February 11, 2000

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

SUBJECT: BROWNS FERRY UNIT 3, ASME CODE RELIEF FOR RISK-INFORMED INSERVICE INSPECTION OF PIPING (TAC NO. MA5355)

Dear Mr. Scalice;

By letter dated April 23, 1999, Mr. T. Abney, Tennessee Valley Authority (TVA), requested approval of an alternative risk-informed inservice inspection (RI-ISI) program for Browns Ferry Unit 3 (BFN3). This request was identified as Cost Beneficial Licensing Action (CBLA) 99-01. The letter included an enclosure describing the proposed program. Additional clarifying information was provided in TVA's letters dated October 25, 1999, November 10, 1999 and January 18, 2000; a meeting held on September 20, 1999 and at a site audit visit conducted December 1 and 2, 1999.

Your BFN3 RI-ISI program was developed in general accordance with Westinghouse Owners Group Topical Report WCAP-14572, Revision 1-NP-A, using the Nuclear Energy Institute template methodology. The results of our review indicate that your proposal is an acceptable alternative to the requirements of the American Society of Mechanical Engineers Code Section XI, and that implementation of the RI-ISI program will result in a reduction in piping weld examinations, with an associated reduction in occupational radiation exposure, with little or no change in risk to the public due to piping failures.

In your April 23, 1999 letter you requested that this review be given pilot plant status. Such status would provide a basis for fee relief. This matter is still under discussion.

Your request for relief is authorized pursuant to 10 CFR 50.55(a)(3)(i). Our safety evaluation is enclosed. If you have any questions regarding this matter, please contact Bill Long at 301-415-3026.

Sincerely,

/RA/

Richard P. Correia, Chief, Section 2
Project Directorate II
Division of Licensing Project Management

Docket No. 50-296

Enclosure: Safety Evaluation

cc: See next page

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Mr. J. A. Scalice
Tennessee Valley Authority

BROWNS FERRY NUCLEAR PLANT

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SAFETY EVALUATION

BY THE OFFICE OF NUCLEAR REACTOR REGULATION

ON THE RISK-INFORMED INSERVICE INSPECTION PROGRAM

FOR THE TENNESSEE VALLEY AUTHORITY

BROWNS FERRY NUCLEAR PLANT, UNIT 3

DOCKET NO. 50-296

FEBRUARY 2000

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DOCKET NO. 50-296

1.0 INTRODUCTION

Current inservice inspection (ISI) requirements for the Browns Ferry Nuclear Plant Unit 3 (BFN3) are contained in the 1989 Edition of Section XI, Division 1 of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, entitled *Rules for Inservice Inspection of Nuclear Power Plant Components* (hereinafter called Code). In a submittal dated April 23, 1999, the licensee, Tennessee Valley Authority (TVA), proposed a new inservice inspection (ISI) program entitled "*Browns Ferry Nuclear Plant (BFN) - Unit 3 - Request for Approval of the BFN American Society of Mechanical Engineers (ASME) Section XI Alternative Inspection Program - Risk Informed Inservice Inspection (RI-ISI) and Cost Beneficial Licensing Action (CBLA) 99-01* (Ref. 1)." The program was developed in general accordance with the Westinghouse Owners Group (WOG) Topical Report WCAP-14572, Revision 1-NP-A (WCAP) (Ref. 2), which has been approved by the Nuclear Regulatory Commission (NRC, Commission) staff. Differences between the approved methodology and the BFN3 analysis are discussed in this safety evaluation (SE).

In the proposed risk-informed ISI (RI-ISI) program, piping systems in addition to those included in the current ISI program were considered for inclusion, if found to be important to safety. Piping failure potential was determined based on estimated failure probability by considering piping material, and design and operating characteristics. Also, a probabilistic risk assessment was performed. Safety ranking of piping segments was established for determination of new inspection locations. The proposed program maintains the fundamental requirements of ASME Code Section XI, such as the examination technology, examination frequency and acceptance criteria. However, the proposed program reduces the required examination locations significantly and is able to demonstrate that an acceptable level of quality and safety is maintained. Thus, the proposed alternative approach is based on the assumption that it provides an acceptable level of quality and safety and, therefore, is in conformance with Title 10, *Code of Federal Regulations* (10 CFR), Section 50.55a(a)(3)(i).

The staff had a meeting with the licensee on September 20, 1999 in which the licensee provided additional information for the staff to gain a better understanding of the proposed program. Subsequently, the staff's review identified important unreported differences between the proposed RI-ISI program and the approved WOG methodology upon which it was based. In order to continue its review, the staff prepared and forwarded a request for additional information (RAI) in a letter dated October 15, 1999 (Ref. 3). The licensee provided a response to the RAI in a November 10, 1999, submittal. An audit meeting with the licensee was held at Browns Ferry on December 1 and 2, 1999 (Ref. 4), to discuss the NRC RAI and to review relevant licensee documents. The licensee provided a revised submittal in a letter dated January 18, 2000 (Ref. 5).

The NRC staff and its consultants, the Idaho National Engineering and Environmental Laboratory and Battelle Pacific Northeast Laboratory, reviewed the licensee's proposed alternative of the ISI program for BFN3, and applicable portions of the WOG risk-informed topical report WCAP-14572, based on guidance stated in NRC documents (Refs. 6, 7 and 8). The staff evaluation is provided below.

2.0 SUMMARY OF PROPOSED APPROACH

The licensee is required to perform ISI of ASME Code Category B-J and C-F piping welds during successive 120-month (ten-year) intervals. Currently, 25% of all Category B-J piping welds greater than 1-inch nominal diameter are selected for volumetric and/or surface examination based on existing stress analyses and cumulative usage factors. For Category C-F piping welds, 7.5% of non-exempt welds are selected for surface and/or volumetric examination.

The licensee submitted the application as an RI-ISI "template" application. Template applications are short overview submittals intended to expedite preparation and review of RI-ISI submittals that comply with a pre-approved methodology. The licensee proposed to implement the staff approved RI-ISI methodology delineated in WCAP-14572, Revision 1-NP-A with the following four deviations.

1. Calculation of Failure Rate: The WCAP methodology uses the Westinghouse Structural Reliability and Risk Assessment (SRRA) computer code to calculate failure rates. TVA uses the computer code WinPRAISE to calculate failure rates. The original version of this code (pc-PRAISE), a probabilistic fracture mechanics computer code for piping reliability analysis, was developed for the NRC. WinPRAISE is a Windows version of pc-PRAISE.

2. Determination of Failure Rate for a Segment: In the WCAP process, the most susceptible failure mechanisms were postulated for each segment, and a failure probability was calculated using the most limiting condition for the segment. At TVA, failure rates are quantified for the individual elements in a segment, and the highest individual failure rate is used to determine segment risk.

3. Uncertainty Analysis: The WCAP advocates using a simplified uncertainty analysis to ensure that no low safety significant (LSS) segments could move into the high safety significance category when reasonable variations are considered. The TVA expert panel considered not only segments with a risk reduction worth (RRW)>1.005 as recommended in the WCAP as high safety significant (HSS), but also those in the range 1.005>RRW>1.001 as HSS, in lieu of performing any limited uncertainty analyses.

4. Structural Element Selection: In the WCAP methodology, selection of elements of low failure potential in Regions 1 and 2 of the Structural Element Selection Matrix is

determined by a statistical evaluation process. At TVA, two methods are noted as being used to select the elements. For those elements with a quantified failure potential, the risk of the individual element was utilized in selecting examination locations. For those elements with no quantified failure potential, the existing examination requirements of Section XI were used.

During the review, which included several telephone conferences, meetings, and the audit, other deviations were identified. For some deviations, the licensee made changes to comply with the WCAP methodology. Discussions and analyses addressing the remaining deviations allowed the staff to conclude that the deviations were acceptable. All the deviations between the TVA methodology and the approved WCAP methodology are discussed in this SE.

The licensee requested approval of this alternative for implementation during the Spring 2000, Unit 3 refueling outage. BFN3 is currently in its first period of the second 120-month interval that started in November 1996.

3.0 EVALUATION

The licensee's submittal was reviewed with respect to the methodology and criteria contained in WOG Topical Report WCAP-14572, Revision 1-NP-A. Further guidance in defining acceptable methods for implementing a RI-ISI program is also provided in Regulatory Guide (RG) 1.174 (Ref. 6), RG 1.178 (Ref. 7), and Standard Review Plan (SRP) Chapter 3.9.8 (Ref. 8).

3.1 Proposed Changes to ISI Program

Pursuant to 10 CFR 50.55a(a)(3)(i), the licensee has proposed to implement Code Case N-577, *Risk-Informed Requirements for Class 1, 2, and 3 Piping, Method A*, with the more detailed provisions provided in WCAP-14572, Revision 1-NP-A, as an alternative to the Code examination requirements for piping systems for the BFN3. A general description of the proposed changes to the ISI program was provided in Section 3 of the licensee's submittal.

3.2 Engineering Analysis

In accordance with the guidance provided in RGs 1.174 and 1.178, an engineering analysis of the proposed changes is required using a combination of traditional engineering analysis and supporting insights from the probabilistic risk assessment (PRA). As noted in the April 23, 1999, submittal, the licensee confirmed that their expert panel considered traditional engineering concerns during the worksheet review of the risk-based information for each pipe segment. In the submittal, the licensee provided a discussion on how traditional engineering analysis is used to ensure that the impact of the proposed ISI changes is consistent with the principles of defense-in-depth. In addition, TVA stated in its letter of January 18, 2000, that TVA further reviewed the program from a defense-in-depth perspective. This review included reconsideration of various degradation mechanisms and ASME Section XI, Code Class 2 welds, including welds in segments determined to be LSS. As a result of this review, a total of 14 welds was added to the proposed RI-ISI program. Further details regarding the engineering analysis and risk evaluations are discussed below.

3.2.1 Scope of Piping Systems

The scope of the piping systems considered in the licensee's RI-ISI Program was based upon guidance in the WCAP topical report which states that the scope should include:

(1) Class 1, 2, and 3 systems currently within the ASME Section XI program,
(2) Piping systems modeled in the Individual Plant Examination (IPE) for the plant, and
(3) Various balance of plant fluid systems determined to be of importance for the Maintenance Rule.

Systems in the scope of the current Section XI program were determined from Surveillance Instruction 3-SI-4.6.G, *Inservice Inspection Program* (Ref. 9), and current isometric drawings. Systems modeled in the plant PRA were determined from the Browns Ferry IPE. Maintenance Rule system significance was determined from Browns Ferry Technical Instruction 0-TI-346, *Maintenance Rule Performance Indicator Monitoring, Trending, and Reporting* (Ref. 10). Table 3.1-1 of the submittal lists the various systems that were identified from the above determinations for inclusion in the RI-ISI scope, and the number of RI-ISI segments which were considered for each of these systems.

3.2.2 Piping Segment Definition

In the approved WOG topical report, WCAP-14572, Revision 1-NP-A, piping systems are divided into segments, with the segment boundaries selected according to failure consequences. Section 3.2 of the licensee submittal states that piping systems are divided into piping segments based on the consequences of the pipe failure and further divided into smaller segments according to degradation mechanisms. The staff stated in its RAI dated October 15, 1999, that the effect of this deviation from the approved WOG methodology is unclear. TVA stated in its response that it has changed the definition of segment boundaries to eliminate the consideration of failure probability. With this clarification, the BFN3 methodology for segment definition is consistent with the WCAP-14572 methodology.

During the December 1-2, 1999 audit, the staff found that some segments contained normally closed reactor coolant system isolation valves within a segment. The consequence of failures upstream or downstream of the valves during normal operation would have different local and plant-level consequences. This represents a deviation from the approved methodology. The licensee stated that, for these segments, the segment part with the highest pipe failure related core damage frequency (CDF) or large early release frequency (LERF) was used to represent the segment in all calculations. Characterizing the risk significance of a combined segment with the risk of the most risk significant segment is a simplification that introduces some conservatism into the analysis. The conservatism will not prevent the identification of any risk significant segment and is, therefore, acceptable.

3.2.3 Piping Failure Potential

In accordance with the WCAP methodology, the licensee reviewed the failure history of piping systems at BFN3 and industry experience to analyze each system for parameters indicative of particular degradation mechanisms. The licensee noted that their submittal deviated from the approved WCAP methodology in two areas related to the determination of failure probabilities for the pipe segments:

The first deviation is that the WCAP process postulates the worst-case parameters (e.g., most susceptible failure mechanisms and stress levels) within the segment and then calculates a failure probability using the most limiting condition for the segment. At TVA, failure rates are quantified for each individual element in a segment, and the highest individual failure rate is used to determine segment risk. The staff requested that TVA evaluate the impact of this deviation. TVA reported that it performed two sensitivity studies. In the first study, bounding failures incorporating the combination of worst-case parameters were used to develop segment failure rates and the segment ranking was performed with these values. In the second study, the sum of the individual element failure probabilities was used as the segment failure probability. TVA reported that, in both cases, there were higher total CDF and LERF, but the same segments were identified as HSS. These studies indicated that the TVA method produced results at BFN3 equivalent to those of the approved WCAP methodology and, therefore, are acceptable.

The second deviation is that the WCAP methodology uses the Westinghouse SRRA computer code to calculate failure rates. TVA uses the WinPRAISE computer code to calculate failure rates where applicable; if not applicable, deterministic methods were used. During the December 1-2, 1999, audit, the staff and its consultant reviewed the documentation and calculations related to the determination of failure frequencies for piping segments using the WinPRAISE code. The documentation of the WinPRAISE calculations:

summarized the approach used to estimate failure frequencies for the different damage mechanisms relevant to the BFN3 piping,

documented the standard procedure to select location-specific input parameters with the information presented in terms of the standard series of interactive input screens used by the user of the WinPRAISE code,

provided weld-by-weld failure probabilities for each piping segment and referenced the individual WinPRAISE computer run for each piping location,

provided a hard copy of each WinPRAISE computer run giving the input parameters to the probabilistic fracture mechanics calculations and the resulting failure probabilities.

The staff found during the audit that on the whole the methods used to estimate failure frequencies were consistent with those described in the Westinghouse Owners Group Topical Report. The WinPRAISE and SRRA codes are based on similar methods and have been shown in past studies to predict similar values of failure probabilities if input parameters are assigned the same values for each code.

Probabilistic fracture mechanics calculations do not give exact values of failure probabilities, but rather are subject to many uncertainties associated with uncertain inputs to the calculations as well as uncertainties in the fracture mechanics models themselves. However, as summarized in the conclusion of this section, the frequencies developed from the application of WinPRAISE have similar characteristics to those developed from SRRA. The staff has found that the frequencies developed from SRRA are adequate for use in RI-ISI methodology.

Zero Values of Calculated Failure Probabilities

A concern expressed by staff in the RAIs was the significance of failure probabilities that were reported to have calculated values of zero. The BFN3 response provided details of the stratified sampling scheme used by the WinPRAISE code. During the December 1-2, 1999, audit, the staff examined computer output files for cases giving the zero probabilities to gain more insight into the reasons for the zero probabilities. It was learned that all such cases corresponded to locations evaluated by WinPRAISE calculations for stress corrosion cracking associated with the initiation of cracks, rather than failures due to preexisting fabrication flaws. Staff review of the output files indicated that all the cases of interest were based on 10,000 Monte Carlo trials for the simulation of piping failures over the 40-year plant life. This means that zero values of calculated failure probability are best described as failure frequencies of less than about $(1/10{,}000)(1/40) = 2.5\times10^{-6}$ failures per year. The object of RI-ISI is to move inspections from lower safety significance to high safety significance. In this case, the less important items are those elements subject to intergrannular stress corrosion cracking (IGSCC) but without pre-existing fabrication flaws. This means that those items that do have calculated failure probabilities are elements subject to IGSCC with pre-existing fabrication flaws. Because these elements are expected to be more safety significant than the elements with no calculated failure probability, the lack of calculated failure probability will not affect the identification of the HSS welds.

Failure Probabilities for Flow Assisted Corrosion

The BNF3 submittal reported that failure probabilities associated with flow assisted corrosion (FAC) were calculated by a deterministic method. It was assumed on the basis of industry-wide operational experience that the U.S. fleet of about 100 plants has been experiencing about one serious pipe rupture per year caused by FAC. It was also assumed that the piping at the BFN3 plant was representative of the piping systems for the population of plants and as such would experience a FAC associated piping failure at a frequency of once per 100 years (or 10^{-2} failures per year). These failures were assumed to be equally likely for all segments identified as subject to the FAC mechanism by the BFN3 augmented inspection program for FAC. Since about 67 segments were in the FAC category, this gives a segment failure rate of $(1/67)(10^{-2}) = 0.000149$. There was no attempt to assign higher or lower failure rates based on the expected severity of the FAC mechanism for particular segments, which could have some effect on the baseline contribution of piping to core damage frequency. For example, the most likely segments for FAC could also be the segments with relatively high values of conditional core damage frequencies. It is noted here that any approximations in this regard are similar to those used in the methodology described in the WOG topical report, and do not represent an inconsistency in the BFN3 methodology. It is also noted that the BFN3 approach is consistent with the WOG methodology because it implicitly includes the effects of augmented inspections on the FAC-related failures by virtue of the use of a failure rate based on recent operational experience for plants that have in-place inspection programs for FAC comparable to the program at the BFN3 plant.

Effects of Inspection on Calculated Failure Rates

WinPRAISE calculations were performed as a sensitivity study for the effects of inspection on piping failure frequencies. These calculations focused on piping segments that are being inspected as part of the BNF3 augmented ISI program for IGSCC. BFN3 has only IGSCC Categories A, C and E piping. It was noted that the BNF3 calculations predicted that the ISI gives either no decrease in the failure rate, or at most a modest decrease (less than a factor of two). The WinPRAISE output files were reviewed in detail to identify reasons for the unexpectedly small effect of ISI on the failure rates. It was concluded that the small effect of ISI was, in part, related to conservative assumptions and inputs to WinPRAISE for the parameters of the augmented inspection program. For example, the inspection intervals were taken to be 10 years, as opposed to smaller intervals for most categories of welds in the augmented program. Also, the probability of detection curves may have been somewhat conservative estimates of the nondestructive examination (NDE) capabilities of inspectors that have been qualified in accordance with current industry efforts in the area of NDE performance demonstrations.

Having noted the conservative features of the inputs to WinPRAISE, there was an even more significant reason for the unexpectedly small effect of ISI. A study of output files for cases with zero effect of ISI showed that these cases included the effects of mid-life changes (stress improvement heat treatment or weld overlays) at 8 years into the life of the plant. There were no simulated failures after 8 years, meaning that the calculated cumulative failure probabilities at 40 years were the same as the probabilities at 8 years. The inspections were assumed to begin at 8 years and occur at 10-year intervals (at years 8, 18, 28 and 38). The WinPRAISE calculations showed no incipient failures to detect over the time span of 8 to 40 years, and, therefore, would (by default) show no benefits from the inspections performed over this time frame. The BFN3 study calculated failure rates as the cumulative failure probability at 40 years divided by 40. The failure rates with inspection and those without inspection would, therefore, be identical. The alternative would be to calculate two failure rates, one rate corresponding to 0 to 8 years (before the mid-life changes) and the other rate corresponding to 8 to 40 years (after the mid-life changes). Even this approach would not provide a meaningful indication of the effects of inspection, because any benefits of inspection would be masked by the even greater benefits of the mid-life changes coming from the stress improvements and weld overlays.

The staff review of the ISI calculations brought increased attention to the approach used to calculate failure frequencies for piping subject to the mid-life changes implemented to reduce or potentially eliminate failures due to IGSCC. In the case of BFN3, the calculated failure rates do not accurately address the failure rates for the current condition of the plant, but rather overestimate the current failure rates by averaging in the effects of failures that might have occurred early in the plant life before the highly effective stress improvements and weld overlays were implemented. The effect of using average rates is to elevate the baseline failure rates for the piping systems, and to also elevate the rankings of segments with (now mitigated) IGSCC and may inappropriately shift inspections away from other segments that now make greater contributions to core damage frequencies. These concerns were discussed with TVA during the December 1-2, 1999, on-site audit, and TVA agreed to modify failure rates for IGSCC Category C and E welds to reflect mitigative actions previously implemented. In its letter of January 18, 2000, TVA indicated that this change in failure rate for IGSCC Category C and E welds results in a lower total CDF, no additional segments determined to be HSS, and one weld inspection being added to an existing HSS Segment as a result of recalculation of RRW for each individual Category A weld.

Effects of Stress Inputs Based on Bounding Values

The staff review of documentation at the plant site indicated that some calculations were based on stress values from the design stress calculations, whereas other stress values were based on bounding or code allowable limits for stresses. These inputs were used both for piping locations governed by fatigue and for piping segments governed by IGSCC. In many cases, such as for piping of the same material and diameter/wall thickness range, the input for stress is the only basis for distinguishing the failure frequency of one segment from that of another segment. Therefore the values for stress inputs could influence the ranking of segments and redirect the resulting focus of the inservice inspection program.

Discussions during the December 1-2, 1999, onsite audit provided details of how stress inputs were selected. The calculations were performed first with bounding or code limiting stresses. In many cases the calculated failure frequencies (even for the bounding stress inputs) were very small and/or the segment was not ranked high. For such cases, no additional calculations were performed. Otherwise, more realistic values for stress inputs were sought using the design stress calculations as the source of data on stresses. The calculations were then rerun using the location specific values of stress.

The use of bounding input in the BNF3 evaluations is consistent with the type of approach described in the WOG topical report. The BFN3 submittal deals with stress inputs in a manner consistent with the topical report.

Conclusion of Review of Piping Failure Potential

In conclusion, the output of the WinPRAISE code is best described as a quantitative estimate illustrating the susceptibility of a pipe segment to failure as determined by the weld material and environmental conditions within the segment. In light of the magnitude of uncertainties, the staff believes that the output of the WinPRAISE code may better be recognized as providing relative values of susceptibility of piping segments to failure. In addition, the acceptability of an estimate is dependent on how it is used. The licensee primarily uses estimate to:

(1) be combined with quantitative estimates from the PRA to support the expert panel's classification of segments into Low and High safety significance, and

(2) provide guidance on the susceptibility of failure for each segment during the selection of welds to be inspected under the RI-ISI program.

The staff finds that the licensee's definition of susceptibility of piping segments to failure is an appropriate characterization of the WinPRAISE output. The estimate of failure probability is a reasonable indication of the relative material and environmental properties of each segment such that, subject to final review and approval of the weld selection process and results by an expert panel, the estimates are acceptable for use to support an RI-ISI change request.

3.2.4 Consequence of Failure

The consequences of the postulated pipe segment failures considered include both direct and indirect effects of each segment's failure. Direct effects always include a diversion of flow large enough to disable a train, disable a system, trip the reactor, or any combination. The BFN3 application is a full scope application that covers much of the piping at the plant. In some cases, TVA screened out parts of some systems from the detailed consequence analysis. These include normally isolated and unused system parts, and some system parts whose failure would not result in the loss of function of important equipment. The staff finds the screening acceptable because the screening process itself is an adequate consequence evaluation.

Early in plant life, the Browns Ferry units were subjected to an extended shutdown. In preparation for restart, the licensee evaluated the spatial effects of high energy pipe ruptures (Ref. 11 and 12). The evaluations included walkdowns, listing of each target and each protective device, a description of the postulated interaction, and an evaluation and classification of indirect effects. The licensee stated that the corrective actions resulting from these studies reconciled all potential effects of high energy line break. Potential flooding events were identified and evaluated in the IPE. Potential spatial effects from the failure of low pressure piping were evaluated through walkdowns to support the RI-ISI analysis.

The approved WCAP methodology requires that a range of piping failure modes be used, that is, leaks, disabling leak, or rupture. The WCAP methodology further defines which consequential failure effects can be expected for each failure mode. For example, spray effects from a small leak could cause consequential failure of nearby electrical equipment, but not the diversion of sufficient flow to disable the leaking pipe's function. The three failure sizes were used in the WCAP because unstable structural failure (causing a rupture) almost always requires an unusual loading and therefore limited structural failure (causing a small or large leak) is the most likely failure mode. The structural mechanical models in the WinPRAISE computer code reflect this property and ruptures are calculated to occur much less frequently than leaks.

The BFN3 RI-ISI methodology deviates from the WCAP methodology in that it only evaluates one leak size, i.e., large leak. However, all possible spatial effects are applied when determining the consequential failure effects of each leak. During the December 1-2, 1999 audit, the staff found that large leak rates were assigned on the basis of a percentage of the full flow rates for the particular piping segment being addressed in each WinPRAISE calculation. The staff believes that the current state-of-the-art in both pipe failure modeling and in consequential failure effects determination, while sufficient to support RI-ISI applications, is not precise enough to clearly require the more detailed failure mode evaluation. The staff recognized this lack of precision when it developed the RG 1.178 and SRP 3.9.8, which allow for the use of a single pipe break size, as long as all possible spatial effects are included. Therefore, the calculation and use of a single large leak potential is an acceptable deviation.

3.3 Probabilistic Risk Assessment

The BFN3 PRA was docketed on August 6, 1997. The BFN3 PRA represented the site configuration for Unit 2 and Unit 3 operating and Unit 1 shutdown. It was created by modifying the multi-unit BFN2 PRA submitted in April 1995, to reflect BFN3 characteristics. For example, the licensee developed new system success criteria for BFN3 given the relationship between shared systems at BFN2 and BFN3. The selected shared systems which were evaluated included the electric power system, control and service air systems, raw cooling water system, turbine building, reactor building closed cooling water system, the fire protection system, and the reactor building and control bay ventilation and cooling system. The BFN3 PRA estimated the CDF to be 9.19E-6/yr. There was no reported LERF.

The staff evaluation report on May 4, 1999 concluded that TVA's BFN3 PRA satisfied the intent of Generic Letter (GL) 88-20. Three weaknesses were identified by the staff in the evaluation. TVA's submittal was a summary document that was not intended as the primary document for the PRA program. Two of the identified weaknesses are related to a lack of submitted documentation and do not reflect the quality of the Unit 3 PRA. The third weakness was the lack of plant specific containment failure and LERF analysis. In support of the RI-ISI program, TVA updated the BFN3 model to include a containment failure and LERF analysis.

The April 23, 1999, RI-ISI submittal reported a CDF of 9.29E-6/yr and a LERF of 2.57E-6/yr. The licensee reported that they had their PRA peer reviewed by a probabilistic safety assessment (PSA) Peer Review Certification Team, administered under the auspices of the Boiling Water Reactor Owners Group Peer Certification Committee. The six-man review team had considerable expertise in the specific PSA methodology used for the BFN3 PSA and was knowledgeable in BWR-4 plant design and operational practices. TVA summarized the peer review findings in the submittal, and provided access to the full-review results during a site visit. The summary indicates that all the PRA review elements are graded as being at least sufficient to support risk ranking applications. RI-ISI is a risk ranking application.

Implementation of the RI-ISI program includes maintaining and adjusting the program as needed. Changes to plant design, procedures, or equipment performance will be monitored and incorporated into the PRA as needed. The PRA related procedures will be revised to ensure that PRA changes also consider changes to the RI-ISI program and that RI-ISI changes are initiated as required. The staff finds that these plans for the long term, active maintenance of the PRA provide an ongoing opportunity to identify and correct any minor errors or inappropriate assumptions in the PRA which might exist.

The IPE completed in June of 1996 included internal initiating events and internal flooding. External event analyses were submitted on July 24, 1995, June 26, 1996, and August 11, 1997. TVA further stated in the submittal that the functions and the corresponding piping segments required to maintain the plant in a shutdown configuration were explicitly and systematically considered by the expert panel. The WCAP methodology requires that functions relied upon to mitigate the external events be reported to the expert panel and used in support of the deliberations and TVA did not report a deviation in this area. The staff finds the scope of the PRA acceptable because initiating events and operating modes outside the scope of the PRA were systematically identified and provided to the expert panel to support their deliberations, consistent with the WCAP methodology.

The staff did not review the PRA to assess the accuracy of the quantitative results. Quantitative results of the 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. Therefore the staff finds that there is reasonable assurance that the PRA quality is adequate to support the submittal because any minor errors or inappropriate assumptions which might remain in the models would only affect the consequence calculations of a few segments and should not invalidate the general results or conclusions.

3.3.1 Evaluating Piping Failures with PRA

The licensee considered the three possible categories of a pipe rupture discussed in the WCAP. That is, failures that 1) result in a plant trip only, 2) only fail parts of mitigating system(s), and 3) result in a plant trip and fail parts of some mitigating systems. The licensee did not incorporate the segment failure events into the PRA model. Instead, depending on the impact the segment failure has on the operating plant, the conditional core damage frequency (CCDF), conditional core damage probability (CCDP), conditional large early release frequency (CLERF), or conditional large early release probability (CLERP) for each segment was determined by identifying an initiating event, basic events, or groups of events, already modeled in the PRA and whose failure captures the effects of the piping segment's failure. The analyst sets the appropriate events to a failed state in the PRA and re-quantifies the PRA or the appropriate parts of the PRA as needed. Segment failure likelihood (probability or frequency as appropriate) is combined with these conditional results as described in the WCAP. The results are subsequently combined into total piping segment CDF (or LERF).

Operator actions modeled in the baseline PRA and contributing to the calculated CCDP, CCDF, CLERP, and CLERF are not changed during the analysis to support ISI. During the development of the surrogate components used to characterize each segment's failure in the PRA, however, human actions associated with the recovery of equipment failed due to the floods (or requiring access to the flooded area) are identified and removed if no longer feasible.

As described by the licensee, the process and equations used to develop quantitative consequences for each segment and their incorporation into total CDF (or LERF) corresponds to the approved WCAP process and equations. Therefore, the staff finds that the methodology develops and uses quantitative consequence and segment failure likelihood of comparable precision such that the results can, after review by the expert panel which considers deterministic insights also, be used to support the assignment of segments into broad safety significance categories.

3.3.2 Safety-Significance Determination

Based on the quantitative results for each segment without credit for current inservice inspections, and the corresponding total pressure boundary failure risk (e.g., only the risk associated with segment failures), the RRW is developed as described in equation 3-11 of the WCAP. The RRW is developed for both CDF and LERF. The use of the quantitative results without credit for ISI is appropriate to determine the safety significance of the segments because the goal of the RI-ISI program is to target inspection to those elements where inspection is most effective.

The approved WCAP methodology does not change augmented examination requirements. That is, neither the frequency nor the location of inspections of augmented programs such as FAC, IGSCC, and microbiologically influenced corrosion will be changed. In the WCAP methodology, the reduction in a segment's failure potential caused by augmented program inspections of locations within the segment is included in the "without credit for inservice inspection" calculations. The failure potential and the safety significance of segments with locations inspected under the current augmented programs are lower when the inspections are credited. TVA will change the location and frequency of inspections of IGSCC Category "A" welds upon implementation of this RI-ISI program. Therefore, reduction in failure potential caused by IGSCC Category "A" inspection of locations within a segment is not included in TVA's "without credit for inservice inspection" calculations. This is a deviation from the approved methodology that leads to higher failure potential and thus higher risk significance for segments with locations currently inspected within the IGSCC Category "A" program. This deviation from the WCAP methodology is necessary to properly characterize the safety significance of segments with Category "A" locations so that the inspections can be targeted at higher safety significant locations and is acceptable.

Operator actions to isolate a break and mitigate the immediate consequences of the break are included in the RI-ISI analysis. For example, an operator closing a motor-operated valve (MOV) will stop the loss of water from a break downstream of the MOV. Instead of estimating an operator error probability for each scenario, a sensitivity study is performed to ensure that the impact of possible operator recovery actions is appropriately included in the evaluation. The WCAP method requires that two sets of core damage and two sets of large early release frequency calculations be performed; one assuming all such actions are successful (failure probability of 0.0), and one assuming that all such actions fail (failure probability of 1.0). RRW measures are calculated for these different assumptions. The segment is assigned the safety-significance category corresponding to the highest of the four results.

TVA did not initially risk rank the segments using all four estimates, but only used a best-estimate CDF and LERF. This was a deviation from the approved WCAP methodology. When TVA performed the four estimates in response to a staff request, 10 new segments were ranked HSS. This demonstrates the need to rank using all four estimates to ensure that the impact of operator actions is fully reflected in the safety significance categorization process. Although TVA's expert panel initially decided that these segments should still be ranked LSS, some were eventually selected for inspection to support the staff's request that the RI-ISI program inspect more locations exposed to degradation mechanisms other than IGSCC and FAC. The staff finds that the use of success and failure bounding probabilities are acceptable because they systematically incorporate the full range of the potential impact of operator actions on the safety significance of the segments.

Each segment has a total of four RRW values, two for CDF (one with and one without credit for operator action) and two for LERF (one with and one without credit for operator action). The RRW values are compared to quantitative guidelines to determine the safety significance category for consideration by the expert panel. The WCAP states that segments with RRW>1.005 are deemed HSS and that segments with medium RRW values between 1.001 and 1.004 are deemed worthy of special consideration by the expert panel. TVA deviated from the RRW guidelines in the WCAP. They did not use the medium category, but used the RRW guideline of 1.001 as the lower boundary for the HSS category. That is, segments with RRW>1.001 are deemed HSS for consideration by the expert panel.

Use of the RRW guideline of 1.001 as the lower boundary for HSS segments instead of the 1.005 used by the WCAP means that TVA will classify a larger number of segments as HSS from a given population. Two related deviations from the WCAP methodology are that (1) TVA did not perform a sensitivity study required by the WCAP and (2) they did not calculate the Risk Achievement Worth (RAW) and provide it to the expert panel. The approved WCAP methodology requires that a sensitivity study be done where uncertainty distributions are assigned to the segment failure likelihoods and the PRA results. The aim of the study is to investigate the potential movement of segments from Low to High based on variation in the quantitative inputs and the guideline values defining the High, Medium, and Low RRW ranges. Experience with the pilot study indicated that no segments moved from Low (RRW<1.001) to High (RRW>1.005) safety significance due to the sensitivity study.

The RAW provides a measure of the impact on risk arising from a segment given that the segment failed. There are no guidelines in the WCAP on what value of RAW constitutes an HSS segment, only that the expert panels are aware of the potential consequences. The TVA submittal stated that the expert panel classified any segment that would result in a large loss of coolant accident if failed as an HSS segment, regardless of the RRW. The staff finds that this is sufficient evidence that the expert panel was sensitive to the potential consequences of segment failure, and sensitivity to the consequences was the reason the WCAP includes the RAW calculation. The staff finds that the conservatism in the use of the lower RRW value provides reasonable assurance that, even with these two deviations from the approved WCAP method, the TVA methodology will tend to select the same, or almost the same, set of HSS segments from a given population as would the application of the WCAP methodology and the deviations are, therefore, acceptable.

The expert panel is responsible for developing the final decisions regarding the categorization of each segment and selects the elements to inspect in each segment. TVA reported no deviations in this area. Although the staff did not review the worksheets or other written information provided to the expert panel, the staff reviewed some of the meeting minutes of the expert panel during the plant audit. The staff noted the panel asked many questions and requested a variety of changes, such as changes in the consequences of some of the segment ruptures and changes in the definition of segment boundaries. The minutes indicate that the expert panel had sufficient information and expertise to review and approve the results.

3.3.3 Determination of the Change in Risk

Specific description of the change in risk calculations can be found in the WCAP and are not repeated here. In general, the approved WCAP methodology estimates any change in segment failure potential (and thus risk contribution) at the segment level and not the weld level. That is, if a segment is being inspected under the current program, and it will continue to be inspected under the RI-ISI program, the failure potential of the segment will not change regardless of any change in the number of welds being inspected. The staff recognizes that the change in risk calculations underestimates risk reductions arising from changing inspection locations from a weld subject to no degradation mechanism to another with a degradation mechanism. It also underestimates risk increases arising from the reduction in the number of welds inspected within each segment.

Targeting RI-ISI inspections to welds exposed to degradation mechanisms should yield relatively large risk reduction for welds that were not previously inspected under the current program. Discontinuing Section XI inspections on welds not exposed to degradation mechanisms should yield relatively small risk increases. There will be substantially more welds where inspections are discontinued than locations where new inspections are initiated. Essentially all the locations selected by TVA to inspect in the RI-ISI program are IGSCC and FAC locations. A sample of 25% IGSCC Category A locations are inspected in the IGSCC augmented inspection program. In the RI-ISI program, TVA reduced the number of total inspections, but transferred 26 inspections to locations of higher safety significance than in the original program.

During the review of the WCAP, the staff found that the change in risk values developed by the WCAP technique are useful illustrations of the change in risk associated with the proposed inspection changes, but that a finding that implementation of the program decreases risk or is essentially risk neutral requires confidence that the four criteria specified in the subsection Criteria for Evaluation of Results in Section 4.4.2 in the WCAP are applied.

TVA reported its best estimate change in CDF as -3.8E-7/yr and the best estimate change in LERF as -1.1E-7/yr. The best estimate CDF and LERF value for each segment includes or excludes the impact of operator actions depending on the judgment of the expert panel. That is, each potential operator action was evaluated by the expert panel and it decided if the with, or the without, operator action CDF and LERF were the most appropriate. The most appropriate CDF and LERF were used in the best estimate calculations. TVA submitted descriptions of several sequences where the “with operator action” CDF and LERF was deemed the best estimate. Potential leaks in these segments are in large and well-traveled areas, tended to cause leak alarms and sump pump operation to remove water, and responses to the leaks are addressed in plant procedures.

The staff finds that a well supported operator action evaluation can be used to select the appropriate consequence for use in the estimation of the change in risk. It will, however, be appropriate in more complex scenarios to develop and apply an operator error probability and not rely on the binary assumption that the operator succeeds or fails. The staff finds the TVA method to be acceptable in this submittal because when used on a few clearly identifiable and easily controllable segment ruptures, the binary assumption is capable of providing risk estimates of sufficient precision to illustrate the change in risk associated with the proposed change in the ISI program.

The licensee did not perform uncertainty calculations on the delta CDF/LERF estimates. The delta CDF/LERF result is only an illustration of the possible change in risk and the approved WCAP methodology does not require these uncertainty calculations for methodologies that are consistent with the topical report. The deviations identified between the TVA and the WCAP methodologies are not great enough that the degree of assurance of the safety benefit of the RI-ISI program implementation is likely to be significantly changed by the propagation of parameter uncertainties.

The staff finds that the delta CDF/LERF calculations illustrate the potential change in risk. TVA did not submit estimates for the dominant system contribution and the system level risk change criteria in Section 4.4.2 of the WCAP, but stated that all the criteria are met. Based on a negative value of the illustrative change in risk and that the individual systems’ risk changes are maintained within small quantitative bands, the staff expects that implementation of the RI-ISI program should be risk neutral or a risk decrease.

3.4 Integrated Decision Making

As described in the BFN3 submittal, an integrated approach is utilized in defining the proposed RI-ISI program by considering in concert the traditional engineering analysis, risk evaluation, and the implementation and performance monitoring of piping under the program. This is in compliance with the guidance of RG 1.178.

In the BFN3 RI-ISI program, integrated decision making is done at the highest level, by the expert panel. The licensee's expert panel included personnel who had the expertise in the following fields; PSA, ISI, NDE, stress and material consideration, plant operations, system design and operation, plant and industry maintenance, repair, and failure history. Minutes are taken of every meeting and maintained as program records.

3.4.1 Selection of Examination Locations

The TVA method to select locations to inspect within segments deviates from the approved WCAP methodology. In most cases a location is a weld although in some cases, FAC for example, a location may be a short run of pipe. For LSS segments, the TVA method is consistent with the approved WCAP method in which the LSS segments are placed in an owner-defined program.

HSS piping segments are placed in Region 1 or 2 of Figure 3.7-1 in the WCAP topical report. Region 3 and 4 pipe segments are LSS, and are considered in "Owner Defined Program" outside of the scope of the RI-ISI program. All four regions continue to receive ASME Code-required system pressure testing and visual examination as part of the current ASME Section XI program.

As illustrated in Figure 3.7-1 of the WCAP, HSS segments are further subdivided into Regions 1 and 2 based on their likelihood of failure. The expert panel makes the final determination of which region each segment is placed in, but the WCAP recommends that segments with large leak probabilities greater than the mid-10E-6/year range be placed in the higher region, Region 1. The remaining HSS segments are placed in Region 2. The WCAP requires that all locations within segments placed in Region 1 that are likely to be affected by a failure mechanism be inspected. If the location is already being inspected in an augmented program, such as FAC, that inspection is sufficient. Finally, the WCAP specifies that a statistical sampling technique may be used to determine how many locations should be inspected in those parts of Region 1 segments without degradation mechanism, and all segments in Region 2. Experience with the pilot application indicates that the statistical sampling method always results in the recommendation to inspect one location in each segment.

The TVA method does not further subdivide HSS segments into two regions, although for defense-in-depth, they placed two segments in which all locations had 0.0 calculated failure rates into Region 2 (Section 3.2.3 of this SE discusses the calculation of 0.0 as a failure rate). TVA calculates the RRW value for each location in each HSS segment. Any individual location in each segment with a RRW>1.001 is inspected. Locations within HSS segments with calculated failure rates of 0.0 are grouped, and the ASME selection criteria is applied to the group. That is, if the locations are ASME Class 1, 25% of this group is selected.

The staff believes this is a reasonable alternative to the WCAP selection process. All segments with RRW>1.001 will be placed in HSS and there is no further subdivision of these segments into two regions. The highest location's failure probability is used to represent the segment failure rate so that location, at least, will have an RRW>1.001. This is consistent with the statistical method's result that at least one weld is inspected in each segment. Furthermore, locations exposed to degradation mechanisms within the segment tend to have relatively high failure rates and thus relatively high RRW's. The submitted results show that most HSS segments had multiple inspection locations and several had up to eight inspection locations. This is consistent with the WCAP's recommendation to inspect all locations subjected to a degradation mechanism within an HSS segment. The staff finds the location selection process consistent with the process approved for the WCAP and therefore acceptable.

The examinations determined in the original submittal for the BFN3 RI-ISI Program are listed in Table 3.8-1 of the submittal. All locations identified for examination in this table, except one, are for elements subject to degradation mechanisms IGSCC or FAC. The reason for this result is the relatively high failure rates associated with IGSCC and FAC which causes segments exposed to these degradation mechanisms to dominate the estimated risk. When the WCAP relative ranking method is used, segments with dominant contributions to risk are ranked as HSS and segments with other degradation mechanisms, having relatively small contributions, are ranked as LSS. The staff was aware that a relative ranking evaluation could be dominated by a small subset of high failure rate segments and stated in the WCAP SER that,

> ". . . although a reduction in the number of welds inspected is anticipated, it is expected that there will be reasonable assurance that the program will provide a substantive ongoing assessment of piping condition."

Except for one high pressure coolant injection system element that was in the current Section XI program, BFN3's original submittal proposed use of existing FAC and IGSCC inspection programs to satisfy all of the examination requirements under the new RI-ISI program. However, during its review, the staff expressed concern that few non-augmented ASME Section XI welds were included in the inspection program. The staff stated that industry studies indicate that boiling water reactor main steam and feedwater systems are subject to thermal fatigue in addition to flow-assisted corrosion, and some emergency core cooling system piping made of stainless are subject to thermal fatigue in addition to IGSCC. The staff expressed the concern that a substantive ongoing assessment of piping condition would warrant that for such systems, some inspections should be performed to detect flaws due to thermal fatigue, including thermal stratification and thermal transients.

The licensee's revised submittal dated January 18, 2000, stated that in response to staff review questions, TVA performed a defense-in-depth review of the BFN3 RI-ISI program. This review included consideration of various degradation mechanisms and ASME Section XI, Code Class 2 welds. As a result of this review, 14 welds were added to the proposed inspection program. Five of the proposed additional welds were selected for thermal fatigue in ASME Class 1 systems which consist of two in the feedwater system, one in the reactor water cleanup system, and two in the residual heat removal system. Five welds were added for ASME Class 2 systems with RRW>1.001 with no operator action which consist of one weld in the reactor core isolation cooling system and four in the residual heat removal system. Four welds were added for additional system coverage in ASME Class 2 systems which consist of two in the main steam system and two in the high pressure coolant injection system.

Based on the rationale discussed in the April 23, 1999, submittal, which was reviewed and discussed during the December 1-2, 1999, audit and revised in the subsequent letter submittal of January 18, 2000, it is concluded that the licensee has provided adequate justification for element selection and sample sizes. The staff finds the location selection process to be acceptable since it is consistent with the process approved for the WCAP, takes into account defense-in-depth, and includes coverage of systems subjected to degradation mechanisms in addition to those covered by augmented inspection programs.

3.4.2 Examination Methods

The objective of ISI required by ASME Section XI is to identify conditions (i.e., flaw indications) that are precursors to leaks and ruptures in the pressure boundary that may impact plant safety. Therefore, the RI-ISI Program must meet this objective to be found acceptable for use. Further, since the risk-informed program is based on inspection for cause, element selection should target specific degradation mechanisms.

The WCAP provides that the HSS piping structural elements should be examined in accordance with the requirements as taken directly out of ASME Code Case N-577 for the areas and/or volumes of concern at each location. The examination methods selected by the licensee are based on Code Case N-577, Table 1. Table 1 of Code Case N-577 provides the specific requirements for Category R-A, Risk-Informed Piping Examinations. This category is subdivided into Item Numbers R1.11 through R1.18, based on degradation modes and specific examination requirements for each mode. The licensee has determined that the degradation mechanisms applicable to the RI-ISI program are: R1.11 - Elements Subject to Thermal Fatigue, R1.16 - Elements Subject to IGSCC and R1.18 - Elements Subject to FAC.

Based on review of the cited portion of Code Case N-577 and the examination methods specified in the licensee's Inspection Plan, the staff concludes that the examination methods are appropriate since they are selected based on specific degradation mechanisms, pipe sizes and materials of concern. This evaluation does not endorse the use of Code Case N-577 in its entirety.

3.5 Implementation and Monitoring

Implementation and performance monitoring strategies require careful consideration by the licensee, and are addressed in Element 3 of RG 1.178 and SRP 3.9.8. The objective of Element 3 is to assess performance of the affected piping systems under the proposed RI-ISI program by implementing monitoring strategies that confirm the assumptions and analyses used in the development of the RI-ISI program. To approve an alternative pursuant to 10 CFR 50.55a(a)(3)(i), implementation of the RI-ISI Program, including inspection scope, examination methods, and methods of evaluation of examination results, must provide an adequate level of quality and safety.

In the April 23, 1999, submittal, the licensee confirmed that their proposed alternative to current ASME Section XI ISI requirements, and to the inspection requirements of IGSCC Category “A” welds, was developed in accordance with guidance from Westinghouse Owners Group Topical Report WCAP-14572, Revision 1, as modified by the September 30, 1998, letter to the Commission from the Westinghouse Owners Group (with some deviations) and the guidance contained in GL 88-01. Therefore, a majority of the criteria included in Element 3 of RG 1.174 have been addressed by the licensee as discussed below.

The WCAP recommends that implementation of an RI-ISI program for piping be initiated at the start of a plant’s 10-year ISI interval but allows that implementation can begin at any point in an existing interval as long as the examinations are scheduled consistent with the requirements of the ASME Code Section XI, Edition and Addenda committed to by an Owner in accordance with 10 CFR 50.55a. The WCAP topical report indicates that examinations and system pressure tests may be performed during either system operation or plant outages, such as refueling outages or maintenance outages. The licensee has stated that the frequency of examinations will be scheduled per the existing augmented programs to satisfy the requirements of Table 1 of Code Case N-577. The proposed examination frequency is provided in Table 3.8-1 of the submittal.

The licensee stated in Section 4 of the submittal that a proposed revision to TVA BFN3 Surveillance Instruction 3-SI-4.6.G has been written to implement and monitor the RI-ISI program. Upon approval, the new program would be integrated into the existing ASME ISI program. The licensee also stated that the proposed monitoring and corrective action program will include periodic updates as well as consideration of any plant changes, plant-specific feedback, or NRC requirements that may require more frequent adjustment of the RI-ISI program. The staff concludes that the licensee has incorporated the results of its RI-ISI evaluation into a plant-specific program procedure that is consistent with the performance-based implementation and monitoring strategies specified in RG 1.178 and ASME Code Section XI.

The licensee stated in Section 4 of the submittal that the RI-ISI program is a living program and its implementation will require feedback of new relevant information to ensure the appropriate identification of HSS piping locations. The submittal also states that, as a minimum, risk ranking of piping segments will be reviewed and adjusted on an ASME-period basis and that significant changes may require more frequent adjustment as directed by NRC bulletin or generic letter requirements, or by plant specific feedback.

The proposed periodic reporting requirements meet existing ASME Code requirements and applicable regulations and, therefore, are considered acceptable. The proposed process for RI-ISI program updates meets the guidelines of RG 1.174 that provide that risk-informed applications must include performance monitoring and feedback provisions; therefore, the process for program updates is considered acceptable.

4.0 CONCLUSIONS

In accordance with 10 CFR 50.55a(a)(3)(i), proposed alternatives to regulatory requirements may be used when authorized by the NRC when the applicant demonstrates that the alternative provides an acceptable level of quality and safety. In this case, the licensee's proposed alternative is to use risk-informed process described in the NRC-approved

Westinghouse Owners Group Report WCAP-14572, Revision 1-NP-A, with some deviations. The impact of the identified deviations from the WCAP methodology on the licensee's results and conclusions have been evaluated by TVA and the staff. The staff concludes that the TVA's proposed RI-ISI program as described in WCAP-14572, Revision 1-NP-A, with the deviations identified in this SE will provide an acceptable level of quality and safety pursuant to 10 CFR 50.55a for the proposed alternative to the piping ISI requirements with regard to the number of inspections, locations of inspections, and methods of inspection.

The staff finds that the results of the different elements of the engineering analysis are considered in an integrated decision-making process. The impact of the proposed change in the ISI program is founded on the adequacy of the engineering analysis and acceptable change in plant risk in accordance with RG 1.174 and 1.178 guidelines.

The BFN3 methodology also considers implementation and performance monitoring strategies. Inspection strategies ensure that failure mechanisms of concern have been addressed and there is adequate assurance of detecting damage before structural integrity is affected. The risk significance of piping segments is taken into account in defining the inspection scope for the RI-ISI program.

System pressure tests and visual examination of piping structural elements will continue to be performed on all Class 1, 2, and 3 systems in accordance with the ASME Code Section XI program. The RI-ISI program applies the same performance measurement strategies as existing ASME Code requirements and, in addition, increases the inspection volumes at weld locations.

BFN3 methodology provides for conducting an engineering analysis of the proposed changes using a combination of engineering analysis with supporting insights from a PRA. Defense-in-depth and quality are not degraded in that the methodology provides reasonable confidence that any reduction in existing inspections will not lead to degraded piping performance when compared to existing performance levels. Inspections are focused on locations with active degradation mechanisms as well as selected locations that monitor the performance of system piping.

The BFN3 RI-ISI program should be resubmitted to the NRC for approval if the RI-ISI methodology and/or inspection program is changed as a result of new information such as industry initiatives to change augmented inspection programs, significant changes to the PRA, significant inspection results, new failure modes experienced by the industry, major replacement activities resulting from materials degradation or failure, or significant plant design or operational changes. This includes generic industry initiatives that are underway to change the IGSCC augmented inspection requirements for BWR piping welds.

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5.0 REFERENCES

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3. Letter, dated October 15, 1999, William O. Long (NRC Senior Project Manager), to J. A. Scalice (TVA Chief Nuclear Officer and Executive Vice President), containing *Browns Ferry Unit Proposed Risk Informed Inservice Inspection Program, Request for Additional Information.*

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