CATEGORY 1

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SUBJECT: Forwards results of evaluation of weld GR-3-63,per GL 88-01 re IGSCC indication.Rev 0 to calculation CD-Q3068-980061 re subject evaluation,encl.

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TITLE: GL 94-03 Intergranular Stress Corrosion Cracking of Core Shrouds in B

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October 5, 1998

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

Gentlemen:

In the Matter of) Docket Nos. 50-296
Tennessee Valley Authority)

BROWNS FERRY NUCLEAR PLANT (BFN) - SUBMITTAL OF EVALUATION OF AN INTERGRANULAR STRESS CORROSION CRACKING (IGSCC) INDICATION ON A UNIT 3 REACTOR RECIRCULATION SYSTEM PIPING WELDMENT

In accordance with guidance specified in NRC Generic Letter (GL) 88-01, TVA is submitting an evaluation of an IGSCC indication in a heat affected zone of a weld located on Reactor Water Recirculation system loop B piping. During performance of scheduled inservice inspection of the Reactor Water Recirculation system piping, TVA identified indications in weld GR-3-63. Per the GL, if any cracks are identified that do not meet the criteria for continued operation without evaluation given in Section XI of the Code, NRC approval of flaw evaluations and/or repairs in accordance with IWB 3640 and IWA 4130 is required before resumption of operation.

TVA completed a stress corrosion crack growth analysis in accordance with NUREG-0313 R2, Technical Report on Material Selection and Processing Guidelines for BWR Coolant Pressure Boundary Piping. The results of TVA's analysis demonstrate weld GR-3-63 is acceptable for a minimum of three additional 24 month fuel cycles.

A018

BFN Unit 3 is currently in the Cycle 8 refueling outage. TVA plans to return Unit 3 to service on October 12, 1998. Therefore, if NRC determines approval of this evaluation is required prior to Unit 3 restart, TVA requests approval of the evaluation by October 11, 1998. This short review period is necessary to support the unit return to service.

Enclosure 1 to this letter provides the evaluation of weld GR-3-63. To further aid NRC in their review of this issue, Enclosure 2 provides NRC with a copy of Calculation CD-Q3068-980061. Enclosure 3 provides isometric drawing 3-ISI-0328-0, Unit 3 Recirculation System Weld Locations.

If you have any questions about this evaluation, please telephone me at (256) 729-2636.

Sincerely,

T. E. Abney
Manager of Licensing
and Industry Affairs

Enclosures
cc: See page 3

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ENCLOSURE 1

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNIT 3
EVALUATION OF INTERGRANULAR STRESS CORROSION CRACKING
(IGSCC) AT WELD GR-3-63

Background

During the present Unit 3, Cycle 8 refueling outage, Ultrasonic Test (UT) inspections of reactor water recirculation system pipe welds conducted in conjunction with the guidance of Generic Letter (GL) 88-01 revealed an IGSCC indication in the Heat Affected Zone (HAZ) of weld number GR-3-63. Weld GR-3-63 is in reactor water recirculation system loop B and is a 28 inch diameter, valve-to-pipe weld. Automated UT examination of the weld was conducted with nondestructive examination (NDE) procedures and techniques which have been qualified in accordance with Appendix VIII of ASME Section XI Performance Demonstration Initiative (PDI) program at the Electric Power Research Institute (EPRI).

The UT results indicated a flaw located at approximately 140-degree azimuth or 35-inches clockwise from top dead center of the pipe which has a nominal wall thickness of 1.2 inches. The indication is 1.7 inches in length with a maximum depth of 0.2 inches. The UT data positions the indication in the HAZ of the type 304 material of the pipe. The flaw is unacceptable per Table IWB-3514-2. The flaw aspect ratio (flaw depth versus length (a/l)), is a/l = 0.118 with an a/t of 16.6%. The maximum allowable for t = 1.2 inch is 10.92%.

This indication was detected using an automated UT system and was further characterized using manual sizing techniques in accordance with qualified NDE procedures. The results indicate that the indication is characteristic of IGSCC and is ID connected on the pipe side of the weld in the HAZ.

Inspection History Of Weld GR-3-63.

In 1984 Induction Heat Stress Improvement (IHSI) was applied to the accessible, Unit 3, recirculation water system pipe welds to mitigate IGSCC. In conjunction with the IHSI process, weld GR-3-63 was examined pre-and post-IHSI using manual UT techniques. These manual examinations did not reveal the presence of an IGSCC indication. Unit 3 was shutdown by TVA in 1985 as part of an extensive recovery program and restarted in November of 1995. Due to advances made in IGSCC detection, TVA conducted additional post-IHSI examinations in 1992 using automated UT techniques.

The manual and automated techniques utilized during the 1983 - 1992 period were qualified through EPRI. A review of the 1992 automated data indicates that the indication was present in the same area but was masked by weld geometry and was not characterized as IGSCC due to limitations of the UT techniques employed by the industry in the 1992 timeframe.

A detailed review of the 1992 data and the 1998 data was performed to assess the characterization activities and identify the differences between 1992 and 1998 data. The primary reason that the indication is now characterized as IGSCC is directly attributable to enhanced, qualified automated UT techniques. The procedure, personnel and equipment utilized during the current Cycle 8 outage were qualified in accordance with Appendix VIII prior to the outage. The enhanced techniques required to successfully qualify to the stringent Appendix VIII, Supplement 2 requirements are directly attributable to the flaw's characterization as IGSCC. The primary enhancements contained in the qualified procedure that enhance discrimination of UT indications when interrogating geometry and flaw features are:

- The examinations for single sided welds are performed using 45-degree and 60-degree shear waves and 60-degree refracted longitudinal waves. Previous examinations (1992) did not incorporate the 60-degree shear wave that is now utilized during evaluation to ascertain indication characteristics.

- The analog to digital (A-D) digitization rate has been increased from 10 MhZ to 50 MhZ. The increase in the A-D rate results in increased ultrasonic resolution of flaw indications adjacent to geometry weld features.

The qualified Appendix VIII approach coupled with the shallow flaw characteristics provide an acceptable explanation of the changes between the 1992 inspection and the 1998 inspection results. Based on this ultrasonic data review the subject weld GR-3-63 flaw has not initiated since 1992 and appears to have experienced no apparent growth during the same period.

Expansion Of Inspection Sample

Prior to finding the indication, weld GR-3-63 was classified as a category "C" weld. Examination of all category "C" welds is being conducted during the current Unit 3 Cycle 8 outage. Since the total population of category "C" welds is being examined, no sample expansion is required per the guidance provided in GL 88-01.

Structural Evaluation of the GR-3-63 Indication

Volumetric and surface examinations of ASME code Class 1 equivalent components required by the ASME Section XI code are required to be evaluated by comparing the examination results with the acceptance standard specified in Table IWB-3410-1, to determine if the component is acceptable for continued service. Table IWB-3410-1 requires that weld GR-3-63 meet the acceptance standard of IWB-3514 for exam category B-J. IWB-3514.3 ("Allowable Flaw Standards for Austenitic Piping") states in part, "The acceptance of these flaws shall be governed by the allowable flaw standards for the volumetric examination method in Table IWB-3514-2."

The Attachment contains the IWB-3500 evaluation. According to the Attachment, the flaw does not meet the acceptance criteria of Table IWB-3514-2. A flaw that exceeds the size of allowable flaws defined in IWB-3500 may be evaluated by analytical procedures, such as those described in ASME Section XI Appendix A to calculate its growth until the next inspection or the end of service lifetime of the component.

The presence of the flaw changes the inspection schedule for this IGSCC weldment. Weld GR-3-63 was originally classified as an IGSCC Category C weldment. IGSCC Category C weldments are those not made of resistant materials and have been given a stress improvement process after more than two years of operation. Weld GR-3-63 will be re-classified as an IGSCC Category E weldment. IGSCC Category E weldments are those with known cracks but have been reinforced by an acceptable weld overlay or have been mitigated by a stress improvement treatment, with subsequent examination by qualified examiners and procedures to verify the extent of cracking. IGSCC Category E weldments are required to be inspected at least once every two refueling cycles after repair. The flaw present in weld GR-3-63 is not currently considered significant to be classified as an IGSCC Category F weldment.

A structural evaluation of the indication was conducted to determine the ability of the pipe to support continued unit operation. Crack growth analysis was conducted using the computer program pc-Crack. The crack growth rate law parameters specified in GL. 88-01 were utilized in the evaluation. For evaluation purposes the indication was assumed to have an initial depth of 0.2 inches and was conservatively assumed to extend 360° around the circumference of the pipe. Since the weld had been stress improved using IHSI, the residual stress was assumed to be zero. A fatigue growth analysis was also conducted which conservatively assumed the initial flaw size was equal to the end of period flaw size calculated in IGSCC growth analysis.

The crack growth evaluation indicates that a depth of 0.4094 inches is predicted following 6 years of continued operation. Using the ASME Section XI acceptable flaw size the predicted size is well within the maximum allowable for continued operation, thus continued operation in the current "as is" condition is acceptable. Additionally, inspection of weld GR-3-63 will be conducted per GL 88-01 guidance which will insure that any possible flaw growth will remain with in acceptable values.

Future Inspections

Consistent with GL 88-01 guidance, weld GR-3-63 will be classified as a Category "E" weldment. (Crack Reinforced By Weld Overlay or Mitigated by SI). Future inspections will be conducted per the schedule listed in Table 1 of GL 88-01. As previously stated in TVA's reply to GL 88-01 (Reference), TVA will provide future inspection information only in the event of changes in the current indication or the discovery of new indications.

REFERENCE:

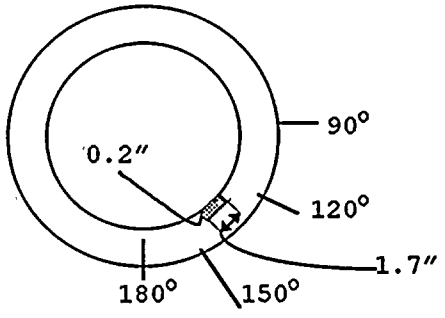
TVA letter to NRC dated August 1, 1988, Browns Ferry Nuclear Plant (BFN) Response to Bulletin 88-01, IGSCC in BWR Austenitic Stainless Steel Piping

ATTACHMENT
IWB-3500 EVALUATION
FLAW ID: Weld GR-3-63

1) Determine Region and Orientation of Flaw. The weld region should be identified by the nearest weld. The orientation is either [A]xial or [C]ircumferential.

Region: Weld GR-3-63
Orientation: C .

2) Sketch Flaw Geometry.



c = Πd = (Π) (28″) = 87.96″
Flaw start = (34.5/87.96) X (360°) = 141.2°
Flaw end = (36.2/87.96) X (360°) = 148.2°

3) Classify Flaw. Combine flaws in close proximity to other flaws and to the surface per the proximity rule of IWA-3300, Section XI of the ASME Code. Classify flaw as either:

Inside Surface: ■
Outside Surface: □
Subsurface: □

4) Size Flaw. Calculate flaw depth.

Surface Flaws:			Subsurface Flaws:		
Flaw Depth, a	=	0.2 (in)	Flaw Depth, a	=	N/A (in)
Flaw Length, L	=	1.7 (in)	Half Depth, a	=	N/A (in)
			Flaw Length, L	=	N/A (in)

5) Calculate Aspect Ratio of Flaw.

Flaw Aspect Ratio, a/L = (0.2)/(1.7) = 0.118

ATTACHMENT
IWB-3500 EVALUATION
FLAW ID: Weld GR-3-63
(continued)

6) **IWB-3500 Flaw Evaluation.** For the given a/L aspect ratio, determine the allowable flaw depth, a (surface) and 2a (subsurface), in accordance with IWB-3510 of the Code and record the value below. If the flaw depth recorded in step 4 is below the allowable value, check the box "Acceptable per IWB-3500" below. Otherwise, Check box "Unacceptable per IWB-3500" and continue to step 7.

Inside Surface Flaws:
Actual flaw information: t = 1.2"; a/t = (0.2)/(1.2) = 16.67%
Section XI a/t allowable interpolated from Table IWB-3514-2 "Inservice Examination" = 10.916%

	Nominal Wall =	1.0 inch	1.2 inch	2.0 inch
Table value	a/l = 0.1	a/t = 11.0%	N/A	a/t = 10.4%
Interpolation	a/l = 0.118	a/t = 11.036%	a/t = 10.916%	a/t = 10.436%
Table value	a/l = 0.15	a/t = 11.1%	N/A	a/t = 10.5%

IWB-3500 Allowable Depth = a =(10.916)X(1.2) = 0.131 (in)

Outside Surface Flaws
IWB-3500 Allowable Depth = a = N/A (in)

Subsurface Flaws:
IWB-3500 Allowable Depth = 2a = N/A (in)

ACCEPTABILITY:

0.2 inch flaw depth exceeds 0.131 inch IWB-3500 Allowable Depth.

☐ Acceptable per IWB-3500
■ Unacceptable per IWB-3500