UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D. C. 20555

April 19, 1983

Honorable Nunzio J. Palladino
Chairman
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Dr. Palladino:

SUBJECT: ACRS REPORT ON THE CLINCH RIVER BREEDER REACTOR PLANT

During its 276th meeting, April 14-16, 1983, the Advisory Committee on Reactor Safeguards (ACRS) completed its review of the application of the U. S. Department of Energy, the Tennessee Valley Authority, and the Project Management Corporation (the Applicants) for a permit to construct the Clinch River Breeder Reactor Plant (CRBRP). Previous consideration had been given to this project during the Committee's 267th meeting, July 8-10, 1982; 271st meeting, November 4-5, 1982; 272nd meeting, December 9-11, 1982; 273rd meeting, January 6-8, 1983; 274th meeting, February 10-12, 1983; and 275th meeting, March 10-12, 1983. Subcommittee and Working Group meetings were held in Washington, D. C. on February 2-3, 1982; March 30-31, 1982; May 4-5 and 24-25, 1982; June 1-2 and 24-25, 1982; August 18-19, 1982; September 30, 1982; October 26 and 27, 1982; November 19, 1982; December 1 and 10, 1982; January 7, 1983; February 3-4, and 24, 1983; and March 16-17, 1983. During this review, the Committee had the benefit of discussions with representatives of the Applicants and their consultants. We also had the benefit of the documents listed.

The CRBRP will be a liquid-sodium-cooled, mixed-oxide-fueled, fast-breeder reactor demonstration power plant. Design power is 975 MWt (350 MWe). This is the only fast breeder power plant which the ACRS has reviewed for formal licensing purposes within the past decade, although the Committee offered advice on the Fast Flux Test Facility design which is similar to that of the the CRBRP.

The proposed CRBRP site is located in Roane County in east central Tennessee approximately 25 miles west of Knoxville, Tennessee. The site consists of approximately 1300 acres on a peninsula formed by a meander in the Clinch River. The site property is owned by the U. S. Government and is currently in the custody of the Tennessee Valley Authority. The minimum distance to the exclusion area boundary is 2200 feet, and the population center distance, based on the actual population distribution, is 7 miles north-northeast of the plant. The ACRS reported on the suitability of the proposed CRBRP site in its report to you dated July 13, 1982.

In its report of July 13, 1982 on the suitability of the CRBRP site, the ACRS said, "With regard to the seismic design of this plant, we believe it is important that the combination of seismic design basis and margins in the seismic design be such that this accident source represents an acceptably low contribution to the overall risk from the plant. We believe this matter will warrant detailed examination at the construction permit stage to assure that necessary margins are available for all important systems and components." The NRC Staff has accepted an SSE and OBE for the CRBRP of 0.25g and 0.12g, respectively. The U.S. Geological Survey has raised a concern regarding a postulated local seismic zone and, while the Staff does not accept the arguments for the local zone, its existence would significantly increase the probability of exceeding the SSE. In any case, we believe that a considerable seismic margin for no loss of function of the shutdown heat removal system should be shown for low probability earthquakes larger than the proposed SSE. Ongoing studies by both the Applicants and the NRC Staff have indicated that appreciable margins exist for the large piping in the primary heat transport system of the plant; however, similar studies have not been made for small piping. Since a common mode loss of piping integrity in all three heat transport loops could disable the entire heat removal system, which in turn could lead to core melt, it is important to assure the integrity of small piping as well as of all other components needed to accomplish shutdown heat removal.

The Applicants are conducting a full-scope probabilistic risk analysis (PRA) on the current CRBRP design. The PRA should be completed soon enough that its review by the NRC Staff and the ACRS, and any resulting recommendations or additional requirements, can be considered in the design of the plant. We recommend that careful detailed attention be given in the PRA to the following topics, among others:

- The adequacy of means for shutdown heat removal, including scenarios involving earthquakes more severe than the safe shutdown earthquake. Among other things, the significance of the vulnerability of the direct heat removal system, as designed, to leaks in the primary system should be examined, as well as the effects of possible steam generator tube degradation.

- The adequacy of the secondary containment, the filter system, and other features important to limiting the uncontrolled release of radioactive material following postulated accidents involving core melt. Scenarios which might lead to overpressure of the containment should be systematically identified, and examination should be made of possible design changes to reduce the likelihood of uncontrolled releases of radioactive materials in terms of their efficacy and costs. The possible merit of a dedicated emergency power supply for the filter system should be included in such studies.

- A careful search for scenarios which have the potential for a loss of containment integrity due to hydrogen combustion. This should include any potential for confusion by the operator as to the proper course of action as well as operator errors, including those of commission.

- An examination of the merits and costs of means of delaying attack of the concrete by sodium and hot fuel.

The ACRS believes that timely completion of the PRA by the Applicants, to permit its review and evaluation by the NRC Staff and the ACRS, should be a condition of the construction permit.

An historical liquid-metal fast-breeder-reactor safety concern has been the potential for large reactivity excursions caused by, for example, a combination of failure to scram and either a loss of coolant flow or an insertion of reactivity. It is sometimes postulated that such an excursion could lead to vaporization of coolant and fuel and to rupture of the primary containment (i.e. reactor vessel, etc.) and possibly secondary containment (i.e., the steel containment shell) due to the pressures resulting from the vaporization. This event is termed an energetic core disruptive accident (CDA). Both the Applicants and the NRC Staff have independently reviewed this potential and have concluded that the probability of such an accident is quite low. Further, both conclude that, even if such a combination of events did occur, the magnitude of the resulting mechanical forces in the CRBRP design would be well below the capability of the primary containment system to withstand such forces without rupture. We concur in the NRC Staff position.

Both the Applicants and the NRC Staff have also concluded that the probability of core melt from a nonenergetic event is low. However, the NRC Staff has required, and the Applicants have provided, means to mitigate the consequences of such a core melt, should one occur. The Committee concurs in this approach and recommends that these mitigative features must be designed so as to afford a very high likelihood of successful function. The Applicants are placing considerable reliance on an air cleaning system to control releases, should the outer containment have to be vented following a major accident in the CRBRP. To confirm the anticipated performance of this system, however, more work needs to be done in many areas, including the following:

- Establishment of the physical and chemical nature, the concentrations as a function of time, and the ultimate fate of the aerosols.

- Establishment of a better basic understanding of the thermal, mechanical and chemical interactions between concrete and sodium or hot fuel.

- Establishment of reliable, unambiguous means of monitoring hydrogen and oxygen concentration in the secondary containment.

- Potential for plutonium criticality within the scrubber proposed as part of the secondary containment venting clean-up system.

- Assessment of hydrogen buildup in the secondary containment under various scenarios including the potential for nonuniform concentrations.

- Assurance of the availability of clear, simple, safe procedures for venting and purging in the unlikely event of such an accident.

In the area of shutdown heat removal reliability, the Applicants will rely on natural circulation capability to remove decay heat should there be a loss of all AC power. The NRC Staff will require demonstration of this capability prior to operation.

The reliability assurance program described by the Applicants is appropriate for this stage of plant development. Most of the emphasis is on what are considered to be safety or protection systems. The Applicants have committed to a more comprehensive reliability analysis. We recommend that, insofar as feasible, this analysis give particular attention to nonsafety systems, the malfunction of which may challenge protection systems.

The Applicants have several materials programs in progress, some of a confirmatory nature, on topics such as creep fatigue and creep rupture damage and the thermal aging of piping. We believe these programs are important and should continue.

Safety knowledge in the area of sodium-water interaction at the steam generator interface seems well in hand. However, it is recommended that both the Applicants and the NRC Staff closely monitor pertinent developments and experience in other countries.

The ACRS has not completely reviewed the proposed CRBRP Principal Design Criteria and is not prepared to endorse them in this letter.

As for any new type of plant, it is recommended that further thought be given to providing design features to reduce, as far as practical, both the feasibility and consequences of sabotage.

The issues discussed above as well as many described in the SER are ones for which more work must be done prior to their resolution. As further information is acquired, we wish to be kept informed and will recommend safety modifications to the existing design as appropriate. We expect to follow the ongoing CRBRP design, development, and construction programs more closely than would be the case for a typical LWR plant.

The Advisory Committee on Reactor Safeguards believes that, if the matters noted above and the open items described in the SER are resolved in a satisfactory manner, the CRBRP can be constructed with reasonable assurance that it can be operated without undue risk to the health and safety of the public.

Additional comments by ACRS Member Robert C. Axtmann are presented below.

Sincerely,

Jesse C. Ebersole
Acting Chairman

Additional Comments by ACRS Member Robert C. Axtmann

Many of its strongest proponents agree that CRBR is an archaic design for a technology that will not be needed until well into the 21st century. On the other hand, far too many LMFBR experiments and reactors have ended disastrously. If fusion proves feasible and environmentally acceptable within the next fifty years, the breeder will share a niche in technological history with the hydrogen-filled dirigible. Whatever the risks of CRBR (and no one claims there are none), I find no rational basis for this project.

References:

1. Project Management Corporation, Clinch River Breeder Reactor Project, "Preliminary Safety Analysis Report," Volumes 1-27 and Amendments 1-75.
2. U. S. Nuclear Regulatory Commission, "Safety Evaluation Report Related to the Construction of the Clinch River Breeder Reactor Plant," NUREG-0968, Volumes 1 and 2, dated March 1983.
3. EG&G, Idaho, Inc., Wood-Leaver and Associates, Inc., and Fauske and Associates, Inc., "Clinch River Breeder Reactor Plant Probabilistic Risk Assessment - Phase I," Main Report and Appendices A-G, EGG-EA-6162, dated January 1983.