Department of Energy
Washington, D.C. 20545
Docket No. 50-537
HQ:S:82:168

DEC 28 1982

Mr. Paul S. Check, Director
CRBR Program Office
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Check:

ADDITIONAL INFORMATION ON SEISMIC QUALIFICATION

The purpose of this letter is to provide additional information to resolve questions asked by the Nuclear Regulatory Commission (NRC) of the Clinch River Breeder Plant project on seismic qualification in Preliminary Safety Analysis Report Section 3.10.

Enclosure 1 is the information requested. Enclosure 1 also contains a revision to NRC Question 270.10 that was requested at the November 23, 1982, meeting on equipment qualification.

Any questions regarding the information provided or further activities can be addressed to A. Meller (FTS 626-6355) or D. Florek (FTS 626-6188) of the Project Office Oak Ridge staff.

Sincerely,

for J. E. Stader

John R. Longenecker
Acting Director, Office of
Breeder Demonstration Projects
Office of Nuclear Energy

3 Enclosures

cc: Service List
Standard Distribution
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D001

Enclosure (1)

<u>Open Item</u> ______________ <u>Margins for non-linear material behavior</u>

<u>DESCRIPTION</u>:

The applicant did not address what method or criteria will be used, including reduction of allowable stresses beyond those that are established for pressure boundary integrity, to account for the effects of material non-linearity at high temperatures and creep to ensure equipment operability. Normal operating loads superimposed with seismic and dynamic loads are likely to produce such non-linear responses in equipment in the presence of high temperatures. In the case of seismic analysis the applicant did not account for the non-linear effects or indicate how the non uniqueness of seismic time history would be considered.

<u>Response</u>:

The non-linear material response and analysis methodology are described in RDT F9-4 and RDT F9-5. In addition, PSAR Section 3.7 Appendix 3.7-A describes the requirements, load combinations and analysis methods for seismic analysis. It is inappropriate to review these in this response. However, for illustrative purposes a more detailed answer is provided for permanent reactor internals.

Permanent reactor internals are designed to the appropriate ASME criteria (ASME - III, including CC N-47) with additional restrictions to assure component operability. The operability requirements are particularly critical for components related to reactor shutdown, such as the control rods and interfacing equipment. In general, these restrictions include an upgrade of the seismic events to more stringent requirements such as evaluating the OBE as ASME Normal (Service Condition A) and the SSE as ASME Emergency (Service Condition C), as well as detailed studies to evaluate the acceptable control rod insertion time. Normally OBE would be evaluated to upset (Service Condition B) and SSE to Faulted (Service Condition D) limits. This upgrade in the seismic loading condition criteria is a significant effect on the critical equipment integrity and operability under these plant loading conditions. An estimate of this effect can be based on the basic seismic input for the plant as the OBE may be as low as 55% of the SSE. There is also a significant difference in the allowable stresses for the service levels.

In general, seismic and thermal stresses are not critical at the same locations due to the different nature of the loading conditions. Seismic events are most significant for thin sections where primary stresses and stability are critical. Thermal stresses are generally most significant at thick sections where the thermal inertia of the component produces large thermal stresses. A typical situation where the thermal and seismic stresses are both important would be the intersection of thin and thick sections. The seismic stresses in this section may be significant by themselves while the thermal stresses may also be significant due to the difference in thermal response of the two sections at the discontinuity. In these situations, the following general procedures apply.

(1) One OBE event is combined with the worst upset event at the most critical time in the upset event. Four OBE events are combined with the worst normal operating condition.

(2) The SSE event is combined with most adverse normal operating condition.

(3) In these situations, there is generally one stress component (or effective stress/strain is used) that is highly predominate relative to the other components. The thermal and seismic events are conservatively combined to maximize these critical stress components.

(4) The requirements of RDT F9-5 regarding bilinear stress strain curves and 10th cycle kinematic hardening are imposed in the analysis.

The effects of this load ...bination may be stated for three separate cases. In all cases, the total increased creep and fatique damage due to this loading combination is generally relatively small due to the limited number of events considered.

Case 1: Structure does not yield

The loading combination produces larger primary plus secondary and fatique stress ranges than either event acting alone, but does not result in a residual stress. Thus the fatique damage is increased, but the creep damage is not effected by the load combination.

Case 2: Structure yields only during loading

The loading combination produces larger primary plus secondary and fatique stress ranges than either event acting alone, and results in a residual stress that may produce creep damage in the structure. The residual stress and resultant creep damage increment is dependent on the maximum strain produced by the loading combination.

Case 3: Structures yield during loading and unloading

This loading combination produces a larger primary plus secondary and fatique stress and strain range than either event alone and results in a residual stress that contributes to creep damage at elevated steady state temperatures. This residual stress is somewhat dependent upon the total strain in the event combination because of the bilinearized stress strain curve (and resultant variations in yield stress and plastic modulus) approach specified by RDT F9-5.

The non-uniqueness of the seismic time history is considered by developing a synthetic motion whose response spectrum envelops the design response spectrum. The design response spectrum is a conservative definition of the floor motion since it is obtained by 1) enveloping spectra for the upper and lower bounds of soil moduli, 2) widening the peaks to take care of uncertainties, and 3) smoothing to eliminate valleys and spectral fluctuations.

Open Item ______________________ Seismic Testing Margins

IEEE Standard 344-1975 requires that the Test Response Spectrum have a margin over the required Response Spectrum. The applicant did not address what method will be used to establish the total margin consisting of an input envelope over a number of similar equipment, differences between the initial input and final design input, and the test input versus the required input.

Response:

For testing of Class 1E equipment, any margin required by IEEE Std. 344 is initially added to the Required Response Spectrum (RRS). This includes a 10% margin required by IEEE Std. 323. The RRS is derived at the mounting of the equipment for the worst location of the equipment on the supporting structure, that is, the location which gives the highest response spectrum. Therefore, testing to this highest RRS conservatively qualifies equipment mounted at other, less severe locations. The test motion is synthesized such that the test response spectrum (TRS) conservatively envelops the RRS. The margin, based on proof testing, is that given by the initial margin in the RRS and the amount by which the TRS exceeds the RRS. Additional margin exists to fragility which is not determined. The qualification testing is performed for the seismic responses obtained from the latest seismic analyses. If the final design input should be different from that for which the test was performed, a comparison is made between the TRS and the final design RRS to ensure that the TRS also envelops the new RRS. A combination of test and analysis may also be used if the final design of the equipment is modified.

Open Item _______________ Load Frequency Combinations

The applicant did not address the procedure that will be used to combine the equipment loading from earthquake, generally in the 0 to 33 Hz range, and from anticipated dynamic loadings with a frequency range to 60 to 100 Hz.

Response:

Mechanical equipment which may be subjected to the simultaneous occurrence of seismic and other dynamic loads is analyzed for the combination of both loadings. The more conservative absolute or linear summation methodology is in general used for this combination. The square root of the sum of the squares methodology is used where appropriate for deriving the total seismic loads given by the three components of the earthquake.

CRBRP RESPONSE DOCUMENTATION

Question CS270.10

The equipment qualification program at CRBR involves several parties: the Department of Energy, Project Management Corporation, and various vendors. When the plant is fully licensed and operational, it will be turned over to the plant operator. It is essential for the operator of the plant to maintain all relevent documentation on equipment qualification in an auditable manner at a central location. Regarding equipment qualification, the details of the interactions of the organizations and locations of the central file should be provided by amending appropriate sections of the PSAR.

Response:

CRBRP will maintain all relevant documentation on equipment qualification in an auditable manner at a central location. The documentation requirements for Class 1E equipment qualification are described in Reference B as specified in PSAR Section 3.11.2, "Qualification Tests and Analysis". The documentation for mechanical equipment will be contained with the Equipment Specification data package. The overall system for collection, storage, and maintenance of this documentation is described in PSAR Chapter 17, Appendix A, paragraph 17.1, "Quality Assurance Records: Owner Implementation," and paragraph 17.2, "Quality Assurance Records: Requirements of Other Participants". Briefly stated, this quality records management system specifies that all data packages which are to be declared as lifetime quality records by each responsible participant are to be transmitted to the Project Office for collection, storage, and maintenance by teh owner at the Owners Level III Quality Records Center, Oak Ridge, Tennessee. Pursuant to the CRBRP Project implementation of the records storage requirements of ANSI N45.2.9, a duplicate file of these records is to be maintained for security purposes at the regional federal records center established for the CRBRP Project.