UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

BORAFLEX SURVEILLANCE PROGRAM

FACILITY OPERATING LICENSE NO. NPF-38

LOUISIANA POWER AND LIGHT COMPANY

WATERFORD STEAM ELECTRIC STATION, UNIT 3

DOCKET NO. 50-382

1.0 INTRODUCTION

By letter dated September 16 and December 15, 1987, Louisiana Power and Light Company (LP&L, the licensee) requested NRC staff concurrence of LP&L's proposal to revise their commitment for surveillance of Boraflex in the spent fuel storage racks (SFSRs) at Waterford 3.

2.0 DISCUSSION

In its FSAR response to NRC Question No. 282.4, dated April 1981, LP&L committed to conduct surveillance testing on samples of the Boraflex poison material (coupons) in the Waterford 3 SFSRs. The surveillance coupons are two-inch-square (0.1 inch thick) pieces of Boraflex enclosed in stainless steel, which are contained within a Boraflex train assembly in the SFSR. The surveillance was to be performed over a five-year period, beginning with the second refueling outage, and includes measurements of dimensions, hardness, weight, boron content through chemical analysis, and the neutron attenuation of the Boraflex surveillance coupons which were exposed to discharged fuel assemblies of greatest burnup. These measurements were intended to demonstrate (1) that there is sufficient boron in the Boraflex to assure subcritical conditions in the SFSRs as assumed in the licensing analysis, and (2) that the Boraflex material does not degrade to an unacceptable condition under gamma irradiation from spent fuel assemblies.

The purpose of the Boron-10 in the material is to reduce the neutron multiplication in the SFSR by absorbing neutrons.

Brand Industrial Services Inc. (BISCO), the Boraflex manufacturer, has determined that the B-10 density in Boraflex is higher than the value assumed in the criticality analysis. Furthermore, the analysis of coupon data taken prior to irradiation which was performed by System Services Inc., shows that the lowest B-10 density in the Boraflex coupons is 29% higher than that used in the criticality analyses. Thus, the criticality analysis is conservative with respect to boron content in assuring a subcritical condition in the SFSRs.

The Boraflex poison material may lose its B-10 content by neutron absorption or by gamma radiation induced physical degradation. Boron depletion due to neutron absorption in the Boraflex is not a significant concern because the low neutron flux in the pool produces only a small number of neutron absorption interactions. However, Boraflex physical degradation due to gamma irradiation is a potential contributor to B-10 losses in the poison material. As long as the material is not physically degraded the boron content will not change. The required chemical analysis to determine the actual boron content in the Boraflex coupons (the original commitment) is thus not necessary, and for the same reason, the neutron attenuation analysis is also unnecessary. Boraflex neutron attentuation capability remains unchanged as long as the material has not suffered any physical degradation due to gamma irradiation.

The original commitment mentions the parameters that should be measured (thickness, length, width, weight, and hardness) but it does not describe how or when (based on these parameters) the Boraflex coupons will be considered to be unacceptably physically degraded. The technical basis for this commitment needs to be improved to reflect new industry developments.

Experience has shown that the surveillance coupons are not representative of the full length Boraflex insert. Wisconsin Electric Power Company (WEPCO) performed a Boraflex coupon surveillance similar to the original LP&L commitment (the design and manufacturer of the spent fuel storage racks as well as the Boraflex material at Point Beach, WEPCO's nuclear facility are the same as for Waterford 3), and found that the Boraflex coupons were not representative of the full length inserts. When comparing the full length inserts with coupons exposed to 1 E+10 rads (equivalent to 20-year gamma dose exposure in the SFSRs), WEPCO found that the full-length inserts did not show any significant signs of degradation. However, the coupons showed decreases in thickness, width, length, and weight, and they were fragile and easily broken.

LP&L has determined that a modification to the existing commitment is appropriate. The bases for this modification are: (1) the need to improve the technical basis to support the required analysis, (2) the surveillance coupons are not representative of the Boraflex full-length inserts, and (3) there is not enough information about Boraflex integrity in the industry at this time in order to set up an appropriate surveillance program.

As an alternative Boraflex Surveillance Program, LP&L proposes the following revised commitments:

1. The current Boraflex coupon surveillance commitment will not be performed.

2. LP&L will develop a log to track the gamma dose buildup in the spent fuel storage racks.

3. LP&L will keep abreast of new industry developments on Boraflex integrity for the next few years. An appropriate surveillance program will be proposed to the NRC by January 1, 1993.

3.0 EVALUATION

BISCO has reported that no evidence of Boraflex deterioration has been found through cumulative gamma radiation in an excess of 1 E+11 rads. Also, at the present time BISCO is engaged in further studies, and they plan to conduct analysis of larger Boraflex samples under conditions which are similar to those at the Waterford 3 SFSRs. The results from these studies are scheduled to be available at the end of 1988. Assessing the results from these studies and other pertinent industry experience is important prior to establishing a revised Boraflex surveillance program with a firm technical basis.

Furthermore, WEPCO concluded that a full-length insert which received an accelerated radiation dose of 1 E+10 rads gamma "had good integrity with no pieces missing, no cracking, or other degradation observed." Overall, the poison insert "although brittle, had good integrity with minimal degradation."

LP&L has estimated the gamma dose of a poison insert in the Waterford 3 SFSR exposed to a fuel assembly with burnup of 45 GWD/MTU, and three different power histories (low, average, and high). The calculations assumed also that the Boraflex material was exposed to four similar spent fuel assemblies to maximize the dose. A 14-year period was assumed because that is the approximate time it would take to fill the Waterford 3 SFSRs while still allowing for a full core discharge. The results on dose buildup from the assembly with high power history show that the estimated maximum dose that the Boraflex material will be exposed to in 14 years is 8.82 E+8 rads gamma (3.82% of WEPCO dose).

On September 8, 1987, the NRC issued Information Notice 87-43 to alert recipients to a potentially significant problem pertaining to gaps identified in the neutron absorber component, Boraflex, of the high-density spent fuel storage racks at Quad Cities Unit 1. Shrinkage of the Boraflex sheet is expected to occur as the material is irradiated and is produced by two radiation-induced mechanisms, crosslinking and scissioning. However, a contributor to the formation of these gaps is the local tensile stress created by the application of an adhesive compound (Dow Silicone #999) during the fabrication process of the Quad Cities' SFSRs.

This adhesive was applied to approximately the center of the stainless steel sheet in a discontinuous bead along the entire length. The bead was spread out to a width of approximately 2½"-3" with a stainless steel scraper. The Boraflex was then rolled into place and pressed against the stainless steel sheets. There were no specific procedures for this process since the only intended function of the adhesive was to hold the

Boraflex in place during the SFSR fabrication process. The bonding between the stainless steel and the Boraflex (created by the adhesive compound), produces high local stresses in the sheet as the material shrinks, forming small gaps along the length of the sheet.

Although the design used for the Waterford 3 SFSRs differs from the Quad Cities Units 1 and 2 design, uncertainties exist as to the effect of rack design and manufacturing methods on shrinkage-induced gap formation. Therefore, a surveillance program is needed to assure suitability of Boraflex neutron absorber material for the life of the high density storage racks. Based on the results of EPRI and BISCO programs to improve understanding of the Point Beach Units 1 and 2 and Quad Cities Unit 1 anomolies (non-representative coupons and gaps), the licensee proposes to submit a surveillance program by January 1, 1993. In the next five years, the maximum estimated dose that the Boraflex will be exposed to is estimated to be 7.3×10^8 Rads gamma. At this exposure, the amount of shrinkage is not expected to produce gaps that would significantly degrade the Boraflex neutron absorption performance. Therefore, a commitment to provide a surveillance program by January 1, 1993 is acceptable. The surveillance program should include non-destructive examination of multiple, representative, full-length Boraflex panels that have received the maximum spent fuel pool exposure to examine for the presence of gaps. The full-length panels should be examined periodically, on a time frame consistent with increasing degrees of predicted shrinkage. Alternatively, an analysis based on the actual Waterford 3 configuration and data which demonstrates the effectiveness of the Boraflex poison material for increased degrees of predicted shrinkage may be performed. The proposed program should incorporate actual data from the examination of approximately 10 representative full-length panels for the presence of gaps to provide a basis for the extended surveillance program.

4.0 CONCLUSION

Based on the above evaluation, the staff finds the licensee's Boraflex surveillance program proposal acceptable. This includes the following revised commitments:

1 - The original Boraflex coupon surveillance program will not be performed.

2 - LP&L will develop a log to track the gamma dose buildup in the spent fuel storage racks.

3 - LP&L will keep abreast of new industry developments on Boraflex integrity for the next few years. An appropriate program will be proposed to the NRC by January 1, 1993.

This surveillance program should include:

- data from the non-destructive examination of approximately 10 representative full-length Boraflex panels for the presence of gaps; and

- periodic re-examination of multiple, representative, full-length Boraflex panels on a time frame consistent with increasing degrees of predicted shrinkage or, alternatively, an analysis based on the actual Waterford 3 configuration and data which demonstrates the effectiveness of the Boraflex poison material for increased degrees of predicted shrinkage.

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