of safeguards which will be present at CRBR and its supporting fuel cycle facilities containing formula quantities of PU. (Testimony of Dr. Cochran, Tr. 3800-3807).

235. While Dr. Cochran stated that CRBR and its supporting fuel cycle facilities are higher risk targets then conventional nuclear facilities, he also admitted that more stringent safeguards would apply to CRBR and its supporting fuel cycle facilities with respect to theft. Testimony of Cochran, Tr. 3814).

236. Although, Dr. Cochran claimed that there was no systematic coordination between NRC, DOE, and DOD to respond to changes in threat levels should they occur in the future, the very reference used by Dr. Cochran to support his statement, in fact, describes a systematic program between NRC, DOE, and DOD to evaluate threat levels. (Testimony of Cochran, Tr. 3856-58; Testimony of Jones, Tr. 3572; Testimony of Dube, Tr. 3717-18).

237. Should any changes in safeguards to respond to a change in threat levels be required, changes in requirements can be made in a period of a few months, to as little as overnight through an order. (Testimony of Dube, Tr. 3687).

238. That CRBR and the supporting fuel cycle facilities do not present unusual risks is evidenced by the fact that CRBR is not unique in its use of plutonium as a fuel source. There are approximately 10 other U.S. reactors using mixed oxide fuels, including plutonium. For example, Mr. Gaskin, the safeguards reviewer for the Fort St. Vrain reactor which uses formula quantities of mixed oxide fuel, testified that there have been no problems

involving either theft or sabotage at that reactor. (Testimony of Dube, Tr. 3728 and Testimony of Gaskin, Tr 3729).

239. Supporting the conclusion that the FESS adequately addresses the environmental effects from the CRBR fuel cycle facilities is the fact that all such facilities proposed will be built or modified by DOE and would also be subject to NEPA requirements as a result of DOE's responsibilities under NEPA. (Testimony of Dube, Tr. 3720).

240. Actions designed to produce vast casualties through sabotage or utilization of strategic nuclear material would be an escalation beyond present experience which has only involved the occurrence of low level actions. Nevertheless, the design and evaluation of safeguards systems under DOE guidance is approached with the assumption that the range of potential threats should be considered credible. ("Applicants' Direct Testimony Con rning Safeguards, NRDC Contentions 4 and 6.6.4" will hereinafter be referred to as Testimony of Applicants on Safeguards.) (Testimony of Applicants on Safeguards, Tr. 3481, Testimony of Dube, Tr. 3581 on sparcity of events in U.S.).

241. As a licensed operating facility, the CRBRP would have to satisfy the safeguards requirements of 10 C.F.R. Part 70 and 73, and would thus have to protect against the NRC design basis threats. The details of compliance with regulations will be reviewed at a later stage in the licensing process for the CRBRP. As part of the environmental review, the Staff has assessed the general reactor safeguards systems proposed by the Applicants and has concluded that it is likely that the Applicants will be able to satisfy the safeguards regulations. This assessment is

contained in Appendix E of the CRBR FESS. (Staff Testimony of Dube, et al, Tr. 3741).

242 For non-licensed fuel cycle facilities that would support the CRBRP, the safeguards systems would be designed in accordance with the DOE's 1976 threat guidance, which is similar to the NRC's desgin basis threat. Safeguards programs designed in accordance with the DOE's guidance will provide a level of protection at least as high as that provided by programs designed in accordance with the NRC's design basis threat. (Staff Testimony of Dube, et al, Tr. 3741).

243. The chance of success in building a clandestine explosive device with stolen plutonium appears small. (Testimony of Hockert, Tr. 3702-03; Staff Testimony of Dube, et al Tr. 3741-42).

244. The consequences of a successful dispersal device made from stolen plutonium are unacceptable and would be protected against by the same safeguards designed to protect against theft of Plutonium for use in explosive devices. (Staff Testimony of Dube, et al, Tr. 3714-42, Testimony of Hockert, Tr. 3591).

245. Additionally, the fact that other radiological, chemical, and biological agents are available, which are not difficult to obtain, makes safeguards plutonium an unlikely target. (Staff Testimony of Dube, et al, Tr. 3714-42, Testimony of Hockert, Tr. 3591).

246. The operating history of licensed nuclear facilities handling plutonium and NRC expertise with respect to safeguards provides an adequate basis by which the safeguards for the CRBR fuel cycle facilities can be judged to determine their adequacy. (Testimony of Dube, Tr. 3643 and 3645).

247. The environmental impact to the safeguards measures necessary to minimize the risk of a successful act of theft or sabotage will be negligible compared to the overall environmental impact of the CRBR fuel cycle. The safeguards systems that DOE proposes to employ for the CRBR fuel cycle will involve minimal construction beyond that required for the operation of the fuel cycle facilities themselves. No new construction will be required for transportation safeguards. (Staff Testimony of Dube, et al, Tr. 3140).

248. The number of operating personnel required for safeguards and the amount of equipment required for their support will be small compared to the overall personnel and equipment requirements of the CRBR fuel cycle. (Staff Testimony of Dube, et al, Tr. 3140).

249. The operation of the safeguards system will not impact the environment beyond the immediate vicinity of the fuel cycle activities. (Staff Testimony of Dube, et al, Tr. 3140).

250. The dollar cost of safeguards for the CRBR fuel cycle will be insginficant compared to the overall fuel cycle costs. An assessment of the expected costs of safeguards at each facility is contained in Appendix E of the FESS. These costs are generally comparable to safeguards costs at NRC-licensed facilities. (Staff Testimony of Dube, et al, Tr. 3140; Testimony of Hurt, Tr. 3644, 3705, Testimony of Dube, Tr. 3668-69).

3. Impacts of Fuel Cycle: Contentions 6(b)(1) and 6(b)(3)

251. In analyses prior to the draft and the Final Environmental Statement Supplement (hereinafter FESS), the Staff had assumed commercial facilities would be available for the Clinch River Breeder Reactor (here-

inafter CRBR) fuel cycle. For the FESS, the Staff requested and obtained from the Applicants an updated fuel cycle approach that projects facilities that are planned to be utilized for CRBR fuel cycle work. ("NRC Staff Testimony of Homer Lowenberg, Edward F. Branagan, Jr., A. Thomas Clark, Jr., and Regis R. Boyle Regarding Contention 6" will be hereinafter referred to as Staff Testimony of Lowenberg, et al.) (Staff Testimony of Lowenberg, et al, Tr. 4452).

252. The Staff conducted the analysis of the fuel cycle reported in the FESS based upon updated information provided by the Applicants in Amendment XIV to the Applicant's Environmental Report (hereinafter ER). (Staff Testimony of Lowenberg, et al, Tr. 4452).

253. The Staff reviewed Applicant's Amendment IV to the ER in sufficient depth to independently determine the environmental effects and draw conclusions as to: a) the reasonableness of the approach, b) the credibility and conservativeness of the assessment methods used by the Applicants, and c) the use of the best available information and analysis techniques. (Staff Testimony of Lowenberg, et al, Tr. 4453).

254. For firmly planned facilities (e.g. mixed oxide fuel fabrication and fuel assembly), the Staff has depended to a large extent on information provided in existing DOE environmental assessment documents. (Staff Testimony of Lowenberg, et al, Tr. 4453).

255. For less well established facilities the Staff evaluations have been based upon a combination of generic or model facility concepts and site conditions, and related commercial or government experience with the use of appropriate scaling factors. (Staff Testimony of Lowenberg, et al, Tr. 4453).

256. The annual U. S. population whole-body dose from normal operations of the CRBR fuel cycle is projected to be approximately 170 man-rem which is less than 0.001% of the corresponding population dose from one year of exposure to natural background radiation. The previous Staff assessment of similar radiological effects is summarized in Table 5.13 of the FES, which projected annual whole body dose to the U. S. population to be 34 man-rem. The latest projection of annual radiological whole body dose to the U.S. population is somewhat higher than the previous assessment due primarily to conservative assumptions of higher levels of gaseous radiological releases from the DRP than from the projected large scale commercial plant. However, both assessment findings are very small fractions of the comparable U. S. population doses projected from natural background radiation (28,000,000 man-rem) and are small compared to the normal range of variations from such values. Accordingly, the Staff's present findings, with regard to radiological dose from the CRBR fuel cycle are essentially of the same order of magnitude as its previous findings in the 1977 FES; that is, that this dose is an insignificant factor in any cost/benefit balance for this project. (Staff Testimony of Lowenberg, et al, Tr. 4457).

257. Since a number of the facilities are yet to be firmly established, the socioeconomic impacts from the CRBR fuel cycle have been considered qualitatively. This assessment indicates that most such effects appear to be small (e.g., equivalent to those of any large capital project). For those portions of the cycle that are similar to the commercial LWR nuclear reactor fuel cycle, the incremental effect of the CRBR fuel cycle portion is very small (approximately 1%) and is not considered to be a measurable

or a significant increment. In summary, the socioeconomic impacts from the CRBR fuel cycle are not a significant factor in the CRBR cost/benefit balance (Staff Testimony of Lowenberg, et al, Tr. 4457-58).

(a) Reprocessing in the CRBR Fuel Cycle

258. For its review and assessment of spent fuel reprocessing where both the specific facility and the site are yet to be chosen, the Staff reviewed the updated information on spent fuel reprocessing provided DOE in its Environmental Report on the Clinch River Breeder Reactor Project (CRBRP) (Amendment XIV), including material referenced therein. This material included DOE's present preference for carrying out this operation for the CRBR fuel cycle at the projected Developmental Reprocessing Plant (CRP) but included three other alternatives for this work.

259. The operations for reprocessing of CRBR spent fuel planned by the applicant will use a variation of the well established Purex process. In addition the Staff's independent analysis of the radionuclide contents of the spent fuel indicates that it is not significantly different from commercial light water reactor spent fuel. Much has been learned about spent fuel reprocessing as a result of decades of experience in government operations and more limited commercial activities. (Staff Testimony of Lowenberg, et al, Tr. 4461).

260. Utilizing these factors, the Staff's independent evaluation of this activity for CRBR has been based upon conservative (low side) assessments of the capabilities of the projected DRP to contain and retain the radionuclide effluents. This bounding assessment methodology results

in the reprocessing activity for CRBR accounting for about 80% of the radiological dose to the population from the entire CRBR fuel cycle.

261. However, despite this conservative approach, the radiological whole body exposure of the public from the entire CRBR fuel cycle is very small ($<$ 0.001%) compared with naturally occurring radioactivity. (Staff Testimony of Lowenberg, et al, Tr. 4461).

262. The assessment of reprocessing at DRP for CRBR is projected to bound the possible alternatives for this activity and still results in small, essentially immeasurable, contributions to whole body population exposures. (Staff Testimony of Lowenberg, et al, Tr. 4461).

263. The Staff estimated the quantities of radioactive effluents from the core fuel fabrication facility and the fuel reprocessing plant. The quantities released per annual fuel requirement for CRBRP are listed in Table D.4 of the Supplement. The Staff used the values in Table D.4 of the Supplement to estimate the dose commitment to the U.S. population from exposure to radioactive effluent releases from the core fuel fabrication facility and the fuel reprocessing plant. (Staff Testimony of Lowenberg, et al, Tr. 4464).

264. In estimating the doses for the fuel fabrication facility and the DRP in the FESS, the Staff used mathematical models that characterize radionuclide movement in the environment. 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. (Staff Testimony of Lowenberg, et al, Tr. 4464).

265. 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. The dose conversion factors used in the RABGAD code are based primarily on ICRP Publication 2 as updated by ICRP Publications 6 and 10. The environmental transport and dose models are described more fully in Chapter IV, Section J, Appendix A, "Dose Calculation Methodology," Volume 3 of GESMO. (Staff Testimony of Lowenberg, et al, Tr. 4464-65).

266. The dose to the total body and critical organs of the U.S. population from exposure to radioactive effluents from the core fuel fabrication plant are estimated to be less than 0.1 person-rem. The dose to the total body of the U.S. population from exposure to radioactive effluents from the fuel reprocessing plant is estimated to be about 140 person-rems. Since over 99% of the estimated dose to the total body of the U.S. population is due to exposure to tritium and carbon-14, other radionuclides are relatively unimportant to this analysis. For perspective, the annual dose to the total body of the U.S. population from exposure to background radiation is about 28,000,000 person-rems. The population dose to the total body of the U.S. population from exposure to radioactive effluents from these facilities is a very small fraction (less than 0.001%) of the population dose from one year of exposure to natural background radiation. (Staff Testimony of Lowenberg, et al, Tr. 4465-66).

267. Past experience in analysis of NRC licensed facilities, the GESMO documentation, Table S-3, hearing documentation, commitments to NRC regu-

latory guides and DOE orders by the Applicant, and Staff analyses of the same type of information for other plants supports the conclusion that the DRP will meet the environmental releases stated in the FESS. (Testimony of Clark, Tr. 4391-92).

268. Evidence at the hearing leads to the conclusion that the NRC and DOE regulations and orders can be complied with as committed to by the Applicants. (Staff Testimony of Lowenberg, et al, Tr. 4434-35).

269. The analysis in the FESS for the DRP contains several conservatisms. The Staff assumed the higher source term for individual isotopes taken from the Staff's ORIGEN-2 computer run and the Applicants analysis in the ER. ("Applicants' Testimony Concerning NRDC Contentions 6.b.1 and 6.b.3" will hereinafter be referred to as Applicants Fuel Cycle Testimony) (Applicants Fuel Cycle Testimony Tr. 4336; and FESS, Table D.8, p. D-16).

270. Two isotopes, tritium and carbon-14, dominate radiological impacts, comprising 99% of the radiological dose. (Applicants Fuel Cycle Testimony, Tr. 4336 and Testimony of Branagan, Tr. 4411 and 4465).

271. As a measure of conservation, the Staff assumed 100% of the tritium and carbon-14 is released, even though all of the alternative reprocessing facilities involved would have krypton removal systems which would also remove a large portion of carbon-14 prior to any release. (Testimony of Lowenberg, Tr. 4404-4406).

272. The assumption of 100% release of tritium and carbon-14 which make-up 99% of the radiological dose also results in the Staff analysis bounding all proposed alternatives to DRP. (Testimony of Lowenberg, Tr. 4406 and 4441).

273. Because the bulk of the tritium may diffuse through the cladding into the liquid sodium where it would be removed by the sodium cold traps, the amount of tritium in the source terms used for the dose calculations may be conservative by a factor of 10. (Applicants Fuel Cycle Testimony, Tr. 4336).

274. During the hearing, testimony was received as to the ability of the DRP to meet the confinement factors assumed for the Staff analysis. Dr. Cochran testified that confinement factors for the Savannah River plant, comparing 1955 through 1978 and 1975 through 1978 data, showed a 450-fold improvement. (Testimony of Cochran, Tr. 4543-45).

275. Dr. Cochran further testified that the latest confinement factors he cited for the PUREX and the Savannah River plant need only be improved by a factor of 10 to reach the confinement factors assumed for DRP. (Testimony of Cochran, Tr. 4545-4547).

276. The addition of a single bank of HEPA filters would increase the confinement factors by a factor orders of magnitude greater than 10. (Testimony of Lowenberg, Tr. 4431).

277. Thus, the confinement factors assumed for the DRP seem readily achievable. (Testimony of Lowenberg, Tr. 4431-32).

278. Dr. Cochran admitted he had no basis for concluding that the confinement factors assumed for DRP could not be achieved. (Testimony of Cochran, Tr. 4563).

279. In the event, no reprocessing plant were available, the radiological impact from the fuel cycle would actually be expected to go down. (Testimony of Lowenberg, Tr. 4439).

(b) Waste Management

280. For its review and assessment of management and disposal of wastes where neither the specific facilities nor sites that will be used for handling; storage and disposal of low level (LLW), transuranic (TRU), or high level (HLW) wastes have been selected, the Staff reviewed the updated information on waste management provided by DOE in its Environmental Report on the CRBRP (Amendment XIV). This information identified each facility of the CRBR fuel cycle that would produce radioactive wastes. These facilities were identified to be (1) the blanket fuel fabrication plant, (2) the core fuel fabrication plant, (3) the reactor plant, and (4) the fuel reprocessing plant. (Staff Testimony of Lowenberg, et al, Tr. 4459).

281. For each of these facilities, the Staff independently assessed the quantity and types of radioactive waste that are likely to be generated over the life of the CRBR. These radioactive wastes were broadly categorized as low-level, high-level, and TRU wastes. In addition, small amounts of gaseous wastes, Kr-85 and I-129, will also be generated over the life of the CRBR. (Staff Testimony of Lowenberg, et al, Tr. 4459).

282. The Staff projected that low-level waste would be disposed of in a suitable commercial shallow-land burial ground. The TRU waste was projected to be stored for a period of time and then transferred to a Federal repository. The high-level waste after solidification and packaging was projected to be transported to a Federal repository for disposal. The gaseous wastes, Kr-85 and I129, were projected to be converted to solid forms and to be disposed of at a Federal repository. (Staff Testimony of Lowenberg, et al, Tr. 4454).

283. The staff compared these wastes with other similar wastes with regard to radionuclides of concern and then estimated the portion of a model or generic waste disposal facility that would be required for the disposition of the wastes from the CRBR. The environmental impacts from the disposal of CRBR wastes is a fraction of all the environmental impacts that would result from the overall use of the disposal facility. The CRBR wastes were generally similar to other wastes that might result from the commercial nuclear power industry and that the portion of the waste management facilities that might be required for CRBR would be a small fraction of the total waste management needs ($< 1\%$). Staff Testimony of Lowenberg, et al, Tr. 4460).

284. The Applicants have analyzed the projected wastes from each step in the CRBR fuel cycle and the means for their handling, storage and disposal. The Staff has reviewed this material and has performed an independent assessment of the effects of waste managment. The wastes are quite similar to radioactive wastes already being handled or planned to be handled by the nuclear industry or government. (Staff Testimony of Lowenberg, et al, Tr. 4462).

285. The wastes from the CRBR fuel cycle also will constitute a small contribution to wastes that must be handled regardless of the existence of the CRBR project. (Staff Testimony of Lowenberg, et al, Tr. 4462).

286. The Staff review and assessment of the environmental effects from the management of CRBR fuel cycle wastes is based upon extensive generic studies that estimated environmental effects of similar activities. These studies have been a part of NEPA activities related to other activities

and are appropriate for extrapolation to CRBR waste management activities. (Staff Testimony of Lowenberg, et al, Tr. 4462).

287. Thus the assessment of CRBR fuel cycle waste management activities adequately characterizes the potential environmental impacts of these future planned activities. (Staff Testimony of Lowenberg, et al, Tr. 4462).

288. The health effects as a result of waste disposal related to Clinch River was determined to be small. (Testimony of Clark, et al, Tr. 4422-25).

289. The analysis of waste management in the FESS for CRBR is conservative in that it overestimates the percentage of the typical waste repository to be used for CRBR waste by a factor of 3. (Applicants Fuel Cycle Testimony, Tr. 4338-39).

(c) General

290. Several issues relating to the fuel cycle analysis as a whole were raised at the hearing.

291. As to the effect of using different burn-up fuel in the CRBR fuel cycle, it was established that the FESS analyses were not dependent on the burn-up of the fuel used but were based upon the isotopic composition of the plutonium to be used. The Staff and Applicants both used conservative (i.e., high side) estimates of plutonium composition. (Testimony of Lowenberg, Tr. 4433-34 and Tr. 4380-4381).

292. It was also established that the staff assumption of isotopic content of the fuel, which was of importance in deriving environmental

effects, was conservative because it assumed 20% PU-240 content fuel when, in fact, the Applicant proposes to use 12 percent PU-240 for CRBR. (Testimony of Lowenberg, Tr. 4380).

293. Dr. Cochran also raised an issue as to the health effects of using plutonium of various isotopic compositions from spent LWR fuel as fuel for CRBR. Specifically, Dr. Cochran testified to several "increased hazard indecies" related to specific plutonium compositoins. (Testimony of Cochran, Tr. 4586-91, 6920-30). However, he admitted that his "increased hazard indecies" of 3, 3.7, and 4.3 were only valid for recycle of plutonium in LWRs for one or more recycles. (Testimony of Cochran, Tr. 4555).

294. The irrelevancy of the spent LWR fuel (plutonium isotopic composition) issue raised by Dr. Cochran was established by the testimony of Mr. Lowenberg that the assumption of the use of such fuel material in CRBR was unrealistic. (Testimony of Lowenberg, Tr. 4360-62).

295. The Staff qualitatively considered both the socioeconomic impacts and the impact of using recycled CRBR plutonium. (Staff Testimony of Lowenberg, <u>et</u> <u>al</u>, Tr. 4457 and 4463).

296. The incremental effects of socioeconomic impacts for fuel cycle facilities attributable to CRBR is very small (approximately 1%). (Staff Testimony of Lowenberg, <u>et</u> <u>al</u>, Tr. 4458).

297. The socioeconomic impacts of the CRBR fuel cycle are not a significant factor in the CRBR cost/benefit balance. (Staff Testimony of Lowenberg, <u>et</u> <u>al</u>, Tr. 4458).

298. The Staff qualitatively considered a CRBR fuel cycle which involved opened ended fuel supplies for the early years of CRBR operation, with recycled CRBR plutonium as the fuel supply for the remainder of the fuel

cycle. This was considered a realistic fuel cycle for CRBR. (Staff Testimony of Lowenberg, <u>et al</u>, Tr. 4463).

299. The Staffs analysis concluded that the recycle of CRBR plutonium had no significant effect on the tritium or carbon-14 content, (the isotopes of greatest concern with regard to health effects). (Testimony of Lowenberg, Tr. 4434).

300. The Staffs' qualitative analysis was subsequently confirmed by the Staff's detailed analysis based on the quantitative data in Applicant's Amendment XVI to the ER. (Testimony of Lowenberg, Tr. 4433).

301. Dr. Johnson has no formal training or experience with the processes that comprise the CRBR fuel cycle (Testimony of Johnson, Tr. 5813-18), nor with the components of the Rocky Flats facility with which Dr. Johnson had concerns, i.e., fire control and ventilation systems for that and other DOE fuel cycle facilities (Testimony of Johnson, Tr. 5819-20). By contrast, Staff witness Lowenberg was very familiar with Rocky Flats and other fuel cycle reprocessing plants by virtue of his facility design experience (Testimony of Lowenberg, Tr. 6075-76). The Rocky Flats facility is not comparable to the CRBR fuel cycle reprocessing facilities (Testimony of Lowenberg, Tr. 6076-78), but that in any event DOE has taken steps through orders, which are applicable to CRBR fuel cycle facilities, which require design features which help to prevent the reoccurrence of fires such as occurred at Rocky Flats and which require protection of the radioactivity filters, mitigation of fire sources, and the installation of fire detection and heat rise instruments. (Testimony of Lowenberg, Tr. 6078-80).

302. The Staff states doses for internal organs for the CRBR blanket fuel and core fuel assembly fabrication plants in the Supplement to its

FES. (Staff Ex. 8, Table D.17). For the CRBR fuel cycle facility with the dominant contribution to population doses, the Staff appropriately considered doses to the whole body, rather than to any specific organs. (Testimony of Johnson, Tr. 5901-6). Dr. Johnson's argument that the Staff had underestimated the radiotoxicity of plutonium is based on a study based of effects of 69 dogs. (Testimony of Johnson, Tr. 5916). The Staff based its assumptions of the radiotoxicity of plutonium on the National Academy of Sciences BEIR I and III reports (Staff Testimony of Branagan, Tr. 4152), which are in turn based on studies of thousands of humans. (Testimony of Johnson, Tr. 5917). The author of the article upon which Dr. Johnson relies for the results of animal studies cautions that a meaningful comparison of human and animal exposures required to produce tumors is not possible at this time. (Testimony of Carl J. Johnson, M.D., M.P.H., Tr. 6057).

4. Alternative Sites: Contentions 5(a) and 7(c)

303. In Section 9.2.4. and Appendix A of the 1975 Environmental Report ("ER"), the Applicants described 11 sites for siting a new LMFBR demonstration plant. The 11 sites, which were screened from 109 potential sites within the TVA power service area, were Spring Creek, Blythe Ferry, Caney Creek, Clinch River, Taylor Bend, Buck Hollow, Phipps Bend, Lee Valley, Murphy Hill, Johntown (Hartsville) and Rieves Bend. The Clinch River site was selected as the preferred alternative site for locating an all-new LMFBR demonstration plant. ("Applicants' Direct Testimony Concerning Intervenors' Contentions 5(a) and 7(c)" will hereinafter be referred to as Applicants Testimony of Kripps. "NRC Staff Testimony of

Paul Leech on Contention 7(c)" will hereinafter be referred to as Staff Testimony of Leech.) (Staff Testimony of Leech, Tr. 4908; Applicants Testimony of Kripps, Tr. 4737-38).

304. The Applicants also considered a "hook-on" LMFBR demonstration plant in the 1975 ER, where the LMFBR nuclear steam supply system would supply steam to turbine-generators at existing conventionally-fired electric generation plants located within the TVA service area (Staff Testimony of Leech, Tr. 4909; Applicants Testimony of Kripps, Tr. 4737).

305. In Sections 9.2.2 and 9.2.3 of the 1975 ER, the Applicants screened all TVA steam power plants expected to be operational on a time schedule consistent with the originally scheduled operation of the LMFBR demonstrated plant. The John Sevier and Widows Creek steam plants were selected by Applicants as suitable alternatives for the "hook-on" option. (Staff Testimony of Leech, Tr. 4909; Applicants Testimony of Kripps, Tr. 4737).

306. Applicants evaluated the Clinch River, John Sevier, and Widows Creek alternatives, and concluded that an all-new LMFBR demonstration plant located at the Clinch River site was the preferred alternative. ER Section 9.2 and Appendix A. (Staff Testimony of Leech, Tr. 4913; Applicants Testimony of Kripps, Tr. 4737-38).

307. The Clinch River site was found to be the preferred site of the 13 TVA alternative sites in the Applicants' 1977 siting analysis. ER Section 9.2 and Appendix A. The Applicant's determination was made from a comparison of the original 13 candidate sites in terms of environmental factors and site engineering considerations (i.e., seismology, foundation conditions, flooding, meteorology, access and transmission facilities).

(Staff Testimony of Leech, Tr. 4913; Applicants Testimony of Kripps, Tr. 4737-38).

308.The Staff reviewed the Applicants' site selection procedure and determined that, in addition to the three alternative sites selected by Applicants, that Murphy Hill and Phipps Bend should also be considered. The Staff assessed the three sites identified by the Applicants, and the two additional alternative sites (Murphy Hill and Phipps Bend) in Section 9.2.5 of the 1977 FES, and concluded that none of these sites were preferable overall to the Clinch River site. (Staff Testimony of Leech, Tr. 4909, 4917).

309. Following the resumption of the NRC's licensing review in September 1981, Applicants reconsidered the original 13 alternative sites in the TVA Service area ("TVA sites") (two hook-on sites, and the 11 sites for an all-new LMFBR plant, including Clinch River), using the approach set forth in the NRC's Proposed Rule on Alternative Sites (45 Fed. Reg. 24168, April 9, 1980) ("Proposed Rule"). The Applicants' reanalysis is contained in the 1982 ER, Appendix G. (Staff Testimony of Leech, Tr. 4909-4910; Applicants Testimony of Kripps, Tr. 4737, 4738-4740).

310. The TVA power service area is an appropriate "region of interest," and 12 of the 13 TVA sites considered in 1977 meet the Proposed Rule's threshold criteria in Section VI.2.b. The one exception is Rieves Bend, which does not meet threshold criteria one, four and eight. ER Appendix G. (Staff Testimony of Leech, Tr. 4909-4910; Applicants Testimony of Kripps, Tr. 4738-39).

311. The Applicants determined that the Yellow Creek site also meets the Section VI.2.b threshold criteria of the Proposed Rule. Accordingly,

Yellow Creek was added to the set of 12 alternate TVA sites, to represent the western portion of TVA's power service area. (Staff Testimony of Leech, Tr. 4910; Applicants Testimony of Kripps, Tr. 4739).

312. The two hook-on sites selected in 1975 were rejected by the Applicants in their 1981-82 reanalysis because the potential dollar savings for the hook-on plant (compared to building a complete new plant) no longer exist and, in fact, substantial economic and schedular penalties would result if this option were pursued. Site-specific engineering for the CRBR is at an advanced stage of completion and some of the balance-of-plant (BOP) equipment has already been delivered. Furthermore, the existing BOP equipment at the John Sevier and Widows Creek fossil fuel-fired plants have aged another six years since the FES was issued, resulting in decreased reliability and remaining life. Appendix G, 1982 ER. (Staff Testimony of Leech, Tr. 4912-13; Applicants Testimony of Kripps, Tr. 4724).

313. The Staff concludes that the potential dollar savings for the hook-on option no longer exist, substantial schedular and economic penalties would result if this option were pursued, and that the benefits of a stand-alone plant design are significantly greater than a hook-on plant design. Section 9.2.5 of the FES Supplement. (Staff Testimony of Leech, Tr. 4913).

314. Eleven of the thirteen alternative TVA sites were selected by Applicants in 1982 as candidate alternatives for siting of a LMFBR demonstration plant: Clinch River, Spring Creek, Blythe Ferry, Caney Creek, Taylor Bend, Buck Hollow, Phipps Bend Lee Valley, Murphy Hill, Hartsville and Yellow Creek. Section 4, Appendix G, 1982 ER. Clinch

River, Hartsville, Murphy Hill, Phipps Bend, and Yellow Creek represent the environmental diversity of the region of interest, and therefore constitute an acceptable set of five candidate sites for the Staff's alternative site review. (Testimony of Leech, Tr. 4774-75, Staff Testimony of Leech, Tr. 4911-12).

315. In their reanalysis of the eleven TVA alternative (candidate) sites, the Applicants concluded that Clinch River is the preferred site and none of the alternate sites is environmentally preferred to the Clinch River site. That analysis was done in accordance with the first part of the Proposed Rule's sequential two-part analytical test, which gives primary consideration to hydrology, water quality, aquatic biological resources, terrestrial resources, water and land use, socioeconomics and population. Applicants also considered the meteorological characteristics of the site in their reanalysis. ER Appendix G, p. G-15. (Staff Testimony of Leech, Tr. 4914; Applicants Testimony of Kripps, Tr. 4739-40).

316. In Applicants' original siting analysis, ER Appendices D and E, Applicants screened two properties owned by TVA in Kentucky and numerous DOE properties elsewhere in the United States as potential alternative sites for a LMFBR demonstration plant. As indicated in Section 9.2.6 of the 1977 FES, most of the properties were rejected because they were too small (less than 300 acres). Others were rejected for one or more of the following reasons: insufficient cooling water, excessive seismic ground motion, interference with projects under the Division of Military Applications weapons program, relatively high population density, insufficient space, or location in close proximity (½ mile) to existing DOE

facilities. (Staff Testimony of Leech, Tr. 4914; Applicants Testimony of Kripps, Tr. 4740-41, 4742)

317. The Applicants identified the Hanford Reservation, the Idaho National Engineering Laboratory (INEL), and the Savannah River Plant (SRP) as alternate (candidate) sites for the LMFBR demonstration plant. All three sites are DOE properties. (Staff Testimony of Leech, Tr. 4914-15).

318. The environmental preferability of the three DOE alternative sites was evaluated by Applicants for siting of the LMFBR demonstration plant. (ER, Appendices D, E; Staff Testimony of Leech, Tr. 4916; Applicants Testimony of Kripps, Tr. 4741-42).

319. Nevada Test Site ("NTS") is described and assessed in Section 2.1.1.8 of ER Appendix D. The reasons given by the Applicants for screening out the NTS as a potential site for the LMFBR demonstration plant are summarized in FES section 9.2.6. As indicated therein, the NTS was not considered suitable because of the estimated 0.75g design requirement for seismic ground motion, lack of surface water and limited groundwater (use for the demonstration plant would conflict with other uses of Nevada's limited supply) and relatively high transmission line costs. Potential interference with activities associated with research, development, and testing nuclear weapons was also indicated. (Staff Testimony of Leech, Tr. 4915-16).

320. The Staff independently concluded that the factors identified by Applicants were good cause to reject the NTS from further consideration as an alternative site for a LMFBR demonstration plant. (Staff Testimony of Leech, Tr. 4916).

321. The Applicants reassessed the 1977 screening process following the resumption of the licensing proceeding, and reviewed all DOE properties which were not considered in the 1977 screening. (ER Appendix F.) The Applicants nonetheless concluded that Hanford, INEL, and Savannah River still remain the best DOE alternative (candidate) sites for siting of a LMFBR demonstration plant. (Staff Testimony or Leech, Tr. 4915; Applicants Testimony of Kripps, 4741-42).

322. The Applicants also re-contacted the utility groups in the Hanford, INEL and Savannah River Plant areas and found that they are currently unwilling to take on the role of operating the plant at those locations. Thus, it appears that demonstrating the project objectives "in a utility environment" at the DOE alternative sites is not possible at the present time. (Staff Testimony of Leech, Tr. 4921; Applicants Testimony of Kripps, Tr. 4742).

323. In their reanalysis of the environmental preferability of the three DOE sites, the Applicants concluded that "neither Hanford, Savannah River nor INEL is environmentally superior or preferable to the Clinch River sites and that none of the three alternate sites is a substantially better alternative for satisfying the program and project objectives for this demonstration plant." (ER, Appendix F.)

324. In reaching that conclusion the Applicants confirmed that the previous findings in ER Appendix [illegible] remain valid, i.e.:

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 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 other siting parameters would not lead one to select the Hanford, Savannah River, or INEL areas as preferable to the Clinch River site.

3. A cooperative arrangement between utilities and DOE for the design, construction, and operation of the LMFBR Demonstration Plant in a utility system is not likely if the LMFBR plant were to be located at either the Hanford, Savannah River, or INEL sites. This would preclude satisfaction of a primary LMFBR Demonstration Plant objective.

(Staff Testimony of Leech, Tr. 4916-17; Applicants Testimony of Kripps, Tr. 4741-42).

325. Two permanent instrumented towers were installed in February 1977 by the Applicants at the CRBR site. The instrumentation consisted of wind speed and wind direction sensors on a ten meter tower, and wind speed and direction, temperature, dew point, solar radiation, and precipitation sensors on the 110 meter tower. ("Joint Testimony of Charles Ferrell, Homer Lowenberg, Leonard Soffer and Irwin Spickler on Contentions 5(a) and 7(c)" will hereinafter be referred to as Staff Testimony of Ferrell, et al) (Testimony of Ferrell, et al, Tr. 4871-72).

326. Meteorological measurements were recorded on the permanent towers during the period of February 16, 1977 to March 2, 1978. The two permanent towers were put back into service during April of 1982 and will operate during construction of CRBR. (Staff Testimony of Ferrell, et. al., Tr. 4871-72).

327 The Staff and the Applicants performed independant X/Q (atmospheric dispersion) analyses utilizing the on-site data collected by the permanent towers for the period February 17, 1977 to February 16, 1978. The joint data recovery rate for that period was 97 percent, and the data meets the standards recommended in Regulatory Guide 1.23. (Staff Testimony of Ferrell, Tr. 4872, 4792).

328. The CRBR site is characterized by a high frequency of stable atmospheric diffusion conditions, westerly winds, and low wind speeds which are typical of the northern Appalachian area of the Southeastern United States. (Staff Testimony of Ferrell, Tr. 4872-73).

329. Stable atmospheric diffusion conditions (Classes E, F and G) at the CRBR site occurred 56 percent of the time. Neutral stability (Class D) and unstable (Classes A, B and C) conditions occurred 36 percent and 8 percent of the year, respectively. Prevailing winds are from the west, with W, WNW and WSW winds, ±22½ degrees, occurring 29%, 25% and 26% of the year, respectively. The annual 10 meter wind speed had an occurence of winds less than 1.5 m/sec 60 percent of the time, winds less than 2.5 m/sec 80 percent of the time, and winds less than 0.4 m/sec 3 percent of the time. (Staff Testimony of Ferrell, et al, Tr. 4872-73).

330. The Staff's and Applicants' X/Q values for routine and accidental releases of radiation were performed in accordance with Regulatory Guides 1.111 and 1.145. (Staff Testimony of Ferrell, et al, Tr. 4873-74, 4875).

331. The Applicants' calculated most limiting off-site annual average X/Q value for evaluating the routine releases of radioactivity from CRBR was 1.02×10^{-4} sec/m^3. The Staff's calculated value was 1.2×10^{-4} sec/m^3. (Staff Testimony of Ferrell, et al, Tr. 4875-76).

332. The Staff's and Applicants' calculated accident X/Q values are presented in the Staff Testimony of Ferrell, et al, Tr. 4875-76).

333. There is a factor of two difference between the Staff's calculated X/Q values for CRBR at the exclusion area boundary, as presented in the 1977 versus the 1982 version of the Site Suitability Report. (Testimony of Spickler, Tr. 2394, 4791, 4846).

334. The change in X/Q values are due to (1) different data sets that were used to calculate the X/Q values in 1977 and 1982, and (2) different X/Q models utilized by the Staff. The use of a different X/Q model in 1982 is the primary contributor to the differences in calculated X/Q values. (Testimony of Spickler, Tr. 4791).

335. The 1982 data base employed by the Staff in its X/Q calculations for CRBR is better than the 1977 data base, since the earlier data may not meet Regulatory Guide 1.23 standards. Mr. Spickler stated he has no reservations that the 1982 data base meets the standards set forth in Regulatory Guide 1.23. (Testimony of Spickler, Tr. 4792).

336. Any uncertainties in the X/Q models employed by the Staff are in the conservative direction. The resolution of these uncertainties would be in the more realistic direction, thereby reducing the potential doses. (Testimony of Spickler, Tr. 4792-93).

337. The new X/Q models are preferable to the older models, in the opinion of Mr. Spickler. He also stated that the new X/Q models, as set forth in Regulatory Guide 1.145 were based on a thorough examination of all experimental data on atmospheric diffusion available at that time, and included data obtained from the Clinch River Site. (Testimony of Spickler, Tr. 4851-52).

338. The X/Q values and diffusion conditions at CRBR are better than at some LWR sites that are currently permitted or licensed, and are comparable to LWR sites in the general region. The X/Q values for LWRs are calculated using the same methodology as that used by the Staff in the Clinch River proceeding. (Staff Testimony of Ferrell, et al, Tr. 4876).

339. As part of its alternative site review, the Staff reviewed the joint occurrences of stable atmospheric diffusion conditions and average wind speeds for the CRBR site and seven alternative sites. This combination of conditions largely determines the relative diffusivity of an area under the poorest diffusion conditions. The joint occurrences of stable atmospheric diffusion conditions and average stable wind speed for the CRBR site and the seven alternative sites were presented in Staff Testimony. (Staff Testimony of Ferrell, et al, Tr. 4877).

340. The Staff also reviewed and compared the accident X/Q values for the CRBR site and the seven alternative sites, as presented in the Staff's testimony. (Staff Testimony of Ferrell, et al, Tr. 4878).

341. The CRBR site has accident X/Q values which are comparable to the four other TVA sites. The TVA sites have comparable stable atmospheric diffusion occurrence frequencies and comparable average stable wind speeds, except for Clinch River. The Savannah River site has significantly less frequent stable conditions, higher wind speeds, and significantly better diffusion conditions than the CRBR Site. The Hanford and INEL sites have high stable atmospheric diffusion frequency and higher average wind speed, compared with the CRBR site. Accident X/Q values are better at Hanford and INEL, compared with the CRBR and five TVA sites. (Testimony of Spickler, Tr. 4811, 4814-15; Staff Testimony of Ferrell, et al, Tr. 4878-79; Applicants Testimony of Kripps, Tr. 4746).

342. The differences in meteorology between the CRBR site and the alternative sites do not significantly change the potential risks of health effects as calculated and described by the Staff in Appendix J of the

1982 FES Supplement. The Applicants acknowledged that the lower population densities and more favorable atmospheric dispersion characteristics of the three DOE alternative sites would result in lower off-site doses associated with releases of radioactive material from the LMFBR Demonstration Plant if it were placed at any of those three sites, compared to the Clinch River site. However, the Applicants' testimony concerning NRDC contentions 11(b) and 11(c) shows that the health effects to the public from normal operation of CRBRP would be small in relation to the background incidence of health effects in the population. In addition, the Applicants' testimony concerning NRDC contentions 1, 2, and 3 showed that the doses at the Clinch River site for the site suitability source term (SSST), which would be greater than those associated with design basis accidents, would be well below the 10 CFR Part 100 dose guidelines and that CRBRP can be designed so that greater accident consequences are highly unlikely. Consequently, the real reduction in expected environmental impacts for an alternative site relative to the Clinch River site because of lower population density and/or more favorable atmospheric dispersion characteristics is judged to be insignificant. (Testimony of Spickler, Tr. 4800-01; Testimony of Kripps, Tr. 4646-52, 4695-4701; Applicants Testimony of Kripps, Tr. 4745-47; Staff Ex. 8 at 5-22).

343. Exclusion area for CRBR is defined by Applicants as a 1364 acre tract of land in Roane County, Tennessee, as described in Section 2.1 of the ER and PSAR, and Section II.A of the Staff's SSR. The exclusion area satisfies the requirements of 10 C.F.R. Part 100. (Staff Testimony of Ferrell, et al, Tr. 4880, 4881).

344. The low population zone ("LPZ") is defined by Applicants as a circular area centered on the CRBR with a radius of 2.5 miles. The LPZ satisfies the requirements of 10 C.F.R. Part 100. (Staff Testimony of Ferrell, et al, Tr. 4880, 4881).

345. The population center for CRBR is the City of Oak Ridge, Tennessee. The population center distance is 7 miles north-northeast ("NNE") of the CRBR. (Staff Testimony of Ferrell, et al, Tr. 4880, 4881).

346. The population center distance of 7 miles is at least one and one-third times the LPZ outer radius of 2.5 miles, and meets the requirement of 10 C.F.R. Part 100. Even if future population growth results in a population center distance of 5 miles, the 10 C.F.R. Part 100 requirement for the population center distance will be met. (Staff Testimony of Ferrell, et al, Tr. 4881).

347. The Staff compared the 2200 ft. minimum distance from the CRBR reactor to the exclusion area boundary with exclusion area distance for LWRs. The Staff concluded that the size of the exclusion area for CRBR is about average when compared to other LWR sites. (Staff Testimony of Ferrell, et al, Tr. 4881-82).

348. The Staff compared the 2.5 mile LPZ for CRBR with the LPZ distances for LWRs, and concluded that the LPZ for CRBR is about average when compared to other LWR sites. (Staff Testimony of Ferrell, et. al., Tr. 4882).

349. The 7 mile population center distance for CRBR is slightly less than average when compared to LWR sites. (Staff Testimony of Ferrell, et. al., Tr. 4882-83).

350. In the absence of Commission regulations regarding population density, the Staff has published criteria on population density in Regulatory Guide 4.7, Revision 1, "General Site Suitability Criteria for Nuclear Power Stations" (November 1975). Section C.3 of Reg. Guide 4.7 provides that if the population density, including weighted transient population, projected at the time of initial operation of a nuclear power station, exceeds 500 persons per square mile averaged over any radial distance out to 30 miles (cumulative population at a distance divided by the area at that distance), or if the projected population density over the lifetime of the facility exceeds 1000 persons per square mile averaged over any radial distance out to 30 miles, applicants must give special attention and consideration to alternative sites with lower population densities. The population density levels set forth in the Regulatory Guide do not represent upper bound limits of acceptability, but are "trip" levels. If the population density "trip" levels are exceeded at the site, the site must be determined to have significant offsetting advantages as compared with available alternate sites of lower density. (Staff Testimony of Ferrell, et al, Tr. 4883).

351. The resident population out to 30 miles from the CRBR site in 1980, 1990 and 2030, are shown in Table III of the SSR. The Staff verified the Applicants' population estimate and projections by several means, including reviewing an independent estimate of the 1980 population within 50 miles, and examining population data for 1970 at several distances together with known growth rates for the period 1970-80. (Staff Testimony of Ferrell, et al, Tr. 4883).

352. Based on these population figures, the Staff projected the 0 to 30 mile population density figure for the year-1990 as being 197 persons per square mile. Appendix L, 1982 FES Supplement. (Staff Testimony of Ferrell, et al, Tr. 4884).

353. The population density, including weighted transients, for the CRBR site at projected time of plant start-up (year 1990) is well below the Regulatory Guide 4.7 trip level of 500 persons per square mile out to 30 miles. The population density at end-of-plant life (year 2030) is well below the Regulatory Guide 4.7 trip level of 1000 person per square mile out to 30 miles. (Staff Testimony of Ferrell, et al, Tr. 4885).

354. The Staff performed an analysis which lists a first-order prioritization of all LWRs with regard to power level and density. SECY 81-25. This analysis divided all LWR sites into five groups on the basis of reactor power level and weighted population density. Using the same methodology utilized in SECY 81-25, the Staff analyzed the CRBR site with regard to reactor power level and weighted population density. The Staff found that CRBR falls into Group II-Average, and its weighted population density is average when compared to other LWR sites. (Testimony of Soffer, Tr. 4829-32; Staff Testimony of Ferrell, et al, Tr. 4885-86).

355. The Staff calculated the year-1990 0 to 30 mile population densities for the seven alternative sites (Staff Testimony of Ferrell, et al, Tr. 4886).

356. The Staff evaluated the differences in population density between CRBR and the seven alternative sites. The Staff concluded that the numerical differences in population between the Clinch River site and each of the alternative sites are not significant for two reasons. First, the

CRBR 0 to 30 mile population density projected at the time of plant start-up is well below the 500 persons per square mile "trip" level of Regulatory Guide 4.7. While the Regulatory Guide states that areas with low population densities are to be preferred for the siting of nuclear power reactors, it does not make any distinction with regard to sites with population densities below the "trip" levels, and defines "low population densities" to be those which are below the "trip" levels. Secondly, the Staff considers population density to be a relatively crude surrogate for the residual risk associated with accidental releases of radioactivity. The Staff's assessment of the residual risk of severe accidents at the Clinch River site showed that the residual risk was very low. Appendix J, 1982 FES Supplement. Therefore, any reduction in the already very low residual risk associated with accidental radiation releases which are attributable to reductions in population density are not significant. The Staff witnesses did not state that the population densities for the alternative sites were comparable. (Testimony of Soffer, Tr. 4799-4802, 4818-19, 4821-28, 4833-37, 4849; Staff Testimony of Ferrell, et al, Tr. 4886-87; Testimony of Spickler, 4800-01).

357. The Staff did not consider meteorology and population density jointly, but did consider each factor independently in its alternative siting analysis in the FES Supplement. Mr. Soffer also stated that the Staff very recently jointly considered wind direction and population density, to determine if its changed the Staff's conclusions in its alternative siting analysis. (Testimony of Soffer, Tr. 4795-97).

358. Mr. Soffer and Mr. Spickler both testified that the Staff's experience has been that joint consideration of meteorology and

population density does not materially alter the Staff's conclusions on siting, when those factors are considered independently of each other. (Testimony of Soffer, Tr. 4799; Testimony of Spickler, Tr. 4799).

359. The Staff independently evaluated the environmental preferability of the five TVA sites. The Staff's initial review of those sites was summarized in Section 9.2.5 of the 1977 FES; that assessment has been updated in Section 9.2.5 of the 1982 FES Supplement. It has also been augmented by the Staff's assessment in Appendix L of the Supplement. (Staff Testimony of Leech, Tr. 4917).

360. The Staff independently reviewed the Applicants' original identification of Hanford, INEL, and Savannah River as suitable alternative DOE sites outside of the TVA power service area for siting the LMFBR demonstration plant, as well as the Applicants' reanalysis and assessment of DOE properties not originally evaluated. The DOE properties rejected by the Applicants were unsuitable candidates for siting an LMFBR demonstration plant. (Staff Testimony of Leech, Tr. 4915-16).

361. The Staff independently evaluated the environmental preferability of the three DOE sites. The Staff's initial review of those sites was summarized in Section 9.2.6 of the 1977 FES; that assessment has been updated in Section 9.2.6 of the 1982 FES Supplement. It has also been augmented by the Staff's assessment in Appendix L of the Supplement. (Staff Testimony of Leech, Tr. 4918).

362. In addition to making their own evaluations of data and analyses provided by the Applicants, the Staff, in its independent assessment of the environmental and socioeconomic characteristics of the TVA and DOE alternative sites, evaluated the analyses in environmental statements or

reports that had been prepared by the Staff for the facilities existing or planned at each candidate site. Other Federal and State agencies were consulted by the Staff to obtain additional information. The Staff's specialists in each area reviewed the information available and inspected the alternate sites, as necessary. (Testimony of Leech, Tr. 4766-67, 4770; Staff Testimony of Leech, Tr. 4918).

363. The Staff's evaluation of Clinch River and the alternative sites included consideration of no-flow conditions in the Clinch River and their effect on striped bass, as well as other potential water quality and aquatic biology impacts. A discussion of all of the parameters and characteristics that were considered in the Staff's alternative sites analysis is provided in the Introduction to Appendix L in the FES Supplement. The Staff's current assessments of those factors for each of the alternative sites are found in Sections 1 and 2 of Appendix L. (Testimony of Leech, Tr. 4768-69, 4770-73, 4843-45, 4852-60; Staff Testimony of Leech, Tr. 4918).

364. The information regarding the TVA and DOE alternate (candidate) sites is sufficient for the Staff to assess whether any of the alternate (candidate) sites are clearly environmentally preferable to the Clinch River. Available reconnaissance-level information is normally adequate for this purpose (see Part III.2 of the Proposed Rule). In this case, the Applicants provided more information than is required by supplying various reference materials. See Bibliography, FES Supplement (Staff Ex. 8), Appendix L, and detailed information (ER Appendices A, D, E, F and G). (Staff Testimony of Leech, Tr. 4919).

365. In its consideration of environmental factors, the Staff did not assign fixed weight to each of the factors. Rather, the weight given to

each environmental factor was adjusted, according to the Staff specialists' professional judgment as to the relative importance of each factor at a given alternative site. (Testimony of Leech, Tr. 4808-11).

366. None of TVA or DOE's alternate sites considered are environmentally preferable to or substantially better than the proposed Clinch River site for construction and operation of the LMFBR demonstration plant. This conclusion is reflected in the composite ratings of these sites which are shown in Table L.1. (Staff Testimony of Leech, Tr. 4919, 4922).

367. Selection of an alternative site to the Clinch River site at this time would result in a delay in completing construction and commencing the operation of a LMFBR demonstration plant. (Staff Testimony of Leech, Tr. 4919; Testimony of Kripps, Tr. 4641-42; Applicants Testimony of Kripps, Tr. 4740, 4742).

368. The two basic sources of this delay are:

1. the impact upon existing project arrangements and authorizing legislation, and

2. the impact upon schedules for the preparation of design and licensing information and issuance by NRC of an environmental statement and a site suitability report to reach today's state of the CRBR licensing process. ER Appendix G, p. G-25.

(Staff Testimony of Leech, Tr. 4920).

369. If an alternative site were selected instead of the Clinch River site, a delay of approximately 36 months in the construction and completion of CRBR is a reasonably optimistic estimate. In arriving at that estimate, the Staff reviewed the basis of the Applicants' estimate that a decision to locate the LMFBR demonstration plant at another site would cause a minimum delay of 33 months and a more probable delay of 43 months starting from the time a decision was made to change sites. The 33-month and

43-month delay schedules are discussed in detail in ER Appendix E and they are summarized in FES Section 9.2.6.1. (Staff Testimony of Leech, Tr. 4920).

370. Mr. Leech, the Staff's witness on the Staff's alternative siting evaluation process for CRBR, stated that a preponderance of factors could outweigh the disadvantage of delay, such that any alternate site could be determined to be substantially better. (Testimony of Leech, Tr. 4776-77).

371. The selection of an alternative site to the Clinch River site would affect the ability of the LMFBR demonstration plant to achieve its objectives under the DOE LMFBR program. The Staff's environmental and site suitability reviews of the CRBR application indicate that the proposed Clinch River site would be acceptable for the LMFBR demonstration plant. Accordingly, the avoidable delay resulting from a decision to relocate the plant is not consistent with DOE's timing objective under the LMFBR program - <u>i.e.</u>, to construct and operate the demonstration plant as expeditiously as possible. DOE/EIS-0085-FS, May 1982, p.7. (Staff Testimony of Leech, Tr. 4921).

372. It may be possible to fulfill the programmatic objective of demonstrating CRBR "in a utility environment" by siting CRBR at an alternative site within the TVA power service area. However, that programmatic objective cannot be fulfilled at any of the DOE alternate sites, since no utility groups located near Hanford, INEL, and Savannah River are currently willing to operate the CRBR at those locations. (Staff Testimony of Leech, Tr. 4921).

373. Relocation to another TVA site would result in an increase in the cost of the project of $39-303 million on a 1982 present-worth basis.

The cost of relocation to one of the three DOE sites, on a present-worth basis, are $94 million for relocation to Hanford, $259 million for relocation to INEL, and $61 million for reloction to Savannah River. Applicants' estimated costs of delay were independently evaluated and appropriately adjusted by the Staff. (Testimony of Leech, Tr. 4779-82, 4845-46; Staff Testimony of Leech, Tr. 4922).

374.The Applicants' selection of the Clinch River site is reasonable, and no substantially better alternative site is available. The Intervenors did not present any evidence on this issue which contradicts these conclusions. Section 9.2.7, FES Supplement. (Staff Testimony of Leech, Tr. 4922).

Underground Siting

375. The underground siting of nuclear power reactors involves the location of a nuclear reactor and possibly other plant equipment beneath the surface of the earth in a mined rock cavity, or a backfilled excavated cut. (Testimony of Soffer, Tr. 4888).

376. Based on the studies of WASH-1250, "The Safety of Nuclear Power Reactors and Related Facilities" (1973), and NUREG-0255, "Underground Siting of Nuclear Power Plants: Potential Benefits and Penalities," (1975), the Staff finds that underground nuclear power reactors have safety advantages over surface reactors with regard to:

(1) protection against aircraft crashes or warfare munitions which could conceivably initiate a reactor accident;

(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 in an isolated condition;

(3) a modest reduction in seismic vulnerability for underground plants.

Underground plants have the following safety disadvantages as compared to surface plants:

(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) greater potential for flooding;

(3) greater potential for groundwater contamination following an accident.

(Staff Testimony of Ferrell, et al, Tr. 4888-89, 4890-91).

377. The underground siting concept is applicable to the siting of an LMFBR and appears to be technologically feasible. (Staff Testimony of Ferrell, et al, Tr. 4890-93).

378. While no engineering design for an underground nuclear power reactor presently exists, certain engineering and occupational problems with the underground siting concept have been identified. Maintenance of penetration seals which isolate the reactor from the surface has been identified as a critical design problem, since prompt isolation is necessary for the success of the underground siting concept. (Staff Testimony of Ferrell, et al, Tr. 4891-92).

379. Prompt isolation could reduce movements of operating or maintenance personnel located below ground at the time of the accident, which may present an occupational hazard problem. (Staff Testimony of Ferrell, et al, Tr. 4892).

380. Underground siting of CRBR would require a cavity approximately 75 meters in diameter, which is significantly larger than the cavities of up to 20 meters which have been utilized for the few research reactors located underground. The effort is unprecedented, and could lead to unforeseen difficulties. (Staff Testimony of Ferrell, et al, Tr. 4892).

381. Underground siting of a nuclear power plant is estimated to cost about 20 to 40% more than a surface plant. (Staff Testimony of Ferrell, et al, Tr. 4892).

382. Mr. Soffer, the NRC Staff expert on underground siting, concluded that underground siting is feasible, but that the expected benefits in terms of improved safety do not offset the penalties of construction difficulties, operational problems leading to degraded safety, and additional costs, as stated in Section 11.9.6 of the 1982 FES Supplement. Mr. Soffer's testimony was not contradicted by Intervenors, who failed to present any evidence on this issue. (Staff Testimony of Ferrell, et al, Tr. 4892-93).

383. Applicants have also considered and rejected the underground siting concept for CRBR in "Supplemental Alternate Siting Analysis for the LMFBR Demonstration Plant." ER Appendix D, Section 2.3.2. (Testimony of Kripps, Tr. 4743; Staff Testimony of Ferrell, et al, Tr. 4890).

384. Intervenors failed to present any affirmative evidence, and did not cross-examine the Staff's or Applicants' witnesses concerning underground siting.

Co-location

385. The co-location concept has been considered for centralized location of large scale fuel cycle facilities with each other, or with nuclear power reactors. (Staff Testimony of Ferrell, et al, Tr. 4893).

386. The most significant potential advantage of co-location is the possibility of decreasing the transportation of separated strategic nuclear materials. This advantage is greatest where fuel reprocessing facilities are co-located with fuel fabrication plants. This advantage is not significant where a single nuclear power reactor is co-located with fuel cycle facilities, since co-location would only decrease the shipment distances of a relatively small amount of fresh and spent fuel. Therefore, co-location of a small nuclear reactor such as CRBR with large-scale fuel cycle facilities has never been considered as a significant alternative in the cost/benefit evaluation of a single nuclear power reactor. (Staff Testimony of Ferrell, et al, Tr. 4893-94).

387. Co-location of nuclear power reactors with fuel cycle facilities essentially have as many disadvantages as advantages. The primary disadvantage of co-location of nuclear power reactors with fuel cycle facilities is the need to constrain the size of the fuel facilities to match the fuel requirements of the power reactors. The capabilities of the fuel cycle facilities for CRBR are significantly larger than the CRBR fuel needs. Therefore, co-location of CRBR with pilot or developmental LMFBR fuel cycle facilities has little merit. (Staff Testimony of Ferrell, et al, Tr. 4894-95).

388. Mr. Lowenberg's conclusions are that there is little merit to co-location of CRBR with proposed LMFBR fuel cycle facilities, and that the co-location concept is not significant with regard to considera-

tion of alternatives to the CRBR site. Mr. Lowenberg's conclusions were not contradicted by Intervenors, who did not present any evidence on this issue. (Staff Testimony at Ferrell, et al, Tr. 4895).

389. Applicants considered and rejected the co-location concept, as discussed in ER Appendix D, Section 2.3.1. (Applicants Testimony of Kripps, Tr. 4743).

390. Intervenors failed to present any affirmative evidence, and did not cross-examine the Staff's or Applicants' witnesses regarding co-location of CRBR.

5. Evacuation of Nearby Facilities: Contention 5(b)

K-25

391. The Oak Ridge Gaseous Diffusion Plant, also known as the K-25 facility, is located approximately 2.5 miles NNW of CRBR. ("NRC Staff Testimony of Homer Lowenberg, Leonard Soffer and Mohan C. Thadani on contention 5(b)" will be hereinafter referred to as Staff Testimony of Lowenberg, Soffer, et al.) (Staff Testimony of Lowenberg, Soffer, et al, Tr. 5687).

392. The K-25 facility is one of three government-owned gaseous diffusion plants ("GDPs") which enrich the content of fissionable U-235 in low grade uranium, to provide uranium suitable for use in LWR plants and for military applications. ("Applicants' Direct Testimony Concernfing NRDC Contention 5(b)" will hereinafter be referred to as Applicants Testimony of Hibbitts.) (Staff Testimony of Lowenberg, Soffer, et al, Tr. 5693; Applicants Testimony of Hibbitts, Tr. 5423).

393. The three GDPs function in a cascade complex, with a combined capacity of 27 million separative work units ("SWUs"). The K-25 facility currently functions as the middle segment of the cascade, providing about 30 percent of the total separative work capacity of the three plant enrichment complex. (Staff Testimony of Lowenberg, Soffer, et al, Tr. 5693-94).

394. The three plant complex is operating at approximately 35 percent of its combined capacity. There is considerable flexibility in varying the operating modes and parameters for the complex, including power levels, feed to product ratios, tails assay, and the use of enriched uranium inventories. (Staff Testimony of Lowenberg, Soffer, et al, Tr. 5694).

395. DOE is currently constructing a gas centrifuge enrichment plant at its Portsmouth, Ohio site. The Portsmouth centrifuge plant is currently projected to operate as a low enrichment facility, similar to K-25, with a capacity of 13 million SWUs. The first increment of the plant is scheduled to come on-line about 1988, with full plant completion of eight units in 1994. (Staff Testimony of Lowenberg, Soffer, et al, Tr. 5694-95).

396. Applicants' calculated doses to personnel at K-25 resulting from a SSST Accident are presented in the written testimony of Wayne Hibbits. App. Ex. 47, Table 1. The Applicants conservatively employed 5% X/Q values, did not assume plume depletion or wet deposition, and assumed that the persons receiving doses were outdoors 24 hours per day at the K-25 site. (Testimony of Hibbits, Tr. 5219, 5233-34, 5275; Applicants Testimony of Hibbitts, Tr. 5426, 5428).

397. The Staff independently calculated that the doses at the K-25 facility due to a SSST Accident at CRBR will be 19 mrem to the whole body, and 320 mrem to the thyroid. The Staff's conservatively assumed no

plume depletion, and no rainfall (wet deposition). (Staff Testimony of Lowenberg, Soffer, et al, Tr. 5688; Testimony of Soffer, Tr. 5656).

398. The Staff's calculated doses at the K-25 facility due to a SSST Accident are less than the Protective Action Guide levels ("PAG") recommended by the U.S. Environmental Protection Agency ("EPA"). The whole body PAG is 1 to 5 rem, and the thyroid PAG is 5 to 25 rem. (Staff Testimony of Lowenberg, Soffer, et al, Tr. 5689).

399. On the basis of a comparison of the Staff's calculated doses at K-25 attributable to the SSST Accident with EPA's PAGs for the whole body and thyroid, the Staff concludes that long-term evacuation of the K-25 facility following an SSST Accident is not expected to be required. (Staff Testimony of Lowenberg, Soffer, et al, Tr. 5689).

400. Applicants' calculated doses to personnel at K-25 resulting from Applicants' Class 2 (Staff's Class 1 Hypothetical Core Disruptive Accident) ("HCDA") are presented in Applicants' Exhibit 47, Tables 3 and

401. Applicants employed 50% X/Q values, but used the same conservative assumptions in calculating SSST doses as in calculating the HCDA doses. (Testimony of Hibbitts, Tr. 5233-34, 5238, 5275; Applicants Testimony of Hibbitts, Tr. 5433-35).

401. The Staff independently calculated that the doses at the K-25 facility due to a Class 1 HCDA at CRBR would be 3 rems to the whole body, and 100 rems to the thyroid. (Testimony of Thadani, Tr. 5664; Staff Testimony of Lowenberg, Soffer, et al, Tr. 5689).

402. The Staff's calculated 100 rems dose to the thyroid at K-25 attributable to the Class 1 HCDA is greater than the 5 to 25 rems PAG for the thyroid. The result is that the K-25 facility may have to be

evacuated following a HCDA at CRBR. (Staff Testimony of Lowenberg, Soffer, et al, Tr. 5689).

403. While evacuation may be required if doses at K-25 (or any other facility) are projected to reach the upper ranges of the PAGs, evacuation would probably be instituted if doses were projected to reach the lower ranges of the PAGs, as a matter of good judgment. (Testimony of Hibbitts, Tr. 5221, 5276; Applicants Testimony of Hibbitts, Tr. 5427).

404. Evacuation decisions are made based on projected doses. Thus, evacuations would occur before personnel would actually receive the projected doses. (Testimony of Hibbitts, 5276-77).

405. Applicants state that they would evacuate non-essential K-25 personnel following a SSST (and HCDA) at CRBR. Following the occurrence of a SSST or HCDA, Applicants project that approximately 65 persons would remain onsite to provide security, emergency support, and operational capability to continue production operations. Should it be desired, the enrichment cascade can be placed in an operational standby condition in less than one hour. This condition would involve recycling the gaseous uranium within the process equipment with no uranium being fed into or withdrawn from the cascade. (Applicants Testimony of Hibbitts, Tr. 5427).

406. K-25 personnel remaining onsite would receive actual radiation doses lower than those calculated by Applicants due to such factors as time of occupancy, the use of respiratory protection, possible use of potassium iodide as a thyroid blocking agent and reduced exposure rates to personnel working indoors. (Testimony of Hibbitts, Tr. 5199-5201; Applicants Testimony of Hibbitts, Tr. 5427).

407. Placing the K-25 facility out of service would not affect the capability of the remaining two GDPs to meet the U.S. need for utility grade uranium into the 1990's. This conclusion is based on the present reduced level of operation of the three unit cascade (35%) and the considerable operational flexibility of the GDP complex. In addition, for the long term, additional separative work capacity will become available when the gas centrifuge enrichment plant at Portsmouth, Ohio is completed. (Testimony of Lowenberg, Soffer, et al, Tr. 5695; Applicants Testimony of Hibbitts, Tr. 5436).

408. All U.S. national security needs for highly enriched uranium are met by the Portsmouth GDP. Loss of the K-25 facility should have little effect on the nation's capability to fulfill its security needs for highly enriched uranium. (Staff Testimony of Lowenberg, Soffer, et al, Tr. 5696).

Y-12

409. The Y-12 facility is located approximately 8.5 miles ENE of CRBR. (Staff Testimony of Lowenberg, Soffer, et al, Tr. 5687).

410. The Y-12 facility is a research and production facility in DOE's military program. Applicants' witness, Mr. Wayne Hibbitts, stated that Y-12 produces components and subassemblies in support of the production of nuclear weapons delivered by DOE to the Department of Defense. The plant also produces components used in the nuclear weapons development and testing programs carried out by the three DOE nuclear weapons design laboratories. The plant population is about 7300, including about 1200 ORNL employees, who work primarily in biological and fusion research, and

corporate staff. (Staff Testimony of Lowenberg, Soffer, et al, Tr. 5693; Testimony of Hibbitts, Tr. 5423).

411. The Y-12 facility does not play any role in the nuclear power reactor fuel cycle. Long-term evacuation of the Y-12 facility would not have any impact on the nation's energy supply. (Staff Testimony of Lowenberg, Soffer, et al, Tr. 5693; Testimony of Hibbitts, Tr. 5272-73).

412. The Applicants' calculated doses at Y-12 following an SSST Accident are presented in Table 2, App. Ex. 47. (Staff Testimony of Hibbitts, Tr. 5431).

413. The Staff's independent dose calculations at Y-12 due to a SSST Accident show that the doses to the whole body would be negligible, and about 11 mrem to the thyroid. (Staff Testimony of Lowenberg, Soffer, et al, Tr. 5688).

414. Long-term evacuation of Y-12 will probably not be required following a SSST Accident release, since the Staff's calculated whole body and thyroid doses at Y-12 are less than the whole body and thyroid PAGs. (Staff Testimony of Lowenberg, Soffer, et al, Tr. 5689).

415. Applicants' calculated doses at Y-12 due to a HCDA are presented in Tables 3 and 4 of App. Ex. 47. (Applicants Testimony of Hibbitts, Tr. 5433-35).

416. The Staff independently calculated that the doses at the Y-12 facility due to a HCDA will be about 100 mrem to the whole body, and 3 rems to the thyroid. (Staff Testimony of Lowenberg, Soffer, et al, Tr. 5689).

417. On the basis of a comparison of the Staff's independently-calculated thyroid and whole body doses at the Y-12 facility following

a HCDA with the EPA's thyroid and whole body PAGs, it can be concluded that long-term evacuation of Y-12 following a HCDA will probably not be required. (Staff Testimony of Lowenberg, Soffer, et al, Tr. 5690).

418. Should evacuation of non-essential Y-12 personnel be instituted following an SSST Accident or HCDA, about 250 workers would remain onsite. This work force is necessary to maintain security and utility requirements. Large scale evacuation would shut down production operations during the short time duration of the release. Since any evacuation would be for a short period of time, such evacuations would not significantly impact production schedules.

419. Protective measures such as those described for K-25 may be implemented by those Y-12 personnel remaining onsite following an evacuation. Therefore, radiation doses actually received by remaining Y-12 personnel would be smaller than those calculated by the Staff and Applicants. (Applicants Testimony of Hibbitts, Tr. 5431-34).

420. The Staff evaluated the risk to the national security due to long term evacuation of the Y-12 plant as part of its NEPA cost/benefit analysis, and concluded that the probability of long-term evacuation was low. (Testimony of Thadani, Tr. 5667; Testimony of Soffer, Tr. 5668-69, 5681-82).

421. Occurrence of a SSST or HCDA would not significantly affect weapons production schedules, and there would be little, if any, impact on national security. (Testimony of Hibbitts, Tr. 5244-45; Applicants Testimony of Hibbitts, Tr. 5430, 5432, 5434).

ORNL

422. The Oak Ridge National Laboratory ("ORNL") is located approximately 4 miles ENE of CRBR. (Testimony of Soffer and Thadani, Tr. 5687).

423. The Staff did not calculate doses at the ORNL attributable to an SSST Accident or HCDA at CRBR. Atmospheric dispersion factors in the NE direction, toward ORNL, are somewhat lower than those in the direction of K-25. ORNL is also approximately twice as far from the CRBR site as K-25. Ground-level releases will result in lower X/Q values at ORNL than at K-25, and doses at ORNL are expected to be lower than the doses calculated for K-25 for both the SSST Accident and the HCDA. (Staff Testimony of Lowenberg, Soffer, et al, Tr. 5696).

424. Based on the doses calculated for the K-25 facility, the greater distance from the CRBR site to ORNL, and the atmospheric dispersion and distance factors at ORNL, the Staff concludes that a SSST Accident release would not require evacuation of ORNL, but that an HCDA release may require evacuation. (Staff Testimony of Lowenberg, Soffer, et al, Tr. 5696-97).

425. The long term evacuation of ORNL is not likely to impact the national energy supply, since it does not have any role in the fuel cycle for any energy generation mode. (Staff Testimony of Lowenberg, Soffer, et al, Tr. 5697; Testimony of Hibbitts, Tr. 5197, 5272-3; Applicants Testimony of Hibbitts, Tr. 5424).

426. Mr. Hibbitts stated that he knew of no significant impact on national security if long term evacuation of ORNL is necessary. (Testimony of Hibbitts, Tr. 5197, 5274; Applicants Testimony of Hibbitts, Tr. 5424).

Accidents More Severe than Staff's Class 1 HCDA

427. A spectrum of accidents involving core disruptive events which are more severe than the SSST Accident or the Class 1 HCDA could occur at CRBR. As discussed in Appendix J of the 1982 FES Supplement, core disruptive accidents which result in loss-of-containment-integrity could result in the release of substantially larger quantities of radioactive materials to the environment than are projected for the SSST Accident or the HCDA. Such accidents may result in long-term evacuation of the K-25 and/or Y-12 facilities. (Staff Testimony of Lowenberg, Soffer, et al, Tr. 5690-91; Testimony of Hibbitts, Tr. 5192-93, 5195).

428. In order for radioactive releases following a core disruptive event to be more severe than the SSST or HCDA, successive multiple failures of highly reliable safety systems, followed by the failure of the containment to isolate, or overpressure failure of the containment must occur. This probability is very small, and no more than 10^{-6} per year. (Staff Testimony of Lowenberg, Soffer, et al, Tr. 5691).

429. The probability of long-term evacuation of either K-25 or Y-12 is about an order of magnitude smaller than the 10^{-6} per year accident and release probability, or about 10^{-7} per year. The lower probability is attributable to the fact that the wind blows toward K-25 or Y-12 approximately 10 percent of the time. (Staff Testimony of Lowenberg, Soffer, et al, Tr. 5691-92).

430. Other factors that would reduce the probability that a severe accident and radionuclide release would necessitate long-term evacuation of either K-25 or Y-12 facilities are the probability that K-25 and/or

Y-12 personnel are equipped with protective measures which would reduce the effects of radionuclide releases, and the existence of radiation shielding in habitable areas, which would be effective in reducing external radiation exposures. (Staff Testimony of Lowenberg, Soffer, et al, Tr. 5692).

431. The consequences of HCDAs in Staff Accident Classes 2, 3 and 4 are greater than the Class 1 HCDA. However, the relative risk of such accidents decreases, since the probability of occurrence of HCDAs in Classes 2 through 4 decreases, as calculated by the Staff in FES Supplement Appendix J, Table J.2. (Testimony of Strawbridge, Tr. 5186-87, 5190-91, 5414; Testimony of Soffer, Tr. 5664).

432. The probability of occurrence of a severe accident at CRBR which would require long-term evacuation of K-25 or Y-12 is approximately equal to or less than the occurrence probability of similar accidents at a LWR. (Staff Testimony of Lowenberg, Soffer, et al, Tr. 5692).

433. Intervenors presented no affirmative evidence on this contention that would tend to contradict the conclusions of the Staff and the Applicant.

6. Alternative Designs and Programmatic Objectives: Contentions 7(a) and 7(b)

434. The timing objective for CRBR project is to complete its construction "as expeditiously as possible". 1982 Supplement to ERDA-1535 (Final Environmental Impact Statement on the LMFDR Program), p. 57. ("Testimony of Paul H. Leech, Richard A. Becker and John K. Long Relative to NRDC Contentions 7(a) and 7(b) "will hereinafter be referred to as

Staff Testimony of Leech, Becker and Long. "Applicants' Direct Testimony Concerning NRDC Contentions 7(a) and 7(b)" will hereinafter be referred to as Applicants Testimony of Longnecker, et al.) (Staff Testimony of Leech, Becker and Long, Tr. 6523; Applicants Testimony of Longnecker, et al, Tr. 6410).

435. A demonstration period of approximately five years following plant startup is planned by Applicants to achieve the major programmatic objectives of the CRBR project, which are:

- to demonstrate the technical performance, reliability, maintainability, safety, environmental acceptability, and economic feasibility of an LMFBR central station steam electric power plant in a utility environment;
- to confirm the value of this concept for conserving important non-renewable natural resources.

(Staff Testimony of Leech, Becker and Long, Tr. 6523; Applicants Testimony of Longnecker, Tr. 6410).

436. The CRBR project is likely to meet its major programmatic objectives in a timely manner. This conclusion is based, in part, on the Staff's review of Section 1.3 of the Applicants' ER; DOE's LMFBR Program Environmental Statement, ERDA-1535 and the 1982 Supplement; and the Staff's independent knowledge and experience. 1977 FES, Section 8.3; 1982 FES Supplement, Section 8.3. (Staff Testimony of Leech, Becker and Long, Tr. 6523-24).

437. An alternative site to the proposed CRBR site would better meet the timing objective for the CRBR project only if the CRBR site is found to be unsuitable, and if the alternate site were "substantially better." The Staff has found that the proposed CRBR site is acceptable, and that

no substantially better alternative site for the siting of a demonstration LMFBR exists. Therefore, a decision to select an alternative site would result in an unnecessary, avoidable delay of approximately three to four years in plant construction and operation. (Staff Testimony of Leech, Becker and Long, Tr. 6525; Staff Testimony of Leech, Tr. 4919-21).

438. The Staff evaluated the likelihood of timely achieving the informational objectives of the CRBR project with the Applicants' current steam generator design development program. As part of this evaluation, the Staff considered the General Accounting Office ("GAO") report on the CRBR steam generator test program. (U.S. General Accounting Office, Revising the Clinch River Breeder Reactor Steam Generator Testing Program Can Reduce Risk, GAO/EMD-82-75) ("GAO Report"). (Staff Testimony of Leech, Becker and Long, Tr. 6526-27).

439. The GAO Report concluded that the CRBR steam generator design development program did not minimize technical risk and that a more exhaustive test program was indicated. The GAO technical consultant did not agree with the conclusion of the report and stated that he was "confident that the steam generator, as currently designed, will operate as predicted." GAO Report, p. 9. (Staff Testimony of Leech, Becker and Long, Tr. 6527).

440. LMFBR steam generator experience, in terms of leaks (or absence of leaks) between the high pressure water and the liquid sodium coolant, has been mixed. Some LMFBR steam generators have operated without water-to-sodium leaks, while other LMFBR plants have had persistent steam generator water-to-sodium leaks. EBR-II has operated a steam generator for 19 years without having a water-to-sodium leak. The

French demonstration reactor Phenix operated 10 years before experiencing its first water-to-sodium leak. The British PFR and the Soviet BN-350 experienced extensive and persistent water-to-sodium leaks in their steam generators. The FERMI reactor experienced water-to-sodium leaks during its operating history. (Staff Testimony of Leech, Becker and Long , Tr. 6528).

441. Careful engineering design, materials selection and control, quality fabrication and full inspection are more important than steam generator configuration for avoiding steam generator leaks. The configuration selected should be capable of incorporating proper design features and the lessons learned from available steam generator experience. (Staff Testimony of Leech, Becker and Long, Tr. 6529; Testimony of Long, Tr. 6474-75; Testimony of Longnecker, Tr. 6297-98, 6300-01).

442. The Staff's ongoing review of the development program and design of CRBR steam generators indicates that experience with PWR and LMFBR steam generators, including failure experiences with foreign LMFBR steam generators, have been understood and assimilated by Applicants in the CRBR steam generator design. (Staff Testimony of Leech, Becker and Long, Tr. 6529; Testimony of Longnecker, Tr. 6296-6301).

443. The basic configuration, design approach to welds, inspection, quality assurance, materials, phenomena and stability for the CRBR steam generators have all been confirmed in individual effects tests and model tests. From these tests, mechanical corrections for tolerances and materials compatibility were incorporated by Applicants in the CRBR prototype steam generator component or system integration test, which is

currently in progress. (Staff Testimony of Leech, Becker and Long, Tr. 6530).

444. Several design improvements adopted by Applicants were not included in the prototype steam generator, since their inclusion would have adversely affected the schedule for steam generator design and testing. These design improvements are minor in nature and are not involved with any of the fundamental aspects of the steam generator concept or structure. (Staff Testimony of Leech, Becker and Long, Tr. 6530; Testimony of Longnecker, Tr. 6303-04).

445. The design improvements which were not incorporated into the prototype steam generator will be tested in a hydraulic test of a 0.42 size scale model. The test is designed to confirm the analytical prediction that there will be no flow-induced vibration problems with these design improvements. As a confirmation of the 0.42-scale model tests, the plant spare steam generator will be hydraulically tested. The plant spare steam generator will incorporate the design improvements not incorporated on the prototype steam generator. (Staff Testimony of Leech, Becker and Long, Tr. 6530-31; Testimony of Longnecker, Tr. 6304-05).

446. Any unanticipated CRBR steam generator problems will be corrected in place, probably by plant operations personnel and designers working together. Such repairs or modifications would be consistent with the programmatic objective c demonstrating component maintainability in a utility environment. (Staff Testimony of Leech, Becker and Long, Tr. 6532).

447. A thorough and well-conceived component development program which includes proper phenomenon, special features and total system

testing can minimize, but cannot eliminate, residual technical risk. GAO acknowledged in their Report that: (1) all steam generator problems are not related to design deficiencies; (2) testing cannot eliminate all elements of risk; and (3) the ultimate test must come when the steam generators are operated in CRBR. GAO Report, p. 9. (Staff Testimony of Leech, Becker and Long, Tr. 6527, 6531).

448. The alternative course advocated by GAO would require a precise steam generator prototype to be fabricated and tested before contracting for production of the plant units. The Staff estimates that the GAO alternative would cause a delay of at least two years, and prevent the timely achievement of the informational objectives for the CRBR program. The Applicants' witness, Mr. John Longnecker, estimates that additional testing of an exact prototype would result in a 3-5 year delay in CRBR construction. (Staff Testimony of Leech, Becker and Long, Tr. 6531-32; Testimony of Longnecker, Tr. 6306-07).

449. Based on the Staff's review of the CRBR steam generator design to date, it appears that the technical risk of a major design defect going undetected by testing and requiring redesign and lengthy delay after installation is very small. (Staff Testimony of Leech, Becker and Long, Tr. 6531-32).

450. There are no steam generator testing alternatives which may lead to more timely achievement of the programmatic objectives for the CRBR than the approach presently being pursued by Applicants. (Staff Testimony of Leech, Becker and Long, Tr. 6524-25; Tr. 6531-32).

451. The proposed Final Environmental Statement for the LMFBR Program (WASH-1535) sets forth the following CRBR objective:

> To demonstrate the technical performance, reliability, maintainability, safety, environmental acceptability, and economic feasibility of an LMFBR central station electric power plant in a utility environment.

The Final Supplement to the Programmatic Statement (Supplement to ERDA-1535, dated May 1982, pp. 38-39) states that:

> Technical feasibility of the LMFBR has been clearly demonstrated and the remaining work is to conduct engineering scale demonstration of the technology at a size leading up to that of commerical plants.

(Staff Testimony of Leech, Becker and Long, Tr. 6533).

452. The primary informational needs of the LMFBR program will best be served by incorporating in CRBR, as far as practical, systems that are similar to those most likely to be chosen for use in an LMFBR of practical commercial size. (Staff Testimony of Leech, Becker and Long, Tr. 6546).

453. For purposes of the Staff's evaluation, the practical commercial size for an LMFBR was assumed to be in the range of approximately 1000 megawatts electric (MWe). (Staff Testimony of Leech, Becker and Long, Tr. 6534).

454. The size, or the gross power rating (975 MWt, 325 MWt per loop), of the CRBRP was selected as a reasonable midpoint between FFTF (400 MWt or 133 MWt per loop) and commercial size reactors (2400-3800 MWt, 600-1270 MWt per loop). Extrapolations of size by a factor of 2.5 to 3.5 are considered to be a prudent compromise between the need for advancement in technology and keeping the scale up risks acceptably low. Development of LWR technology followed approximately the same path. Foreign LMFBR programs have utilized similar extrapolation factors. The information

obtained from a plant of the size of CRBRP is relevant to a commercial size reactor in that a similar extrapolation of the technological base from the CRBRP would lead to a commercial size LMFBR. (Applicants Testimony of Longnecker, Tr. 6433).

455. The next plant under development by DOE and U.S. electric utilities and private industry is the 1000 MWe Large Developmental Plant (LDP). The LDP size extrapolation from CRBRP is similar to the extrapolation to CRBRP from FFTF. This extrapolation factor for LDP was established after an intensive interaction and analysis by the industry and DOE based on balancing considerations of advancements in technology and attaining a low risk basic design. Furthermore, based on the concept already developed for LDP, an assessment was made by DOE and the industry on the bases available for the design of LDP systems. CRBRP systems design provides a basis for all the LDP systems designs. (Applicants Testimony of Longnecker, Tr. 6433-34).

456. The CRBR design includes an extensive number of design features which would be directly pertinent and relevant to a LMFBR of a practical commercial size. An extensive list has been compiled and presented in the Applicants' LMFBR Programmatic Environmental Impact Statement. Supplement to ERDA-1535, DOE/EIS-0085-FS, p. 61. These features include the fuel elements and assemblies; the reactor closure rotating plug seals, bearings, insulation and cooling; in-vessel refueling equipment; and instrumentation and control equipment systems. The major design features of CRBR were selected after extensive review and evaluation, and are responsive to the needs of the utility industry. (Staff Testimony of

Leech, Becker and Long, Tr. 6534; Testimony of Longnecker, Tr. 6353-54, 6359-62; Applicants Testimony of Longnecker, Tr. 6442-43).

457. The designs for the rotating seals, bearings, insulation, cooling, in-vessel refueling equipment and instrumentation/control equipment for CRBR are essentially transferable to commercial LMFBRs, with appropriate scaling. The demonstration of these CRBR designs components are extremely relevant to the LMFBR program. (Staff Testimony of Leech, Becker and Long, Tr. 6536).

458. The fuel and assembly hardware of the CRBR could be externally identical to those of a large future LMFBR. The heat ratings (kw/foot), and thermal hydraulic effects during normal operation of CRBR are generally the same for large LMFBR. The fuel enrichment is generally less for larger reactors. Despite the difference in fuel enrichment, the CRBR design is expected to generate relevant information concerning the design of larger, commercially-sized LMFBRs. (Staff Testimony of Leech, Becker and Long, Tr. 6535).

459. The change in fuel enrichment is accompanied by various changes in core physics, including sodium-void coefficient, Doppler coefficient and breeding ratio. These variations are well known, have been calculated for many years for reactors that differ principally in scale, and are important for safety analyses. Each new reactor that comes on-line provides data that serves as a check point to verify and adjust previous calculations. CRBR will provide such a check point and therefore is relevant to the design of larger reactors. (Staff Testimony of Leech, Becker and Long, Tr. 6535).

460. The original CRBR homogenous 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 thermal expansion of the sodium in the heterogeneous core is calculated to be associated with less positive components of reactivity than the homogeneous core. It is anticipated that the detailed verification of this effect in CRBR will provide information of considerable value of the LMFBR program. The CRBR in its current heterogeneous design will be a valuable demonstration of the ability to calculate such complex fast reactor systems. The construction of a homogeneous core as originally proposed would only provide a verification of coefficients that are considered to be more straightforward to calculate and which have been verified in other reactors. (Testimony of Long, Tr. 6498-6508; Staff Testimony of Leech, Becker and Long, Tr. 6544, 6549; Testimony of Longnecker, Tr. 6356-58; Applicants Testimony of Longnecker, Tr. 6440-41).

461. The use of heterogeneous blanket regions in the core of CRBR introduces a variable in the design parameters that has not previously been utilized. The availability of this parameter permits the designer a new latitude in the adjustment of sodium-void coefficient, Doppler coefficient and breeding characteristics. Safety, efficiency, and breeding performance can be better optimized by taking advantage of this parameter Thus, CRBR will be relevant to the optimization of the design of subsequent reactors. (Testimony of Long, Tr. 6498-6513; Staff Testimony of Leech, Becker and Long, Tr. 6535; Testimony of Anderson, Tr. 6383-88).

462. In a sequence of scaled-up LMFBR facilities which culminate in a large commercial plant, each member of the sequence contributes some data on reliability to be factored into the design of the subsequent members. Although the reliability of any single detail, such as fuel performance, might be fairly well established in test reactors or sodium test facilities, the demonstration of the reliable interaction of components requires a facility in which whole systems can interact with each other. (Staff Testimony of Leech, Becker and Long, Tr. 6536-37).

463. The CRBR facility will demonstrate the reliability of an integrated LMFBR electric power plant in the commercial environment of a power grid, since its design and operation will allow the interaction of the nuclear, steam and electric systems with each other. Section 8.3, 1977 FES; Section 8.3, FES Supplement. (Staff Testimony of Leech, Becker and Long, Tr. 6537, 6543).

464. Larger reactors in the LMFBR program are currently expected to utilize the loop design, rather than the pool design. The Applicants' decision to employ the loop design for CRBR will maximize informational value of the CRBR project to the LMFBR program. Many components for CRBR would be very similar in materials, principles of operation and temperatures for larger LMFBRs. Even if larger LMFBR reactors should utilize the pool rather than the loop design, the CRBR project would nevertheless provide information of considerable value. Section 8 of the FES and Supplement. (Staff Testimony of Leech, Becker and Long, Tr. 6537, 6550; Applicants Testimony of Longnecker, Tr. 6444).

465. Construction and operation of the CRBR would generate important information even if a commercial LMFBR employed the pool, rather than loop

concept, since many of the general principles would be the same in both plants. The maintenance of purity of the sodium, the operation in a radioactive sodium environment, the production of superheated steam of high quality, and the isolation between steam and nuclear systems by an intermediate sodium loop, all have important consequences for reliability, and all are features of both loop and pool systems. Details of piping, seals and pumping for CRBR would be different from a commercial pool LMFBR, so that reliability data would not be as effectively generated in these respects. Nonetheless, the CRBR demonstration would be extremely valuable. (Staff Testimony of Leech, Becker and Long, Tr. 6537-38; Applicants Testimony of Longnecker, Tr. 6439-40).

466. There are maintainability data which cannot be obtained in a test facility, and which requires experience with a complete working LMFBR. This maintainability data, which has programmatic relevance, includes the economic costs of maintenance, the enforced reduction in plant operating factor, and the personnel hazards involved. Definitive measures of these problems can only be obtained through an actual demonstration under realistic operating conditions. Applicants will document reliability data down to the individual component level for each system, which will be useful in the design of future LMFBRs. (Staff Testimony of Leech, Becker and Long, Tr. 6538; Testimony of Longnecker, Tr. 6307-08).

467. Operation of CRBR is reasonably likely to demonstrate the maintainability of a relevant commercial LMFBR central electric power plant under realistic operating conditions. The maintainability aspects of the CRBR will be divided into those which are related to first-of-a-kind test facilities and those which are related to more routine operations in

order to provide useful projections for commercial plants. The maintainability records of CRBR would be valuable input for the decision of LMFBR commercialization, provided the loop concept is followed. The CRBR experience would be of less benefit if the pool design is selected for a commercial LMFBR, since maintenance of equipment within the primary and intermediate systems of pool type reactors requires different techniques. (Staff Testimony of Leech, Becker and Long, Tr. 6538; Testimony of Longnecker, Tr. 6310-6312; Applicants Testimony of Longnecker, Tr. 6424-29).

468. The CRBR is likely to demonstrate whether commercial LMFBR central electric power plants are economically feasible. The economic projections for an LMFBR utility plant will be guided by a detailed cost accounting of capital and operating expenses for the CRBR after proper corrections for non-repetitive, prototypic costs associated with the first-of-a-kind nature of the plant. The project is undertaking a very comprehensive cost-reporting system to provide the information for such an evaluation. The costs reported for the CRBR will also be adjusted to account for improvements associated with increasing the plant scale, in order to provide possible information relevant to commercial LMFBRs. Such adjustments are determined subjectively and are partly based on other experiences with small scale plants that have later been extrapolated to larger sizes. Although the process of cost extrapolation is not precise, the cost data from the CRBRP will provide a better basis for estimates of the cost of future LMFBR electric power plants than currently exists. Without CRBR, the degree of extrapolation would be considerably larger. (Testimony of Long, Tr. 6476-6480, 6484-86; Staff Testimony of

Leech, Becker and Long, Tr. 6539; Testimony of Longnecker, Tr. 6310-12; Applicants Testimony of Longnecker, Tr. 6430-31).

469. The achievement of full rated technical performance in CRBR is not essential to provide technical performance information relevant to the LMFBR program. Negative information from CRBR could be factored in as corrections to the LMFBR program, or partial technical performance in CRBR could provide a data base for further improvements in the program. (Testimony of Long, Tr. 6470-72; Staff Testimony of Leech, Becker and Long, Tr. 6539-40).

470. Based on past experience the Staff expects that the energy conversion systems of LMFBRs are more likely to present problems in demonstrating technical performance than the nuclear or control systems. For example, steam generators have presented problems in some foreign reactors. However, any deficiencies in the energy conversion system would be correctable within a reasonable time, as they have been on other LMFBRs, without modification to the CRBR nuclear system. This is due to the almost completely non-radioactive nature of the secondary sodium and steam systems. Thus, deficiencies in the conversion system would be likely to delay, but not prevent, the demonstration of full technical performance of a LMFBR electric power plant in a utility environment. (Staff Testimony of Leech, Becker and Long, Tr. 6540).

471. A high level of technical performance for the CRBR can be achieved, as evidenced by the successful design, construction and operation of LMFBRs in the U.S. and in foreign countries. The record of performance of the major LMFBRs is considerable and it is impressive.

Except for major shutdowns in 1977 for intermediate heat exchanger repair, Phenix has operated continuously from 1975 until the present. The Prototype Fast Reactor (PFR) operated intermittently from 1977 to the present, except for one major shutdown of about 8 months for steam generator repairs. BN-350 has operated extensively since 1973. BN-600 commenced operation in 1980. Japan has placed the JOYO reactor in operation and has begun construction of its successor, MONJU. (Staff Testimony of Leech, Becker and Long, Tr. 6541).

472. CRBR will demonstrate environmental acceptability of future LMFBRs by conducting its construction and operation in conformance with applicable federal and state environmental requirements. (Testimony of Longnecker, Tr. 6308-6310; Applicants Testimony of Longnecker, Tr. 6430).

473. The ability of the CRBR to demonstrate environmental acceptability of commercially-sized LMFBRs electric generating plants will also depend on the scalability of impacts resulting from its construction and operation. The various LMFBR concepts are not expected to have substantially different radioactive effluent generation from one another. The Staff therefore believes that the demonstration results provided by the CRBRP will be scalable (with minor modifications) to any of the future LMFBRs now proposed. All LMFBRs would have an inert cover-gas system in conjunction with the sodium coolant, and all concepts would include systems to clean up the radioactive contamination in this cover-gas. Moreover, the conditions encountered by these systems in contamination control or release are not substantially different among the various designs. (Staff Testimony of Leech, Becker and Long, Tr. 6541-42).

474. All LMFBRs will have to restrict and control the release of tritium. Much of the tritium is retained in the system cold traps. The quantities of tritium produced are somewhat design-dependent, but they are not so different among the various designs that the demonstration provided by CRBR would be inapplicable if another design concept were adopted. (Staff Testimony of Leech, Becker and Long, Tr. 6542).

475. Consideration of other environmental impacts of the CRBR, which are discussed in Chapters 4 and 5 of the FES and the FES Supplement, have been reviewed by the Staff and no impacts have been found which could not be scaled to larger LMFBRs, or modified slightly to accommodate different LMFBR concepts. The CRBR would provide a useful demonstration of the environmental impact of LMFBR technology. (Staff Testimony of Leech, Becker and Long, Tr. 6542).

476. Fuel cycle and waste disposal aspects of LMFBR technology are the subject of separate studies which will include the environmental impact of the balance of the cycle. The entire impact of the LMFBR program will be estimated by DOE using all available sources of information. The CRBR is capable of making a significant contribution to this study. (Staff Testimony of Leech, Becker and Long, Tr. 6542-43).

477. Initial operation of CRBR will verify whether natural circulation predictions that have been developed from tests on smaller systems such as FFTF are correct. This will provide a bridge for extension of natural circulation to larger LMFBR systems. (Staff Testimony of Leech, Becker and Long, Tr. 5642).

478. The CRBR can make a significant contribution to knowledge of the safety of LMFBRs by narrowing the uncertainties in component and

system behavior that now exist, through a large scale demonstration of the core clamping and support design. There has been no way of demonstrating on an engineering mockup the full combination of thermal and hydraulic effects that influence the expansion and bowing behavior of the fuel elements and assemblies in a reactor the size of CRBR. FFTF testing and data in this area may not be directly applicable to CRBR due to the size difference and the fact that FFTF is a homogeneous core. Elaborate calculations of this type of behavior have been done to supplement an engineering test program, but the actual behavior of the reactor is required for final validation of the engineering predictions. The additional effects of irradiation on fuel assembly behavior, through irradiation swelling and constrained creep, will also be demonstrated. These effects are essential to calculations of power coefficient and transient behavior, and are thus safety related. Experience with the CRBR will permit a demonstration of these phenomena on a scale that can be extrapolated to commercial plants. (Staff Testimony of Leech, Becker and Long, Tr. 6544-45).

479. The objective of demonstrating the safety of LMFBRs will not be achieved solely by safe operation of CRBR. Although a satisfactory record of performance based on (1) reliable operation of systems and components important to normal safe operation, and (2) the effectiveness of measures to control off-normal events should they occur would be encouraging, it would not provide a direct indication of the total safety of larger LMFBRs. Much of the safety program relevant to the larger reactors is being carried out in separate studies in reactor test facilities and in out-of-pile-tests. (Staff Testimony of Leech, Becker and Long, Tr. 6543-44).

480. The objective of operating the Clinch River Breeder Reactor Plant in a utility environment will be met by operation of CRBR on the Tennessee Valley Authority (TVA) system, supplying power to that grid, by TVA personnel. (Applicants Testimony of Longnecker, Tr. 6431).

481. Dr. Long, the NRC Staff expert witness, concluded that the CRBR is reasonably likely achieve its objectives of generating information relevant to design, construction, technical performance, reliability, maintainability, safety, environmental acceptability and economic feasibility of practical, licensable, commercial-sized LMFBRs. (Testimony of Long, Tr. 6545).

482. The incorporation of alternative features in the CRBR which are not currently proposed for commercial-size LMFBRs represents a secondary informational need. The information concerning alternative features which will meet this secondary need may be obtained in several ways. The features may be studied in research and development programs out-of-pile, in reactors other than CRBR, or in CRBR itself. Since the primary objectives of CRBR as a generator of information for the LMFBR programs are served by the present design, it would be detrimental to the program to require the incorporation into CRBR of alternatives to meet this secondary need unless they were:

1) clearly necessary to the LMFBR program, and
2) fully developed to the extent that their incorporation in CRBR would not delay or jeopardize the primary informational mission of CRBR.

(Staff Testimony of Leech, Becker and Long, Tr. 6546-47).

483. The pool concept is not a substantially better alternative compared to the loop concept, and CRBRP in a loop plant configuration has a higher likelihood of meeting its objectives. On a purely functional basis, both pool and loop-type LMFBRs are feasible and neither has a significant overall advantage over the other. Considering fabrication/ construction differences between pool and loop-type reactors, the cost and schedule estimate differences are generally recognized to be within the range of uncertainty of the estimating accuracy. However, there is a lack of large pool-type reactor construction experience in this country, and there is a schedule risk associated with the greater estimated field labor requirements for a pool-type reactor. (Applicants Testimony of Longnecker, Tr. 6363-64; 6443-6445; Staff Testimony of Leech, Becker and Long, Tr. 6550).

484. The installation of flywheels on the primary sodium pumps for CRBR is not a substantially better alternative for CRBR, since flywheel utilization would not augment the information generated for the LMFBR program in any significant way. Reactors are individually designed so that the coastdown characteristics of the flowing sodium for that reactor provide a sufficient match to the shutdown cooling requirements to prevent fuel overheating in a sudden shutdown while minimizing thermal transients. Flywheels can be installed on the motor generator sets to provide stored additional energy for coastdown flow, or the pump rotors can be designed to provide the energy. There is also a large inertia in the flowing sodium itself. Applicants state that the inertia of the flowing sodium considered with the inertia of the pump rotor is sufficient, in the case of CRBR, to provide the necessary coolant coastdown period. The Staff is

presently reviewing the Applicants' position on this matter. (Testimony of Long, Tr. 6488-90; Staff Testimony of Leech, Becker and Long, Tr. 6548; Testimony of Anderson, Tr. 6364-67; Applicants Testimony of Longnecker, Tr. 6445-47).

485. The Staff is presently reviewing whether the coastdown of the liquid sodium in the CRBR cooling system needs to be augmented in some way for larger LMFBRs, but it is not anticipated that augmentation would be a serious problem if the need arises. Accordingly, the decision whether or not to use flywheels on the primary sodium pumps should be based on the coolant coastdown requirements of the CRBR itself, and not on a need for information for the LMFBR program. (Staff Testimony of Leech, Becker and Long, Tr. 6548).

486. Self-actuated shutdown systems are not considered to be an essential need for the LMFBR program. The Staff knows of no reason why more conventional shutdown systems could not satisfy the safety requirements of the CRBR program. The CRBR shutdown systems are diverse--that is, they have different operating principles and use different components, and they are redundant--that is, each system is designed to shut the reactor down without action by the other system. All credible failure modes are addressed by the CRBR primary and secondary shutdown systems. In addition, self-actuated shutdown systems have not yet reached the stage of development in the U.S. that would permit their use in the CRBR. The development of these systems can be continued in out-of-pile studies in the event that they are later determined to be needed. (Testimony of Long, Tr. 6468-70, 6491-92; Staff Testimony of Leech, Becker and Long, Tr. 6547-48; Applicants Testimony of Longnecker, Tr. 6448-49).

487. Lower CRBRP operating temperatures would not be a substantially better alternative for meeting project objectives. Lowering the operating temperatures without lowering the design temperatures would have the effect of increasing equipment sizes and costs and decreasing efficiency, while providing more margin to system limiting conditions and slightly improved fuel performance. Lower operating temperatures would not affect the likelihood and consequences of a loss-of-flow HDCA. Accidents beyond the HCDA would not be favorably affected by reducing operating temperatures. (Applicants Testimony of Longnecker, Tr. 6447-48; Testimony of Anderson, Tr. 6313-14).

488. The installation of a core retention device in CRBR would not likely generate any useful operating data for future reactors since the Staff conservatively estimates the probability of its being called into use during the operating life of CRBR to be less than 10^{-3}. Any operating information in connection with core retention devices must be obtained from out-of-pile studies, not from CRBR. Incorporation of a core-retention device does not represent a substantially better alternative for fulfilling the programmatic objectives of the LMFBR program. (Testimony of Long Tr. 6492-95; Staff Testimony of Leech, Becker and Long, Tr. 6547-48).

489. Applicants' witness, Carl Anderson, concluded that incorporation of a core retention device for CRBR is not a substantially better alternative, since it does not reduce the likelihood of an HCDA, and it must work when called upon, since it would be impossible to repair following an HDCA. Dr. Anderson also stated that the core retention device would probably not result in any substantial mitigation of a HCDA. (Testimony

of Anderson, Tr. 6313-16, 6369-74; Applicants Testimony of Longnecker, Tr. 6449-50).

490. The utilization of a heterogeneous core design for CRBR, rather than with the originally proposed homogeneous core, will maximize the information value of the CRBR project to the LMFBR program.

491. A no-vent containment is not a substantially better alternative. In normal operation, continuous venting provides for access to containment during operation, which improves the operability and maintainability of CRBR. In the event of a HDCA, Applicants' analysis shows that containment venting may be required to maintain containment vessel integrity. However, even under HDCA conditions, radiological releases from the controlled, filtered venting are acceptably low. (Applicants Testimony of Longnecker, Tr. 6450-52).

492. The use of a fully-isolated containment system, rather than a filtered-vent containment system for CRBR, will not significantly augment the informational value of the CRBR project to the LMFBR program. There are many fully contained systems in existence and relatively few filtered-vent systems. If the CRBR filtered-vent system can be designed to satisfy safety and environmental requirements, the design, construction, testing and operation of a filtered-vent system will provide new information with greater potential for value in the LMFBR program than would the construction of another conventional containment. (Staff Testimony of Leech, Becker and Long, Tr. 6549).

493. The alternative design features which are embodied in foreign breeder reactors do not provide substantially better satisfaction of the CRBR and LMFBR informational objectives than the present CRBR design, and

therefore are not substantially better alternatives. (Staff Testimony of Leech, Becker and Long, Tr. 6550; Testimony of Longnecker, Tr. 6336-38; Applicants Testimony of Longnecker, Tr. 6441, 6453).

7. <u>Genetic Effects of Operation</u>: <u>Contention 11(b)</u>

494. The genetic effects from operation of CRBR using as a basis the dose estimates supplied in the FES Supplement (Staff Exh. 8 at Sec. 5.7) and the genetic effects estimates made by the National Academy of Sciences Committee on the Biological Effects of Ionizing Radiation as given in its BEIR III Report, results in an upper limit of about 0.004 case among the one million births to the 50 mile population in the first generation from non-occupational exposure for 30 years and about 2.25 cases from occupational exposure for the 30-year plant lifetime. ("NRC Staff Testimony of Michael A. Bender, Ph.D. Regarding Contention 11(b)" will hereinafter be referred to as Staff Testimony of Bender. "Applicants' Direct Testimony Concerning NRDC Contentions 11(b) and 11(c)" will hereinafter be referred to as Applicants Testimony on Contention 11.) (Staff Testimony of Bender, Tr. 4113, 4124; Applicants Testimony on Contention 11, Tr. 4290). This upper limit of genetic effects encompasses the range of effects estimated by the Staff (Staff Testimony of Bender, Tr. 4121) and the Applicants (Applicants Testimony on Contention 11, Tr. 4290), who also utilized the BEIR III methodology (Applicants Testimony on Contention 11, Tr. 4294; Staff Testimony of Bender, Tr. 4116).

495. The applicability of the BEIR III linear hypothesis to genetic effects estimation for popuation exposed to low-level chronic radiation is supported by both experimental evidence and radiological theory. The

linear hypothesis is thus a conservative basis for hazard estimation, and its use will inevitably in such a case lead to an overestimate for all dose levels in between. (Staff Testimony of Bender, Tr. 4117). The estimates given in the BEIR III Report, though not made specifically for the purpose of evaluating the consequences of the operation of nuclear facilities, constitute the most appropriate basis for estimating the genetic effects likely to result from operation of the CRBRP. (Id.)

496. Any numerical estimates of genetic hazards of radiation exposure at the very low dose rates anticipated are simply conservative estimates of the upper credible limits of risk. Such estimates cannot be considered reliable point estimates. (Staff Testimony of Bender, Tr. 4117-18). The actual increase will very likely be smaller, possibly much smaller, than the upper limit estimates. Therefore, the genetic effects from operation of the CRBR will be so small as to constitute a negligible impact upon human health and welfare. (Id., Tr. 4124).

8. Risk of Cancer from Operation: Contention 11(c)

497. The Staff adequately assessed the potential cancers that may occur from exposure of plant employees and the general public. In Section 5.7.2.5 of the Supplement to the FES for CRBRP (Staff Ex. 8), the Staff presented estimates of potential fatal cancers that may occur among the exposed work force. In Section 5.7.3 of the Supplement to the FES for CRBRP the Staff presented estimates of the risk of potential premature dealth from cancer to the maximally exposed individual to radioactive effluents from CRBRP. ("NRC Staff Testimony of Edward F.

Branagan, Jr. Regarding Contention 11(c)" will hereinafter be referred to as Staff Testimony of Branagan) (Staff Testimony of Branagan, Tr. 4153).

498. The potential fatal cancer risk estimators that were used in the FES Supplement and in Applicants' estimate were based on models described in the National Academy of Sciencies BEIR Reports, utilizing the conservative linear, non-threshold model. (Staff Testimony of Branagan, Tr. 4148-49; Applicants Testimony on Contention 11, 4292). Use of this model is consistent with the recommendations of other major radiation portection organizations such as the ICRP, NCRP and UNSCEAR. These organizations represent the views of the overwhelming majority of the members of the scientific community. (Staff Testimony of Branagan, Tr. 4150-54).

499. The average risk of potential premature death from cancer to an individual within 50 miles of CRBRP from exposure to radioactive effluents from the reactor is much less than the risk to the maximally exposed individual. (Staff Testimony of Branagan, Tr. 4150). The risk to a maximally exposed individual to radioactive materials released from one reactor-year of routine operations at CRBRP (a risk of potential premature death due to cancer of about 1 chance in a million using a conservative dose estimate of 5 mrems) is much less than the risk from exposure to any of the major sources of radiation (e.g., medical exposure and natural background radiation). The risk is also within the same range as the risks from exposure to many of the other common sources of enhanced radiation exposure. The risk of potential premature death from cancer to the average individual within 50 miles of the reactor from exposure to radio-

active effluents from the reactor is much less than the risk to the maximally exposed individual. (Id., Tr. 4152-53).

500. These Staff's and Applicants' estimates of the potential cancers that may occur from exposure of plant employees and the general public are appropriately conservative. (Staff Testimony of Branagan, Tr. 4154).

9. Health Effects: Contentions 11(d) and 2(e)

See findings in Section B.1 and D.1.

Respectfully submitted,

Daniel T. Swanson
Counsel for NRC Staff

Bradley W. Jones, by DTS
Bradley W. Jones
Counsel for NRC Staff

Geary S. Mizuno
Counsel for NRC Staff

Dated this 24th day of January, 1983, at Bethesda, Maryland.

APPENDIX A

STATEMENT OF CONTENTIONS

The Licensing Board's Prehearing Conference Order of April 14, 1982 admitted the following contentions for consideration during the LWA-1 phase of this proceeding:

Contention 1

The envelope of DBAs should include the CDA.

a) Neither Applicants nor Staff have demonstrated through reliable data that the probability of anticipated transients without scram or other CDA initiators is sufficiently low to enable CDAs to be excluded from the envelope of DBAs.

Contention 2

The analysis of CDAs and their consequences by Applicants and Staff are inadequate for purposes of licensing the CRBR, performing the NEPA cost/benefit analysis, or demonstrating that the radiological source term for CRBRP would result in potential hazards not exceeded by those from any accident considered credible, as required by 10 CFR §100.11(a), fn. 1.

a) The radiological source term analysis used in CRBRP site suitability should be derived through a mechanistic analysis. Neither Applicants nor Staff have based the radiological source term on such an analysis.

b) The radiological source term analysis should be based on the assumption that CDAs (failure to scram with substantial core disruption) are credible accidents within the DBA envelope, should place an upper bound on the explosive potential of a CDA, and should then derive a conservative estimate of the fission product release from such an accident. Neither Applicants nor Staff have performed such an analysis.

c) The radiological source term analysis has not adequately considered either the release of fission products and core materials, e.g., halogens, iodine and plutonium, or the environmental conditions in the reactor containment building created by the release of substantial quantities of sodium. Neither Applicants nor Staff have established the maximum credible sodium release following a CDA or included the environmental conditions caused by such a sodium release as part of the radiological source term pathway analysis.

d) Neither Applicants nor Staff have demonstrated that the design of the containment is adequate to reduce calculated offsite doses to an acceptable level.

e) As set forth in Contention 11(d), neither Applicants nor Staff have adequately calculated the guideline values for radiation doses from postulated CRBRP releases.

f) Applicants have not established that the computer models (including computer codes) referenced in Applicants' CDA safety analysis reports, including the PSAR, and referenced in the Staff CDA safety analyses are valid. The models and computer codes used in the PSAR and the Staff safety analyses of CDAs and their consequences have not been adequately documented, verified or validated by comparison with applicable experimental data. Applicants' and Staff's safety analyses do not establish that the models accurately represent the physical phenomena and principles which control the response of CRBR to CDAs.

g) Neither Applicants nor Staff have established that the input data and assumptions for the computer models and codes are adequately documented or verified.

h) Since neither Applicants nor Staff have established that the models, computer codes, input data and assumptions are adequately documented, verified and validated, they have also been unable to establish the energetics of a CDA and thus have also not established the adequacy of the containment of the source term for post accident radiological analysis.

Contention 3

Neither Applicants nor Staff have given sufficient attention to CRBR accidents other than the DBAs for the following reasons:

b) Neither Applicants' nor Staff's analyses of potential accident initiators, sequences, and events are sufficiently comprehensive to assure that analysis of the DBAs will envelop the entire spectrum of credible accident initiators, sequences, and events.

c) Accidents associated with core meltthrough following loss of core geometry and sodium-concrete interactions have not been adequately analyzed.

d) Neither Applicants nor Staff have adequately identified and analyzed the ways in which human error can initiate, exacerbate, or interfere with the mitigation of CRBR accidents.

Contention 4

Neither Applicants nor Staff adequately analyze the health and safety consequences of acts of sabotage, terrorism or theft directed against the CRBR or supporting facilities nor do they adequately analyze the programs to prevent such acts or disadvantages of any measures to be used to prevent such acts.

a) Small quantities of plutonium can be converted into a nuclear bomb or plutonium dispersion device which if used could cause widespread death and destruction.

b) Plutonium in an easily usable form will be available in substantial quantities at the CRBR and at supporting fuel cycle facilities.

c) Analyses conducted by the Federal Government of the potential threat from terrorists, saboteurs and thieves demonstrate several credible scenarios which could result in plutonium diversion or releases of radiation (both purposeful and accidental) and against which no adequate safeguards have been proposed by Applicants or Staff.

d) Acts of sabotage or terrorism could be the initiating cause for CDAs or other severe CRBR accidents and the probability of such acts occurring has not been analyzed in predicting the probability of a CDA.

Contention 5

Neither Applicants nor Staff have established that the site selected for the CRBR provides adequate protection for public health and safety, the environment, national security, and national energy supplies; and an alternative site would be preferable for the following reasons:

a) The site meteorology and population density are less favorable than most sites used for LWRs.

(1) The wind speed and inversion conditions at the Clinch River site are less favorable than most sites used for light-water reactors.

(2) The population density of the CRBR site is less favorable than that of several alternative sites.

(3) Alternative sites with more favorable meteorology and population characteristics have not been adequately identified and analyzed by Applicants and Staff. The analysis of alternative sites in the ER and the Staff Site Suitability Report gave insufficient weight to the meteorological and population disadvantages of the Clinch River site and did not attempt to identify a site or sites with more favorable characteristics.

b) Since the gaseous diffusion plant, other proposed energy fuel cycle facilities, the Y-12 plant and the Oak Ridge National Laboratory are in close proximity to the site an accident at the CRBR could result in the long term evacuation of those facilities. Long term evacuation of those facilities would result in unacceptable risks to the national security and the national energy supply.

Contention 6

The ER and FES do not include an adequate analysis of the environmental impact of the fuel cycle associated with the CRBR for the following reasons:

b) The analysis of fuel cycle impacts must be done for the particular circumstances applicable to the CRBR. The analyses of fuel cycle impacts in the ER and FES are inadequate since:

(1) The impact of reprocessing of spent fuel and plutonium separation required for the CRBR is inadequately assessed;

(3) The impact of disposal of wastes from the CRBR spent fuel is inadequately assessed;

(4) The impact of an act of sabotage, terrorism or theft directed against the plutonium in the CRBR fuel cycle, including the plant, is inadequately assessed, nor is the impact of various measures intended to be used to prevent sabotage, theft or diversion.

Contention 7

Neither Applicants nor Staff have adequately analyzed the alternatives to the CRBR for the following reasons:

a) Neither Applicants nor Staff have adequately demonstrated that the CRBR as now planned will achieve the objectives established for it in the LMFBR Program Impact Statement and Supplement.

(1) It has not been established how the CRBR will achieve the objectives there listed in a timely fashion.

(2) In order to do this it must be shown that the specific design of the CRBR, particularly core design and engineering safety features, is sufficiently similar to a pratical commercial size LMFBR that building and operating the CRBR will demonstrate anything relevant with respect to an economic, reliable and licensable LMFBR.

(3) The CRBR is not reasonably likely to demonstrate the reliability, maintainability, economic feasibility, technical performance, environmental acceptability or safety of a relevant commercial LMFBR central station electric plant.

b) No adequate analysis has been made by Applicants or Staff to determine whether the informational requirements of the LMFBR program or of a demonstration-scale facility might be substantially better satisfied by alternative design features such as are embodied in certain foreign breeder reactors.

c) Alternative sites with more favorable environmental and safety features were not analyzed adequately and insufficient weight was given to environmental and safety values in site selection.

(1) Alternatives which were inadequately analyzed include Hanford Reservation, Idaho Reservation (INEL), Nevada Test Site, the TVA Hartsville and Yellow Creek sites, co-location with an LMFBR fuel reprocessing plant (e.g., the Development Reprocessing Plant), an LMFBR fuel fabricating plant, and underground sites.

Contention 11

The health and safety consequences to the public and plant employees which may occur if the CRBR merely complies with current NRC standards for radiation protection of the public health and safety have not been adequately analyzed by Applicants or Staff.

b) Neither Applicants nor Staff have adequately assessed the genetic effects from radiation exposure including genetic effects to the general population from plant employee exposure.

c) Neither Applicants nor Staff have adequately assessed the induction of cancer from the exposure of plant employees and the public.

d) Guideline values for permissible organ doses used by Applicants and Staff have not been shown to have a valid basis.

(1) The approach utilized by Applicants and Staff in establishing 10 CFR §100.11 organ dose equivalent limits corresponding to a whole body dose of 25 rems is inappropriate because it fails to consider important organs, e.g., the liver, and because it fails to consider new knowledge, e.g., recommendations of the ICRP in Reports 26 and 30.

(2) Neither Applicants nor Staff have given adequate consideration to the plutonium "hot particle" hypothesis advanced by Arthur R. Tamplin and Thomas B. Cochran, or the the Karl Z. Morgan hypothesis described in "Suggested Reduction of Permissible Exposure to Plutonium and Other Transuranium Elements," Journal of American Industrial Hygiene (August 1975).

APPENDIX B

EXHIBIT LIST

The following Applicants' exhibits were marked for identification and/or received in evidence:

Exhibit No.	Applicants	In Evidence
1	"Applicants' Testimony Concerning NRDC Contentions 1, 2, and 3" (Neil W. Brown, George H. Clare, L. Walter Deitrich, Vencil S. O'Block and Lee E. Strawbridge)	Tr. 1989
2	Clinch River Breeder Reactor Project Preliminary Safety Analysis Report, Section 2.3 to 2.4, Meteorology	Tr. 2116
3	Clinch River Breeder Reactor Project Preliminary Safety Analysis Report, Section 4.2.3 to 4.2.4, Reactivity Control Systems	Tr. 2116
4	Clinch River Breeder Reactor Project Preliminary Safety Analysis Report, Chapter 5, Heat Transport and Connected Systems	Tr. 2116
5	Clinch River Breeder Reactor Project Preliminary Safety Analysis Report, Section 6.2 to 6.3, Containment Systems	Tr. 2116
6	Clinch River Breeder Reactor Project Preliminary Safety Analysis Report, Section 7.1.2 to 7.1.3, Identification of Safety Criteria	Tr. 2116
7	Clinch River Breeder Reactor Project Preliminary Safety Analysis Report, Section 7.5.4 to 7.5.5, Fuel Failure Monitoring System	Tr. 2116
8	Clinch River Breeder Reactor Project Preliminary Safety Analysis Report, Section 15.1.1 to 15.1.2, Design Approach to Safety	Tr. 2116

Exhibit No.	Applicants	In Evidence
9	Clinch River Breeder Reactor Project Preliminary Safety Analysis Report, Section 15.1.4 to 15.1.5, Effect of Design Changes on Analyses of Accident Events	Tr. 2116
10	Clinch River Breeder Reactor Project Preliminary Safety Analysis Report, Section 15.2 to 15.3, Reactivity Insertion Design Events	Tr. 2116
11	Clinch River Breeder Reactor Project Preliminary Safety Analysis Report, Section 15.3 to 15.4, Undercooling Design Events	Tr. 2116
12	Clinch River Breeder Reactor Project Preliminary Safety Analysis Report, Section 15.4 to 15.5, Local Failure Events	Tr. 2116
13	Clinch River Breeder Reactor Project Preliminary Safety Analysis Report, Section 15.6 to 15.7, Sodium Spills	Tr. 2116
14	Clinch River Breeder Reactor Project Preliminary Safety Analysis Report, Appendix 15.A, Radiological Source Term for Assessment of Site Suitability	Tr. 2116
15	CRBRP-3, Hypothetical Core Disruptive Accident Considerations in CRBRP, Volume 1, Section 4.0 to 5.0, Assessment of HCDA Energetics	Tr. 2116
16	CRBRP-3, Hypothetical Core Disruptive Accident Considerations in CRBRP, Volume 1, Section 5.0 to 6.0 Assessment of Structural Margin Beyond the Design Base	Tr. 2116
17	CRBRP-3, Hypothetical Core Disruptive Accident Considerations in CRBRP, Volume 2, Section 2.0 to 3.0, Design Features Providing Thermal Margin Beyond the Design Base	Tr. 2116

Exhibit No.	Applicants	In Evidence
18	CRBRP-3, Hypothetical Core Disruptive Accident Considerations in CRBRP, Volume 2, Section 3.0 to 4.0, Assessment of Thermal Margin	Tr. 2116
19	CRBRP-3, Hypothetical Core Disruptive Accident Considerations in CRBRP, Volume 2, Appendix A, Development Programs Supporting Thermal Margin Assessments	Tr. 2116
20-23	NOTE: It is intentional that these exhibit numbers do not have documents assigned to them. (Tr. 1953)	
24	WARD-D-0185, Clinch River Breeder Reactor Plant Integrity of Primary and Intermediate Heat Transport System Piping in Containment, Volume 1 by Westinghouse Electric Corporation	Tr. 2116
25	"Applicants' Direct Testimony Concerning NRDC Contention 2e" (R.O. McClellan, J.W. Healy and R.C. Thompson)	Tr. 2072-2073
26	Table 4-2a, SSST Guidelines and Doses (Meteorology from PSAR Amendment 38)	Withdrawn
27	Table 4-2b, SSST Guidelines and Doses (Meteorology from PSAR Amendment 65)	Withdrawn
28	"Errata to Applicant's Direct Testimony Concerning NRDC Contention 2e"	Tr. 2072-2073
29	"The Consequences of Safety Prescriptions for Fast Breeder Reactor Design in France," by J.M. Megy, M. Cravero, J. Leduc and H. Noel before the British Nuclear Energy Society, London, 1977	Tr. 2798
30	"Incidents and Accidents Considered in the Safety Analysis of CDFR," by D. Broadley and K.W. Brindley, National Nuclear Corporation, July 20, 1982	Tr. 2801

Exhibit No.	Applicants	In Evidence
31	Proceedings of the International meeting on Fast Reactor Safety Technology, Volume 1, European Nuclear Society and Americal Nuclear Society, August 19-23, 1979, pp. 28-31, 34, 35, 40 and 41 entitled "Design Criteria, Concepts and Features Important to Safety and Licensing" by Shigehiro An and Keiichi Mochizuki	Tr. 2801
32	APDA-233, Report on the Fuel Melting Incident in the Enrico Fermi Atomic Power Plant on October 5, 1966 by Atomic Power Development Associates, Inc., December 15, 1968, pp. 35, 36, 37 and 38	———
33	Letter to John A. McCone (Chairman) from Leslie Silverman (ACRS), Dated December 13, 1960, Subject: Site Criteria for Nuclear Reactors	Tr. 3148
34	Clinch River Breeder Reactor Plant Environmental Report, 1982, Project Management Corporation, Vol. I	Tr. 3241
35	Clinch River Breeder Reactor Plant Environmental Report, 1982, Project Management Corporation, Vol. II	Tr. 3241
36	Clinch River Breeder Reactor Plant Environmental Report, 1982, Project Management Corporation, Vol. III	Tr. 3241
37	Clinch River Breeder Reactor Plant Environmental Report, 1982, Project Management Corporation, Vol. IV	Tr. 3241
38	Clinch River Breeder Reactor Plant Environmental Report, 1982, Project Management Corporation, Vol. V	Tr. 3241
39	Applicants' Direct Testimony Concerning Safeguards (NRDC Contentions 4 and 6.b.4) (Edward F. Penico and Glenn A. Hammond)	Tr. 3473

Exhibit No.	Applicants	In Evidence
40	By the Comptroller General, Report to the Honorable Gary Hart, United States Senate of the United States, Obstacles to U.S. Ability to Control and Track Weapons-Grade Uranium Supplied Abroad, GAO ID 82-21, dated August 2, 1982, pp. 64-67	Tr. 3864
41	Overview Report to the Director General of the IAEA, International Atomic Energy Agency, No. RC-232.3-3 pp. 88-96	_____
42	Applicants' Direct Testimony Concerning NRDC Contentions 11 b) and 11 c) (R. Julian Preston, Roger O. McClellan, John W. Healy and Roy C. Thompson)	Tr. 4266
43	Applicants' Testimony Concerning NRDC Contentions 6.b.1 and 6.b.3 (George L. Sherwood, Jr., Douglas C. Newton, William M. Hartman and Orlan O. Yarbro	Tr. 4323
44	Environmental Protection Agency, 40 C.F.R. § 191, Environmental Standards and Federal Radiation Protection Guidance for Management and Disposal of Spent Nuclear Fuel, High-level and Transuranic Radioactive Wastes, Working Draft No. 21 - Federal Register - 6/3/82	_____
45	Applicants' Direct Testimony Concerning Intervenors' Contentions 5a) and 7c) (Lawrence J. Kripps)	Tr. 4732
46	Applicants' Testimony Concerning NRDC Contentions 2d), 2f), 2g), 2h), 3c) and 3d), (Environmental Effects and 5b) (George H. Clare, Lee E. Strawbridge and L. Walter Deitrich)	Tr. 5374
47	Applicants' Direct Testimony Concerning NRDC Contention 5(b) (H. Wayne Hibbitts)	Tr. 5374
48	"The Final Environmental Impact Statement, Rocky Flats Plant Site, Golden, Jefferson County, Colorado, U.S.," Vol. 1, Department of Energy, April 1980	Tr. 6016

Exhibit No.	Applicants	In Evidence
49	"Chromosome Changes in Somatic Cells of Workers with Internal Depositions of Plutonium," W.F. Brandom, et. al., IAEA March 26-30, 1979 Symposium, IAEA-SM-237/38, pp. 195-210	Tr. 6016
50	"Dose-Rate Conversion Factors for External Exposure to Photon and Electron Radiation from Radionuclides Occurring in Routine Releases from Nuclear Fuel Cycle Facilities," by D.C. Kocher, Oak Ridge National Laboratory, Volume 38, Health Physics, 1980, pp. 543-578	Tr. 6016
51	Histograms of the Prevalence of Structural Chromosome Aberrations in Rocky Flats Controls and Plutonium Workers Arranged by Chromosome Aberration Categories	Tr. 6016
52	Letter to Carl J. Johnson (Jefferson County Health Department) from William A. Mills (U.S. Environmental Protection Agency), Dated February 27, 1979	Tr. 6016
53	Reactor Safety Study Methodology Applications Progra Calvert Cliffs #2 PWR Power Plant by Steven W. Hatch and Gregory J. Kolb (Sandia National Laboratories), Peter Cybulskis and Roger O. Wooton (Battelle Columbus Laboratories), NUREG/CR-1659/3 of 4, May 1982	Tr. 6289
54	"Primary Containment Leakage Integrity Availability and Review of Failure Experience," by Michael B. Weinstein, Nuclear Safety, Volume 21, No. 5, September-October 1980	Tr. 6289
55	"Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants, Appendix VI, Calculation of Reactor Accident Consequences," Nuclear Regulatory Commission, October 1975, pp. 9-3 to 9-5	Tr. 6289

Exhibit No.	Applicants	In Evidence
56	Letter to Honorable Morris Udall from Bryce Johnson, Peter Davis and Hong Lee (California Underground Safety Study), RE: Testimony for Hearings on Risk Assessment Review Group, Dated February 21, 1979	Tr. 6289
57	Final Report on Comparative Calculations for the AEC and CRAC Risk Assessment Codes, Science Applications, Inc., Palo Alto, California, pp. 3-6, 3-8 and 5-2	Tr. 6289
58	Applicants' Direct Testimony Concerning NRDC Contentions 7a) and 7b) (John R. Longenecker, Carl A. Anderson, Jr. and Narinder N. Kaushal)	Tr. 6406

The following NRC Staff Exhibits were marked for identification and/or received in evidence:

Exhibit No.	NRC Staff	In Evidence
1	NUREG-0786, Site Suitability Report in the Matter of Clinch River Breeder Reactor Plant, Revision to March 4, 1977 Report, Published June, 1982	Tr. 2444
2	"NRC Staff Testimony on Intervenor's Contentions 1a, 2b, 3b, 3c, and 3d Regarding Site Suitability Accident Analysis" (Bill M. Morris, Jerry J. Swift, Richard Becker, Thomas L. King and Edmund Rumble	Tr. 2444
3	"NRC Staff Testimony on Intervenor's Contention 2a, 2c, 2d, 2e, 2f, 2g and 2h Regarding Site Suitability Accident Analysis" (Larry W. Bell, Edward F. Branagan, Jr., Lewis Hulman, John K. Long, Jerry J. Swift, Farouk Eltawila and Irwin Spickler)	Tr. 2444

Exhibit No.	NRC Staff	In Evidence
4	Letter to Nunzio J. Palladino (Chairman), from P. Shewmon (ACRS), Dated July 13, 1982, Subject: ACRS Report on the Suitability of the Clinch River Breeder Reactor Plant Site	Tr. 2444
5	Letter to Lochlin W. Caffey, Director, Clinch River Breeder Reactor Project Office from Richard F. Denise (NRC), Dated May 6, 1976	Tr. 2444
6	NUREG-0800, U.S. NRC Standard Review Plan, Office of Nuclear Reactor Regulation, Section 22.3 Evaluation of Potential Accidents, Revision 2 - July, 1981	Tr. 3192
7	NUREG-0139, Final Environmental Statement related to construction and operation of Clinch River Breeder Reactor Plant, February 1977	Tr. 3244
8	NUREG-0139, Supplement No. 1, Vols. 1&2, Supplement to Final Environmental Statement related to construction and operation of Clinch River Breeder Reactor Plant, October 1982	Tr. 3244
9	Errata Sheet to NUREG-0139, Supplement No. 1	Tr. 3244
10	NRC Staff Testimony of Robert J. Dube, Robert Davis Hurt, John W. Hockert, Charles E. Gaskin, and Harvey B. Jones, Jr., Regarding Contentions 4 and 6(b)(4)	Tr. 3732
11	"Note on the 'Ease' of Producing a Nuclear Explosive by J. Carson Mark for Pugwash Symposium"	Tr. 3704
12	NRC Staff Testimony of Michael A. Bender, PhD, Regarding Contention 11(b)	Tr. 4111
13	NRC Staff Testimony of Edward F. Branagan, Jr., Regarding Contention 11(c)	Tr. 4142

Exhibit No.	NRC Staff	In Evidence
14	NRC Staff Testimony of Homer Lowenberg, Edward F. Branagan, Jr., A. Thomas Clark, Jr., and Regis R. Boyle Regarding Contention 6	Tr 4443
15	Joint Testimony of Charles Ferrell, Homer Lowenberg, Leonard Soffer and Irwin Spickler on Contentions 5(a) and 7(c)	Tr. 4864
16	NRC Staff Testimony of Paul H. Leech on Contention 7(c)	Tr. 4864
17	NRC Staff Testimony of Bill M. Morris, Jerry J. Swift, John K. Long, Edmund T. Rumble, III, Mohan C. Thadani, and Lewis G. Hulman on Intervenors' Contention and Its Subparts 2c, 2d, 2f, 2g and 2h and Contention 3 and Its Subparts 3c and 3d	Tr. 5747
18	NRC Staff Testimony of Homer Lowenberg, Leonard Soffer and Mohan C. Thadani on Contention 5(b)	Tr. 5682
19	Errata Corrections to NUREG-0139, Supplement No. 1, December 10, 1982	Tr. 5324
20	A Note on the Pipe Rupture Probability Calculations for the Primary Heat Transport System of CRBRP By D.O. Harris, Science Applications, Inc., October 7, 1977	Tr. 6289
21	NRC Staff Testimony of Paul H. Leech, Richard A. Becker and John K. Long Relative to Contention 7(a) and 7(b)	Tr. 6521

The following Intervenors' Exhibits were marked for identification and/or received in evidence:

Exhibit No.	Intervenors	In Evidence
1	Clinch River Breeder Reactor Project Reliability Program, January, 1976, pp. 1, 6-8	Tr. 3144-3145
2	Letter to Roger S. Boyd (NRC) from Peter S. Van Nort, dated April 30, 1976	Tr. 3144
3	"Testimony of Dr. Thomas B. Cochran, Part I"	Tr. 2809
4	"Testimony of Thomas B. Cochran, Part II"	Tr. 3050
5	"Safety Measures at the Creys-Malville Power Station" by H. Noel, H. Freslon and G. Lucenet	Tr. 2802
6	"Superphenix News" dated July 1978, No. 1, by Novatome	Tr. 2802
7	"Superphenix News" dated March, 1982, No. 7, by Novatome	Tr. 2802
8	"Testimony of Dr. John Chandler Cobb"	Tr. 3050
9	"Testimony of Dr. Karl Z. Morgan"	Tr. 3050
10	Proposed Guidance on Dose Limits for Persons Exposed to Transuranium Elements in the General Environment, EPA 520/4-77-016, U.S. Environmental Protection Agency	———
10A	Proposed Guidance on Dose Limits for Persons Exposed to Transuranium Elements in the General Environment, EPA 520/4-77-016, U.S. Environmental Protection Agency, pp. 11-33	Tr. 3189-3190

Exhibit No.	Intervenors	In Evidence
11	By the Comptroller General, Report to the Congress of the United States, Nuclear Fuel Reprocessing and the Problems of Safeguarding Against the Spread of Nuclear Weapons, EMD-80-38, March 18, 1980	Tr. 3562
12	Testimony of Dr. Thomas B. Cochran, Part V (Intervenors' Contentions 4 and 6(b)(4)	Tr. 3886
12A	Supplement to Testimony of Thomas B. Cochran, Part V (Intervenors' Contentions 4 and 6(b)(4))	Tr. 3886
13	Testimony of Dr. Thomas B. Cochran, Part III, as Supplemented by New Information in CRBR Final Environmental Impact Statement Supplement (Primarily Intervenors' Contention 6(b)(1) and (3))	Tr. 2566
14	Graph entitled "Figure IV C-15. Plutonium Composition vs. Fuel Exposure (Model BWR)	Tr. 4617
15	"Fault Trees For the Clinch River Breeder Reactor Plant Protective System," by F.L. Leverenz and D.E. Leaver, November 1977, No. SAI-066-77-PA	———
16	Modeling of Core Melt Accident Management in the Clinch River Breeder Reactor Plant, Subtitled II, CACECO, Code results for 0 to 110 days with sodium recycle, J. Maly and R.L. Ritzman, Science Applications, Inc., January 19, 1979	———
17	Risk to Residents of the CRBRP Vicinity Due to Seismically Induced Collapse of or Damage to Structures, by Science Applications, Inc., No. SAI-071B-77-PA, December 5, 1977	———

Exhibit No.	Intervenors	In Evidence
18	The Consequences of Catastrophic Floods in the CRBRP Vicinity Due to Partial Collapse of Major Dams Induced by Large Earthquakes, by Science Applications, Inc., No. SAI-071C-77-PA, December 5, 1977	_____
19	Modeling of Core Melt Accident Management in the Clinch River Breeder Reactor Plant, Subheading, I, Results from the first 245 hours using the CASECO Code, J. Maly and R.L. Ritzman, Science Applications, Inc., No. SAI-107-78-PA, December 1978	_____
20	Flood Hazard for the CRBRP, Science Applications, Inc., No. SAI-122-78-PA, December 1978	_____
21	Testimony of Carl J. Johnson, M.D., M.P.H.	Tr. 6017
22	Testimony of Dr. Thomas B. Cochran, Part IV, As Supplemented by New Information in CRBR Final Environmental Impact Statement Supplement (Intervenors' Contentions 1, 2 and 3)	Tr. 6194
23	"Clinch River Breeder Reactor Project: Postulated Accidents, Offsite Dose Estimates"	_____
24	"Worst Sector X/Q's"	_____

Other documents which were incorporated into the record are as follows:

Attachment A to NRC Staff Exhibit 3	TID-14844, Calculation of Distance Factors for Power and Test Reactor Sites by J.J. DiNunno, F.D. Anderson, R.E. Baker and R.L. Waterfield, U.S. Atomic Energy Commission, March 23, 1962 (Tr. 2542)

Attachment 2 to Intervenors Exhibit 12	September 13, 1982 letter to Cecil Thomas (NRC) from Barbara Finamore and Thomas Cochran (NRDC) Re: Draft Supplement to Final Environmental Statement related to construction and operation of Clinch River Breeder Reactor Plant, NUREG-0139, Supplement No. 1 Draft Report (July 1982) (Tr. 3939)
Enclosure to Attachment 2 to Intervenors Exhibit 12	NRDC Comments on the Draft Supplement to the Final Environmental Statement Related to Construction and Operation of the Clinch River Breeder Reactor Plant (NUREG-0139, Supplement No. 1 Draft Report, Docket No. 50-537 (Tr. 3940).
Attachment 3 to Intervenors Exhibit 12	"External Threats to Nuclear Facilities" dated April 13, 1978 (Tr. 3952)
Attachment 4 to Intervenors Exhibit 12	February 21, 1979 letter to Thomas Cochran (NRDC) from John Griffin (DOE) Re: FOIA request (Tr. 3959)
Enclosure 8 to Attachment 4 to Intervenors Exhibit 12	February 6, 1976 letter to Honorable Clement Zablocki from Leonard Kojoin (ERDA) (Tr. 3961)
Enclosure 9 to Attachment 4 to Intervenors Exhibit 12	December 23, 1975 Memorandum to James Poor (ERDA) from Ray Marble (ERDA) Subject: Meeting with Consultants of Subcommittee on International Security and Scientific Affairs (Tr. 3962)
Attachment to Enclosure 9 to Attachment 4 to Intervenors Exhibit 12	January 1, 1976 draft letter to Honorable Clement Zablocki from Alred Starbird (ERDA) (Tr. 3963)
Attachment to Enclosure 9 to Attachment 4 to Intervenors Exhibit 12	February 5, 1976 Memorandum to Ray Marble (ERDA) from James Poor (ERDA) Re: Questions concerning the disappearance of Source Material from the EURATOM safeguards control system in late 1968 (Tr. 3964)
Enclosure 10 to Attachment 4 to Intervenors Exhibit 12	January 27, 1970 Memorandum to Commissioners Seaborg, Ramey, Thompson, Johnson and Larson (AEC) from Myron Kratzer (AEC) Re: January 27, 1970 Memorandum to the Files regarding disappearance of natural uranium of Belgian origin (Tr. 3968)

Enclosure 11 to Attachment 4 to Intervenors Exhibit 12	December 23, 1969 Memorandum to Commissioners Seaborg, Ramey, Thompson, Johnson and Larson (AEC) from Myron Kratzer (AEC) Re: disappearance of natural uranium of Belgian origin (Tr. 3973)
Attachment to Enclosure 10 to Intervenors Exhibit 12	December 19, 1969 letter to Myron Kratzer (AEC) from R. Glenn Bradley (AEC) (Tr. 3974)
Attachment to Enclosure 10 to Intervenors Exhibit 12	December 11, 1969 Memorandum to Commissioners Seaborg, Ramey, Johnson, Thompson and Larson (AEC) from Delmar Crowson (AEC) Re: Loss of Eratom Source Material (Tr. 3977)
	November 1, 1982 Letter to Scott Stucky (NRC) from Thomas Cochran (NRDC) (Tr. 3989)
	Glossary (Contentions 1, 2, 3 and 5b) (Tr. 5375)
Exhibit 2 to Intervenors' Exhibit 21	"Cancer Incidence in an Area Contaminated with Radionuclides Near a Nuclear Installation" by Carl J. Johnson (Tr. 6031)
Exhibit 3 to Intervenors' Exhibit 21	"Plutonium Hazard in Respirable Dust on the Surface of Soil" by Carl J. Johnson, Ronald R. Tidball and Ronald C. Severson, Science, August 6, 1976, Vol. 193 (Tr. 6039)
Exhibit 4 to Intervenors' Exhibit 21	"Radionuclides and Trace Metals in Surface Air" by Herbert W. Feely, Lawrence E. Toonkel and Richard J. Larsen (Tr. 6043)
Exhibit 5 to Intervenors' Exhibit 21	"The Feasibility of Epidemiologic Studies of Cancer in Residents Near the Rocky Flats Plant," Health Physics, Vol. 42, No. 1, January, 1981 (Tr. 6047)
Exhibit 6 to Intervenors' Exhibit 22	"Investigations of Health Effects in Populations Living Near Nuclear Installations," by Carl J. Johnson, August 17, 1982 (Tr. 6049)
Exhibit 7 to Intervenors' Exhibit 22	"Carcinogenic Effects of Radon Daughters Uranium Ore Dust and Cigarette Smoke in Beagle Dogs," by F.T. Cross, R.F. Palmer, R.F. Filipy, G.E. Dagle and B.O. Stuart, Health Physics, Vol. 42, No. 1, October, 1980 (Tr. 6057)

Attachment 1 to Intervenors' Exhibit 22	CRBRP Risk Assessment Report, Volume 2: Technical Appendices, CRBRP-1, March, 1977, p. II-14 to II-22 (Tr. 6240)
Attachment 2 to Intervenors' Exhibit 22	Letter to Honorable John D. Dingell from Charles A. Bowsher (Comptroller General of the United States), Subject: Revising the Clinch River Breeder Reactor Steam Generator Testing Program Can Reduce Risk (GAO/EMD-82-75), Dated May 25, 1982 (Tr. 6250)
Attachment 3 to Intervenors' Exhibit 22	Letter to H.B. Piper (U.S. Department of Energy) from David Leaver (Science Applications, Inc.), Dated November 17, 1978 (Tr. 6261)
Enclosure to Attachment 3 to Intervenors' Exhibit 22	Relative Pipe Rupture Probability for the Primary Heat Transport System of CRBRP by D.O. Harris, Science Applications, Inc., November 13, 1978 (Tr. 6262)
Attachment 4 to Intervenors' Exhibit 22	Clinch River Breeder Reactor Hearing before the Subcommittee on Nuclear Regulation of the Committee on Environment and Public Works United States Senate Ninety-fifth Congress, July 11, 1977 (Tr. 6273)

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of)
)
UNITED STATES DEPARTMENT OF ENERGY)
PROJECT MANAGEMENT CORPORATION) Docket No. 50-537
TENNESSEE VALLEY AUTHORITY)
)
(Clinch River Breeder Reactor Plant))

NRC STAFF'S TRANSCRIPT CORRECTIONS FOR
AUGUST 23-27, NOVEMBER 16-19, DECEMBER 13-17, 1982
AND JANUARY 4 & 5, 1983 LIMITED WORK AUTHORIZATION HEARING

The NRC Staff proposes the following transcript corrections:

AUGUST 25, 1982

PAGE	LINE	CORRECTION
2119	16	delete "Dr."; change "the" to "a"; change "Reactors" to "Reactor"
2124	4	change "ACRA" to "ACRS"
2129	12	delete "the" after "of"
2131	10	delete "the"
2131	11	change "numbered" to "number"
2131	13	delete "the"; change "numbered" to "number"
2133	21	change "exclusionary boundary of the low population zone" to "exclusion area boundary and the outer boundary of the low population zone"
2136	5	change "DBR" to "EBR"
2139	10	change "DAI" to "DOE"

PAGE	LINE	CORRECTION
2137	14	change "Swason" to "Swanson"
2143	6	change ", the General Electric head end," to "for General Electric"
2148	6	insert "set of" before "criteria"
2150	11	insert "10 C.F.R. § 50" before "Appendix"
2158	5	delete "a"
2169	22	change "currents" to "occurrences"
2169	24	change "by" to "for"
2170	1	change "in" to "and"
2170	7	insert "," after ")"
2170	8	change "of" to "for"
2170	9	insert "," after "testing"
2170	10	delete ","
2171	19	change "Everything --" to "With everything but the word risk --"
2175	2	change "and that" to "than"
2198	22	change "Morris" to "Rumble"
2228	10	delete "we're"
2237	18	insert "that" after "that"
2259	21	change "ligght" to "light"
2260	17	change "give" to "gave"
2266	1	delete "at"
2266	2	delete "a light water reactor"

PAGE	LINE	CORRECTION
2270	15	change "probably" to "probable"
2291	10	change "Morrison" to "Morris"
2291	18	change "Morrison" to "Morris"
2291	22	change "Morrison" to "Morris"
2292	3	delete "this" after "that"
2309	13	change "that" to "of"
2323	21	change "Na^{20}" to "Na_2O"
2326	20	insert "release," after "plutonium"
2343	5	change "servant" to "surrogate"
2347	24	insert "in" after "coming"
2348	16	change "that we" to "We"
2379	3	change "reactive" to "reactor"
2384	25	insert "you refer to as a" before "factor"
2385	14	insert "team" before "that"
2397	10	change "sequence" to "sequences"
2408	23	insert "50" after "CFR"
2413	25	change "Long" to "Rumble"
2417	1	change "nubys" to "minus"
2433	4	change "weight" to "rate"
AUGUST 27, 1982		
3043	17	insert "of" before "the panel"
3043	22	change "Their" to "The"

PAGE	LINE	CORRECTION
NOVEMBER 16, 1982		
3574	18	change "Plumbad" to "Plumbat"
3576	2	change "nation/state" to "nation-state"
3576	4	change "nation/state" to to "nation-state"
3576	7	change "non nation/state" to "non nation-state"
3576	9	change "nation/state" to "nation-state"
3576	25	change "product/utilization" to "production or utilization"
3576	25	change "for amendment" to "for an amendment"
3577	1	change "license is" to "license, is"
3577	3	change "of, (a), attacks" to "of (a) attacks"
3577	6	change "or, (b), use" to "or (b) use"
3579	25	change "Marks," to "Mark,"
3581	20	change "analogged the" to "the analog"
3582	7	change "generic" to "Generic"
3582	8	change "adversary characteristics study" to "Adversary Characteristics Summary Report"
3583	2	change "generic adversary" to "Generic Adversary"
3583	3	change "characteristics report" to "Characteristics Summary Report"
3584	12	change "BY WITNESS JONES" to "BY WITNESS HOCKERT"

PAGE	LINE	CORRECTION
3584	24	change "MR. JONES" to "WITNESS HOCKERT"
3589	25	change "barrier. We" to "barrier."
3590	4	change "ACR's" to "ACRS"
3591	15	change "That from the" to "The"
3591	16	change "the dispersal" to "dispersal"
3591	24	change "generic" to "Generic"
3591	25	change "adversary characteristics summary report" to "Adversary Characteristics Summary Report"
3593	11	change "of" to "in"
3595	5	change "terrorists" to "terrorist"
3596	10	change "threat-" to "surviv-"
3596	20	change "on" to "out"
3596	21	change "wish" to "wished"
3598	7	change "is an" to "is that an"
3598	9	change "this is" to "success versus"
3601	7	change "individual" to "independent"
3639	23	change "little" to "rule"
3639	25	change "of all the" to "of the"
3640	4	change "in the distinction" to "to the distinction"
3646	14	change "bonding" to "bounding"

PAGE	LINE	CORRECTION
NOVEMBER 17, 1982		
3662	25	change "high mix of" to "high enriched"
3663	25	change "sarin" to "Sarin"
3667	4	change "insolubles," to "insolubles."
3667	5	change "basically. That's" to "Basically, that's"
3677	13	change ", but would" to ", but it would"
3677	14	change "certainly would" to "certainly it would"
3679	17	delete "," after "safeguards"
3680	20	change "'limited error'" to "'limit of error'"
3681	17	change "limited number of errors" to "limit of error numbers"
3681	20	change "probability detection" to "probability of detection"
3682	18	add "." after "definition"
3682	19	change "and it" to "As"
3683	19	change "BY WITNESS DUBE" to "BY WITNESS HURT"
3684	6	change "BY WITNESS DUBE" to "BY WITNESS HURT"
3684	11	change "BY WITNESS DUBE" to "BY WITNESS HURT"
3684	15	change "BY WITNESS DUBE" to "BY WITNESS HURT"
3688	12	change "preparing the proposed" to "preparing a proposed"

PAGE	LINE	CORRECTION
3688	13	change "Kind" to "Kinds"
3689	21	change "through put that's" to "throughputs that are"
3700	2	change "Proliferation safe-guards" to "Proliferation and Safeguards"
3701	12	change "six generations" to "sixth generation"
3709	11	change "it" to "they said it"
3713	8	change "Car Mark" to "Carson Mark"
3715	12	change "containing uranium and uranium" to "contained uranium"
3715	14	change "plutonium, grams" to "plutonium and grams"
3717	16	change "of" to "in"
3721	14	change "a reprocessing facilities" to "reprocessing facilities"
3725	9	change "or some" to "and there are some"
3725	12	change "the" to "in"
3725	13	change "intent of detecting" to "detecting"
3725	18	change "in no kind" to "some kinds"
3725	19	change "material controlled accounting will we back off, because" to "material control and accounting will provide a back up capability"
3725	20	change "there are some provisions--but" to "but"

PAGE	LINE	CORRECTION
3726	8	change "that's the" to "that's that the"
3726	8	change "bsically" to "basically"
3726	16	change "believe" to "believes"
3726	18	change "of the prompt" to "of prompt"
3728	23	change "Grain" to "Vrain"
3728	24	change "risk" to "enriched"
3728	25	change "head-in" to "head-end"
3729	3	change "Grain" to "Vrain"
3729	7	change "Grain" to "Vrain"
3729	10	change "Grain" to "Vrain"
3729	18	change "pits" to "pins"
4068	12	change "BIER" to "BEIR"
4068	23	change "BIER" to "BEIR"
4069	2	change "BIER" to "BEIR"
4069	12	change "BIER" to "BEIR"
4069	19	change "BIER" to "BEIR"
4069	24	change "BIER" to "BEIR"
4070	10	change "BIER" to "BEIR"
4070	11	change "BIER" to "BEIR"
4070	18	change "BIER" to "BEIR"
4070	23	change "BIER" to "BEIR"
4074	13	change "BIER" to "BEIR"

PAGE	LINE	CORRECTION
4074	23	change "the Journal of Science, is, in effect, peer review." to "the journal SCIENCE, is, in effect, peer reviewed."
4076	10	change ";even then, the" to ";even then, it would not have influenced the"
4077	14	change ", given, stated" to ", given, as stated"
4077	15	change "percentage of 106,000" to "percentage, or 106,000"
4077	23	change "whether man-made, not" to "whether man-made, or not"
4081	23	change "that is, the " to "that is, they are the"
4084	18	change "I would have is it does" to "I would make is that it"
4094	9	change "Goffman" to Gofman"
4094	24	Change "Goffman to Gofman"
4095	2	change "Goffman to Gofman"
4095	8	change "Goffman to Gofman"
4095	10	change "Goffman to Gofman"
4095	13	change "BIER" to "BEIR"
4097	24	change "constitute a larger" to "that it would thus constitute"
NOVEMBER 18, 1982		
4364	23	change "Table D.5, the third" to Table D.5 on Page D-11, the third"

PAGE	LINE	CORRECTION
4363	24	change "column and that lists, on page D-11, that list" to "column and lists,"
4365	25	change "1980-A" to "DOE 1980a"
4366	6	change "1980---1981 B" to "DOE 1981B"
4371	14	change "processing" to "reprocessing"
4378	24	change "fission" to "fissioned"
4378	25	change "composition" to "isotope"
4380	10	change "percent to 40" to "percent 240"
4380	13	change "percent to 40" to "percent 240"
4380	17	change "percent to 40" to "percent 240"
4380	19	change "12 percent" to "20 percent"
4380	21	change "percent to 40" to "percent 240"
4392	4	change "SRS-3" to "S-3"
4393	9	change "or S-3" to "or Table S-3"
4398	15	change "there" to "their"
4406	18	change "Carbon 14 Krypton" to "Carbon 14 and Krypton"
4409	9	change "on" to "our"
4410	18	change "--the best" to "--to the best"

PAGE	LINE	CORRECTION
4417	17	change "A. Mr. Boyle" to "Q. Mr. Boyle?"
4417	18	change "Q. Excuseme" to "A. Excuse me"
4417	19	change "Mr. Clark" to "Mr. Boyle"
4418	14	change "thrid" to "third"
4421	21	change "assume" to "assumed"
4431	13	change "than ten to" to "then ten. To"
4431	15	change "do by just" to "do, such as just"
4431	17	change "might knock" to "might add knock"
4433	12	change "ORIGEN-II" to "ORIGEN-2"
4434	9	change "ORIGEN-II" to "ORIGEN-2"
4435	11	change "ERDA 7621" to "ERDA 76-21"
4435	14	change "---99.95," to "---99.95 percent"
4435	15	change ", 99.97," to ", 99.97 percent,"
4435	19	change "N5.10" to "N510"
4437	18	change "filters that do not" to "filters <u>such</u> that <u>they</u> do not"
4441	12	change "unde-" to "under-"
4441	18 & 19	change "from the atmosphere over the gaseous effluents and release," to "from the gaseous effluents and release to the atmosphere,"

PAGE	LINE	CORRECTION
NOVEMBER 19, 1982		
4771	6	change "but no" to "that no"
4787	4	change "as" to "is"
4788	23	change "large" to "small"
4801	11	change "was a factor" to "was not a factor"
4804	15	change "zero to two X/Q" to "zero to two hour X/Q"
4821	22	change "guide" to "site"
4831	4	change "average average" to "above average"
4838	4	change "on the Hanford" to "on the Skagit - Hanford"
4855	4	change "degrees above," to "degrees above ambient, let's say, for no flow at all. It would go over to"
4855	8	change "they say in the" to "we say in the"
4855	22	change "It is 17 or 23." to "It is 17 or 23 degrees above ambient."
4857	20	change ", Dr. Mastic," to ", Dr. Masnik,"
4861	16	change "Pasqual's" to "Pasquill's"
4861	18	change "Pasqual's" to "Pasquill's"
4861	25	change "Pasqual's" to "Pasquill's"
4862	2	change "Pasqual's" to "Pasquill's"

PAGE	LINE	CORRECTION
4862	14	change "Pasqual" to "Pasquill"
4878	2	change "0.2 Hr." to "0-2 Hr."1/
DECEMBER 14, 1982		
5443	24	change "sync" to "sink"
5445	2	change "On Appendix J" to "In Appendix J"
5445	2	change "CA" to "CDA"
5447	23	change "sync" to "sink"
5448	10	insert "leak" before "detection"
5450	14	change "these protected" to "the protected"
5451	18	change "that we" to "that was"
5453	20	change "CRACK" to "CRAC"
5454	10	change "to these" to "of these"
5456	9	change "CRACK" to "CRAC"
5461	16	change "left approximately" to "left in approximately"
5463	12	change "executive vice president" to "Executive Vice President"
5471	22	change "McClain" to "McLean"
5476	11	change "assessment of" to "assessment for"
5477	6	change "sync" to "sink"
5477	9	change "was asked" to "was not asked"

1/ Corrected at Transcript page 4804.

PAGE	LINE	CORRECTION
5498	24	change "and certainties" to "and uncertainties"
5502	7	change "prepared" to "sponsored"
5519	2	change "merely it" to "it merely"
5545	25	change "X^2" to "Chi-squared"
5552	6	change "token" to "turbine"
5555	1	change "it" to "you"
5559	3	change "end" to "N"
5567	12	change "Surrey" to "Surry"
5567	17	change "Surrey" to "Surry"
5571	7	change "A.10 are all mock" to "A.10. They are all auxiliary"
5571	9	change "PRA, basically" to "PRA. Basically"
5571	11	change "Norris" to "Morris"
5571	14	change "reough" to "rough"
5575	25	change "that was" to "that it was"
5580	9	change "initiator" to "inventory"
5581	22	change "protected air cooled condensers" to "air blast heat exchangers"
5583	10	change "occur" to "occurs"
5583	11	change "therefore, initiator" to "therefore, the initiator"
5587	9	change "event, which" to "event, in which"
5587	12	change "bubble" to "bundle"
5616	22	change "my" to "the"

PAGE	LINE	CORRECTION
5618	4	change "isolation of frequency failure" to "isolation failure frequency"
5625	25	change "recreation" to "evacuation"
5626	6	change "recreation" to "evacuation"
5632	19	change "LD-56" to "LD-50/60"
5636	20	change "same as the BEIR III" to "same people as the BEIR III group."
5652	25	change "I the" to "I am the"
5656	7	change "less." to "less,"
5656	8	change "If" to "if"
5656	9	change "less and even" to "less even"
5658	2	change "is the" to "are the doses at the"
5658	4	change "out where" to "out"
5658	7	change "those to others" to "others"
5672	18	change "rows" to "rose"
5679	13	change "around that--" to "obtained as a part of"
5679	14	change "--that other number." to "using the code which calculates the bone surface dose."
5680	4	change "It's a run that calculates everything, you" to "It's obtained from a computer run"

PAGE	LINE	CORRECTION
5680	5	delete "know. All"
6075	22	change "1960" to "the 1960's"
6076	2	change "works, which" to "works, for which"
6076	3 & 4	change "plants for it" to "plants."
6077	8	change "fission products" to "fission or activation products"
6078	17	change "fission products" to "fission or activation products"
6078	18	change "there is no" to "there are no"
6078	19	change "fission product" to "fission or activation product"
6078	21	change "fission products" to "fission or activation products"
6079	8	change "These facilities--that" to "For those facilities, as"
6079	10	change "the design phase--both the DRP" to "the design phase, both the DRP and FMEF"
DECEMBER 16, 1982		
6475	5	change "respect to you" to "respect do you"
6496	18	change "I have done background" to "I have a background"

PAGE	LINE	CORRECTION
JANUARY 5, 1982		
6948	4	change "Sauffert" to "Soffer"
6948	25	change "Sauffert" to "Soffer"
6949	6	change "Sauffert" to "Soffer"
7003	20	change "C-4" to "SEFOR"

Respectfully submitted,

Daniel T. Swanson

Daniel T. Swanson
Counsel for NRC Staff

Dated at Bethesda, Maryland
this 24th day of January, 1983

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of UNITED STATES DEPARTMENT OF ENERGY PROJECT MANAGEMENT CORPORATION TENNESSEE VALLEY AUTHORITY (Clinch River Breeder Reactor Plant)	)	Docket No. 50-537

CERTIFICATE OF SERVICE

I hereby certify that copies of "NRC STAFF'S PROPOSED OPINION AND FINDINGS OF FACT ON LWA-1 MATTERS" with Appendices A and B, together with "NRC STAFF'S TRANSCRIPT CORRECTIONS FOR AUGUST 23-27, NOVEMBER 16-19, DECEMBER 13-17, 1982 and JANUARY 4 & 5, 1982 LIMITED WORK AUTHORIZATION HEARING" in the above-captioned proceeding have been served on the following by deposit in the United States mail, first class or, as indicated by an asterisk, through deposit in the Nuclear Regulatory Commission's internal mail system, this 25th day of January, 1983.

William M. Leech, Jr., Attorney General
William B. Hubbard, Chief Deputy
Attorney General
Michael D. Pearigen, Asststant
Attorney General
Michael E. Terry, Esq.
450 James Robertson Parkway
Nashville, TN 37219

William E. Lantrip, Esq.
City Attorney
Municipal Building
P.O. Box 1
Oak Ridge, Tennessee 37830

Lawson McGhee Public Library
500 West Church Street
Knoxville, Tennessee 37902

R. Tenney Johnson
Leon Silverstrom
Warren E. Bergholz, Jr.
William D. Luck
U.S. Department of Energy
1000 Independence Ave., S.W.
Room 6-B-256
Washington, D.C. 20585

Eldon V. C. Greenberg, Esq.
Galloway & Greenberg
1725 Eye Street, N.W.
Suite 601
Washington, DC 20006

Project Management Corporation
P.O. Box U
Oak Ridge, Tennessee 37830

Manager of Power
Tennessee Valley Authority
819 Power Building
Chattanooga, Tennessee 37401

Director
Clinch River Breeder Reactor Plant
Project
U.S. Department of Energy
Washington, D.C. 20585

Atomic Safety and Licensing Appeal
Board Panel
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555 *

Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555 *

Docketing and Service Section
Office of the Secretary
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555 *