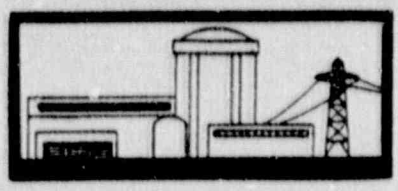
THE B&W OWNERS GROUP

Arkansas Power & Light Company
Duke Power Company
Florida Power Corporation
GPU Nuclear Corporation

ANO-1
Oconee 1, 2, 3
Crystal River 3
TMI-1



Sacramento Municipal Utility District
Toledo Edison Company
Tennessee Valley Authority
Babcock & Wilcox Company

Rancho Seco
Davis Besse
Bellefonte 1,2

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November 27, 1989
OG-606

Mr. Terence L. Chan, Senior Project Manager
Project Directorate V
Division of Reactor Projects - III,
IV, V and Special Projects
Office of Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Babcock & Wilcox Owners Group Response to NRC Bulletin 88-11, "Pressurizer Surge Line Thermal Stratification"

References: 1) NRC Letter, Terence L. Chan to Daniel F. Spond, "NRC Bulletin 88-11, 'Pressurizer Surge Line Thermal Stratification,'" dated August 17, 1989

2) B&WOG Letter, Daniel F. Spond to Terence L. Chan, "Babcock & Wilcox Owners Group Response to NRC Bulletin 88-11, 'Pressurizer Surge Line Thermal Stratification,'" dated September 29, 1989, OG-854

Dear Mr. Chan:

Reference 1 documented the NRC's request for additional information regarding the B&W Owners Group (B&WOG) report BAW-2085, Submittal in Response to Nuclear Regulatory Commission Bulletin 88-11 "Pressurizer Surge Line Thermal Stratification," dated May 1989. Reference 2 provided the B&WOG's response to the Staff's request for additional information with the exception of Question 9 on Section 5 (Q5.9) of BAW-2085. Reference 2 provided the following information:

Attachment 1 - B&W Owners Group Responses to NRC Questions on BAW-2085, September 1989

Attachment 2 - B&W Owners Group Status Report on Thermal Striping Evaluation, September 1989

IE30
1/1

The purpose of this letter is to provide the Staff with the B&WOG's response to Q5.9 of Reference 1. Our response is provided as an attachment to this letter in the same format as Attachment 1 of Reference 2.

The B&WOG is continuing work on its comprehensive program in response to NRC Bulletin 88-11. The B&WOG will document the results of this program in a topical report which is scheduled for submittal in December 1990. This submittal will meet the technical and schedule requirements of NRC Bulletin 88-11.

Individual licensees will submit or reference the material provided by this letter so that it is appropriately docketed. Should you require any further information, please contact me at (501) 377-3865 or contact the B&W Owners Group Project Manager, W. R. Gray, at (804) 385-2783.

Very truly yours,

Daniel F. Spond

Daniel F. Spond, Chairman
B&WOG Materials Committee

DFS/leh

Attachment

cc: W. T. O'Connor - TE
R. B. Borsum - B&W

B&W OWNERS GROUP RESPONSE TO NRC QUESTION 5.9 ON BAW-2085

SECTION 5 - QUESTION 9 (5.9)

The use of twice "strain-hardened" yield strength in place of the 3Sm limit required by the ASME Code may be non-conservative. The acceptable interim limit is twice yield strength based on CMTR values.

RESPONSE (Q5.9)

In order to be responsive to the Staff's question (above), additional stress analyses have been performed for comparison with the 3Sm limit.

SUMMARY OF RESULTS

A more detailed stress analysis of the surge line elbows has been performed to demonstrate compliance with the ASME Code (Eq. 12) based on a 3Sm limit. This analysis was limited to the elbows since the simplified Eq. 12 piping stress is well within Code allowables for the surge line straight piping. This analysis was performed for the worst Oconee 1 measured stratification temperature differential.

The resultant Eq. 12 stress was found to be lower than the 3Sm value, based on CMTR yield strength. The resultant fatigue usage factor remains bounded by that which is reported in BAW-2085.

Background information on the bounding analysis and the verification analysis (which utilized Oconee data) is summarized in the last section of this response.

SUPPLEMENTARY STRESS ANALYSIS

The analyses performed in response to Q5.9 made use of CMTR values to adjust the surge line elbow Code allowables. The CMTR values for both the yield strength and the ultimate tensile strength are a minimum of 10% higher than the Code allowables for any 177 FA plant. Therefore, the 3Sm Code limit, adjusted for the minimum CMTR values, is 66.0 Ksi (1.10*60.0). The stress was then calculated using Table NB-3685.1-2 of the ASME Code and the moments resulting from the most critical Oconee 1 measured top-to-bottom thermal stratification (delta T=280F). The maximum calculated stress was determined to be 65.4 Ksi occurring in the second elbow from the hot leg. This is less than the adjusted Code allowable. The thermal expansion stress range of 65.4 Ksi is a "Tresca" stress intensity using the maximum difference

between the principal stresses. As a point of comparison, the maximum thermal expansion stress range using the "von Mises" criterion was determined to be 57.7 Ksi ("von Mises stress intensity").

In addition, an elastic finite element stress analysis of each elbow has been performed using the loadings from the maximum measured temperature difference, assuming the surge line boundaries are rotationally rigid, and applying a 25% increase to the thermal expansion stress range for non-linearity. The finite element analysis achieved approximately a 10% reduction in the stresses calculated above using Table NB-3685.1-2 of the ASME Code. This 10% reduction applies to both the "Tresca" and "von Mises" stress intensity values shown above.

USAGE FACTOR

The following table summarizes the contributions to the cumulative usage factor at the most critical elbow location:

	LOADINGS	FATIGUE CONTRIBUTION	
1.	Heatup	36%	(including striping)
2.	Cooldown	24%	(including striping)
3.	Stress report	32%	(stress same as bounding fatigue analysis)
4.	Thermal striping	8%	
	TOTAL	100%	(89% of bounding fatigue analysis presented in BAW-2085)

This table is presented in accordance with the conditions listed in Appendix B of BAW-2085 and is similar to Tables 1 and 2 of the B&WOG's September 29, 1989 submittal of responses to the other Staff questions on BAW-2085. For each condition, a percentage of the total cumulative usage factor is provided. The verification of the bounding fatigue analysis was performed using the ASME Code stress indices (Table NB-3681(a)-1), Oconee data for the heatup, the most critical heatup thermal stratification cycle (280F) for the cooldown, and the 3Sm Code allowable to calculate the penalty factor, Ke, for each thermal stratification cycle. The Eq. 10 and Eq. 11 stresses do not utilize the more detailed stress analysis discussed above for Eq. 12; and Eq. 13 remains well within its allowable value. As noted in the above table, the cumulative usage factor determined in this manner is 11% smaller than that calculated in the bounding fatigue analysis. Therefore, the fatigue results using the Oconee 1 measured data are enveloped by the fatigue results of the bounding analysis.

The foregoing discussion applies to all 177FA plants except Davis-Besse, since the Davis-Besse surge line meets the stress criteria of USA-Standard B31.7.

BACKGROUND

Section 5.1 of BAW-2085 documents the bounding fatigue analysis which calculated an Eq. 12 elbow stress of 92.3 Ksi. This was compared to the cyclically strain-hardened yield (2Sb) as described in Appendix C of BAW-2085. A further review of published literature, performed as a result of this question, indicates that the 2Sb limit could be a reasonable replacement for 3Sm. The bounding analysis used conservative inputs, i.e., 422F stratification, rigid rotational boundaries, simplified Eq. 12 stress, and no credit for CMTR values.

The fatigue was verified to be conservative (the Oconee verification analysis) by using the as-measured Oconee data (280F worst case thermal stratification). The highest Eq. 12 stress for this evaluation was 76.9 Ksi and the comparison to 2Sb was retained. Conservative assumptions were also input to this analysis, i.e., rigid rotational boundaries, simplified Eq. 12 stress, no credit for CMTR values, and a 25% increase in the total thermal expansion stress to account for the non-linearity of the temperature profile.

The more detailed analysis presented in this response utilizes the Oconee 1 as-measured data since it is considered to be representative of the 177 FA plants. As reported above, the equivalent Eq. 12 stress for this more detailed analysis was determined to be 65.4 Ksi which is lower than the 3Sm value based on CMTR yield strength.