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

# SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

# CONCERNING

# BORAFLEX DEGRADATION IN SPENT FUEL RACKS

# NORTHEAST NUCLEAR ENERGY COMPANY

# MILLSTONE NUCLEAR POWER STATION, UNIT NO. 2

# DOCKET NO. 50-336

## 1.0 INTRODUCTION

By letter dated August 7, 1990, Northeast Nuclear Energy Company, the licensee, informed us that Boraflex material in the vent hole of one of the test coupons was missing. A subsequent examination has indicated that the material was removed from the area due to combined effects of radiation and flow induced erosion. In order to verify to what extent this phenomena could affect Boraflex panels, the licensee has performed blackness testing on 420 panels and by letter dated October 1, 1990, informed us that 45 panels had one gap and 3 panels had two gaps in their Boraflex material. The largest gap was 1.8-inch wide. In addition, Combustion Engineering performed an analysis which confirmed that the K-eff would be less than 0.95 for 2.7 inch gaps located at the same axial elevation throughout all of the Region I spent fuel storage racks fully loaded with fuel assemblies with a maximum enrichment of 4.5 weight percent U-235. In response to our questions, the licensee, by letter dated January 4, 1991, informed us that the panels containing gaps were exposed to between 5.9E0 and 2.3E10 rads of gamma radiation and that it is estimated that the panels will receive additional radiation at about 1.1E7 rads/day for 1 year storage. The licensee has indicated that they will implement an increased surveillance plan of follow-up blackness testing.

## 2.0 EVALUATION

Boraflex material consists of boron carbide particles imbedded in a polysiloxane matrix. Under nuclear radiation polysiloxane polymer undergoes changes which alter its physical characteristics. Radiation induces crosslinking of molecules which results in shrinking of the Boraflex panels. Higher radiation produces also scissioning of the polymer molecules which produces brittleness and reduces panels' mechanical strength. In the spent fuel racks Boraflex panels are encapsulated in metal wrappers and in many cases are not free to move within the wrappers. The causes them to break as polymer contracts and one or more gaps may be formed. This size of the gaps depends on the degree of contraction and on the way Boraflex panel is restrained witnin the wrapper. Since the contraction depends on radiation dose absorbed by the Boraflex, the gaps increase as the Boraflex panel receives more radiation. However, at certain doses, crosslinking reaches saturation and then very little contraction of polymer takes place as more radiation energy is absorbed. For Boraflex this limit is reached at about 5E9 rads. Since accumulated gamma radiation by the Millstone 2 spent fuel racks

is higher than this value, it is not expected that the maximum gap of 1.8 inches would significantly increase with additional gamma irradiation. Higher radiation can, however, induce degradation of mechanical properties of the polymer due to scissioning. This effect is not very significant since Boraflex panels are protected by metallic wrappers and except for the exposed portions near the vent holes, are not subjected to hydraulically induced erosion. Although it is not expected that the integrity Boraflex panels will be affected, it is recommended that, as a precaution, occasional checks of their integrity be performed by visual inspection and blackness testing.

## 3.0 CONCLUSION

Based on our reviews, we conclude that the Boraflex panels in the Millstone 2 spent fuel racks did not undergo degradation which would affect their functional performance. The licensee should be aware of the existence of degrading mechanisms, especially increase of brittleness of polymer with irradiation. Therefore, we concur in the licensee's increased surveillance plan. We conclude that the licensee's surveillance plan is adequate to confirm that continued spent fuel storage in the Millstone 2 spent fuel racks will not cause the staff's acceptance criterion of K-eff no greater than 0.95 to be violated. However, we want to be informed if future blackness tests indicate increased gap sizes which may invalidate the current criticality analyses.

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Dated: February 7, 1991