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NUDOCS-ABSTRACT

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### WASHINGTON PUBLIC POWER SUPPLY SYSTEM

P.O. Box 968 • 3000 George Washington Way • Richland, Washington 99352

May 15, 1991 G02-91-098

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Docket No. 50-397

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

Gentlemen:

91052401

ADO

PDR

91051

- Subject: NUCLEAR PLANT NO. 2, OPERATING LICENSE NPF-21 REPORT ON FLAW IN REACTOR RECIRCULATION PIPING, ADDITIONAL INFORMATION (TAC NO. 80358)
- References: 1) Letter, G02-91-096, G.C. Sorensen (SS) to NRC, same subject, dated May 10, 1991
  - 2) Letter, G02-89-123, G. C. Sorensen (SS) to NRC, "Supply System's Response to Generic letter 88-01 Request for Additional Information", dated July 20, 1989

The following is provided in response to questions asked by the Staff of the Reference 1 submittal.

- 1. Water Chemistry History The history of the WNP-2 water chemistry is provided in Attachment 2.
- 2. UT Characterization of 20RRC(6)-8 Indication The characterization of this indication is provided in Attachment 3.
- 3. Input to Flaw Evaluation This is provided in Attachment 4.
- Post-IHSI Examination IHSI was performed on this weld but it was not post IHSI UT examined because the IHSI was done on this weld prior to service.
- 5. Location of 20RRC(6)-8 The location of this weld is shown on Figure RRC-105 of Reference 2.

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Page Two REPORT ON FLAW IN REACTOR RECIRCULATION PIPING ADDITIONAL INFORMATION

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6. WNP-2 R6 Flaw Evaluation Summary - The summary provided in Reference 1 has been revised to define the code allowable crack depth of 0.62 inches based upon the welding process used for this weld. The revised summary is included as Attachment 1. Page 3 of this attachment discusses the need for the revision in more detail.

7. Sample Expansion - Three circumferential welds were scheduled to be examined during R6. As a result of the indication found on 20RRC(6)-8 the examination was expanded by an additional three circumferential welds of the same category (Category B).

<u>Weld</u>	<u>Drawing</u>
20RHR(2)-1 20RHR(2)-2	RHR-104 RHR-104
12RRC(7)B-1	RRC-107

The drawing reference refers to the drawings included with Reference 2.

Very truly yours,

G. C. Sorensen, Manager

Regulatory Programs

AGH/bk Attachments

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cc: JB Martin - NRC RV NS Reynolds - Winston & Strawn PL Eng - NRC DL Williams - BPA/399 NRC Site Inspector - 901A

### Attachment 1

### WNP-2 R6 FLAW EVALUATION SUMMARY (Rev. 1)

### INTRODUCTION

A fracture mechanics evaluation was performed to evaluate a linear indication found during in-service inspection of ISI weld number 20 RRC (6)-8. This particular weld consists of a SA-358 GR. 304 stainless steel pipe welded to a valve manufactured from SA-351 CF8M stainless steel. The indication was found on the upstream side of valve RHR-V-113. The defect is located in the 304 base metal at the top of the pipe centered at the 0° location (twelve o'clock position). The defect was sized at 0.15 inches deep and 4.5 inches long. The size of the defect exceeds the 1986 ASME Code Section XI Table IWB 3514-2 allowable and thus requires evaluation per paragraph IWB 3640 of the Code. The following discussion provides a comprehensive summary of the fracture mechanics model, applied loads (stresses), and Code evaluations that were performed.

### METHODOLOGY

### Stress (Loads) Evaluation

The stress state at the location of the flaw is required to determine the driving force for crack propagation. Stresses for the applicable loading conditions were extracted from the ASME Class 1 Stress Report for the subject RHR piping (Calculation No. 8.14.107) to complete the RHR piping flaw evaluation.

The following load combinations were evaluated to determine if the crack would grow under the imposed loads. Two of the evaluations (fatigue and intergranular stress corrosion cracking (IGSCC)) encompass the requirements of IWB-3640. The third evaluation was done to evaluate the flaw growth under the relatively short duration applied load caused by the worst thermal transient experienced by the system, i.e. plant shutdown.

The imposed load for fatigue evaluation consists of superimposing the pressure, deadweight bending, normal operating thermal bending stress and the weld residual stress to complete the evaluation of the minimum fracture stress intensity. Pressure, deadweight bending, and thermal bending stresses are conservatively combined with the worst case faulted dynamic bending stresses (without regard to the direction of the applied stress) to complete the evaluation of the maximum fracture stress intensity range. This methodology conservatively includes faulted dynamic stresses in the normal/upset evaluation and conservatively adds additional thermal stresses into the faulted evaluation. The number of dynamic loading cycles is based on the design basis main steam safety relief valve actuations which yield approximately 300 stress cycles per year. The peak

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### Attachment 1

### WNP-2 R6 FLAW EVALUATION SUMMARY (Rev. 1)

dynamic loading includes 300 cycles of the Safe Shutdown Earthquake event even though the plant design basis is 10 stress cycles.

The IGSCC evaluation was completed using the steady state deadweight pressure and bending stress and the normal plant operation thermal stress.

The thermal transient load evaluation superimposed the pressure and deadweight bending stresses on the thermal bending and thermal gradient stresses. The dynamic stress was not included due to the low probability of occurrence during the short duration of the peak thermal gradient stress.

In each loading condition the above stress states were then superimposed on the weld residual stress distribution to complete the respective flaw evaluations. The resulting flaw sizes were then evaluated against the end of evaluation period depth-to-thickness ratios from Tables IWB-3641-5 and IWB-3641-6.

### Flaw Evaluation

The indication was evaluated using the NASCRAC computer code developed by Failure Analysis Associates. This code uses stress field influence functions as the basis for flaw propagation. The NASCRAC model selected is a shell element containing an elliptically shaped circumferential flaw. The model is identified as 703 in the NASCRAC manual. This particular model includes three crack growth degrees of freedom encompassing the respective circumferential and crack depth coordinates. The evaluation was performed using conservative linear elastic fracture mechanics principles.

The modeling applies the requirements identified in NRC Generic Letter 88-01. The flaw was evaluated as an intergranular stress corrosion crack using the crack growth rate equation provided in the generic letter. The weld residual stress distribution provided in the letter was also used even though the weld in question had induction heat stress improvement (IHSI) performed on it in 1983. The weld residual stresses are developed from room temperature yield for 304 material (30 ksi) as the normalization stress outlined in the generic letter. The flaw aspect ratio was reviewed and compared to the requirements of NUREG-0313, Rev. 2. The aspect ratio was determined to be 30:1 which exceeds the NRC requirements for maintaining the same aspect ratio during crack growth. Therefore the final crack growth aspect ratio was determined by the NASCRAC flaw model.

In performing the evaluation the flaw model was run to evaluate fatigue damage for a one year operating cycle. The crack was evaluated using both a da/dn curve

2 of 3

### Attachment 1

### WNP-2 R6 FLAW EVALUATION SUMMARY (Rev. 1)

for BWR water environments and an air environment for austenitic stainless steel. The da/dn equation used for BWR environments was provided in the EPRI report NP-4690-SR "Evaluation of Flaws in Austenitic Piping " dated July 1986, page 3-2, Equation 3-1. In this EPRI equation the E-factor selected for a BWR environment was taken as ten. The curve used for the air environment is that provided in ASME Code Section XI, Appendix C, Figure C-3210-1 for an R-ratio of 0.79.

Upon completion of the fatigue evaluation the NASCRAC flaw model was executed to complete the IGSCC evaluation. The crack dimensions for the evaluation period as determined by fatigue would normally be used as input for the initial crack dimensions for the IGSCC model. However the growth due to the 300 fatigue cycles did not yield a significant change in the initial crack size. Therefore the original flaw size was used as the input for the IGSCC model. The equation used for the IGSCC crack growth rate, as mentioned earlier, was that provided in the generic letter.

The above described flaw evaluation and computer outputs are documented in Supply System calculation ME-02-91-30.

### CONCLUSION

Based on the flaw evaluation results it is determined that WNP-2 may operate for the single cycle evaluation period before reevaluation of the linear indication is again required. The evaluation demonstrates that under the worst imposed loading conditions the flaw meets the acceptance criteria of ASME Section XI Tables IWB-3641-5 and 3641-6. The Fatigue evaluation for the flaw propagation shows that growth due to the piping system mechanical loads is insignificant. The fracture mechanism which can propagate the flaw is intergranular stress corrosion cracking. If the IGSCC phenomena is active the crack will increase in depth to 0.29 inches in the next year which is less than the ASME Code allowable of 0.62 inches per Table IWB-3641-5 and 6.

Revision 1: The weld root and hot passes were performed using gas tungsten-arc welding (GTAW) for an approximate thickness of 1/8 to 3/16 inch. The remainder of the weld was performed utilizing shielded metal arc welding (SMAW). Therefore the acceptance criteria of tables IWB-3641-5 and IWB-3641-6 is used in lieu of IWB-3641-1 and IWB-3641-2. ATTACHMENT 2 WATER CHEMISTRY HISTORY

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ATTACHMENT 3

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UT CHARACTERIZATION OF 20RRC(6)-8

## WASHINGTON PUBLIC POWER SUPPLY SYSTEM

WNP-2 ISI Evaluation Sheet

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	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	OFF 222nS 500 <sup>22</sup>
	GAIN REFERENCE GAIN 74.0dB REF LVL 40.0dB % CHANGE XXXX dB CHANGE 34.0	
COMPANY	INSPECTION REPORT	
ADDRESS OPERATOR TNSP. PROCEDURE	P.L. TOMPKINS QCI 6-25 Rev.C TIME 13:47	
CODE/SPEC	5121.04	
JOB NUMBER OBJECT TRANSDUCER TYPE COMMENTS	ADEPT 60 - MOST MATERIAL 55	
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STAVELEY	INSTRUMENTS - SONIC 136 PLUE DATA REPORT				
STORED DISPLAY # 2 CAL PROGRAM 3 - MOST					
	RANGE RECEIVER RANGE 2.801n GAIN 74.0dB DELAY 1.1111n DISPLAY FILT2 VEL 0.227 in/us FREQ 2.25MHz UNITS in REJECT OFF <u>GATE</u> <u>PULSER</u> LEVEL OFF PULSE 222nS POSN 1.811n DAMPING 500 <sup>10</sup> WIDTH 0.7011n DUAL POLARITY + REP RATE 4 KHz GAIN REFERENCE GAIN 74.0dB REF LVL 40.00B COC % CHANGE 34.0 INSPECTION REPORT				
COMPANY	<u>Supply</u> System				
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OBJECT TRANSDUCER TYPE	ADEPT 60 MOST MATERIAL 55				
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SIGNATURE	Paul L. Tompkins DATE 5-4-91				

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STAVELEY	INSTRUMEN	rs - sonic 136	PLUE DATA REPORT
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	TIP	RANGE RANGE 0.7461n DELAY 1.331n VEL 0.127 in/us UNITS in GATE LEVEL 85% POSN 1.68in WIDTH 0.119in POLARITY + GAIN REFERENCE GAIN 66.2dB REF LVL 36-2dB % CHANGE XXXX dB CHANGE 30.0	RECEIVER GAIN 66.2dB DISPLAY FILT1 FREQ 5MHz REJECT OFF PULSE 10075 DAMPING 500: PULSE ECHO REP RATE 4 KHz
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### Stress (Loads) Evaluation

The stress state at the location of the flaw is required to determine the driving force for crack propagation. Stresses for the applicable loading conditions were extracted from the ASME Class 1 Stress Report for the subject RHR piping (Calculation No. 8.14.107) to complete the RHR piping flaw evaluation.

The input data and loads for the RHR-V-113 flaw evaluation are tabulated below.

Pipe Stresses and Geometry:

Deadweight (Dwt)	1494 psi
Pressure (P)	6062 psi
Upset	1754 psi
Emergency	1907 psi
Faulted (F)	3275 psi
Thermal NPO (TH)	1050 psi

Total Load Dwt + P + TH + F = 11881 psi

Physical Dimensions:Nominal Pipe OD.20 in.Nominal Pipe Thick.1.031 in.Moment of Inertia2770 in<sup>4</sup>

Material Allowable: SA-358 type 304  $S_m$ =16675 psi.

Load Combinations:

The following load combinations were evaluated to determine if the crack would grow under the imposed loads. The evaluations (fatigue and intergranular stress corrosion cracking (IGSCC)) encompass the requirements of IWB-3640.

The imposed load for fatigue evaluation consists of superimposing the pressure, deadweight bending, normal operating thermal bending stress and the weld residual stress to complete the evaluation of the minimum fracture stress intensity. Pressure, deadweight bending, and thermal bending stresses are conservatively combined with the worst case faulted dynamic bending stresses (without regard to the direction of the applied stress) to complete the evaluation of the maximum fracture stress intensity range. This methodology conservatively includes faulted dynamic stresses in the normal/upset evaluation and conservatively adds additional thermal stresses into the faulted evaluation. The number of dynamic loading cycles is based on the design basis main steam safety relief valve actuations which yield approximately 300 stress cycles per year. The peak dynamic loading also includes 300 cycles of the Safe Shutdown Earthquake event even though the plant design basis is 10 stress cycles.

Fatigue Stress: Dwt + P + TH + F = 11881 psi

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The IGSCC evaluation was completed using the steady state deadweight pressure and bending stress and the normal plant operation thermal stress.

IGSCC Stress: Dwt + P + TH = 8606 psi

In each loading condition the above stress states were then superimposed on the weld residual stress distribution to complete the respective flaw evaluations. The resulting flaw sizes were then evaluated against the end of evaluation period depth-to-thickness ratios from Tables IWB-3641-5 and IWB-3641-6.