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February 11, 1992

Docket No. 50-423
B13939
Re: Spent Fuel Pool Boraflex

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

References:

1. G. S. Vissing letter to E. J. Mroczka, "Boraflex Degradation in Millstone 2 Spent Fuel Racks (TAC No. 77725)," dated February 7, 1991.
2. J. F. Opeka letter to U.S. Nuclear Regulatory Commission, "Millstone Nuclear Power Station, Unit No. 2, BORAFLEX Degradation In Spent Fuel Racks (TAC No. 77725)," dated November 21, 1991.

Gentlemen:

Millstone Nuclear Power Station, Unit No. 3
Spent Fuel Pool Boraflex Surveillance Coupons

Boraflex has been widely used as a neutron absorbing poison within the spent fuel pool storage racks of many commercial nuclear power plants. Industry experience in the use of this material has shown that Boraflex is mechanically susceptible to gamma radiation damage associated with spent fuel rack storage service. The damage results in either perimeter shrinkage of the panels if the Boraflex is mechanically unrestrained or "in panel" separation (gap formation) if the Boraflex is mechanically restrained. At times, a combination of both types of damage can occur. The purpose of this letter is to provide the NRC Staff with Northeast Nuclear Energy Company's (NNECO) assessment of this phenomenon for the Millstone Unit No. 3's spent fuel pool storage racks.

In 1987, the NRC Staff issued Information Notice No. 87-43 "to alert recipients to a potentially significant problem . . . wherein gap formation in neutron absorbing materials (Boraflex) might excessively reduce the margin of nuclear subcriticality in the fuel pool and compromise safety." At that time, gap formation in Boraflex was attributed to fabrication induced restraints within the spent fuel rack structure. NNECO's evaluation and review of Millstone Nuclear Power Station, Unit Nos. 2 and 3 spent fuel rack design was based on this notice and determined that due to the respective rack designs, Millstone Unit Nos. 2 and 3 were not susceptible to the fabrication induced restraints and the associated gap formation.

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In 1990, Millstone Unit No. 2 discovered deterioration of the Boraflex material while preparing a surveillance coupon for routine examination. Subsequent to this discovery, blackness testing of the Boraflex panels in the racks was performed and revealed that gap formation was present in the spent fuel racks. These gaps were assessed to be a result of a potential inservice restraint mechanism. NNECO reanalyzed the rack design to incorporate the gaps observed into the criticality analysis and determined that the racks would maintain the required K_{eff} less than 0.95. The NRC Staff concurred with this analysis in a letter to NNECO dated February 7, 1991 (Reference 1).

By letter dated November 21, 1991 (Reference 2), NNECO informed the NRC Staff of the results of the second blackness testing campaign, which began on October 15, 1991, at Millstone Unit No. 2. The test results indicated that gap growth had been experienced in the cell locations previously identified to have gaps. Additionally, new gaps had been detected in cells where no gaps had been previously identified. In addition to the immediate corrective actions identified in the November 21, 1991, letter, NNECO also identified the need to reevaluate the integrated gamma dose value associated with the Millstone Unit No. 2 analysis. The test results have indicated that the Boraflex continues to be susceptible to damage and had not reached the saturation level as previously assumed. As a result of this testing, Millstone Unit No. 2 has restricted fuel movements within the spent fuel pool until further analysis is completed.

Because of the problems experienced with the use of Boraflex at Millstone Unit No. 2, NNECO revisited the 1989 evaluations and examinations of the first set of Boraflex coupon specimens retrieved from the Millstone Unit No. 3 spent fuel pool. The Boraflex coupon specimens were removed from the spent fuel pool and sent to a vendor, NUSURTEC, for analysis. The NUSURTEC analysis established "that Boraflex absorbers . . . have retained their neutron absorption properties . . . and are capable of continuing to perform their intended function of controlling reactivity." However, the NUSURTEC report also established that "the coupons were found to be broken" and under compressive load. The report suggested that this compression is probably not representative of the use of Boraflex in the storage racks and does not necessarily suggest degradation of the Boraflex in the spent fuel storage racks. The compression of the surveillance coupons was attributed to the coupon holders and not the coupons. The report also determined that, due to the compressive loading of the coupons, the coupons cannot be used in determining shrinkage characteristics of the Boraflex in the storage racks. Because the coupons are not able to predict shrinkage of the Boraflex, Millstone Unit No. 3 does not have the ability to directly determine physical dimensional changes to the Boraflex.

In 1991, a second set of coupons was forwarded from Millstone Unit No. 3 to NUSURTEC for examination and analysis. The results reported were consistent with the 1989 report including the presence of cracks in the coupon specimens. However, NUSURTEC concluded that the continued "appearance of the unexplained cracks in the coupons opens the possibility that Boraflex between cells of the racks may have developed cracks and gaps."

Boraflex's shrinkage properties have been extensively studied by the industry as addressed in EPRI Report NP-6159, "An Assessment of Boraflex Performance in Spent Nuclear Fuel Storage Racks." At least twelve nuclear units, along with BISCO, a Boraflex fabricator, provided the data for this report. Among the conclusions drawn in this report was that the maximum amount of shrinkage resulting in gap formation and propagation of Boraflex, when exposed to a radiation field, is no greater than 4 percent in either direction (length or width). The majority of the observed shrinkage was less than 3 percent.

Based on EPRI's extensive data collection and analysis of this shrinkage phenomenon, any Boraflex shrinkage experienced at Millstone Unit No. 3 can be assumed to be consistent with industry data. Utilizing this data provides a comparable indirect determination of shrinkage and thus the surveillance coupons would not be required to directly monitor Boraflex shrinkage.

Taking into account the industry experience with Boraflex shrinkage, an evaluation to determine if potential degradation in the Boraflex panels, assuming a worse case degradation of 3.3 percent maximum shrinkage, was performed for the gap formation. Each region of the spent fuel pool was evaluated with respect to the actual fuel loading that has been experienced.

Irradiated fuel has never been stored in Region 1 of the spent fuel pool. Since irradiation is the cause of Boraflex degradation, the Region 1 criticality analysis remains valid and the design limit of $k_{eff} \leq 0.95$ was preserved. It must be noted, however, that this limit could have been exceeded if the assumed worst case degradation (3.3 percent shrinkage or gap) had existed.

The spent fuel loaded into Region 2 since the end of Cycle 2 was evaluated against the K_{eff} criterion. The Boraflex was not irradiated until fuel was loaded into this region at the end of Cycle 1. Therefore, the end of Cycle 2 is considered the earliest time when serious Boraflex degradation may have existed. All fuel loaded in Region 2 since the end of Cycle 2 has had a high enough burnup to offset any potential reactivity effects of the postulated Boraflex degradation.

In summary, enough reactivity credit exists in the actual conditions of the spent fuel storage racks to offset the potential reactivity penalties in Region 2 of the spent fuel pool. The Region 1 racks have never seen irradiation and thus the reactivity limits have been met. Additionally, it is judged that there is sufficient margin with the fuel currently on-site that even if the Region 1 racks had been irradiated prior to loading fresh fuel into them, the pool would remain subcritical although the criterion to maintain K_{eff} less than 0.95 could have been violated. It should be noted that all of these evaluations assumed there is no boron in the spent fuel pool water, which is an additional conservatism.

It is important to note that this evaluation only takes into account the spent fuel currently residing in the spent fuel pool. The storage racks, previously qualified to store spent fuel with maximum enrichments up to 5.05 weight percent U235, may not maintain this qualification should the Boraflex panels experience gap formation of the magnitude assumed in this evaluation. Blackness testing, to determine the maximum extent of the gap formation within the storage racks, will be performed on the Millstone Unit No. 3 spent fuel racks to validate these assumptions. This testing, contingent on vendor availability, is expected to occur in June of 1992. To provide an additional level of confidence that the spent fuel storage racks satisfy design conditions, a reanalysis of the fuel pool criticality analysis will be performed utilizing the data obtained from the blackness testing of the racks. Additionally, because NNECO intends to utilize blackness testing and industry data to account for any shrinkage effects or gap formation in the Boraflex, the intent of the Boraflex surveillance program commitment described in the FSAR remains valid.

We trust you will find this information satisfactory and we remain available to answer any questions you may have.

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY

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Executive Vice President

BY: C. F. Sears
C. F. Sears
Vice President

cc: T. T. Martin, Region I Administrator
Vernon L. Rooney, NRC Project Manager, Millstone Unit No. 3
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