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SUBJECT: Forwards justification for continued operation applicable to Unit 2 re pressurizer surge line thermal stratification.

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A. B CUTTER
Vice President
Nuclear Services Department

United States Nuclear Regulatory Commission
ATTENTION: Document Control Desk
Washington, DC 20555

H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-261/LICENSE NO. DPR-23
JUSTIFICATION FOR CONTINUED OPERATION
REGARDING PRESSURIZER SURGE LINE THERMAL STRATIFICATION

Gentlemen:

In our February 27, 1989 letter, Carolina Power & Light Company (CP&L) requested an alternate schedule for H. B. Robinson Steam Electric Plant, Unit No. 2 (HBR2) to complete the analysis identified in Item 1.b of NRC Bulletin 88-11. In that letter, CP&L committed to provide a Justification for Continued Operation to support the requested alternate schedule.

The enclosure to this letter provides the Justification for Continued Operation applicable to HBR2 regarding pressurizer surge line thermal stratification which incorporates the results of the April 11, 1989 meeting between WOG and NRC.

Should you have any questions regarding this matter, please contact Mr. L. I. Loflin (919) 546-6242.

Yours very truly,

A. B. Cutter

ABC/DBB/crs (293CRS)
Enclosure

cc: Mr. S. D. Ebneter
Mr. L. Garner (NRC - HBR)
Mr. R. Lo

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A. B. Cutter, having been first duly sworn, did depose and say that the information contained herein is true and correct to the best of his information, knowledge and belief; and the sources of his information are officers, employees, contractors, and agents of Carolina Power & Light Company.

Lisa M. Randall
Notary (Seal)

LISA RANDALL NOTARY PUBLIC WAKE COUNTY, N.C.

My commission expires: 6-7-93

JUSTIFICATION FOR CONTINUED OPERATION
REGARDING
PRESSURIZER SURGE LINE STRATIFICATION

H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2

BACKGROUND

It was first reported in INPO SER 25-87 that temperature measurements at a German PWR indicated thermal transients different than design. Recent measurements at several domestic PWRs have indicated that the temperature difference between the pressurizer and the hot leg results in stratified flow in the surge line, with the top of the flow stream being hot (pressurizer temperature) and the bottom being colder (hot leg temperature). The top-to-bottom temperature difference can reach 250°F to 300°F in certain modes of operation, particularly during heatup and cooldown.

Surge line stratification causes two effects:

- o Global bending of the pipe is different than that predicted in the original design.

- o Fatigue life of the piping could be reduced due to the global and local stresses from stratification and striping.

More recently, the NRC has issued Bulletin 88-11 "Pressurizer Surge Line Thermal Stratification," December 20, 1988, identifying actions to be taken by licensees.

a) Conduct visual inspection - walkdown
b) Update stress and fatigue analysis to account for stratification and striping
c) Obtain monitoring data, as necessary

The bulletin encourages licensees to perform actions b) and c) above through collective efforts with other plants. In October 1988, Carolina Power & Light Company (CP&L) and other members of the Westinghouse Owners Group (WOG) authorized a program to perform a generic evaluation of surge line stratification in Westinghouse PWRs that will address portions of Bulletin 88-11.

The WOG program is designed to benefit from the experience gained in the performance of several plant specific analyses on Westinghouse PWR surge lines. These detailed analyses included definition of revised thermal transients (including stratification) and evaluations of pipe stress, fatigue usage factor, thermal striping, fatigue crack growth, leak before-break, and support loads. The overall analytical approach used in these analyses has been consistent and has been reviewed, in detail, by the NRC staff.

As of March 1989, plant-specific analyses have been performed on five domestic Westinghouse PWRs. In addition, twelve Westinghouse plants have completed or are currently performing an interim evaluation of surge line stratification which includes finite element structural analysis of their specific configuration under stratified loading conditions.

WOG Program Status

Surge line physical and operating data has been collected and summarized for 55 domestic Westinghouse PWRs. Information relating to piping layout, supports and restraints, components, size, material, operating history, etc., has been obtained. This data has been evaluated in conjunction with available monitoring data and plant-specific analyses performed by Westinghouse. The results of this evaluation were presented to the NRC in a meeting on April 11, 1989. The evaluation is being formalized into a Westinghouse topical report (WCAP-12277, Proprietary and WCAP-12278, Non-proprietary version) scheduled for submittal to the NRC on June 15, 1989.

This topical report forms the basis for the following justification for continued operation.

JUSTIFICATION FOR CONTINUED OPERATION

A. Stratification Severity

Thermal stratification ($\Delta T > 100^{o}F$) has been measured on all surge lines for which monitoring has been performed and which have been reviewed by the WOG to date (eight surge lines).

The amount of stratification measured and its variation with time (cycling) varies. This variation has been conservatively enveloped and applicability of these enveloping transients has been demonstrated for plant-specific analyses.

Various surge line design parameters were tabulated for each plant. From this, four parameters judged to be relatively significant were identified.

A. Pipe inside diameter
B. Piping slope (average)
C. Entrance angle of hot leg nozzle
D. Presence of mid-line vertical riser

These parameters were used in a grouping evaluation which resulted in the definition of 10 monitoring groups corresponding to various combinations of these parameters at Westinghouse PWRs. Approximately 40% of the plants fall into one group for which a large amount of monitoring data has already been received and for which the enveloping thermal transients, discussed above, are applicable. The remaining 60% of Westinghouse PWRs are divided among the other nine additional groups. Although monitoring data has not yet been received representative of all these groups, in general, the combination of significant parameters of these nine groups is expected to decrease the severity of stratification below that of the enveloping transients. This conclusion is also supported by a comparison of available monitoring data.

B. Structural Effects

Significant parameters which can influence the structural effects of stratification are:

a. Location and design of rigid supports and pipe whip restraints
b. Pipe layout geometry and size
c. Type and location of piping components

Although the material and fabrication techniques for Westinghouse surge lines are reasonably consistent and of high quality, the design parameters listed above vary among Westinghouse PWRs. This variation in design is primarily a result of plant-specific routing requirements.

A preliminary evaluation, comparing the ranges of these parameters to those of plants for which plant-specific analysis and interim evaluations are available (approximately 20% of Westinghouse PWRs), has been performed. This comparison indicates a high degree of confidence that, from a combined transient severity and structural effects standpoint, the worst configuration has most likely been evaluated. This conclusion is supported by plant-specific analyses covering five plants and interim evaluations of six additional plants (interim evaluation is in progress on six more plants as of March 1989). These analyses and evaluations have included various piping layouts, pipe sizes, support and restraint designs and piping components. Although the full range of variation in these parameters has not been evaluated, experience gained from these evaluations indicates that further evaluations will not result in a more limiting configuration than those already evaluated.

C. Operating Procedures

The WOG currently has available the surveys of operating procedures performed in support of existing plant-specific analyses. Experience indicates that heatup and cooldown procedures have a significant effect on stratification in the surge line. Conclusions reached by the WOG to date have assumed a steam bubble mode heatup and cooldown procedure which may result in a temperature difference between the pressurizer and reactor coolant system (RCS) hot leg of more than 300^{o}F. In many cases, individual plant operating procedures and technical specifications provide limits on this value. It is also known that some procedures utilize nitrogen, during at least part of the heatup/cooldown cycle, as a means of providing a pressure absorbing space in the pressurizer. Based on information currently available to the WOG, a high confidence exists that the steam bubble mode heatup, assumed to date, is conservative with respect to Westinghouse PWRs.

D. Pipe Stress and Remaining Life

The design codes for surge line piping have requirements for checking pipe stress limits and the effects of fatigue loadings. These stress limits provide a means of controlling stress from primary loads such as pressure, deadweight, and design mechanical loading, as well as stress from secondary loads such as thermal and anchor motion effects.

Stratification in the surge line is a secondary load which will only affect the qualification of secondary stresses. The qualification of primary stresses is not affected by this loading.

Secondary stresses are controlled to prevent excessive displacements and gross plasticity and to prevent excessive fatigue loadings in the pipe. The basic characteristic of a secondary stress is that it is self limiting; thus, a failure from a single application of a secondary loading is not expected.

For the stratification issue, the potential effects of excessive displacements have been investigated through a detailed visual observation of the surge line during the walkdown required per Bulletin 88-11 action 1.a. No discernible distress or structural damage was identified in the walkdown.

The effects of secondary stresses on the remaining life of the surge line have been evaluated on a generic basis through the WOG program. The following summarizes the results of this evaluation.

The plant-specific analyses performed as of March 1989 have demonstrated compliance with applicable ASME Codes and a surge line fatigue life in excess of a 40-year plant life. Review of plant-specific fatigue calculations indicates that the surge line fatigue life is primarily dependent on the number of heatup and cooldown cycles, rather than years of operation.

Considering the worst case years of operation (28.5 yr.) in combination with the worst case number of heatup-cooldown cycles (75, at a different plant) at any Westinghouse PWR, and assuming a 40-year life for all surge lines, it is estimated that no more than approximately 50% of the fatigue life has been used at any Westinghouse plant to date.

For a design life considering 200 heatup-cooldown cycles (used in plant-specific analyses), this would indicate approximately 100 remaining cycles. This number of remaining cycles far exceeds the postulated worst case number for the two-year time frame needed to resolve the stratification issue.

E. Leak Before Break

The plant-specific analyses performed to date that have included the loadings due to stratification and striping have validated the "leak-before-break" concept and have substantiated a 40-year plant life. Fatigue crack growth calculations, performed as part of these plant-specific analyses, have demonstrated that any undiscovered crack as large as 10% of the wall thickness would not grow to cause leakage within a 40-year plant life. Nevertheless, any postulated through wall crack propagation would most likely result in "leak-before-break" and thus permit a safe an orderly shutdown.

F. Inspection History

The NDE inspection history at H. B. Robinson Steam Electric Plant, Unit No. 2 (HBR2), as well as other domestic Westinghouse designed PWRs, has not revealed any service induced degradation (cracking) in the surge line piping that has been attributed to thermal stratification.

Summary of Conclusions from WOG Program

Based on information assembled on surge lines for domestic Westinghouse PWRs, and evaluation of that information in conjunction with plant-specific and other interim evaluation results, the WOG concluded that:

- o A high degree of confidence exists that further evaluation will confirm that the worst combination has already been evaluated for stratification severity, structural effects and operating procedures.

- o All plant-specific analyses, to date, have demonstrated a 40-year life of the surge line. Assuming that further evaluation leads to the same conclusion for the remaining Westinghouse PWRs, the worst case remaining life is approximately 100 heatup-cooldown cycles.

- o Through wall crack propagation is unlikely, however, "leak-before-break" would permit a safe and orderly shutdown if a through wall leak should develop.

- o NDE inspection history demonstrates the present day integrity of Westinghouse PWR pressurizer surge lines.

- o While additional monitoring, analyses, and surveys of operating procedures are expected to further substantiate the above conclusions, the presently available information on surge line stratification indicates that Westinghouse PWRs may be safely operated while additional data is obtained.

Overall Conclusion

Based on the above discussions and results of the recent inspection, CP&L believes it is acceptable for HBR2 to continue power operation for at least ten additional heatup-cooldown cycles. Carolina Power & Light Company has committed to address the remaining requirements of Bulletin 88-11 by January 1991. Based on all evidence to date, this work is expected to confirm a life expectancy beyond design life.