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Docket No. 50-348 May 1, 1989

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D. C. 20555

Gentlemen:

Joseph M. Farley Nuclear Plant - Unit 1
NRC Bulletin No. 88-11
Pressurizer Surge Line Thermal Stratification

By letter dated March 3, 1989 Alabama Power Company submitted to the NRC a request for a two year extension for Item 1.b of NRC Bulletin No. 88-11 for Farley Nuclear Plant, Units 1 and 2. This request was based on Alabama Power Company participation in the Westinghouse Owners Group program to address thermal stratification effects on pressurizer surge lines at Westinghouse plants.

As a result of the visual inspection performed on the Farley Nuclear Plant, Unit 2, pressurizer surge line on March 29 and 30 and April 1, 1989, an assessment of the Farley Nuclear Plant, Unit 1, pressurizer surge line has been performed. The assessment was performed considering the effects of stratification loading in accordance with Section III of the ASME Code, which is the design code of record for Farley Nuclear Plant, Unit 1. The assessment included an evaluation of maximum flow stratification and conditions which were observed during the Unit 2 surge line inspection. The results of this assessment indicate that the highest usage factor on the Unit 1 surge line occurs at the hot leg nozzle. The controlling hot leg nozzle has been conservatively determined to be acceptable for a total of fifteen years of plant operation or 75 heatups and cooldowns. Since Farley Unit 1 has been operating for less than twelve years and has experienced 22 heatup and cooldown cycles during that time, continued power operation is acceptable for at least an additional three years of operation or 53 heatup and cooldown cycles.

Accordingly, Alabama Power Company hereby submits the attached Justification for Continued Operation (JCO) for Farley Nuclear Plant, Unit 1, which has been reviewed by the Plant Operations Review Committee. Although a visual inspection of Unit 1 has not been performed to date, this JCO is based on the similarity of the Units 1 and 2 surge line configurations. Alabama Power Company will conduct a visual inspection of the Unit 1 pressurizer surge line at the next available cold shutdown which exceeds seven days but no later than prior to restart of Unit 1 from the ninth refueling outage, which is scheduled to commence in September 1989. Upon completion of the visual inspection, any findings will be evaluated and reported to the NRC as required by NRC Bulletin No. 88-11.

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If there are any questions, please advise.

Respectfully submitted,

ALABAMA POWER COMPANY

W. G. Hairston, III

WGH,III/RGW:mV.646

Attachment

cc: Mr. S. D. Ebneter
Mr. E. A. Reeves
Mr. G. F. Maxwell

SWORN TO AND SUBSCRIBED BEFORE ME

THIS 1ST DAY OF May ,1989

Notary Public

My Commission Expires: MY COMMISSION EXPIRES DEC. 15, 1992

# JUSTIFICATION FOR CONTINUED OPERATION
# REGARDING
# PRESSURIZER SURGE LINE STRATIFICATION

## JOSEPH M. FARLEY UNIT 1

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## 1. INTRODUCTION

First reported in INPO SER 25-87, pressurizer surge line temperature measurements at a German PWR indicated thermal transients different than design. Recent measurements at several domestic PWR's 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 Modes 3, 4, or 5 during heatup and cooldown.

Surge line stratification causes two effects:

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

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

Westinghouse has performed an assessment of the Farley Unit 1 pressurizer surge line, with regard to stratification loading conditions and the acceptability of continued operation. The results of our assessment are discussed in the following sections.

## 2. EVALUATION OF THE FARLEY UNIT 1 SURGE LINE

### Bulletin 88-11 Visual Inspection

A visual inspection of the Farley Unit 1 pressurizer surge line, per the requirements of NRC Bulletin 88-11, has not yet been performed. However, the three supports on the surge line (one snubber and two spring type supports) were visually inspected in 1985. (See attached sketch ALA 1-4500.) No structural damage or unusual conditions were noted.

### Non-Destructive Examination

Pre-service non-destructive examinations (NDE) have been performed on the Farley Unit 1 surge line welds using ASME Section XI criteria. Only one reportable indication was found, which was evaluated and determined to be acceptable.

Inservice nondestructive examinations (NDE) have also been performed during the first ten years of operation at several locations on the surge line, in accordance with the existing Unit 1 examination schedule. Ultrasonic examination (UT), dye penetrant examination (PT), and visual examinations have been performed on the pressurizer nozzle to safe end weld. No reportable indications were noted. In addition, UT and visual examination were performed on two (out of five) of the surge line butt welds. Again, no indications were noted. The UT, PT, and visual examination procedures used were in accordance with the existing ASME Section XI criteria.

### Thermal Stratification Assessment Analysis

Westinghouse has performed an assessment of the surge line, including the effects of stratification loading, in accordance with Section III of the ASME Code, which is the design code of record for Farley Unit 1. The review included an evaluation of maximum assumed flow stratification

condition. Although complete fatigue usage for the entire line has not been calculated in this assessment, an estimate of the fatigue usage has been made at the critical location (hot leg nozzle) in order to justify continued safe operation.

In order to evaluate the potential of meeting the ASME Section III Code limits including the effects of stratification, a structural model was constructed for the Farley Unit 2 surge line using the ANSYS general purpose finite element computer code. The Farley Unit 1 surge line is very similar to the Unit 2 surge line, from both structural and thermal hydraulic considerations. The case of maximum assumed stratification transient and step temperature profile has been analyzed for Farley Unit 2, and is based on bounding Farley system temperatures and measured flow stratification profiles at several plants.

The analysis performed for Unit 2 addressed the condition of the surge line with failed spring support 2RC-R3, as well as with 2RC-R3 redesigned. From the most recent inspection data on Unit 1, it appears that spring support RC-R2 (which corresponds to 2RC-R3 on Unit 2) maintained its function. Therefore, for Unit 1, the assessment was modified to reflect the probable condition that the spring support remained intact, and may have bottomed out to become a rigid support in the vertical direction. The spring support capacity was used as the limit on the loads that could have been transmitted to the pipe.

The maximum assumed thermal stratification, which may occur in Mode 3 (hot standby), Mode 4 (hot shutdown), or Mode 5 (cold shutdown), shows a vertical downward movement of the line which is larger than that predicted by the original design analysis. The results of the ANSYS analysis show the piping loads to be maximum at the hot leg nozzle. The expansion stress range between the stratification case and normal operating conditions, while higher than the thermal expansion stress range from the original design analysis, was found to be within the ASME Code allowable stress.

Westinghouse has performed complete, detailed analyses for several plants in which ASME fatigue usage factors have been calculated. These calculations considered both thermal stratification and thermal striping at various locations in the surge line. Total stresses include the combined effects of pressure, operating basis earthquake (OBE), global thermal expansion moments from ANSYS analyses, local stratification, and local striping stresses in the pipe wall. Of these stresses, the pressure, local stratification, and striping effects in the pipe wall will be applicable to Farley Unit 1 and have been used in the assessment of total stress for Farley Unit 1. The maximum global thermal expansion stresses have been obtained from the case of maximum assumed stratification as noted previously; OBE stresses from the previous design analysis are still valid.

The results of the fatigue assessment indicate the highest usage factor occurs at the hot leg nozzle. The controlling hot leg nozzle weld has been conservatively determined to be acceptable for a total of 15 years of plant operation or 75 heatups and cooldowns. Since Farley Unit 1 has been operating for less than twelve years and has experienced 22 heatup and cooldown cycles during that time, continued power operation is acceptable for at least an additional three years or 53 more heatup and cooldown cycles.

It is judged, however, that the actual stratification temperature profile for Farley Unit 1 is significantly lower than the maximum assumed stratification profile used in this assessment. This judgement is supported by a number of surge line monitoring programs that have been conducted at other plants, and also by the geometry of the Farley Unit 1 surge line, which has a somewhat larger slope than most plants. Based on data which will be obtained from instrumentation currently being installed on the Farley Unit 2 surge line, it is judged that a detailed analysis will demonstrate a fatigue life consistent with the 40-year design life of the plant.

Unit 2 Surge Line Monitoring Program

In order to more effectively evaluate the thermal stratification phenomenon at both Farley units, instrumentation is being installed on the Unit 2 surge line that will provide the capability for continuous monitoring of pipe outside wall temperatures and pipe displacements. Because of the similarity between the Farley units, the monitoring data obtained from Unit 2 will be equally applicable to Unit 1. It is intended that the instrumentation is temporary and will remain in place on the surge line through the course of the next fuel cycle, at which time it will be removed.

Resistance temperature detectors (RTD's) and linear position transducers (lanyards) will measure pipe temperature and horizontal and vertical pipe movement, respectively. The data will be recorded, via multiplexer, on a data logger located outside containment.

It is expected that the data obtained from the Unit 2 monitoring program will not only demonstrate the conservatism of the stratification loading used in the current assessment of Farley Unit 1, but will support the use of a lower, more realistic profile in the detailed stratification analysis required by Bulletin 88-11.

## 3. OVERALL SAFETY ASSESSMENT

Summary of the Status of the Farley Unit 1 Surge Line

Although the Bulletin 88-11 walkdown of the Farley Unit 1 surge line has not yet been conducted, various examinations and inspections have been performed, both preservice and inservice. In addition to the preservice examinations, inservice UT, PT, and visual examinations, as applicable, have been done for several of the surge line welds. The snubber support and both spring supports have also been visually inspected. Only one reportable indication was found (during the preservice inspection), which was evaluated and found to be acceptable. No indications of structural damage were found.

Westinghouse has performed an assessment of the surge line, including the effects of stratification loading, in accordance with the ASME Code Section III, which is the design code of record for Farley Unit 1. The assessment included an evaluation of the maximum assumed stratification condition. The results of this assessment indicate that continued safe operation of Farley Unit 1 is justified.

The design of the Farley Unit 1 surge line is similar to the surge lines of other Westinghouse plants. The layout includes three bends and one long radius elbow to allow for thermal expansion of the line. The material is Type 316 stainless steel. Operation of the plant relative to parameters affecting the surge line (primarily the maximum temperature difference between the pressurizer and the reactor coolant loops) is also similar to many other plants. Therefore, the acceptable analysis results that have been obtained from detailed stratification evaluations on other plants are indicative of a favorable fatigue situation at Farley Unit 1.

Probability of Surge Line Failure

Preservice and inservice non-destructive examinations (NDE) have been performed on the Farley Unit 1 surge line, using ASME Section XI criteria.

To date, the NDE results have identified no cracks or rejectable indications in the surge line.

Westinghouse has performed several plant-specific, detailed surge line analyses that have included the loadings due to surge line stratification. In each case, the leak-before-break (LBB) concept has been validated specifically for the surge line for a 40-year plant life. Although specific calculations have not been performed for Farley Unit 1, Westinghouse fracture mechanics experience indicates that the overall criteria which forms the basis for LBB methodology, i.e. the substantial margin between a detectable leakage crack and an unstable crack, would also be valid for Farley Unit 1.

Based on the similarity of the Farley Unit 1 surge line loadings and materials to other plants for which Westinghouse has performed analyses, and the fact that no rejectable indications have been found during the inspections of the Farley Unit 1 surge line to date, it would be unlikely that a through wall crack would be generated. Furthermore, even if such a crack were to develop, experience indicates that the crack would remain stable and would not cause catastrophic failure of the surge line.

Plant LOCA Design Basis

The Farley Unit 1 plant design is based, in part, on the postulation of breaks in high energy piping, including breaks in the pressurizer surge line. As a result of this design basis, pipe whip restraints have been installed, and the effects of pipe break on containment design, instrumentation qualification, and ECCS performance have been addressed.

Even in the extremely remote event that a full double ended break should occur in the surge line, the resultant effects of such a break have been accounted for in the design of the plant.

NRC Activities

Westinghouse has had a number of meetings with the NRC concerning surge line stratification involving a number of Westinghouse plants. The stratification phenomenon and its potential effect on piping integrity have been discussed. As a result of these meetings, as well as NRC meetings with the three PWR Owners Groups, the NRC issued Information Notice 88-80, "Unexpected Piping Movement Attributed To Thermal Stratification," dated October 7, 1988. Increased fatigue usage is the primary thrust of this Notice.

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

- o Conduct visual inspection -- walkdown.
- o Update stress and fatigue analysis to account for stratification.
- o Install monitoring, as necessary.

It is mentioned in the bulletin that licensees may obtain monitoring data through collective efforts with other plants of similar design.

WOG Pressurizer Surge Line Stratification Program

In October 1988, the Westinghouse Owners Group (WOG) authorized a program to perform a generic evaluation of surge line stratification in Westinghouse PWR's. This program will evaluate the design and operation of Westinghouse units with respect to the surge line, and determine the factors which could significantly contribute to thermal stratification. The key objectives of this program are :

- o Collect and summarize plant physical and operational data for all WOG plants.

- Develop a generic Justification for Continued Operation.
- Categorize and prioritize plants and parameters
- Estimate the extent of fatigue damage.
- Provide short term and long term recommendations.

The program has been presented to the NRC, and they are in agreement with the approach.

## 4. SUMMARY AND CONCLUSIONS

A study has been performed to assess the effect of thermal stratification loading on the Farley Unit 1 pressurizer surge line. The study assumed that the surge line supports have remained intact per the 1985 inspections, and also, by virtue of the work on Unit 2, covers the possibility of a failed spring support. Thermal expansion stresses have been calculated using maximum assumed stratification conditions, enabling an estimate of fatigue usage. Based on this effort, the continued integrity of the surge line piping system can be demonstrated in its current support configuration under stratified conditions. Farley Unit 1 is scheduled for a refueling outage in September 1989, at which time the Bulletin 88-11 visual inspection is scheduled to be performed.

Temperature and displacement monitoring instrumentation being installed on the Unit 2 surge line will provide valuable data to support the detailed analysis of Unit 1 required by Bulletin 88-11.

Westinghouse's extensive fracture mechanics experience in fatigue crack growth and LBB technology suggests a very small likelihood of a through wall crack. The likelihood of a full double ended break would be even more remote.

In conclusion, Westinghouse believes it is acceptable for Farley Unit 1 to continue power operation until a detailed analysis has been completed for Farley Unit 1, addressing the stratification phenomenon. Consistent with the requirements of NRC Bulletin 88-11, this analysis will be available in January 1991.

# 14" PRESSURIZER SURGE LINE

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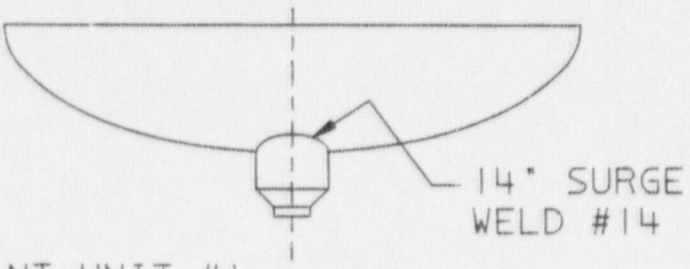


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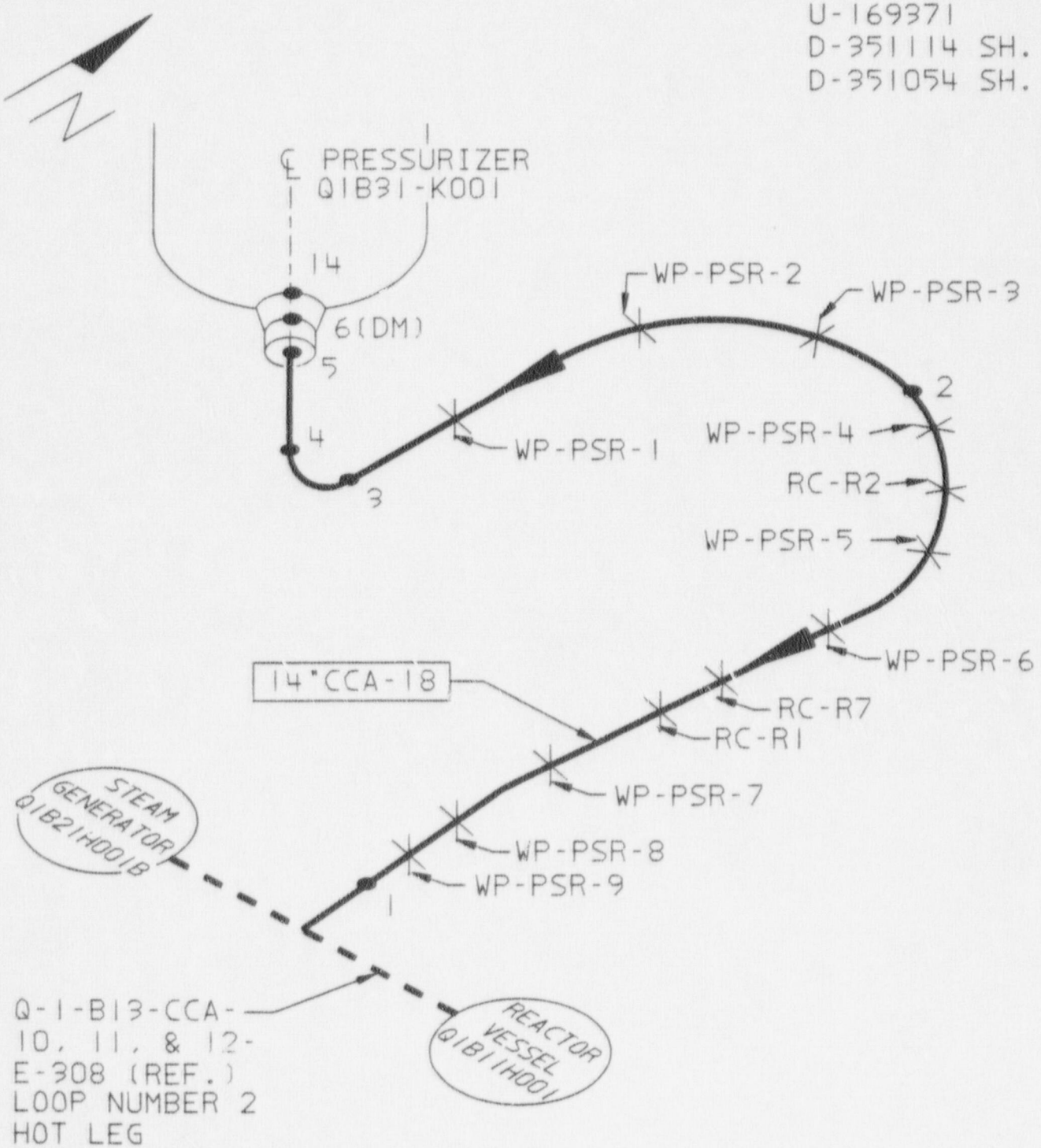
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