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Docket No. 50-289

Mr. Henry D. Hukill, Vice President
and Director - TMI-1
Metropolitan Edison Company
P. O. Box 480
Middletown, Pennsylvania 17057

Dear Mr. Hukill:

The staff has completed its review of the B&W Report, BAW-1623, June 1980, "Control Rod Guide Tube Wear Measurement Program". The results of our review of this report are contained in the enclosed Safety Evaluation Report.

Based on this review, the staff has concluded that the issue of Control Rod Guide Tube Wear has been adequately addressed for B&W facilities and considers this Multi-Plant issue to be closed.

If you have any questions on this subject, please contact your NRC Project Manager.

Sincerely,
"ORIGINAL SIGNED BY
JOHN F. STOLTZ"

John F. Stolz, Chief
Operating Reactors Branch #4
Division of Licensing

Enclosure:
Safety Evaluation Report

cc w/enclosure:
See next page

OFFICE	ORB#4:DL	C-ORB#4:DL					
SURNAME	DDiIanni/cb	JStolz					
DATE	7/24/81	7/24/81					

cc w/enclosure(s):

Mr. Marvin I. Lewis
6504 Bradford Terrace
Philadelphia, Pennsylvania 19149

Walter W. Cohen, Consumer Advocate
Department of Justice
Strawberry Square, 14th Floor
Harrisburg, Pennsylvania 17127

Robert L. Knupp, Esq.
Assistant Solicitor
Knupp and Andrews
P. O. Box P
407 N. Front Street
Harrisburg, Pennsylvania 17108

John E. Minnich, Chairman
Dauphin Co. Board of Commissioners
Dauphin County Courthouse
Front and Market Streets
Harrisburg, Pennsylvania 17101

* Atomic Safety and Licensing Appeal Board
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

* Atomic Safety and Licensing Board Panel
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

* Docketing and Service Section
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Robert Q. Pollard
609 Montpelier Street
Baltimore, Maryland 21218

Chauncey Kepford
Judith H. Johnsrud
Environmental Coalition on Nuclear Power
433 Orlando Avenue
State College, Pennsylvania 16801

Ms. Frieda Berryhill, Chairman
Coalition for Nuclear Power Plant
Postponement
2610 Grendon Drive
Wilmington, Delaware 19808

Mrs. Rhoda D. Carr
1402 Marene Drive
Harrisburg, Pennsylvania 17109

Dr. Walter H. Jordan
881 W. Outer Drive
Oak Ridge, Tennessee 37830

Dr. Linda W. Little
5000 Hermitage Drive
Raleigh, North Carolina 27612

Ms. Gail P. Bradford
Anti-Nuclear Group Representing
York
245 W. Philadelphia Street
York, Pennsylvania 17404

John Levin, Esq.
Pennsylvania Public Utilities Comm.
Box 3265
Harrisburg, Pennsylvania 17120

Jordan D. Cunningham, Esq.
Fox, Farr and Cunningham
2320 North 2nd Street
Harrisburg, Pennsylvania 17110

Ms. Louise Bradford
TMIA
1011 Green Street
Harrisburg, Pennsylvania 17102

Ms. Marjorie M. Aamodt
R.D. #5
Coatesville, Pennsylvania 19320

Ms. Karen Sheldon
Sheldon, Harmon & Weiss
1725 I Street, N.W. - Suite 506
Washington, D. C. 20006

Earl B. Hoffman
Dauphin County Commissioner
Dauphin County Courthouse
Front and Market Streets
Harrisburg, Pennsylvania 17101

Ms. Ellen R. Weiss, Esq.
Sheldon, Harmon & Weiss
1725 I Street, N.W.
Suite 506
Washington, D. C. 20006

Mr. Steven C. Sholly
Union of Concerned Scientists
1725 I Street, N. W., Suite 601
Washington, DC 20006

Mr. Thomas Gerusky
Bureau of Radiation Protection
Department of Environmental Resources
P. O. Box 2063
Harrisburg, Pennsylvania 17120

G. F. Trowbridge, Esq.
Shaw, Pittman, Potts & Trowbridge
1800 M Street, N.W.
Washington, D. C. 20036

Mr. E. G. Wallace
Licensing Manager
GPU Service Corporation
100 Interpace Parkway
Parsippany, New Jersey 07054

Ms. Virginia Southard, Chairman
Citizens for a Safe Environment
264 Walton Street
Lemoyne, Pennsylvania 17043

Government Publications Section
State Library of Pennsylvania
Box 1601 (Education Building)
Harrisburg, Pennsylvania 17126

Mr. David D. Maxwell, Chairman
Board of Supervisors
Londonderry Township
RFD#1 - Geyers Church Raod
Middletown, Pennsylvania 17057

U. S. Environmental Protection Agency
Region III Office
ATTN: EIS COORDINATOR
Curtis Building (Sixth Floor)
6th and Walnut Streets
Philadelphia, Pennsylvania 19106

Ms. Jane Lee
R.D. 3, Box 3521
Etters, Pennsylvania 17319

Karin W. Carter, Esq.
505 Executive House
P. O. Box 2357
Harrisburg, Pennsylvania 17120

Honorable Mark Cohen
512 D-3 Main Capital Building
Harrisburg, Pennsylvania 17120

Dauphin County Office Emergency Preparedness
Court House, Room 7
Front & Market Streets
Harrisburg, Pennsylvania 17101

Department of Environmental Resources
ATTN: Director, Office of Radiological Health
P. O. Box 2063
Harrisburg, Pennsylvania 17105

Ms. Lennie Prough
U. S. N. R. C. - TMI Site
P. O. Box 311
Middletown, Pennsylvania 17057

Mr. Robert B. Borsum
Babcock & Wilcox
Nuclear Power Generation Division
Suite 420, 7735 Old Georgetown Road
Bethesda, Maryland 20014

* Ivan W. Smith, Esq.
Atomic Safety & Licensing Board Panel
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Ms. Kathy McCaughin
Three Mile Island Alert, Inc.
23 South 21st street
Harrisburg, Pennsylvania 17104

Mr. C. W. Smyth
Supervisor of Licensing TMI-1
Metropolitan Edison Company
P. O. Box 480
Middletown, Pennsylvania 17057

Mr. R. J. Toole
Manager, TMI-1
Metropolitan Edison Company
P. O. Box 480
Middletown, Pennsylvania 17057

Allen R. Carter, Chairman
Joint Legislative Committee on Energy
P. O. Box 142
Suite 513
Senate Gressette Building
Columbia, South Carolina 29202

Daniel M. Pell, Esq.
ANGRY
32 South Beaver Street
York, Pennsylvania 17401

William S. Jordan, III, Esq.
Harmon & Weiss
1725 I Street, NW, Suite 506
Washington, DC 20006

J. B. Lieberman, Esq.
Berlock, Israel & Liberman
26 Broadway
New York, NY 10004

General Counsel
Federal Emergency Management Agency
ATTN: Docket Clerk
1725 I Street, NW
Washington, DC 20472

York College of Pennsylvania
Country Club Road
York, Pennsylvania 17405

Mr. Donald R. Haverkamp
Senior Resident Inspector (TMI-1)
U. S. N. R. C.
P. O. Box 311
Middletown, Pennsylvania 17057

Mr. Richard Roberts
The Patriot
812 Market Street
Harrisburg, Pennsylvania 17105

Governor's Office of State Planning
and Development
ATTN: Coordinator, Pennsylvania
State Clearinghouse
P. O. Box 1323
Harrisburg, Pennsylvania 17120

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

Enclosure

SAFETY EVALUATION REPORT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

CONTROL ROD GUIDE TUBE WEAR IN FACILITIES

DESIGNED BY BABCOCK AND WILCOX (B&W)

A degradation of control rod guide tube walls was observed during post irradiation examinations of fuel assemblies removed from several pressurized water reactors. In the investigation of this problem the NRC requested information from B&W designed facilities related to the susceptibility of their facilities to significant guide tube wear. B&W prepared report BAW-1623, June 1980, "Control Rod Guide Tube Wear Measurement Program" for the B&W Mk-B User's Group to provide this requested information. The findings of this report are as follows.

Several flow-related mechanisms may cause Control Rod Assembly (CRA) vibration and guide tube wear; two of these appear to be the most probable. The first is turbulent flow along the rod or crossflow across the control rods in the upper internals, resulting in wear at the lower tip of the rod when in the park position. The second hypothesized mechanism is axial flow inside the guide tube and a turbulent vibration response. In both cases, an increase in primary coolant flow could result in higher rod vibration and possible higher wear; however it is felt that turbulent flow with some possible crossflow in the internals area is the most probable cause of rod vibration.

B&W's 15x15 array fuel assembly design includes 16 Zircaloy guide tubes for the control rods. Each CRA has 16 stainless steel clad control rods connected to a stainless steel spider which is in turn connected to the drive mechanism. Full length guidance for each CRA is provided by the guides in the upper plenum assembly and in the fuel assembly. The control rod tip always remains inside the fuel assembly guide tube during normal operation. When the control rod is in the full out (parked) position, the tip of the control rod is approximately nine inches inside the fuel assembly guide tube. The CRAs and guide tubes are designed with flexibility and clearances to permit freedom of motion within the fuel assembly guide tubes throughout the stroke of the CRA.

The B&W upper reactor internals design, in addition to the full-length guidance for the CRAs, has two features that minimize crossflow excitation and turbulence on the CRAs. The first is an upper plenum, which directs approximately 82% of the flow in an axial direction while allowing only 18% of the flow to be taken out directly into the outlet nozzles. This strong tendency towards axial flow will minimize any dependence of CRA vibration on outlet nozzle location. The second feature is the use of the full-length upper plenum tubes enclosing each CRA in the upper reactor internals. These full-length tubes provided additional protection for the CRAs against crossflow and turbulence.

Fuel assemblies were selected from across the core and for various effective full-power days (EFPD) of control rod operation in the safety position to determine the effect of core-position, time, fluence exposure, etc. To obtain the effect of flow rates on guide tube wear, fuel assemblies were examined at Oconee 1, Oconee 3, and Rancho Seco, the nominal flows of which run from approximately 109 to 114% of design flow. Two potential areas of concern were investigated. The first concern is that any one guide tube could wear through at the control rod park position (approximately 9 inches from the top of the control rod guide tube). The second concern is that smaller amounts of wear in all 16 guide tubes in a fuel assembly could cause high stresses in that fuel assembly.

The results from the Rancho Seco examination (high flow rate) indicates that the largest measured wear was 57% (through-wall wear). In general, the wear was located approximately 9 inches down from the top of the guide tube, which corresponds to the location of the lower tip of the control rods of the safety banks in their park position. This location also corresponds to the control rod park position for control banks in some reactors. Four Rancho Seco fuel assemblies indicated wear ranging from 6.9 to 14.9% for one and one half cycles of operation. The other five assemblies examined indicated no wear.

The results from the Oconee examination (low flow rates) indicate less wear than Rancho Seco, with a maximum measured indication of 27% (in Oconee 3). The average wear for each Oconee fuel assembly was low, with a maximum of 6.7%.

The second concern was that each guide tube would have some wear and that unacceptable stresses could occur. A stress analysis was performed that showed that through-wall wear for a single tube was acceptable. This analysis also considered the case with some wear in each guide tube. Two types of wear were considered - localized wear on only one side of the tube and uniform wear around its circumference. The results of this analysis show an allowable of 100% wear for localized (one-sided) defects and 55% wear for uniform circumference wear. Therefore, if the average wear in any fuel assembly (average of 16 tubes) does not exceed 55% uniform wear, the fuel assembly will maintain a positive design margin.

The results of both the Oconee and Rancho Seco measurements show small average wear with the maximum average of 14.9% for one Rancho Seco assembly with 1 1/2 cycles of operation. The 14.9% was one-sided wear which is compared to an allowable wear of 100%.

The results from the Rancho Seco statistical analysis indicate the probability of one guide tube wearing a hole is very low and is not expected. The probability that a hole will occur in 150 weeks of operation is 0.000011. The results from this analysis also indicate that the probability of the average of 16 tubes in one assembly reaching 55% wear is also very low and is not expected. The probability of the average of 16 tubes reaching 55% wear is 0.000001 for 150 weeks of operation. This case assumes uniform circumferential wear, which is not expected. The more likely case is wear occurring on only one side of the guide tube. This case has a higher allowable wear (100% versus 55%) and hence a significantly smaller probability of reaching this wear. (The assumed maximum core residence time for a fuel assembly with an installed CRA is 150 weeks.)

The NRC staff has found that the B&W Report accounts for all of the major variables that affect the control rod guide tube wear process. Based on our review, we conclude that the control rod guide tube wear has an acceptably low likelihood of keeping within allowable wear limits.

Dated: JULY 2 4 1981