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MEMORANDUM FOR: R. O. Meyer, Leader, Reactor Fuels Section, CPB, DSI

FROM D. A. Powers, Reactor Fuels Section, CBP, DSI

SUBJECT: GUIDE TUBE WEAR INPUT FOR THE ANNUAL REPORT

As requested for the next Fuel Performance Annual Report, I have prepared the attached material which discusses the licensing actions during 1979 that pertain to PWR guide tube wear.

D. A. Powers
Reactor Fuels Section
Core Performance Branch
Division of Systems Integration

Attachment:
As stated

cc: L. Rubenstein
M. Tokar
W. Johnston

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ATTACHMENT

As reported in last year's annual report (1), a fretting wear has been observed in irradiated fuel assemblies taken from operating PWR reactors. These observations revealed an unexpected degradation of rodded guide tubes. It was subsequently concluded that coolant turbulence was responsible for inducing vibratory motions in the normally fully withdrawn control rods and, when these vibrating rods were in contact with the inner surface of the guide tubes, a wearing of the guide tube wall has taken place. Significant wear has been found to be limited to the relatively soft Zircaloy-4 guide tubes because the Inconel-625 cladding on the control rods provides a relatively hard wear surface. The extent of the observed wear has been observed to be both time and plant dependent and has in some cases extended completely through the tube wall.

Guide tubes function principally as the main structural members of the fuel assembly and as channels to guide and decelerate control rod motion. Significant loss of mechanical integrity due to wear or hole formation could (a) result in the inability of the guide tubes to withstand their anticipated loadings for fuel handling accidents and condition 1-4 events and (b) hinder scramability. Therefore in light of this significance, the NRC staff has continued to review the guide tube wear issue on both a generic basis with vendors and owner's groups and on a case-by-case basis with applicants and licensees.

Combustion Engineering

During 1979 C-E continued to rely mainly on chrome-plated stainless-steel sleeves to mitigate control rod wear to guide tube walls. In pursuit of a permanent solution, C-E now has flow-modifying test assemblies inpile at four plants: Maine Yankee; Arkansas Nuclear One, Unit 2; Millstone, Unit 2; and Calvert Cliffs, Unit 2.

In 1979 reload outage surveillance on guide tube integrity was reported on five C-E NSSS plants: Fort Calhoun (2); Millstone, Unit 2 (3); St. Lucie, Unit 1 (4); Calvert Cliffs, Unit 1 (5); and Calvert Cliffs, Unit 2 (6). The surveillance (5) at Calvert Cliffs, Unit 1 revealed a large number of sleeved guide tubes that failed confirmatory pull testing (non-destructive testing which is used to verify adequate motion resistance of the sleeve to axial drag force). The affected guide tubes were found to be unique to the specific installation sequence procedure used only on previously irradiated fuel assemblies at Calvert Cliffs, Unit 1. Repairs were subsequently performed by recrimping the affected guide tube sleeves. With the exception of this anomaly, the C-E use of sleeves continues to be an acceptable means of alleviating guide tube wear.

Westinghouse

In response to the NRC's attempt to assess the susceptibility and impact of guide tube wear in Westinghouse plants, Westinghouse submitted information (7) on (a) guide tube wear measurements taken on irradiated 14x14 fuel assemblies

from Point Beach, Units 1 and 2, (b) a mechanistic wear model, and (c) the impact of the model's wear predictions on the safety analyses of plant designs.

Westinghouse believes that their fuel designs will experience less wear than that reported in some other NSSS designs because the Westinghouse designs use thinner, more flexible, control rods that have relatively more lateral support in the guide tube assembly of the upper core structure.

The staff concluded (for example see Reference 8) that the Westinghouse analysis probably accounts for all of the major variables that control this wear process, and that the wear in 15x15 fuel assemblies should be equivalent to that experienced and measured in 14x14 fuel assemblies, and therefore these designs are not likely to experience significant wear to the degree that the design capabilities will be impaired.

However, because of the complexities and uncertainties in determining input variables for the new 17x17 fuel assembly design, the staff required (for example see Reference 8) several near-term OL applicants to submit to a surveillance program. For acceptability, the minimum objective of such program was to demonstrate that there is no occurrence of hole formation in rodded guide tubes. At present these applicants are forming an owner's group which is tentatively planning to submit a surveillance program during 1980.

Babcock & Wilcox

Responding to NRC inquiries, B&W has submitted information (9) on their assessment of the potential for guide tube wear in their plants. The B&W submittal did not provide a means for predicting the rate of wear nor were wear measurements on irradiated fuel assemblies submitted, therefore the submittal was found to be deficient (10). Consequently, NRC has required (for example see Reference 11) that B&W licensees and an applicant provide confirmatory measurements on spent fuel assemblies that verifies that the B&W designs will not experience through-the-wall wear in guide tubes. On December 20, 1979, a B&W owner's group met with the NRC staff and presented the details of a preliminary 1980 surveillance program designed to verify the resistance of B&W NSSS plants to guide tube wear.

Exxon

ENC will supply (12) the reload fuel for cycle 5 operation of Maine Yankee. To mitigate guide tube wear in this C-E designed plant, the ENC fuel will incorporate a sleeved guide tube design that is similar to that used in the residual fuel assemblies which were supplied by C-E.

In light of the lower wear rates in W designed plants, the ENC reload fuel for these NSSS plants do not employ design modifications to reduce guide tube wear. In 1980 ENC plans (13) to perform surveillance on their spent fuel assemblies discharged from H. B. Robinson, Unit 2 to verify the adequacy of their guide tube design in W plants.

REFERENCES

1. M. Dean Houston, "Fuel Performance Annual Report (Period Through December 1978)," USNRC Report NUREG-0633, December 1979.

2. Letter from T. E. Short, Omaha Public Power District, to Director of I&E, USNRC, Docket No. 50-285, dated March 1, 1979.

3. Letter from W. G. Council, Northeast Utilities, to R. Reid, USNRC, Docket No. 50-336, Subject: "Sleeved CEA Guide Tube Inspection," dated May 23, 1979.

4. Letter from R. E. Uhrig, Florida Power and Light Company, to R. W. Reid, USNRC, Docket No. 50-335, Subject: "CEA Guide Tube Inspection/Evaluation," dated May 23, 1979.

5. Letter from W. J. Lippold, Baltimore Gas and Electric Company, to E. Conner, USNRC, Docket No. 50-317, dated May 24, 1979.

6. Letter from R. C. L. Olson, Baltimore Gas and Electric Company, to R. W. Reid, USNRC, Docket No. 50-318, Subject: "CEA Guide Tube Inspection Program," dated November 12, 1979.

7. Letter from T. M. Anderson, Westinghouse Electric Corporation, to D. G. Eisenhut, USNRC, NS-TMA-2102, dated June 27, 1979.

8. Letter from L. S. Rubenstein, USNRC, to H. G. Parris, Tennessee Valley Authority, Docket Nos. 50-327/328, Subject: "Degradation of Guide Thimble Tube Walls," dated December 14, 1979.

9. Letter from J. H. Taylor, Babcock & Wilcox, to B. K. Grimes, USNRC, dated January 12, 1979.

10. Letter from B. K. Grimes, USNRC, to J. H. Taylor, Babcock & Wilcox, dated August 22, 1979.

11. Letter from L. S. Rubenstein, USNRC, to S. H. Howell, Consumers Power Company, Docket Nos. 50-329/330, Subject: "Request for Additional Information on Fuel Assembly Guide Tube Wear for Midland Plant, Units 1 and 2," dated November 15, 1979.

12. Letter from R. H. Groce, Maine Yankee Atomic Power Company, to R. W. Reid, USNRC, Docket No. 50-309, Subject: "Questions Pertaining to Cycle 5 Reload Fuel," dated November 6, 1979.

13. Letter from G. F. Owsley, Exxon Nuclear Company, to T. A. Ippolito, USNRC, dated December 5, 1979.