SYSTEM ENERGY
RESOURCES, INC.
A Middle South Utilities Company

William T. Cottle
Vice President
Nuclear Operations

U.S. Nuclear Regulatory Commission
Mail Station P1-137
Washington, D.C. 20555

December 5, 1989

Attention: Document Control Desk

Gentlemen:

SUBJECT: Grand Gulf Nuclear Station
Unit 1
Docket No. 50-416
License No. NPF-29
Response to NRC Request for
Additional Information Regarding
Boraflex Gap Analysis
AECM-89/0209

Ref: 1. NRC Letter dated August 25, 1989 regarding Gaps in Boraflex of High Density Spent Fuel Racks (MAEC-89/0258).

Please find attached System Energy Resources Inc. (SERI) response to the NRC request for additional information (Reference 1) regarding Boraflex gap analysis for the GGNS high density spent fuel racks.

As discussed with Mr. L. L. Kintner on October 10, SERI was unable to provide this response by the requested date of October 15, 1989 due to delays in obtaining appropriate vendor information. This information has been obtained and is included in this response.

This response has been reviewed and approved by the GGNS Plant Safety Review Committee. Please advise, if you require any additional information on this matter.

Yours truly,

W T Cottle

WTC:tkm
Attachment

cc: (See Next Page)

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P.O. BOX 756 | GRAND GULF NUCLEAR STATION
PORT GIBSON, MISSISSIPPI 39150 | (601) 437-6800
A Middle South Utilities Company

cc: Mr. D. C. Hintz (w/a)
Mr. T. H. Cloninger (w/a)
Mr. R. B. McGehee (w/a)
Mr. N. S. Reynolds (w/a)
Mr. H. L. Thomas (w/o)
Mr. H. O. Christensen (w/a)

Mr. Stewart D. Ebneter (w/a)
Regional Administrator
U.S. Nuclear Regulatory Commission
Region II
101 Marietta St., N.W., Suite 2900
Atlanta, Georgia 30323

Mr. L. L. Kintner, Project Manager (w/a)
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Mail Stop 14B20
Washington, D.C. 20555

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION ON BORAFLEX GAPS

1. The sample of cells selected (104 in a high gamma flux region) is only about 2% of the 4348 cells in the spent fuel pool and is based on the assumption that radiation is the only significant parameter causing gaps. What assurance is there that the other 98% of the cells will have less adverse gaps than the cells monitored?

   Response 1: The shrinkage of Boraflex panels has been well correlated to gamma radiation fluence (1). The Boraflex test procedure requires that freshly discharged fuel be placed in the test area during Refueling Outage (RFO)-3 and 4. The test area was also the site of fuel discharged during RFO-1. The fuel will remain in the test area approximately 10-14 months. This process will result in a gamma fluence equivalent to those associated with equilibrium Boraflex shrinkage and the corresponding maximum gap size.

   In order to insure that Boraflex gaps in other areas of the racks do not exceed those measured in the test area, the fluence in these areas will be evaluated relative to that of the test area. As described in response to question 6 below, areas with a gamma fluence approaching the maximum fluence corresponding to the most recent Boraflex gap measurements will have restricted use.

   Such restrictions are not generally required in the spent fuel pool since the test area's fluence significantly exceeds other regions of the spent fuel pool. At the end of the third Boraflex gap measurement, when the test area gaps are estimated to reach equilibrium gap sizes, other areas of the racks will have accumulated 75% less gamma fluence.

   The Upper Containment Pool (UCP) racks will not generally require restrictions since irradiated fuel is only present for short periods of time during each refueling outage. This is due to the use of incore fuel shuffling at GGNS. However, since extended refueling outages are possible, the racks will be evaluated prior to each refueling outage to establish residence time restrictions for irradiated fuel or areas where scatter loading is required.

   The test area is somewhat small relative to the total area of the spent fuel racks. However, the gamma fluence in this area will bound other areas of the spent fuel racks. Therefore, Boraflex gap sizes and their distribution will be determined in the test area in advance of other areas of the racks and a large Boraflex test area is not necessary.

2. The fabrication process is believed to contribute to the formation of gaps under gamma radiation. Describe the procedure used in the fabrication of the Boraflex panels, including the use of adhesives on mechanical devices that can restrain the Boraflex from shrinkage under gamma radiation.

   <u>Response 2</u>: The fabrication of the Boraflex panels was accomplished through the use of Dow Corning RTV adhesive, a silicone-based cement. The process used was to lay a thin bead of this cement down the length of the assembly, smear the cement into a thin film, and then attach the Boraflex material to it. (See also response #5.)

3. Describe the analysis method for determining that measured gap sizes and distribution are bounded by the gaps assumed in the criticality calculation and that the surveillance intervals are conservatively selected to predict maximum gap growth.

   <u>Response 3</u>: Following each Boraflex gap test, the gap size and frequency distributions will be developed in a manner consistent with that used in the criticality analysis (2). The observed gaps/cell and gap size frequency distributions will be determined. Multiple gaps/panel will be combined into a single gap. The resulting probability table will be combined with the K-effective response matrix from Table 7 of Reference 2. This combination will use the same method described in Reference 2 except the observed probability table will replace the analyzed probability table from Reference 2. If this evaluation results in a lower K-effective than determined in Reference 2, then the observed gaps will be bound by the analysis.

   In order to determine that the maximum gap size model used in the criticality safety analysis (2) remains bounding, gamma fluence calculations for the test area will be performed. The gamma fluence for the panels in each gap size frequency bin will be determined. The gap size will be converted to shrinkage based upon the Boraflex panel length. If the observed shrinkage vs. fluence is less than the EPRI model described in Figure 5.2 of Reference (1), then the maximum gap size projected in the analysis (2) remains valid.

   The previous gap measurement and the two additional measurements currently planned will cover the range of gamma exposures associated with gap formation, growth and maximum gap size (10^9 - 10^{11} Rads). Current industry data is bounded by the maximum gap size predicted by the EPRI model (1) which was used in the criticality analysis (2). However, as an additional conservatism, the current management of the spent fuel rack precludes the gamma fluence in areas outside the test region from exceeding the maximum fluence associated with the most recent Boraflex test measurements. Therefore, the surveillance interval is assured of being conservative.

4. Describe the criterion for a finding of excessive Boraflex gaps in panels or excessive degradation of coupon specimens and the actions to be taken if such degradation is found.

   Response 4: A discussion of the method and criteria for excessive Boraflex gaps is provided in response to question number 3 above. Some changes in Boraflex coupon properties and dimensions are normal and expected. Acceptable bounds for these properties and dimensions are:

   a) Dimensions: changes in length or width should not exceed 4% of the original coupon dimensions. This is established consistent with the maximum gap size assumptions used in Reference 2.

   b) Neutron Attenuation: The minimum Boron content, as indicated by Neutron Attenuation measurements should not be less than 100% of the nominal value assumed in the criticality analysis (2) with a 5% acceptance band.

   c) Hardness: Boraflex becomes fully hard upon irradiation. Once Boraflex has become harder than 90% Shore A, a minimum of 90% Shore A hardness is applied as an acceptance criteria.

   If degradation is indicated by failure of one or more of these criterion then the criticality impact will be evaluated and restrictions on fuel movement will be imposed as described in response to question 6 below.

5. Provide a discussion of the potential for downward movement of Boraflex segments within the cladding under vibration of the racks caused by inserting or removing fuel assemblies or the design basis earthquake.

   Response 5: The cementing process used in the assembly of the cells for the GGNS High Density Spent Fuel Racks has provided for a wide dispersion of the silicon cement over the Boraflex material. In the case where a Boraflex slab is segmented into individual pieces after installation, this dispersion of the cement will ensure that each segment remains securely in place within the cell wall.

   Furthermore, the Boraflex slabs used in the cell walls of the GGNS Spent Fuel Racks are tightly sandwiched between sheets of stainless steel. These stainless steel sheets are welded together in such a manner that there is no clearance for individual Boraflex segments to shift position. Thus, even if a Boraflex segment was to become unattached to the cell wall, it would not be susceptible to movement since no path would exist for such motion.

   Therefore, the potential for downward movement of Boraflex segments within the stainless steel cladding due to induced vibration is negligible.

6. Describe administrative controls that will be used to implement the surveillance program and actions resulting from the tests, including a description of the program to be included in the Updated Final Safety Analysis Report.

   Response 6: Two separate surveillance programs have been established at GGNS to monitor Boraflex degradation in fuel racks in the Spent Fuel Pool (SPF). The first is the blackness testing program which was previously described in Attachment 2 to AECM-89/0037 dated February 27, 1989. The next scheduled blackness test is in 1990.

   The second surveillance program is the coupon specimen removal and inspection program as previously described in AECM-85/0143 dated May 6, 1985. Nine pairs of coupons were installed in the SFP for periodic removal and inspection. The inspections are nondestructive and have been selected to provide an indication of the general condition of the Boraflex and any indication of gross or unusual degradation. These coupons are sent offsite to an independent laboratory for testing. Three pairs of coupons have already been removed and analyzed with no unexpected performance.

   During each refueling outage, freshly discharged spent fuel will be loaded into the surveillance areas. For blackness testing, the surveillance area of the rack is administratively controlled to ensure only discharged fuel for blackness testing purposes is loaded into this restricted area. For coupon testing, the coupon is placed in an area that ensures it will continue to lead the other racks in the integration of gamma fluence. Loading freshly discharged fuel into this blackness test surveillance area each cycle will induce a significantly higher gamma fluence in the surveillance area than in other areas of the racks. Since gamma fluence has been strongly correlated to gaps and degradation in Boraflex, this approach will ensure the surveillance areas will lead other areas of the racks in the formation of gaps and in the integrated fluence.

   Until equilibrium gap sizes have been demonstrated, fluence calculations will be performed on incore fuel to be discharged or shuffled to determine maximum residence time allowed in the racks. This residence time will be selected to ensure the fluence experienced by a rack is always less than the maximum fluence associated with the last blackness test measurement.

   Fuel loading in areas where excessive degradation is indicated by either surveillance program or where maximum residence times may be exceeded, will be controlled administratively to ensure that loading of nondischarge fuel into these areas will be restricted to scatter loading until a safety evaluation is performed. These administrative controls will be implemented prior to RF04. Since gaps are nearly randomly distributed, the probability of finding a significant number of overlapping gaps is remote. Additionally, scatter loading effectively doubles the amount of Boraflex between adjacent bundles, providing a large margin to compensate for any general Boraflex degradation. Therefore, adequate margin to criticality will be maintained.

UFSAR section 9.1.2.3 will be updated to include a summary of this surveillance program.

Reference 1. "An Assessment of Boraflex Performance in Spent-Nuclear-Fuel Storage Racks", EPRI NP-6159 December 1988.

2. Attachment 1 to AECM-89/0037, "Criticality Safety Analysis of the Grand Gulf Nuclear Station, Unit 1 Spent Fuel Storage Racks with Gaps in the Neutron Absorbing Panels", RPAS-SR-89/007, February, 1989.