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ComEd

November 2, 1998

JMHLTR: #98-0269

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

Subject: Supplement to Response to Request for Additional Information Concerning Jet Pump Riser 15/16 Weld Flaw Evaluation
Dresden Nuclear Power Station, Unit 2
NRC Docket No. 50-237

References:

a) J.M. Heffley Letter #98-0115 to USNRC, Jet Pump Riser 15/16 Weld Flaw Evaluation Report, dated April 11, 1998

b) Request for Additional Information (RAI) for Dresden Nuclear Power Station, Unit 2 (TAC No. MA1672)," dated June 10, 1998

c) J.M. Heffley Letter #98-0195 To USNRC, Jet Pump Riser 15/16 Weld Flaw Evaluation Report, dated July 10, 1998.

The purpose of this letter is to provide a supplement to the Commonwealth Edison (ComEd) Company response (Reference c) to the Request for Additional Information (RAI) in Reference b. The RAI poses four questions concerning the Flaw Analysis (Reference a) that was prepared by ComEd and provided to the NRC. This analysis addressed an IGSCC flaw identified during the In-Vessel Visual Inspection (IVVI) performed during the 15th refuel outage for Dresden Unit 2 (D2R15). The flaw was identified on the recirculation riser piping internal to the reactor vessel at the riser elbow to thermal sleeve, weld RS-1 of Jet Pump pair 15/16.

A001

This supplement elaborates further on the response to question #4 of the RAI (Reference b). The technical basis used in the preparation of this response is provided in the attached General Electric letter DSB 98088, dated September 23, 1998.

Please direct any questions regarding this matter to Mr. Frank Spangenberg, Regulatory Assurance Manager at (815) 942-2920 extension 3800.

Sincerely,

J.M. Heffley
Site Vice President
Dresden Nuclear Power Station

Attachment

cc: Regional Administrator, Region III
Senior Resident Inspector, Dresden Nuclear Power Station

Attachment
Response to Question #4 of Request for Additional Information
Dresden Nuclear Power
Station Unit 2
50-237

Question #4

Crack Growth Evaluation (page 10 of attachment A to Reference a)- Instead of providing the allowable crack size due to flow induced vibration (FIV), provide the crack growth due to FIV in two fuel cycles to be added to the evaluated flaw length of 4.7".

ComEd Response

To clarify the information pertaining to Flow Induced Vibration (FIV) on page 10 of Attachment A to Reference a, the evaluated flaw length of 4.7" is not anticipated to grow due to FIV. This is based on the fact that the FIV stress intensity factor range, ΔK_{FIV}, for this flaw length is below the stress intensity factor threshold for fatigue crack growth, $\Delta K_{th} = 5$ ksi $\sqrt{in}$. The table below presents the FIV peak-to-peak stress range with the circumferential crack length at the fatigue crack growth threshold. Since the RS-1 threshold crack length is greater then the evaluated flaw of 4.7", fatigue crack growth will not contribute to crack growth during the evaluation period. General Electric Nuclear Energy has provided the values presented in the following table via the attached letter.

DRESDEN 2 Weld Location	FIV Stress Range (psi)	Threshold FIV Crack Length (in)
RS-1 (thermal sleeve-to-elbow)	1020	6.5
RS-2 (elbow-to-riser)	790	8.3
RS-3 (riser-to-ram's head)	730	8.8

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DSB-98088
September 23, 1998

DRF # B11-00825-00

To: Guy DeBoo

cc. E.R. Cooper
T.A. Caine
R.W. Wu
H.S. Mehta
L.K. Liu

From: David S. Braden

Subject: **Dresden 2 and 3 Jet Pump Vibration**

This transmittal provides a description of the new method for determining the FIV stresses and an explanation of the basic differences between the old and new FIV stresses.

I. D2 and D3 Vibration Data

Flow induced vibration (FIV) loads are caused by turbulent flow in the piping exciting the natural frequencies of the jet pump assembly. Because the Dresden 2 and Dresden 3 riser brace designs are different, the FIV loads are expected to be different. This is true in spite of the fact that Dresden 2 and 3 jet pump design geometry (except for the riser brace) and flow characteristics are identical.

During the startup testing of Dresden Units 2 & 3, vibration measurements were made. Unfortunately for Dresden 2, only one displacement gage survived at 100% power testing. This displacement gage measured the jet pump motion only in the tangential direction. Thus information on jet pump radial motion of Dresden 2 is not available.

In view of the scarcity of Dresden 2 data, it was decided that the Dresden 2 FIV loads would be theoretically determined from Dresden 3 startup test data. In the following, the method of calculating the vibration stress for the Dresden 3 plant from the startup test data is first described. Then the methodology used to calculate the Dresden 2 FIV stress from Dresden 3 data is delineated.

II Dresden 3 FIV Stress Determination

1. Review the startup vibration data to determine the primary modes of interest for the jet pump.
2. Using a finite element model of the jet pump, determine the natural frequencies, mode shapes, and modal stresses and strains of all modes of interest.
3. Normalize the modal strains such that they are equal to the measured strain data observed during startup testing.

4. Select the normalized modal stresses at the weld locations on the riser pipe for each mode. Absolute sum the modal stresses from each mode to arrive at the final FIV stresses.

III Dresden 2 FIV Stress Determination

In order to convert the Dresden 3 FIV stresses to Dresden 2 values, it is necessary to determine the effect of the differences in riser brace design on the dynamic response. The following steps are used to determine the stress ratios for each natural mode:

1. Apply a random forcing function to the D3 finite element model and calculate the response for each mode. Apply the same random forcing function to the D2 model and calculate the response for each mode.
2. Calculate the ratio of the D2 to D3 response for each mode of interest. This ratio (D2/D3) represents the effect of the differences in riser brace design on the dynamic response of each mode.
3. Multiply the D3 FIV stresses by the (D2/D3) ratio to arrive at the final D2 FIV stresses.

IV Comparison of the Original and Revised D2 FIV Stresses

Because only a tangential displacement signal was available for the D2 plant during power testing, the original D2 FIV stress analysis assumed that the first analytic mode (which was a tangential mode) corresponded to the measurement. Such an assumption was reasonable. Because the mode shape factor for the first mode was very small, the resulting riser pipe stresses were also very small. Since radial displacement information was not available, it was assumed that the radial displacement was zero. This resulted in a very low total riser pipe stress.

The revised analysis, using the D3 data from one radial displacement gage and six riser brace strain gages, showed that the second mode (a combined radial and vertical mode) stresses are orders of magnitude higher than those from the first mode. The third and fourth modes also had significant contributions to the final stresses.

In summary, the original analysis suffered from a lack of radial displacement data which resulted in riser pipe stresses which were substantially too low.

RESULTS

The table below shows the FIV stresses resulting from the reanalysis of Dresden 2 and 3 FIV test data. The associated threshold FIV crack lengths, the crack lengths at which FIV stresses would begin to cause crack growth, are shown as well. The reanalyzed FIV stresses are higher than those determined originally, so the threshold FIV crack lengths are significantly smaller. However, they are larger than the predicted end-of-cycle cracks for Dresden 2. Note that the FIV crack lengths were calculated assuming Schedule 30 pipe, while the piping is Schedule 40 (the FIV stress model used Schedule 40). The results here are, therefore, conservative by about 5%. FIV crack lengths based on Schedule 40 piping dimensions will be determined when the flaw analysis report is revised.

Weld Location	FIV Stress Range (psi)	Threshold FIV Crack Length (in)
DRESDEN 2		
RS-1 (thermal sleeve-to-elbow)	1020	6.5
RS-2 (elbow-to-riser)	790	8.3
RS-3 (riser-to-ram's head)	730	8.8
DRESDEN 3		
RS-1 (thermal sleeve-to-elbow)	1020	6.5
RS-2 (elbow-to-riser)	760	8.5
RS-3 (riser-to-ram's head)	600	10.3

Please contact Tom Caine (408)-925-4047 if you have questions or need additional information regarding this transmittal.

T A Caine for

David S. Braden, Consulting Services