May 30, 2006

Mr. Karl E. Singer
Chief Nuclear Officer and
Executive Vice President
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

SUBJECT: BROWNS FERRY NUCLEAR PLANT UNIT 1 - SUPPLEMENTAL RESPONSE TO GENERIC LETTER 88-01, NRC POSITION ON INTERGRANULAR STRESS CORROSION CRACKING IN BWR [BOILING WATER REACTOR] AUSTENITIC STAINLESS STEEL PIPING (TAC NO. MC4891)

Dear Mr. Singer:

The Nuclear Regulatory Commission (NRC) staff has reviewed and evaluated the information submitted by Tennessee Valley Authority (TVA, the licensee), in its letter dated July 21, 2004, and supplemental letters dated April 25, 2005, and February 22, 2006. The letters were in response to Generic Letter (GL) 88-01, "NRC Position on Intergranular Stress Corrosion Cracking in BWR Austenitic Stainless Steel Piping."

The NRC staff has completed its review of the response, and concluded in the enclosed safety evaluation that TVA has provided an acceptable resolution to the GL 88-01 concerns.

If you have any questions regarding this matter, please contact me at (301) 415-4041.

Sincerely,

***/RA by B. Mozafari for/***
Margaret H. Chernoff, Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-259

Enclosure: Safety Evaluation

cc w/encl: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

SUPPLEMENTAL RESPONSE TO GENERIC LETTER 88-01

BROWNS FERRY NUCLEAR PLANT, UNIT 1

TENNESSEE VALLEY AUTHORITY

DOCKET NO: 50-259

## 1.0 INTRODUCTION

By letter dated July 21, 2004, as supplemented by letters dated April 25, 2005, and February 22, 2006, Tennessee Valley Authority (TVA, the licensee), submitted responses to Generic Letter (GL) 88-01, "NRC Position on Intergranular Stress Corrosion Cracking in BWR [Boiling-Water Reactor] Austenitic Stainless Steel Piping." The Nuclear Regulatory Commission (NRC) staff notes that Browns Ferry Nuclear Plant, Unit 1 (BFN 1), deferred responding to GL 88-01 until now because it has been in an extended outage since March 1985, and is now preparing for restart. The NRC staff reviewed the information provided by TVA. The staff evaluation of the response follows.

## 2.0 REGULATORY EVALUATION

The licensee stated that nondestructive examinations, repairs, stress improvement and pipe replacement with corrosion resistant materials are being implemented at BFN1. These activities are being performed to reduce the potential for Intergranular Stress Corrosion Cracking (IGSCC) and are consistent with the guidelines in GL 88-01 and prevailing BWR industry practice.

As required in GL 88-01 the licensee has provided a supplemental response to the NRC. The licensee response includes the following topics:

(1) Plans regarding long-term mitigation of IGSCC.

(2) A discussion of the inservice inspection program.

(3) A verification of the adequacy of the Browns Ferry Nuclear Technical Specifications (TSs).

(4) Confirmation of leakage detection methods.

(5) Reporting requirements to NRC for flaws.

2.1 Plans Regarding Long-Term Mitigation of IGSCC

The licensee stated the following measures are being taken at BFN1 to improve inspection quality and reduce/control IGSCC:

- Inspections using nondestructive examination equipment, qualified examiners and qualified techniques in accordance with the American Society of Mechanical Engineers Code are being used. Weld crown reduction is also being employed to enhance the quality of the examination. In a letter dated February 22, 2006, the licensee stated that the personnel qualified for inspecting for IGSCC were qualified in accordance with the Tri-party agreement and re-qualification of personnel would be performed every 3 years.

- Repair of IGSCC indications is being performed by using replacement piping. Replacement piping materials are resistant to IGSCC as defined in GL 88-01. In a letter dated April 25, 2005, the licensee stated that no weld overlays were used on the replacement piping.

- Where practical, mechanical stress improvement of susceptible piping and replacement piping is being performed.

- A reduction in the number of welds is being achieved by using designs which employ integral bends and branches in replacement piping where possible.

- Hydrogen water chemistry is being implemented to reduce susceptibility to IGSCC. Additionally, in a letter dated February 22, 2006, the licensee stated that the inspection schedule for IGSCC weldments follows the guidelines in BWRVIP [BWR Vessel and Internals Project] -75, including hydrogen water chemistry (HWC) effectiveness, where credit for HWC is taken.

The NRC staff considers these measures acceptable because the measures would mitigate the effects of IGSCC.

The wrought austenitic stainless steel piping systems and components that are considered susceptible to IGSCC according to the guidelines given in GL 88-01 are as follows:

- Reactor Recirculation from the recirculation inlet and outlet nozzles to the connections with residual heat removal.

- Residual Heat Removal (RHR) from the recirculation system to the first isolation valve outside of the drywell penetration.

- Reactor Water Cleanup (RWCU) from its connection to the RHR system to the first isolation valve outside of the drywell penetration.

- Core Spray (CS) from the core spray inlet nozzles to the drywell penetration, including the core spray inlet safe ends. The piping within and upstream of the penetration is not considered susceptible due the low-operating temperature, generally 130EF or less.

- Jet pump instrument safe ends.

The licensee stated that the head spray system is not included because it will be removed from Unit 1 prior to restart. Similarly, the control rod drive return and recirculation discharge valve bypass have been removed from Unit 1 and are, therefore, not considered. The NRC staff finds that the licensee has adequately defined the piping systems that are susceptible to IGSCC, as required by GL 88-01.

The licensee also stated that IGSCC susceptible weldments are being inspected or are being removed from service and replaced. The inaccessible welds will be inspected as described in a letter to the NRC dated November 25, 1992. This methodology was approved by the NRC in a letter dated February 18, 1993. In a response to a request for additional information (RAI) dated April 25, 2005, concerning inspection techniques and methods for weld overlays, the licensee stated there will be no weld overlays in Unit 1 since all of the previously affected piping with weld overlays has been removed and replaced.

The licensee indicated that the following piping will be replaced at BFN1:

- Reactor recirculation inlet and outlet safe ends are being replaced due to concerns of crevice corrosion attack. The replacement safe ends utilize an improved design employing resistant material and a crevice-free configuration.

- Reactor recirculation piping is being replaced. This includes the 28-inch pump suction and discharge piping, the 12-inch risers and 22-inch ringheader. The replacement piping is 316NG stainless steel, which is less susceptible to IGSCC. Improved construction methods and bent pipe result in fewer welds. The ringheader design eliminates the ringheader cross-tie valves.

- CS and RHR piping inside the containment are being replaced. The replacement piping is 316NG stainless steel for the RHR system and American Society for Testing and Materials SA-333 Grade 6, high toughness grade of carbon steel for the CS system, which is less susceptible to IGSCC.

- RWCU piping is being replaced both inside and outside containment, as was discussed in a letter to the NRC dated May 22, 1989. This replacement included the penetration process piping and eliminated the uninspectable weld located inside the penetration. The replacement material utilized is resistant to IGSCC. The licensee stated that 316NG stainless steel is being used for all piping operating above 200EF.

- Jet pump instrumentation nozzle safe ends and seal assemblies are being replaced to remove cracking and overlays. The replacement assemblies are an improved design, fabricated from IGSCC resistant materials.

The NRC staff finds the licensee's plan acceptable because piping susceptible to IGSCC would be replaced with piping that is resistant to IGSCC.

Also, the licensee stated that welds containing indications of cracking were replaced with 316NG IGSCC resistant material.

2.2 Discussion of the Inservice Inspection (ISI) Program

The licensee stated that future inspections performed on piping within the scope of GL 88-01 will conform to the NRC staff positions on methods, personnel, schedules and expansion plans. The NRC staff considers this program to be acceptable.

2.3 Conformance to the ISI Requirements of GL 88-01

GL 88-01 requested a change to the TSs to include a statement in the section on ISI that the ISI program for piping covered by the scope of this letter will be in conformance with the staff position on schedule, methods, and personnel. The licensee submitted this TS change to the NRC on December 9, 1988 as TS 262; it was approved on May 19, 1989, as Amendment 166 for Unit 1.

The licensee has since submitted Unit 1 TS Change 362 - Improved TSs (ITSs). The licensee stated this change was TVA's conversion package from Custom TSs to ITSs. The NRC approved this change in a letter to the licensee on July 14, 1998. The licensee stated the TS requirements for the ISI program are no longer part of ITSs or the BFN TSs. As discussed in the GL, the licensee stated the requirements regarding schedule, methods, and personnel will be included in the Unit 1 ISI program.

The NRC staff finds this program meets the ISI requirements of GL 88-01 and is, therefore, acceptable.

2.4 TSs on Conformance to Staff Positions on Leak Detection

The licensee stated the TS conformance to the staff positions on leak detection was previously submitted to the NRC on December 15, 1986, as TS-222 and approved on August 26, 1987, as Amendment 137 for Unit 1.

As stated previously, TVA submitted Unit 1 TS Change 362 - ITS. The NRC approved this change in a letter to the licensee dated July 14, 1998.

The NRC staff finds the licensee's program on leak detection meets the NRC position and is, therefore, acceptable.

2.5 Plans to Notify NRC of Flaws

The licensee stated that in the past, the NRC has been notified of the inspection results, flaw evaluations and repair mitigation measures associated with the BFN units through a comprehensive report submitted before plant startup. The licensee stated this report covers Unit 1 activities. The licensee stated that after the IGSCC mitigation work scopes have been fully implemented, reports will be made only in the event of the discovery of new flaws or a change is found in the condition of flaws previously detected. For these events, a full report of the flaw evaluation and strategy and technical justification for repair or continued operation will be submitted prior to plant startup. Additionally, a 90-day ISI summary report will still be submitted to the NRC for review.

The NRC staff finds the licensee's program for NRC notification of flaws to be acceptable.

2.6 Differences Between the Unit 1 Program and the Program Previously Approved for Units 2 and 3

The licensee stated that replacement of piping susceptible to IGSCC with piping resistant to IGSCC is more extensive in BFN1 than in Units 2 or 3. The licensee stated that Unit 1 has replaced more piping. To support the statement, the licensee has provided a general description of the piping replaced in Unit 1 and a comparison with the piping replacement efforts of Units 2 and 3.

- Reactor Water Recirculation piping in Unit 1 is being completely replaced with resistant materials versus a partial replacement scope for this system in Units 2 and 3. Recirculation riser piping was replaced in Unit 2, and the riser piping, header arms and crosses were replaced in Unit 3. The Unit 1 replacement piping material is the same material as used in Unit 3.

- RWCU piping is also being completely replaced in Unit 1, including the containment penetration piping, similar to the replacement effort scope in Unit 3. Unit 2 piping was partially replaced inside the drywell, penetration piping and a portion of the piping adjacent to valve FCV 69-01, in conjunction with replacement of RWCU piping outside the drywell. The Unit 1 replacement piping material is the same material as used in Unit 3.

- CS piping replacement scope inside the drywell for Unit 1 extends to the containment penetration piping. The Units 2 and 3 CS piping replacement inside the drywell extended to the inboard containment isolation valve. One loop of the Unit 1 CS pipe replacement also included replacement of a piping section containing a weld overlay outside containment between the penetration and an outboard containment isolation valve. The Unit 1 replacement piping material is the same material as used in Unit 3.

- RHR piping replacement inside the drywell for Unit 1 extends to the containment penetration piping for the two injection lines and the shutdown cooling suction line. The RHR piping on Unit 3 was replaced between the manual isolation valves for the two injection lines and the tie-in to the Recirculation tee connection for the 24-inch piping. The licensee stated that the Unit 2 RHR piping was not replaced. The replacement piping used in Unit 1 is the same material as used in Unit 3.

Additionally, the licensee provided clarifications to three RAIs in a letter dated February 22, 2006. The RAIs referred to the Table 1 listing of piping identified in the supplemental response to GL 88-01.

RAI No. 2 requested clarification or justification as to why two welds with limited accessibility (DRHR-1-3 and DRHR-1-12) are listed in Category D and not in Category G.

The licensee stated that IGSCC Category D weldments are defined as those not made with resistant materials and have not been given a Stress Improvement (SI) treatment, but have been inspected by examiners and procedures in conformance with Section 5.2.1 (NUREG-0313, Rev.2), and found to be free of cracks. IGSCC Category G weldments are those not made of resistant materials, have not been given an SI treatment and have not been inspected in accordance with Section 5.2.1. Stress

improved welds that were not inspected after the SI treatments are considered to be Category G weldments until the post-SI inspection has been performed.

The licensee stated that the two Category D welds, DRHR-1-3 and DRHR-1-12, are composed of nonresistant materials and have no stress improvement. This categorization is consistent with Units 2 and 3 for their corresponding weldments. These weldments were examined to the maximum extent practical utilizing qualified personnel and procedures in accordance with their classification as Category D.

RAI No. 3 requested clarification that Category G and D welds listed in Table 1 that are having Mechanical Stress Improvement Process (MSIP) performed would undergo an inservice examination prior to MSIP to ensure that no unacceptable flaws are present.

The licensee stated that ultrasonic examinations that are capable of IGSCC detection are performed prior to application of MSIP to ensure a flaw does not exist, which could propagate in the weldment during the application of the stress improvement process. Existing weldments that were made prior to the current BFN1 recovery effort, which were categorized as Category G or D, were ultrasonically examined utilizing qualified personnel and procedures for IGSCC detection both prior to and following MSIP application. The weldments made in the process of BFN1 recovery, for all IGSCC categories, were ultrasonically examined on a sampling basis (13 welds examined) prior to MSIP application and ultrasonically examined on a 100-percent basis following MSIP application. There were no relevant indications detected in the post-MSIP IGSCC examinations.

RAI No. 4 requested clarification concerning why a number of Category D welds are characterized as new welds, since all new piping is made of IGSCC resistant materials.

The licensee stated that there were two cases where replacement materials were initially categorized as Category D weldments. In the first case, existing cast stainless valves were refurbished and reinstalled in the system in conjunction with the installation of IGSCC resistant piping. The subsequent weldments were conservatively listed as Category D. A subsequent review of the NRC safety evaluation of BWRVIP-75, dated September 15, 2000, indicated that these weldments may be upgraded to Category A. In the second case, the IGSCC-resistant piping was connected to nonresistant piping at penetrations. In this case, the weldment remains Category D, until stress improvement is performed and then it is reclassified as Category C.

The NRC staff finds the response to the above RAIs, which clarified the categorization of the welds, to be acceptable.

## 3.0 CONCLUSION

Based upon the information provided above, the NRC staff concludes that the supplemental response to GL 88-01 from BFN 1 is in compliance with the staff's position on IGSCC in BWR Austenitic Stainless Steel Piping.

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