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Director
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Waterford 3

W3F1-96-0185
A4.05
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October 24, 1996

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Subject: Waterford 3 SES
Docket No. 50-382
License No. NPF-38
Response to Generic Letter 96-04
Boraflex Degradation In Spent Fuel Pool Storage Racks

Gentlemen:

The purpose of this letter is to provide the Waterford 3 response (Attachment) to Generic Letter (GL) 96-04. GL 96-04 requested licensees that use Boraflex as a neutron absorber in their spent fuel pool racks to (1) assess the capability of the Boraflex to maintain a 5-percent subcriticality margin and (2) submit a plan describing proposed actions in the event this margin cannot be maintained by the Boraflex material because of current or projected Boraflex degradation.

GL 96-04 also required the licensees to provide a written response regarding the following information:

1. An assessment of the physical condition of the Boraflex, including any deterioration, on the basis of current accumulated gamma exposure and possible water ingress to the Boraflex and state whether a subcritical margin of 5-percent can be maintained for the rack in unborated water.

2. A description of any proposed actions to monitor or confirm that the 5-percent subcritically margin can be maintained for the lifetime of the storage racks and describe what corrective actions could be taken in the event it cannot be maintained.

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3. A description of the results of previous post operational blackness tests and state whether blackness testing, or other in-situ tests or measurements will be periodically performed.

4. Chronological trends of pool reactive silica levels along with the timing of significant events such as refueling, pool silica cleanup, silica impact on Boraflex performance, etc.

If you have any questions concerning this response, please contact me at (504) 739–6424 or Tim Gaudet at (504) 739–6666.

Very truly yours,

James J Fisicaro

J.J. Fisicaro
Director
Nuclear Safety

JJF/RWP/ssf
Attachment

cc: L.J. Callan, NRC Region IV
C.P. Patel, NRC-NRR
R.B. McGehee
N.S. Reynolds
NRC Resident Inspectors Office

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the matter of	)	
	)	
Entergy Operations, Incorporated	)	Docket No. 50-382
Waterford 3 Steam Electric Station	)	

AFFIDAVIT

J.J. Fisicaro, being duly sworn, hereby deposes and says that he is Director, Nuclear Safety - Waterford 3 of Entergy Operations, Incorporated; that he is duly authorized to sign and file with the Nuclear Regulatory Commission the attached Response to NRC Generic Letter 96-04; that he is familiar with the content thereof; and that the matters set forth therein are true and correct to the best of his knowledge, information and belief.

James J Fisicaro
J.J. Fisicaro
Director, Nuclear Safety - Waterford 3

STATE OF LOUISIANA	)	
	) ss	
PARISH OF ST. CHARLES	)	

Subscribed and sworn to before me, a Notary Public in and for the Parish and State above named this 24TH day of OCTOBER, 1996.

Steve R. Fahs
Notary Public

My Commission expires WITH LIFE.

Response to GL 96-04

Background

The Waterford 3 spent fuel storage racks use Boraflex as a neutron absorber. The racks were installed prior to the first fuel cycle, which commenced in 1985, and were designed by Watcher Associates. The racks are composed of cells containing stainless steel partitions which provide a fuel assembly storage area and two poison insert areas per cell. The cells are oriented so that face adjacent assemblies are separated by a poison insert area (flux trap design). The poison inserts contain two Boraflex panels which are encapsulated in stainless steel cladding. The Boraflex panels are restricted from movement by indentations in the clad which apply continuous pressure over the entire length of the panel. A fusion weld was applied across the bottom and top of the clad, continuous at the bottom and intermittent at the top. Seam welds were applied along the axial length of the clad. This clad/weld configuration yields a stable and relatively "tight" configuration that minimizes the potential for water ingress.

On December 31, 1992, the results of measurements which confirmed the presence of gaps and proposed the current surveillance program were submitted to the NRC. This program was approved by NRC letter dated August 23, 1993. Consequently, a criticality analysis was performed to demonstrate the safety of the storage racks with the presence of Boraflex gaps as required by the surveillance program.

On January 27, 1995, an additional criticality analysis was submitted to the NRC to address an allowable maximum enrichment Technical Specification change. This analysis included credit for fixed integral poisons and assumed that 4.5 inch gaps were present in each Boraflex panel at the most reactive location, the top of the panels. This co-planar gap assumption is very conservative when compared to the actual randomly distributed gap configuration. This analysis was approved by NRC letter dated June 14, 1995.

Planned Rack Replacement

Waterford 3 has evaluated options to replace the existing spent fuel pool storage racks in order to increase the number of storage locations. The replacement is currently planned to occur during the Summer of 1998. The replacement racks will use Boral, instead of Boraflex, as the neutron absorber.

Existing Monitoring Program

Revisions to the initial Boraflex surveillance program which relied on coupon specimens were proposed on December 31, 1992. The changes were approved by the NRC on August 23, 1993. The key elements of these revisions are: termination of the Boraflex coupon surveillance program; maintenance of a database of calculated Boraflex panel gamma exposures; periodic nondestructive testing of selective panels; and periodic destructive testing of selected panels if determined necessary by engineering assessment.

The program uses neutron blackness testing to determine the size and frequency measurements of gaps in the Boraflex panels. The results of these measurements are compared to the assumptions used in the current criticality safety analysis to verify that the 0.95 k-effective criticality safety limit is not compromised.

Blackness tests are performed in the same area of the spent fuel pool. The approved surveillance area was a 4 x 4 array of spent fuel pool storage locations. In actual practice, the tests have been performed over a larger test area. During each refueling outage, freshly discharged spent fuel is loaded into the surveillance area. Blackness testing is performed periodically with a maximum interval of four years.

Loading freshly discharged fuel into the surveillance area each cycle induces a significantly higher gamma fluence in the surveillance area than in other areas of the rack. Since gamma fluence has been strongly correlated to gaps in Boraflex, the surveillance area will lead other areas of the racks in the formation of gaps.

The Boraflex configuration assumed in the current analysis accounts for the potential slumping that has been postulated to occur following a seismic event since the gaps are assumed to occur at the upper edge of all panels.

In summary, this surveillance program utilizes a test area which leads other areas of the rack in the formation and growth of gaps in Boraflex panels. The results of this program are expected to verify that the criticality analysis assumptions are bounding and to provide a more realistic characterization of Boraflex gap behavior in an in-service rack environment.

Results Of Blackness Testing

Two blackness test campaigns have been performed at Waterford 3. The results of the two campaigns are summarized on Figure 1. This figure is generated by totaling the size of the gaps in each panel and converting this sum to a percent shrinkage based on the total panel length. The shrinkage is then plotted versus gamma dose accumulated by that panel. The overall trend of the data is consistent with the EPRI model results although shifted to the right and somewhat upward. This is consistent with the tendency of point kernel shielding codes, as the one used in these calculations, to over predict dose. Additionally, some portion of the shrinkage only increases the strain in the Boraflex and does not result in gap formation.

The largest panel shrinkage observed during the second campaign is 4.49 inches, although half of the gaps are approximately two inches. Almost 25% of the panels contain gaps. Table 1 summarizes the results from the two tests. New gaps continue to form and a few large gaps have developed. The gaps have a higher probability of being located in the upper 50% of a panel than in the lower 50%.

Spent Fuel Pool Dose Levels

In addition to the dose assessment of the surveillance area, calculations of the dose in other areas of the racks are also performed. These assessments were performed in conjunction with the two surveillance campaigns. Additionally, the doses have been determined as of September 1, 1996. The lead panel dose inside the surveillance area is 3.6×10^{10} Rads. The lead panel outside the surveillance area is 2.1×10^{10} Rads.

EPRI has established that insignificant Boraflex dissolution occurs below threshold doses of 2×10^9 to 3×10^9 Rads. The majority of the irradiated spent fuel storage cells at Waterford 3 have achieved this dose; therefore, they are susceptible to degradation due to water ingress.

Trend of Pool Silica Concentrations

The available silica data is provided in Figure 2. Reductions in the silica concentration can be observed during outages as expected. No silica cleanup campaigns have been conducted at Waterford 3. The silica levels for recent cycles are consistent with levels at other PWR racks which have a relatively "tight" configuration as reported at the recent EPRI Boraflex workshop. The trends are inconclusive, but the silica levels indicate that some degradation due to water ingress may be occurring. The extent of this effect depends on detailed evaluation of the fuel pool design and operation. EPRI has developed the RACKLIFE system to perform this evaluation. An initial application

has been successfully performed at another site. Model enhancements are currently being incorporated into the system based on initial utility use. Efforts to develop a RACKLIFE model for Waterford 3 is currently in progress to perform silica evaluations.

Criticality Analysis Assessment

The existing Waterford 3 criticality analysis provided allowances for Boraflex gapping. This analysis assumes credit for fixed integral poisons; however, no credit for burnup is assumed. The existing analysis assumes panel gaps as large as 4.5 inches conservatively modeled as co-planer at their most reactive location (at upper edge of each panel). This shrinkage assumption is very conservative relative to the realistic configuration where gaps occur randomly at various axial locations. Additionally, blackness testing has shown all panels do not contain gaps. The criticality analysis established that an infinite rack containing this configuration had a k-effective, including uncertainties, below the 0.95 acceptance criteria. Because the surveillance area has been loaded with freshly discharged fuel after each cycle, its dose is significantly higher than the bulk of the racks.

Monitoring Program and Proposed Actions

As discussed, work is underway to replace the existing spent fuel storage racks. In order to ensure that the 5 percent subcriticality margin can be maintained until the existing spent fuel storage racks are replaced, it is proposed to continue the currently approved surveillance program. Additionally, the following actions will be taken:

> Waterford 3 will perform an evaluation of the spent fuel pool silica using RACKLIFE or its equivalent to project potential degradation due to water ingress. A criticality evaluation will be performed assuming measured gap configurations and the projected degradation to confirm this configuration is bounded by the current analysis. This evaluation will be completed in approximately one year. In the event this analysis determines the 5-percent subcriticality margin cannot be maintained, immediate steps will be taken to maintain soluble boron levels to insure this margin is sustained. Additionally, criticality analyses would be performed to justify continued use of the racks in unborated water by restricting loading of new fuel to locations with panel doses less than 2×10^9 Rads or a two of four checkerboard configuration. EPRI has established that insignificant Boraflex dissolution and shrinkage less than that assumed in the current criticality analysis occurs in panels below this dose level. The decrease in reactivity due to burnup of discharged assemblies will be confirmed to exceed the needed additional margin for locations with panels at higher dose levels.

The existing surveillance program along with these proposed actions provide assurance the margin of safety in the spent fuel pool racks will be maintained until the Waterford 3 spent fuel pool storage racks are replaced.

Table 1: Comparison of gap sizes for two campaigns.

Campaign	1 Nov. 1992	2 Oct. 1994
Number of panels tested	697	416
Number panels with gaps	159	77
Maximum Gap Size (inch)	3.57	4.49
Total number of gaps	185	95
Total panel shrinkage (inch)	XX	XX
0.5-1.0	3	1
1.0-2.0	7	10
2.0-3.0	13	9
3.0-4.0	3	7
4.0-4.5	-	3

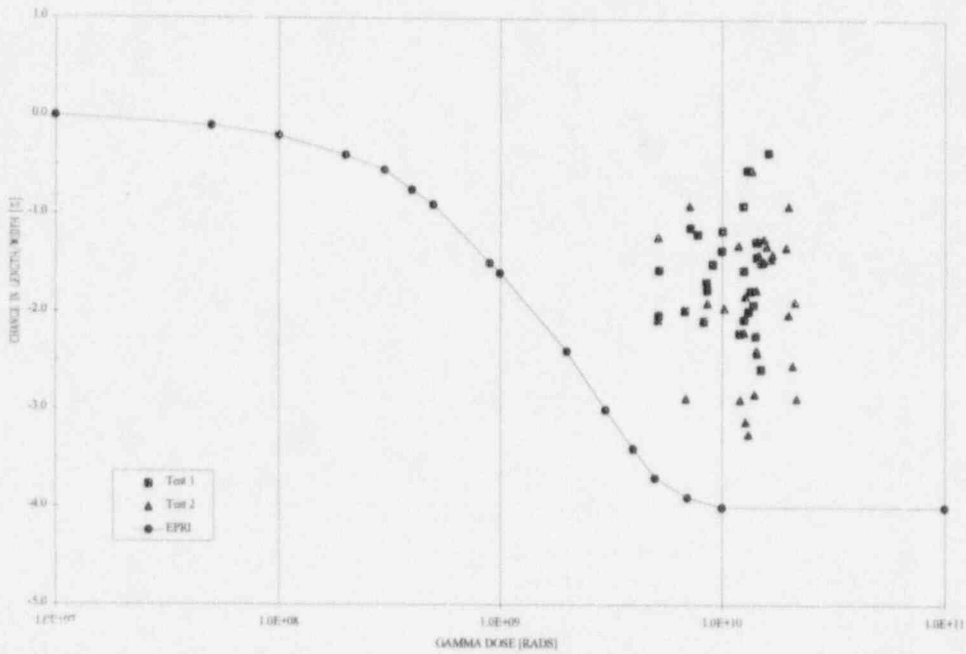

Figure 1. Waterford 3 Boraflex panel dose versus shrinkage.

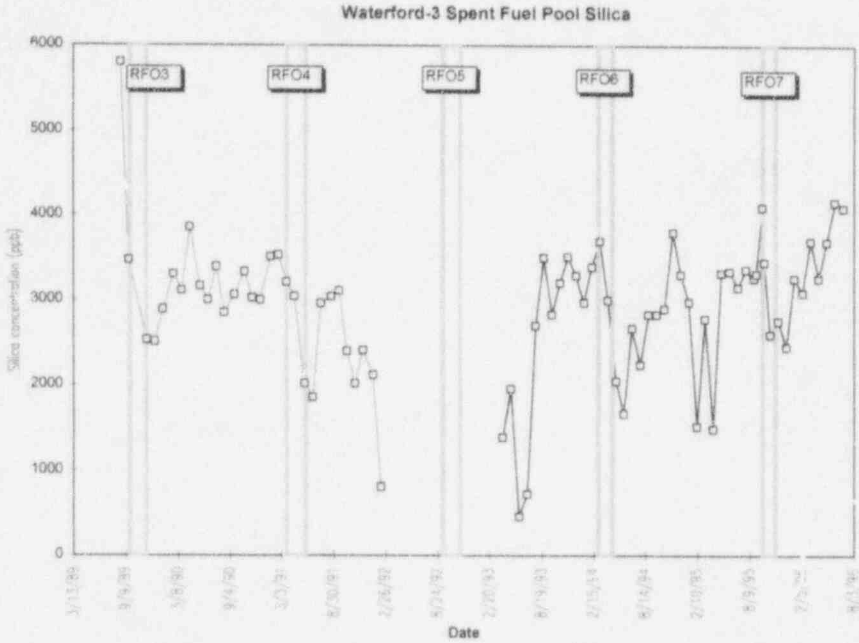

Figure 2. Waterford 3 spent fuel pool silica data.