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SUBJECT: Responds to 990623 RAI to support review of evaluation of planar indication found on weld number 24RRC(2)A-1 during 1998 RO.

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WASHINGTON PUBLIC POWER SUPPLY SYSTEM
P.O. Box 968 • Richland, Washington 99352-0968

July 2, 1999
GO2-99-122

Docket No. 50-397

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

Gentlemen:

Subject: **WNP-2, OPERATING LICENSE NPF-21
REPLY TO REQUEST FOR ADDITIONAL INFORMATION
INSERVICE INSPECTION EXAMINATION RESULTS**

Reference: Letter, dated June 23, 1999, Jack Cushing (NRC) to JV Parrish (Supply System), "Request for Additional Information (RAI) for the Washington Public Power Supply System Nuclear Project No. 2 (TAC No. MA4602)"

In the reference, the staff requested that additional information be provided to support review of our evaluation of a planar indication found on weld number 24RRC(2)A-1 during the 1998 refueling outage. The additional information requested by the reference is addressed in the attachment.

As stated in previous correspondence, we have determined that the planar indication is neither a crack nor an indication due to Intergranular Stress Corrosion Cracking (IGSCC). The indication is considered an ultrasonic signal reflector condition from a fabrication repair. The indication exceeded the acceptance standards listed in ASME, Section XI (1989 Edition), Table IWB-3410-1 (our current inspection interval code). Accordingly, the indication was evaluated pursuant to ASME, Section XI, IWB-3132.4, and we demonstrated that the indication was acceptable for continued operation without repair.

We concluded from the evaluation that the indication was acceptable for continued operation until the next required inspection period, which is the R-15 refueling outage (2001). We also concluded that, if the IGSCC phenomena was present and became active, the indication would not increase to a depth that would exceed the ASME Code acceptance criteria of 1.08 inches for the allowable flaw size.

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Should you have any questions or desire additional information pertaining to this letter, please call PJ Inserra at (509) 377-4147.

Respectfully,

Tom Messersmith for

DW Coleman
Manager, Regulatory Affairs
Mail Drop PE20

Attachment

cc: EW Merschoff - NRC RIV
JS Cushing - NRC NRR
NRC Senior Resident Inspector - 927N
PD Robinson - Winston & Strawn
DL Williams - BPA/1399

Question 1: In CMR-98-0243, Page 1.4003, second paragraph you state, "The input file for N1FAT1.IN contains the flaw length of 18.7 inches and a depth of .935 inch. This flaw depth and length was then ran for one year of fatigue cycles due to discontinuity, OBE and SSE in accordance with ASME Code 1989 Section XI Rules. The final length was determined to be 18.712 inches and 1.05 inches deep."

This correlates to a crack depth growth rate due to fatigue of .115 inch per year (1.05 - .935 = .115).

The table on page 2 of the April 29, 1999 submittal lists the fatigue crack depth change from June 1998 until April 2001. The greatest change in crack depth is .0051 for the period from November 1999 until April 2001 and equals a crack growth rate due to fatigue of only .034 inch per year.

Please explain the difference in the fatigue crack growth rates.

Response

In our April 1999 letter[1], we provided a table that contains information pertaining to our crack growth model. The table included the crack growth associated with the fatigue cycles assumed to occur during each startup and shutdown cycle. The stresses used were conservative and are a combination of thermal stress and operating basis earthquake and safe shutdown earthquake dynamic stresses. The table was adjusted to reflect current and future startup and shutdown cycles.

The difference in the increment of crack growth between CMR 98-0243 and our April 1999 letter is that the table data in the letter had not been corrected for a 20:1 aspect ratio (NUREG-0313, Revision 2). The table was simply used to illustrate that the incremental crack growth associated with the fatigue cycles was insignificant and that the fatigue cycle input, when added to the calculation output, was less than the ASME Code acceptance criteria for the allowable flaw size. As an aside, we did not intend to include in the table corrected data pursuant to NUREG-0313, Revision 2.

The fatigue growth when the flaw is shallow was determined to be insignificant and was not considered in the calculation until the end of the 970 days. The table in our letter reflected actual startups based upon the current operating history and also the recently scheduled April 2001 shutdown (which had not been established at the time that the CMR was prepared). In the table, the April

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[1] Letter GO2-99-083, dated April 29, 1999, DW Coleman (SS) to NRC, "Supplemental Information, Analytical Evaluation of Inservice Inspection Examination Results"

2001 shutdown was determined to occur at approximately 953 days of operation.

The table in our letter was developed to show the increment of crack growth for the specific IGSCC depth at the specific plant startups. These values are not crack growth rates, but increments of crack growth at the specific IGSCC depths. Accordingly, the reference to a linear growth rate of 0.034 inches per year is not applicable. The values for the incremental fatigue crack growth are the values determined by the fatigue computer analysis.

Table 5 of CMR 98-0243[2] represents the summary of the flaw evaluation for the planar indication. The flaw evaluation was performed for the longest duration that would occur between the R-13 (1998) and R-15 (2001) refueling outages, which was estimated at the time to be 970 days of operation.

The table in the CMR contains the days of operation, the calculated flaw depth and the length. The length in this table was corrected in accordance with NUREG-0313, Revision 2, for an aspect ratio of 20:1 flaw length versus depth. Accordingly, the depth at the end of 970 days of intergranular stress corrosion cracking growth of 0.935 inches was multiplied by 20 to obtain the length of 18.7 inches. For this flaw depth and length, a computer model (N1FAT1.IN) was developed and included a conservative combination of thermal stress and operating basis earthquake and safe shutdown earthquake dynamic stresses. The results of the computer analysis showed that, if the occurrence of the fatigue loading due to these thermal stresses were to occur on day 970 of operation prior to shutdown, the total flaw depth that would occur in the nozzle would be 1.05 inches. Because the depth was less than the ASME Code allowable value of 1.08 inches as determined by our calculations, we concluded that the planar indication was acceptable for continued operation until the R-15 refueling outage.

In the CMR, the increment of crack growth for the flaw depth of 0.935 inches and length of 18.7 inches was determined to be 0.115 inches. This is not a growth rate per year, but rather an increment of crack growth for the specific depth and length as determined by $da/dn = 6.155\text{ E-}18\ (\Delta K)^{3.302}$ for psi$\sqrt{in}$, where ΔK is a function of crack geometry, depth, length and change in loading, and is a nonlinear function.[3] Since the growth increment is not linear and is a function of crack depth and length, the increment of crack growth due to fatigue of 0.115 is specifically for the depth and length as determined for 970 days.

2 Calculation Modification Record (CMR) 98-0243, "Fracture Mechanics Evaluation of N1A Nozzle Safe End"

3 Calculation ME-02-98-04, "Fracture Mechanics Evaluation of N1 Safe End," Revision 0, Page 5.008A

Question 2: Using the year-by-year growths provided in the above-mentioned table and the fatigue growth of .115 inch for one year beyond the 970 days, provide your estimate of the total crack depth growth due to fatigue for the entire period of 970 days.

Response

The following table was developed for illustration purposes and represents our estimate of the total crack depth growth due to fatigue for the entire period of 970 days. The table includes the days of operation and the depth of the indication with the fatigue value added to the IGSCC growth value, and includes data adjusted for a 20:1 aspect ratio (NUREG-0313, Revision 2). For ease of comparison, the table was formatted in the same way as the table in our April 1999 letter, using the same startup dates.

ILLUSTRATION OF FATIGUE IMPACT				
Days Operation	Startup Date	IGSCC (Depth - Inches)	Fatigue Change (Depth - Inches)	Fatigue+IGSCC (Depth - Inches)
0	June-98	0.29	0.00064	0.29064
8	July-98	0.29744	0.00066	0.2981
42	August-98	0.32916	0.00088	0.33
325	June-99	0.57128	0.0022	0.57348
422	November-99	0.64256	0.00276	0.64532
	Shutdown Date		Adjusted for 20:1	
953	April-01**	0.931	0.1144	1.045
970		0.9385	0.116	1.055
**Shutdown for R-15 (perform weld examination)				

In development of the table, we used an initial depth of 0.29 inch and assumed that all of the fatigue occurs at each startup. The stresses used are conservative and are a combination of thermal (one cycle startup/shutdown), operating basis earthquake (300 cycles, including safety/relief valve loads), and safe shutdown earthquake (ten cycles) dynamic stresses for each startup and shutdown. Furthermore, for additional conservatism we included an additional startup/shutdown at the end of the 953 or 970 day cycles.

The value of 0.29-inch was then used as a starting point in the IGSCC computer run to determine the crack growth that will occur during the next interval between startups. The new value from the IGSCC model is used as the starting value in the fatigue computer run to determine the increment for fatigue at this IGSCC crack depth. The increment of fatigue that is determined is then added to the IGSCC value to determine the next IGSCC starting point. This process continues until the IGSCC growth is determined. The new depth for 953 or 970 days was then multiplied by 20, pursuant to NUREG-0313, Revision 2, to determine the flaw length to use in the fatigue model. Based upon the results of our evaluation, the final flaw depth at the end of 953 days was determined to be 1.045 inches.

From the table it is clearly shown that the fatigue cycles are insignificant early in the crack growth until the flaw starts to exceed 0.5 inch in depth. This supports the original assumption made in the calculation. Also, there is minimal impact on the end-of-life depth due to the inclusion of the fatigue crack growth. For the initial evaluation, we calculated a depth of 1.05 inches for 970 days without factoring in fatigue stress values. With the fatigue stress values included, the depth was calculated at 1.055 inches for 970 days.

Based upon our calculations, all of these values were determined to be less than the ASME Code acceptance criteria of 1.08 inches for the allowable flaw size.