UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

June 13, 2011

Mr. R. M. Krich
Vice President, Nuclear Licensing
Tennessee Valley Authority
3R Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

SUBJECT: BROWNS FERRY NUCLEAR PLANT, UNIT 2: RELIEF FROM THE REQUIREMENTS OF THE ASME CODE (TAC NO. ME3720)

Dear Mr. Krich:

By letter dated March 31, 2010 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML100920542), as supplemented by letter dated May 4, 2011 (ADAMS Accession No. ML11129A187), Tennessee Valley Authority (TVA, licensee), submitted a request to the U.S. Nuclear Regulatory Commission (NRC) relief from certain American Society of Mechanical Engineers, Boiler and Pressure Vessel Code requirements for Browns Ferry Nuclear Plant, Unit 2.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.55a(a)(3)(i), the licensee requested to use the proposed alternative on the basis that the alternative provides an acceptable level of quality and safety.

The NRC staff has reviewed the subject request and concludes, as set forth in the enclosed safety evaluation, that TVA has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(a)(3)(i).

If you have any questions, please contact Mr. Christopher Gratton at 301-415-1055.

Sincerely,

Douglas A. Broaddus, Chief
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-260

Enclosure:
Safety Evaluation

cc w/enclosure: Distribution via Listserv

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RISK-INFORMED INSERVICE INSPECTION PROGRAM

FOURTH TEN-YEAR INTERVAL INSERVICE INSPECTION PROGRAM PLAN

TENNESSEE VALLEY AUTHORITY

BROWNS FERRY NUCLEAR PLANT UNIT 2

DOCKET NUMBER 50-260

1.0 INTRODUCTION

By letter dated March 31, 2010 (Reference 1), as supplemented by letter dated May 4, 2011 (Reference 2), Tennessee Valley Authority (TVA, licensee), requested U.S. Nuclear Regulatory Commission (NRC) authorization to adopt risk-informed (RI) selection of Class 1 and 2 piping welds for examination for the fourth 10-year inservice inspection (ISI) interval at Browns Ferry Nuclear Plant, Unit 2 (BFN2). The proposed process is similar to that proposed for BFN2 in a letter dated June 1, 2000 (Reference 5), and supplemented in letters dated October 16, 2000 (Reference 6), and December 13, 2000 (Reference 7). The previous request was reviewed and approved by the NRC for use in the third 10-year ISI interval in a letter dated January 19, 2001.

The licensee has considered relevant information since the development of the original program, reviewed and updated the RI-ISI program. The current TVA submittal proposed the continuation of the updated RI-ISI program during the fourth 10-year ISI interval.

2.0 REGULATORY EVALUATION

Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.55a(g), American Society of Mechanical Engineers (ASME) Code Class 1, 2, and 3 components (including supports) shall meet the requirements, "except design and access provisions and pre-service examination requirements" set forth in the ASME Code to the extent practical within the limitations of design, geometry, and materials of construction of the components. It also states in paragraph 10 CFR 50.55a(g) that ISI of the ASME Code Class 1, 2, and 3 components is to be performed in accordance with Section XI of the ASME Code and applicable addenda, except where specific relief has been granted by the NRC. The objective of the ISI program, as described in Section XI of the ASME Code and applicable addenda, is to identify conditions (i.e., flaw indications) that are precursors to leaks and ruptures in the pressure boundary of these components that may impact plant safety.

The regulations also require, during the first 10-year ISI interval and during subsequent intervals, that the licensee's ISI program complies with the requirements in the latest edition and addenda of Section XI of the ASME Code incorporated by reference into 10 CFR 50.55a(b) 12 months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein. BFN2 is currently in its fourth 10-year ISI interval, which began March 1, 2010. The applicable ASME Code Section XI code of record for the fourth 10-year ISI interval at BFN2 is the 2004 Edition.

Pursuant to 10 CFR 50.55a(g), a certain percentage of ASME Code Category B-F, B-J, C-F-1 and C-F-2 pressure retaining piping welds must receive ISI during each 10-year ISI interval. The ASME Code requires 100 percent of all B-F welds and 25 percent of all B-J welds greater than 1-inch nominal pipe size be selected for volumetric or surface examination, or both, on the basis of existing stress analyses. For Categories C-F-1 and C-F-2 piping welds, 7.5 percent of nonexempt welds are selected for volumetric or surface examination, or both. According to 10 CFR 50.55a(a)(3), the NRC may authorize alternatives to the requirements of 10 CFR 50.55a(g), if an applicant demonstrates that the proposed alternatives would provide an acceptable level of quality and safety, or that compliance with the specified requirement would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. The licensee has proposed to use an RI-ISI program based on Westinghouse Owners Group (WOG) Topical Report WCAP-14572, Revision 1-NP-A (WCAP-14572, or Reference 3) for ASME Code Class 1 and Class 2 piping (Examination Categories B-F, B-J, C-F-1 and C-F-2 piping welds), as an alternative to the ASME Code, Section XI requirements. In Reference 1, the licensee requests NRC authorization to extend its RI-ISI program, previously approved for use in the second and third intervals, for use in the fourth ISI interval at BFN2. The scope of the RI-ISI program, however, was changed. The licensee states in the submittal that based on precedents in the rest of the industry and at other TVA nuclear facilities RI-ISI programs at BFN Units 1 and 3 were limited to ASME Code Class 1 and Class 2 only (i.e., Categories B-F, B-J, and C-F-1 and C-F-2 welds). The licensee indicates that, for consistency, it revised the BFN2 program to this same scope. Reference 9 provides that this revision from a full scope to partial scope program is acceptable as long as the partial scope is well defined, and the change in risk due to the implementation of the RI-ISI program meets the guidelines in Regulatory Guide (RG) 1.174, "An Approach for Using Probabilistic Risk Assessment In Risk-Informed Decisions On Plant-Specific Changes to the Licensing Basis" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML023240437). These criteria are evaluated in the next section of this safety evaluation (SE).

3.0 TECHNICAL EVALUATION

The licensee is requesting relief to use the proposed RI-ISI program plan in the fourth 10-year ISI interval in lieu of the ASME Code, Section XI program requirements for the selection of Class 1 and 2 piping welds for examination. An acceptable RI-ISI program plan is expected to meet the five key principles of risk-informed decisionmaking discussed in RG 1.178, "An Approach for Plant-Specific Risk-Informed Decisionmaking - Inservice Inspection of Piping" (ADAMS Accession No. ML032510128), Standard Review Plan Chapter 3.9.8, "Standard Review Plan for Review of Risk-Informed Inservice Inspection of Piping," NUREG-0800, and WCAP-14572, as stated below.

1. The proposed change meets the current regulations unless it is explicitly related to a requested exemption or rule change.

2. The proposed change is consistent with the defense-in-depth philosophy.

3. The proposed change maintains sufficient safety margins.

4. When proposed changes result in an increase in core damage frequency (CDF) or risk, the increases should be small and consistent with the intent of the Commission's Safety Goal Policy Statement.

5. The impact of the proposed change should be monitored by using performance measurement strategies.

The first principle is met in this relief request because an alternative ISI program may be authorized pursuant to 10 CFR 50.55a(a)(3)(i), and therefore, an exemption request is not required.

The second and third principles require assurance that the alternative program is consistent with the defense-in-depth philosophy and that sufficient safety margins are maintained, respectively. Assurance that the second and third principles are met is based on the application of the approved methodology and not on the particular inspection locations selected.

In Reference 1, the licensee states that the process used to develop the proposed RI-ISI program for the fourth ISI interval is the same as that outlined in TVA's original submittal of June 1, 2000, and follow-on letters, References 5, 6, and 7. The program was then authorized by NRC in Reference 8. In Enclosure 1 of Reference 5 (with additional clarification in References 6 and 7), the licensee notes that the processes used to develop its RI-ISI program are consistent with the methodology described in ASME Code, Section XI, Code Case N-577, and WCAP-14572, with exception of nine documented deviations. These nine deviations involved the processes of:

- Failure Assessment - two deviations: 1) use of a different structural analysis code than the one approved in WCAP-14572, and 2) applying the highest individual element failure probability as the segment's failure probability for segment risk-ranking purposes, in lieu of applying the "limiting" or "worst-case" element concept specified in the approved methodology,

- Risk Evaluation - treating all segments with risk reduction worth (RRW) $\geq$ 1.001 as high safety significant (HSS) in lieu of performing a sensitivity study and/or a RRW uncertainty analysis for assigning segments with 1.001 $\leq$ RRW $\leq$ 1.005 as HSS or low safety significant (LSS), and

- Element Selection - selecting each individual element in an HSS segment with RRW $\geq$ 1.001 for nondestructive examination (NDE) instead of using the approved statistical selection process. In segments where the structural analysis code calculates a RRW $\leq$1.001 for all elements, but where qualitative consideration results in the segment being placed in HSS, the traditional ASME

Code criteria of selecting 25 percent of Class 1 elements for NDE is applied (Reference 5).

- Segment Definition - Some segments contained normally closed reactor coolant system isolation valves. During risk characterization, the licensee used that part of the segment with the highest pipe failure-related CDF or large early release frequency (LERF) to represent the segment. The NRC staff documented this deviation as acceptable in Reference 8.

- Consequence Evaluation - evaluating only one leak size, (i.e., large leak), for system impact. However, all possible spatial impacts were applied in the evaluation, and Reference 8 documented this deviation as acceptable.

- Failure Assessment - The licensee declined to credit augmented inspection program related NDEs in the calculation of "without inspection" failure potential for intergranular stress-corrosion cracking (IGSCC) Category "A" elements previously selected for NDE under this augmented inspection program. This treatment was due to WCAP-14572's subsuming of the IGSCC augmented inspection program for Category "A" elements. Hence these inspections would not necessarily be continued on each of these previously inspected elements, under RI-ISI. The licensee took the conservative approach to give no credit for these inspections in calculating failure potential. As a result, Reference 8 documented this deviation as acceptable.

- Risk Achievement Worth Calculation - There were no calculations of segment Risk Achievement Worth performed for the Expert Panel. Because the licensee's Expert Panel had invoked a qualitative criterion that all segments whose rupture would initiate a large Loss-of-Coolant Accident (LOCA) would be classified as HSS, Reference 8 documents the staff's assessment that this would provide equivalent sensitivity to ruptures of truly high consequence, and hence this deviation was found acceptable.

- Uncertainty Analysis - An uncertainty analysis of the delta CDF/LERF calculations was not performed. Reference 8 documents the staff's finding of this deviation's acceptability on the basis of the relative similarity between the licensee's processes and the approved methodology.

The NRC staff concluded that the licensee's original proposed RI-ISI program reasonably conforms to WCAP-14572, with exception of the above nine deviations. In Reference 8, the staff concluded that these nine deviations, as used by the licensee to develop its original RI-ISI program, were acceptable.

In Reference 1, the licensee provides a table (Attachment 10, page 6 of 6) that compares the RI-ISI program (i.e., the number of NDEs within each system in scope) for the second interval, with the existing RI-ISI program (third interval), and the proposed RI-ISI program for the fourth interval. The licensee is proposing reducing the number of NDEs from 81 in the third interval to 79 in the fourth interval. The licensee explains in the submittal that this reduction is "attributable to the implementation of the hydrogen water chemistry/noble metal injection program, with the corresponding impact on IGSCC and a change in ASME Code Class boundary."

The staff concludes that the licensee's methodology for evaluating and developing the previous RI-ISI program (which derives from the methodology in WCAP-14572, but includes a number of acceptable deviations approved in Reference 8), has been appropriately re-applied in updating this program for the fourth 10-year interval. Hence, the staff concludes that the second and third key principles have been met.

The fourth principle (any increase in CDF or risk should be small and consistent with the intent of the Commission's Safety Goal Policy Statement) requires an estimate of the change in risk, and the change in risk is dependent on the location of inspections in the proposed ISI program compared to the location of inspections that would be inspected using the requirements of ASME Code, Section XI. WCAP-14572 requires that a change in risk measurement must consider the discontinuance of ASME Code-required inspections, as well as any new inspections resulting from the application of its methodology. Reference 5 indicated that, for the second interval, the ASME Code Section XI code of record was the 1989 edition with no addenda. As previously mentioned, the licensee plans to update to the 2004 Edition. It is possible to impact the risk analysis if a revised ASME Code inspection program for the fourth interval were developed for this updated code of record since the number and/or locations of inspections mandated by the updated code of record could increase or change due to potential new scoping requirements, changes in code sampling percentage requirements, or other reasons. However, development of an acceptable RI-ISI program is primarily achieved through the risk-ranking and the inspection location selection processes. When applied as part of an integrated decision-making process, subsequent change in risk estimates provides reasonable assurance that the change in the ISI program would result in a total plant risk neutrality or risk decrease, which will be consistent with staff guidelines found in RG 1.174. Although the ASME Code, Section XI inspection program may change slightly when developed from the updated code of record, the accuracy of the change in risk calculations does not warrant developing a new ASME Code program for the new code of record simply to be used as a new baseline for the change of risk analysis, and then discarded. The licensee reported that an updated change in risk evaluation was performed for the current program, and the risk from the current program is lower when compared to the last deterministic ASME Code, Section XI inspection program, and that the change in risk calculations were performed according to the applicable guidelines provided in Section 4.4.2 of WCAP 14572, Revision 1-NP-A. Therefore, the staff finds that the licensee's approach in estimating the change of risk between the RI-ISI program proposed in the submittal, and the ASME Code program based on the code of record from which relief was granted in Reference 8, is acceptable.

Quantitative results of the probabilistic risk assessment (PRA) are used, in combination with a quantitative characterization of the pipe segment failure likelihood, to support the development of broad safety significance categories reflecting the relative impact of pipe segment failures on CDF and LERF. The safety significance categories determined from the PRA are considered, together with the individual weld or element failure likelihood, to support the determination of the number of elements to inspect in each segment. Inaccuracies in the PRA models, or assumptions large enough to invalidate the broad categorizations developed to support RI-ISI, should have been identified in the licensee or the staff reviews. The NRC staff found that the quality of the BFN2 PRA is adequate to support the submittal because any minor errors or inappropriate assumptions that might remain in the models would only affect the consequence calculations of a few segments and should not invalidate the general results or conclusions.

Based on the use of the approved methodology and on the reported results, the staff finds that any change in risk associated with the implementation of the RI-ISI program will be small and consistent with the intent of the Commission's Policy Statement and RG 1.178; therefore, the fourth key principle is met.

With regard to the fifth key principle, Section 4.5.2 of WCAP-14572 states that RI-ISI programs are living programs and should be monitored continuously and that monitoring of these programs encompasses many facets of feedback or corrective action, which includes periodic updates. The licensee reports in the submittal that it has been performing reviews and updates on an ASME Code periodic basis. Specifically, the first period following the initial implementation of its RI-ISI program for BFN2 ended on May 25, 2001. The program was evaluated at this point with no update required. However, prior to the next periodic update, the licensee had updated the PRA for BFN2, and had initiated a new hydrogen water chemistry/noble metals injection program. Given these changes, the licensee performed a review and program update in March 2002, ahead of the end of the period. This is consistent with Section 4.5.2 of WCAP-14572, which notes that the PRA used in the development of any RI-ISI program is a state of knowledge at the time of implementation. Hence, any significant changes in these parameters that affect CDF or LERF by a critical factor should be considered as expeditiously as possible. Then, to conform to the requirement of the periodic update, the licensee states that another review and update was completed at the end of the first period of the third interval on May 24, 2004. The licensee also notes that the second period of the third interval ended May 24, 2008, and that the periodic review was completed at that time.

As discussed in Section 2.0 of this SE, one of the changes being made in the licensee's RI-ISI program for the fourth interval is to reduce the scope of the BFN2 RI-ISI program from "high safety significant piping segments regardless of ASME Class" to ASME Code Class 1 and 2 piping only. Reference 9 provides that such a partial scope program is acceptable as long as (a) the partial scope is well-defined, and (b) the change in risk due to the implementation of the RI-ISI program meets the guidelines in RG 1.174. The first requirement is met on the basis that ASME Code, Section XI Class 1 and 2 components are formally defined by all licensees to comply with 10 CFR 50.55a. The second requirement was shown to be met in Section 3.0 of this SE. In addition, the licensee notes in the submittal that the same segments were determined to be significant (i.e., HSS) regardless of scope. The staff reviewed the licensee's data for both the third and fourth intervals, and notes that none of the tables of HSS segments for either of the ISI intervals includes any segments from ASME Code Class 3 or non-Class systems, nor are any of the ASME Code Class 3 or non-ASME Code Class systems' elements selected for NDE. Hence, the staff concurs that this proposed reduction in scope will have no effect on the implementation of the fourth 10-year interval RI-ISI program. However, the licensee is expected to conform to ASME Code, Section XI requirements for its ASME Code Class 3 systems in the fourth ISI interval and beyond. Based on the above considerations, the staff concludes that the licensee's RI-ISI program is consistent with the "living program" concept, and therefore, the fifth key principle is met.

Based on the above discussion, the staff finds that the five key principles of risk-informed decision making are ensured by the licensee's proposed fourth 10-year RI-ISI interval program plan, and therefore, the proposed program for the fourth 10-year ISI interval is acceptable.

4.0 CONCLUSION

As set forth above, the NRC staff determines that the proposed alternative, which is based on the methodology of Reference 3 with a number of deviations considered and approved by the staff, provides an acceptable level of quality and safety. Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(a)(3)(i), and is in compliance with the ASME Code's requirements. Therefore, the NRC staff authorizes the proposed alternative - the adoption of the risk-informed process for the selection of Class 1 and 2 piping welds for examination - at BFN2 for the remainder of the fourth 10-year ISI interval, which ends on May 24, 2021.

All other ASME Code, Section XI requirements for which relief was not specifically requested and authorized above, remain applicable, including the third party review by the Authorized Nuclear Inservice Inspector.

5.0 REFERENCES

1. Letter, R.M. Krich (Tennessee Valley Authority) To U.S. Nuclear Regulatory Commission containing "American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section XI, Inservice Inspection Program for the Fourth Ten-Year Inspection Interval" for Browns Ferry Nuclear Plant, Unit 2, March 31, 2010 (ADAMS Accession Number ML100920542).

2. Letter, R.M. Krich (Tennessee Valley Authority) To U.S. Nuclear Regulatory Commission containing "Response to Request for Additional Information Regarding Relief Request 2-ISI-1, Updated Risk Informed Inservice Inspection Program" for Browns Ferry Nuclear Plant, Unit 2, May 4, 2011 (ADAMS Accession Number ML11129A187).

3. WCAP-14572, Revision 1-NP-A, "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report," February 1999.

4. ASME RA-Sb-2005, Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications, Addendum B to ASME RA-S-2002, ASME, New York, New York, December 30, 2005.

5. Letter, T.E. Abney (Tennessee Valley Authority) To U.S. Nuclear Regulatory Commission, containing "Browns Ferry Nuclear Plant Unit 2, Request for Approval of the BFN American Society of Mechanical Engineers Section XI Alternate Inservice Inspection Program- Risk Informed Inservice Inspection Program," dated June 1, 2000 (ADAMS Accession Number ML003722388).

6. Letter, T.E. Abney (Tennessee Valley Authority) to U. S. Nuclear Regulatory Commission, containing Browns Ferry Nuclear Plant Unit 2, Proposed Risk-Informed Inservice Inspection Program- Response to NRC Request for Additional Information, October 16, 2000 (ADAMS Accession Number ML003762456).

7. Letter, T.E. Abney (Tennessee Valley Authority) to U. S. Nuclear Regulatory Commission, containing Browns Ferry Nuclear Plant Unit 2, Proposed Risk-Informed

Inservice Inspection Program- Supplemental Response to NRC Request for Additional Information, December 13, 2000 (ADAMS Accession Number ML003779285).

8. Letter from Richard P. Correia, U.S. Nuclear Regulatory Commission, to Mr. J. A. Scalice, Tennessee Valley Authority, dated January 19, 2001, Browns Ferry Unit 2, ASME Code Relief For Risk-Informed Inservice Inspection of Piping Safety Evaluation (ADAMS Accession Number ML010190294).

9. Letter from Thomas H. Essig, U.S. Nuclear Regulatory Commission, to Mr. Lou Liberatori, Westinghouse Owners Group, dated December 15, 1998, "Safety Evaluation of Topical Report WCAP-14572, Revision 1, 'Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report.'"

Principal Contributors: J. Patel
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Date: June 13, 2011

June 13, 2011

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If you have any questions, please contact Mr. Christopher Gratton at 301-415-1055.

Sincerely,

/RA/

Douglas A. Broaddus, Chief
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Safety Evaluation

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