Tennessee Valley Authority, Post Office Box 2000, Decatur, Alabama 35609-2000

November 3, 2000

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

Gentlemen:

In the Matter of) Docket No. 50-296
Tennessee Valley Authority)

BROWNS FERRY NUCLEAR PLANT (BFN) - UNIT 3 - RESPONSE TO NRC REQUEST REGARDING THE INTERGRANULAR STRESS CORROSION CRACKING (IGSCC) INDICATION FOR WELD GR-3-63 OF THE REACTOR WATER RECIRCULATION SYSTEM PIPING (TAC NO. MA3709)

This letter provides TVA's response to the actions requested by the NRC in its letter dated October 9, 1998, for weld GR-3-63 of the Reactor Water Recirculation System loop B piping.

During the Unit 3 Cycle 8 refueling outage (Fall 1998), ultrasonic test (UT) inspections of Reactor Water Recirculation System piping welds, conducted in conjunction with the guidance of Generic Letter (GL) 88-01, revealed an IGSCC indication in the heat affected zone of weld GR-3-63. TVA submitted a flaw evaluation of the weld to the NRC staff for review and approval prior to resumption of operations as required by Section XI of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code.

TVA concluded that weld GR-3-63 was acceptable for a minimum of three additional fuel cycles since the final predicted flaw size at the end of the evaluation period would not exceed the ASME Code allowable flaw size. The staff concurred with TVA's flaw evaluation by letter dated October 9, 1998, and concluded that BFN Unit 3 could be safely operated for at least one fuel cycle with weld GR-3-63 in the "as-is" condition. However, in

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that letter, the staff also identified concerns regarding the effectiveness of the Induction Heat Stress Improvement (IHSI) that was performed on the weld since the flaw was found after the IHSI treatment. Consequently, the staff requested that TVA: (1) review the IHSI processing data for weld GR-3-63 to ensure that all parameters required by the processing specification were met, (2) reinspect the weld during the BFN Unit 3(Cycle 9/Spring 2000) refueling outage, and (3) submit the information for NRC staff review within six months after the UT inspection of weld GR-3-63 is completed. The enclosure to this letter provides the results of TVA's actions regarding the staff's request.

There are no new commitments contained in this letter. If you have any questions, please contact me at (256) 729-2636.

Sincerely,

T. E. Abney
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and Industry Affairs

Enclosure
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ENCLOSURE

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNIT 3

RESPONSE TO NRC REQUEST REGARDING INTERGRANULAR STRESS CORROSION CRACKING (IGSCC) INDICATION ON REACTOR WATER RECIRCULATION SYSTEM PIPING WELD GR-3-63

Background

During the Unit 3, Cycle 8 refueling outage, ultrasonic test (UT) inspections of Reactor Water Recirculation System piping 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 GR-3-63. Weld GR-3-63 is in the Reactor Water Recirculation System loop B piping 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 stainless steel pipe.

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

In 1984 Induction Heat Stress Improvement (IHSI) was applied to the accessible, Unit 3, Reactor Water Recirculation System piping 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. Subsequently, 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 1992.

A detailed review of the 1992 NDE data and the 1998 NDE 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 Cycle 8 refueling outage were qualified in accordance with Appendix VIII prior to the outage.

A flaw evaluation of the indication was performed to determine the ability of the pipe to support continued unit operation. A 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 degrees 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 performed which conservatively assumed the initial flaw size equal to the end of period flaw size calculated in the IGSCC growth analysis.

TVA concluded in its flaw evaluation that weld GR-3-63 was acceptable for a minimum of three additional fuel cycles since the final flaw size at the end of the evaluation period would not exceed the ASME Code allowable flaw size. The staff concurred with TVA's flaw evaluation by letter dated October 9, 1998, and concluded that BFN Unit 3 could be safely operated for at least one fuel cycle with weld GR-3-63 in the "as-is" condition. However, in that letter, the staff also identified concerns regarding the effectiveness of the IHSI that was performed on the weld since the flaw was found after the IHSI treatment. The staff requested that TVA: (1) review the IHSI processing data for weld GR-3-63 to ensure that all parameters required by the processing specification were met, (2) reinspect the weld during the BFN Unit 3 (Cycle 9/Spring 2000) refueling outage, and (3) submit the information for NRC staff review within six months after the UT inspection of weld GR-3-63 is completed.

The specific NRC request is restated below for clarity followed by the corresponding TVA response.

NRC Request No. 1

"Review the IHSI processing data pertaining to weld GR-3-63 to ensure that all parameters required by the processing specification are met, such as the through wall temperature gradient."

TVA Response

TVA performed a review of the IHSI process control parameters and the actual IHSI data recorded for weld GR-3-63 (stainless steel to stainless steel weld joint). TVA has determined that the IHSI process control specification (General Electric Procedure P50YP214, Revision 3, Table 1) parameters were met. The specific process control parameters for weld GR-3-63 are listed below with the results of TVA's review.

- **Pipe Outer Surface Temperature Within Treatment Zone -** The GE specification for the IHSI process control required that the pipe outer surface temperature be within 400 to 575 degrees Centigrade (°C). The IHSI treatment data sheet and thermocouple data plot for weld GR-3-63 shows that the pipe outer surface minimum and maximum temperatures recorded during the IHSI treatment was 410°C and 525°C respectively.

- **Minimum Throughwall Temperature Difference (ΔT) Of 275°C -** The minimum required throughwall temperature difference (ΔT) of 275°C was achieved by heating the pipe outer surface within the treatment zone between 400°C and 575°C while simultaneously cooling the inner surface with system water, flowing at, or above, the specified minimum water velocity of 0.5 meters per second, as stated by the IHSI process control specification.

- **Minimum Width Of Zone Heated To (ΔT) Minimum -** The minimum required width of zone heated to ΔT minimum for weld GR-3-63 was 155 millimeters. The actual width of zone heated to ΔT minimum for weld GR-3-63 was 158 millimeters.

- **Minimum Distance From Weld Center To Boundary Of (ΔT) Minimum -** The minimum required distance from the weld center to the boundary of ΔT minimum for weld GR-3-63 was determined to be 16 millimeters. The actual distance from the weld center to the boundary of ΔT minimum was 19 millimeters.

- **Minimum Heating Time To Temperature** - The minimum required heating time to temperature for weld GR-3-63 was determined to be 151.29 seconds. The actual heating time to temperature was 205 seconds.

- **Maximum Total Time For Outer Surface Above Temperature Of 425°C** - A review of the eleven thermocouple data sheets for weld GR-3-63 shows that the maximum total time of 20 minutes for the outer surface above the temperature of 425°C was not exceeded. The maximum time above 425°C for any of the eleven thermocouple readings was two minutes and ten seconds.

- **Frequency** - The frequency for the IHSI process was monitored on an electronic display for the equipment during the IHSI treatment process, and met the IHSI process control specification.

- **Minimum Induction Coil Length** - The minimum required induction coil length for weld GR-3-63 was determined to be 309 millimeters. The actual induction coil length was 336 millimeters.

- **Minimum Water Velocity (In Vertical Or Horizontal Flooded Pipe)** - The minimum required water velocity of 0.5 meters per second was met for the IHSI treatment of weld GR-3-63. The actual water velocity for the IHSI treatment of weld GR-3-63 was approximately 2.1 meters per second.

- **Minimum Water Velocity (In Pipe With Air Pockets)** - This parameter is not applicable for weld GR-3-63.

NRC Request No. 2

"Reinspect weld GR-3-63 during the next refueling outage using the same techniques, procedures and instrument that were used in the current cycle 8 outage. If there is no change in flaw size, then the subsequent reinspection schedule can follow that of IGSCC Category E welds (once every two fuel cycles)."

TVA Response

In accordance with the NRC staff's request dated October 9, 1998, weld GR-3-63 was reexamined during the BFN Unit 3 Cycle 9 (Spring 2000) refueling outage using the same techniques, procedures, and instrument that were used during the Cycle 8 refueling outage. The indication was sized and

determined to be unchanged (1.7 inches in length and 0.2 inches in depth) since the last examination during the Cycle 8 refueling outage. Additionally, the area containing the indication was examined utilizing an outside diameter creeping wave and a 70 degree refracted longitudinal wave to provide assurance that no cracks have propagated to, or approaching, the outside surface. No indications were observed. Weld GR-3-63 is currently classified as a Category E weld (cracked, reinforced by weld overlay or mitigated by SI) in the BFN Inservice Inspection Program and, as such, will receive a UT examination every two refueling cycles.

Based on the results of this examination, TVA confirms its position stated in our letter to the NRC dated October 5, 1998. The indication identified for weld GR-3-63 existed prior to 1992 and was masked by the weld geometry and was not characterized as IGSCC at that time due to limitations of the UT techniques employed by the industry in 1992. TVA considers its actions regarding the staff's request for weld GR-3-63 to be complete.