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

November 10, 1999

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 - TVA'S REPLY TO NRC'S REQUEST FOR ADDITIONAL INFORMATION (RAI) REGARDING THE PROPOSED RISK-INFORMED INSERVICE INSPECTION (RI-ISI) PROGRAM (TAC NO. MA5355)

This letter provides TVA's reply to NRC's RAI dated October 15, 1999, regarding the proposed BFN Unit 3 RI-ISI program submitted to NRC on April 23, 1999. The proposed RI-ISI program contains an alternative to the current American Society of Mechanical Engineers Section XI inservice inspection requirements for Code Class 1, 2, and 3 piping.

On August 31, 1999, in a meeting notice, the staff provided TVA with a list of questions regarding the proposed RI-ISI program and a scheduled meeting date to discuss the program. On September 20, 1999, TVA met with the staff regarding the staff's questions. During the meeting, TVA addressed each of the staff's questions. Based on TVA's responses, the staff requested some additional information. TVA responded to this request in a follow-up letter dated October 25, 1999.

The October 15, 1999, RAI contains statements in the second paragraph of the background section that are inconsistent with TVA's position. Specifically, the paragraph reads:

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"For the Browns Ferry Unit 3 (BFN3) RI-ISI program, your submittal was based on the template developed for RI-ISI submittals and your letter dated April 23, 1999, stated that the RI-ISI program has been developed based on the approved WOG methodology. Although your submittal listed three deviations from the approved WOG methodology, subsequent meetings between the staff and TVA personnel identified four additional important deviations discussed below. Based on the review performed to date, it appears that the results of the proposed BFN3 RI-ISI program are different from those expected by the staff since the approved WOG methodology was not adhered to in developing the program."

The following clarifies the statements in the above paragraph. First, TVA's letter to NRC dated April 23, 1999, submitted the original proposed BFN Unit 3 RI-ISI program and identified four deviations from the WOG methodology rather than three as cited above. Secondly, with regard to the meetings between the staff and TVA, only one additional deviation was identified. This was a deviation regarding pipe segment definition. TVA's RI-ISI program contained an option to use failure probability to further define piping segments. This option was not used and TVA's letter to NRC dated October 25, 1999, clarified how segments were identified and eliminated the deviation. Finally, TVA does not believe that the other three deviations from the WOG methodology identified by the staff in the October 15, 1999, RAI are new deviations but rather are applications of the four deviations previously identified by TVA. TVA does not believe that the deviations from the WOG methodology caused differences in what the staff expected but rather the focus of the pilot plants on Pressurized Water Reactors (PWRs). Therefore, TVA believes that the differences in results are due to the dominant failure mechanisms of Boiling Water Reactors versus that of PWRs.

The BFN proposed Unit 3 RI-ISI program engineering analyses and supporting documentation are available for review at the BFN site offices. The staff is encouraged and invited to review the BFN Unit 3 RI-ISI program supporting information at its earliest convenience.

The enclosure to this letter formally provides the information requested by the NRC October 15, 1999, RAI. This information was provided informally to the staff on October 26, 1999. There are no commitments contained in this letter. If you have any questions, please telephone me at (256) 729-2636.

Sincerely,

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and Industry Affairs

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ENCLOSURE

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

REPLY TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
REGARDING THE RISK INFORMED INSERVICE INSPECTION (RI-ISI)
PROGRAM
DATED OCTOBER 15, 1999

I. Purpose

The purpose of this enclosure is to provide TVA's reply to the NRC RAI dated October 15, 1999.

II. Background

On April 23, 1999, TVA submitted the BFN Unit 3 RI-ISI program to NRC. The proposed program contains an alternative to the current American Society of Mechanical Engineers Section XI inservice inspection requirements for Code Class 1, 2, and 3 piping. In a meeting notice dated August 31, 1999, the staff identified a list of questions to be addressed in a meeting scheduled for September 20, 1999.

On September 20, 1999, TVA personnel met with the staff regarding the proposed BFN Unit 3 RI-ISI program submittal. During the meeting, TVA addressed each of the staff's questions listed in the August 31, 1999, meeting notice. Based on TVA's responses, the staff requested some additional information. TVA responded to this request in a follow-up submittal dated October 25, 1999.

On October 1, 1999, by teleconference, the NRC provided TVA with additional questions regarding the BFN Unit 3 RI-ISI program. NRC's letter to TVA dated October 15, 1999, provided the request for additional information.

The following is a restatement of the requested information followed by TVA's reply.

III. NRC Questions/TVA Replies

NRC Question Number 1

In the approved WOG topical report WCAP-14572 methodology, segments are selected according to failure consequence. The BFN Unit 3 methodology further divides segments based on consequences into smaller segments with unique degradation mechanisms. The effect of this deviation from the approved WOG methodology is unclear. The BFN Unit 3 methodology may break a single WCAP high safety significant segment into two or more segments. Because segments without degradation mechanisms have very low failure probabilities, it would appear that most of the "new" segments would be of low safety significance. This difference is most likely the reason that TVA has no segment sections in zone 1(B). Because each segment section in zone 1(B) has one weld inspected in the WCAP methodology, the TVA method appears to result in fewer welds to inspect. Another potential impact is that one high safety significance (HSS) segment under the WOG methodology may, under the BFN methodology, become three (or more) smaller segments, two with high failure probabilities and one with a low failure probability. Because we are working with relative results the impact would be to raise the total core damage frequency and large early release frequency (CDF/LERF) and decrease the individual importance measures. Please provide an assessment of the impact of this change in the methodology on the number and distribution of proposed weld inspections as compared to the WOG methodology.

TVA's Reply, Question 1

As stated in TVA's letter to the NRC dated October 25, 1999, the BFN methodology is consistent with the WCAP-14572. In that letter, TVA clarified how segments were defined at Browns Ferry. The option to change segment boundaries based on change in failure probability was not used and is not needed; therefore, the definition was changed to eliminate the consideration of failure probability. Since there is no change, there is no impact on the number and distribution of proposed weld inspections as compared to WOG methodology.

NRC Question Number 2

The WOG methodology includes the effect of augmented inspections for intergranular stress corrosion cracking (IGSCC) and flow assisted corrosion (FAC) in its baseline Section XI calculations while TVA excludes them. The baseline calculations determine which segments are HSS and need to be inspected. The exclusion of the effects of the augmented IGSCC and FAC inspections in the baseline calculations greatly increases the failure probability of segments exposed to these degradation mechanism which, in turn, greatly increases their importance. This is probably the reason that the only segments having HSS are those subject to FAC and IGSCC, and the only elements subject to inspection, with one exception, are those in the current FAC and IGSCC augmented inspection programs. The WOG methodology included the impact of IGSCC and FAC inspection in its baseline calculations, which reduced the relative contribution from these segments allowing other degradation mechanisms to be represented in the HSS category. It is noteworthy that TVA includes credit for microbiologically induced corrosion (MIC) augmented inspections in its baseline calculations and, because of this credit, finds only low safety significance (LSS) segments in several support systems that the probabilistic risk assessment (PRA) has found to be very important. TVA should assess the impact of this change in methodology on the number and distribution of proposed weld inspections and report the results to the staff.

TVA's Reply, Question 2

The TVA baseline calculation does credit the effect of the initial inspection of each IGSCC-susceptible weld. Since the objective of the Risk-Informed analysis was to determine which elements should be subject to further augmented inspections, credit for those inspections was not given. As a sensitivity study, the failure rate for all piping segments subject to IGSCC was changed to reflect an inspection every interval. Based on these new failure rates CDF and risk reduction worth (RRW) were recalculated. The results of this study are that the base CDF was reduced by eight percent, but no additional segments were identified with RRW greater than or equal to 1.005. This study was then combined with the FAC sensitivity study where the failure rate

TVA's Reply, Question 2 (Continued)

for the dominant degradation mode other than FAC was used. The results were the same, with the exception that CDF was reduced by 15 percent and the segments which had been significant due to FAC were no longer significant. These studies provide assurance that the dominant degradation modes at a BWR do not mask any other degradation modes which would be significant in their absence. These sensitivity studies conclude that there is no impact on the number and distribution of proposed weld inspections due to the methodology used.

The TVA baseline does not credit MIC inspections; rather, the Expert Panel determined that due to the preventive measures instituted under the Raw Water Fouling and Corrosion Control Program (e.g., a chemical treatment program involving the use of biocides and monitoring of material coupons), MIC should not be considered an applicable failure mechanism for the piping being analyzed. The monitoring under that program only serves to validate the effectiveness of the other measures instituted. Therefore, credit was taken for the program mitigating MIC rather than the inspections to detect it.

NRC Question Number 3

The WOG methodology estimates the CDF and LERF for the current and proposed programs at the system and plant level. These estimates are subtracted from each other to estimate the change in CDF/LERF. The topical report provides acceptance criteria for the system and plant level change estimates. The BFN methodology produces estimates that it labels "detected CDF and LERF." TVA has stated that "detected CDF and LERF" is different from "CDF and LERF." Without the different estimates of CDF and LERF, and the changes in risk obtained by subtraction, the proposed change in risk cannot be compared with the WOG acceptance criteria, nor with that of Regulatory Guide 1.174. Furthermore, if "detected CDF and LERF" are being estimated, as opposed to CDF and LERF, what is the relationship between the risk reduction worth (RRW) being calculated and plant risk? What relationship does it have to the quantity calculated by the WOG methodology, and why is it a suitable measure to identify the safety significance of the segments? Please provide an assessment of the impact of this change in methodology on the number and

NRC Question Number 3 (Continued)

distribution of proposed weld inspections and report the results to the NRC staff.

TVA's Reply

The TVA study calculated both CDF and LERF for each applicable case, and the changes in each are reported in the various tables. The change in risk evaluations are consistent with the WCAP in that they evaluate CDF or LERF addressed by the examination of each element, as illustrated by WCAP Figures 4.4-1,-2, and -3.

The CDF and LERF including the effect of inspections has also been calculated. As reported in the letter of October 25, 1999, the applicable piping CDF under the current programs (both Section XI and augmented) is 1.101E-05, and the corresponding LERF is 3.091E-06. The applicable piping CDF with the Risk-Informed inspections is 1.063E-05, with a corresponding LERF of 2.983E-06. This represents a reduction in CDF of 3.8E-07 and a reduction in LERF of 1.08E-07 due to the Risk-Informed program.

There is no change in methodology, and therefore there is no impact on the number and distribution of proposed weld inspections.

NRC Question Number 4A Through 4D

4. *The WOG methodology is based on the Structural Reliability and Risk Assessment (SRRA) code. The staff recognizes that TVA states in the submittal that the WinPRAISE code is the Windows-based version of the PRAISE code. We note, however, that the SRRA code was modified as a result of the WOG review to produce results that more fully support RI-ISI.*

A. The SRRA calculation yields the probability of pipe rupture over a 40-year life span with or without inspection as two different numbers. That is, when inspection is performed, crack growth is monitored and, if a crack grows to a detectable size, it will (with some probability of detection) be detected and repaired. Please describe if the WinPRAISE code has this feature, and, if not, how the difference in failure probability with and without ISI is determined.

TVA's Reply, Question 4A

WinPRAISE yields the probability of pipe rupture over a 40-year life span both with or without inspection as two different numbers.

NRC Question Number 4B

B. During the WCAP review, the staff determined that large leak probabilities were much larger than rupture probabilities, especially for large pipes. Consequently the SRRA code calculates both the probability of rupture (which requires a design-limiting event) and the probability of a large leak. Large leak is defined as the leak rate which would disable the system function. Crack leak rate is determined from the system pressure and crack size. Please describe what is used to define pipe failure in the WinPRAISE code.

TVA's Reply, Question 4B

Similar to SRRA, WinPRAISE allows calculations for three different leak types: Leak (detectable), Big Leak (system-disabling), and LOCA (rupture). The TVA study used the failure rate for a system-disabling leak for all direct consequences, and the failure rate for a detectable leak for indirect consequences. Crack leak rate is determined from the system pressure and crack size.

NRC Question Number 4C

C. The SRRA code included importance sampling, and increased the number of samples, as necessary, to always provide a pipe failure estimate, i.e., there were no zero pipe failure probability estimates. Some manipulation is involved because even very large weld failure estimates of 1E-5/yr (or 4E-4 over 40 years) would normally require tens of thousands of simulations without importance sampling. Your WinPRAISE code often yields zero pipe failure estimates which does not provide confidence that the Monte Carlo simulation is continued until a stable result is obtained. Please describe what techniques the WinPRAISE code uses to reduce the number of sample runs needed for the calculations of pipe failure probability.

TVA's Reply, Question 4C

WinPRAISE uses a stratified sampling technique to improve the efficiency of the Monte Carlo simulations. The crack plane is stratified into a number of strata and each strata is subjected to a given number of simulations. When a given number of failures has been obtained from a cell, the simulations are discontinued and the next cell is tested. There is no need to draw 10,000 samples from a given cell if 5 failures occur in the first 10 samples. In trials during software development, 1000 samples per cell was found to be usually adequate. In the TVA study, 10,000 samples per cell was set as the standard. As a sensitivity study, the number of samples in some calculations which resulted in a zero pipe failure probability estimate was increased to 100,000 and even 1,000,000. In some cases, a zero probability still resulted. In other cases, if a probability was obtained, it was on the order of 1E-15 to 1E-20. Based on this study, it was determined that the standard of 10,000 samples per cell was adequate and robust.

NRC Question Number 4D

D. *The staff expressed a number of concerns regarding the values of the input parameters used in the SRRA code. These concerns are discussed in detail in the WCAP-14572 safety evaluation report, and the accepted resolution of the concerns by the WOG are discussed in detail in Supplement 1 to WCAP-14572, Revision 1-NP-A. Please confirm that selection of the input values used in your calculations are consistent with the resolutions described in the Supplement, and provide a description of any inconsistencies.*

TVA's Reply, Question 4D

It should be noted that the SRRA code was benchmarked against the NRC sponsored pc-PRAISE code as part of the WCAP-14572 SER. Many of the Staff's concerns were in the area where the SRRA code did not meet the standards of the pc-PRAISE code. TVA used WinPRAISE which is a windows based version of pc-PRAISE. Therefore, input parameter differences due to differences between pc-PRAISE and SRRA do not exist.

TVA's Reply, Question 4D (Continued)

The selection of input values is consistent with the resolutions described in the Supplement, with the exception of material wastage. Wastage is not considered in WinPRAISE. As discussed in the submittal, the failure probabilities for Flow Accelerated Corrosion (FAC) were evaluated deterministically and a sensitivity study was performed to validate the results.

The technical basis for WinPRAISE calculation inputs is provided in Engineering Mechanics Technology Technical Report TR-98-4-1, dated April 1998, written by D.O. Harris and D. Dedhia, which is referenced in the TVA RI-ISI submittal. Many of the assumptions which required detailed instructions for the SRRA input are specific inputs to WinPRAISE, such as mitigating measures associated with IGSCC, rather than a general range of potential.