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

November 9, 1999

LICENSEE: Tennessee Valley Authority

FACILITY: Browns Ferry Nuclear Plant Unit 3

SUBJECT: MEETING SUMMARY RELATING TO LICENSEE RELIEF REQUEST FOR ALTERNATE RISK-INFORMED INSERVICE PIPING INSPECTION PROGRAM (TAC NO. M5355)

## INTRODUCTION

A meeting was conducted on September 20, 1999, with the Tennessee Valley Authority (TVA), licensee for the Browns Ferry Nuclear Plant, and its contractor. Attachment 1 is the list of attendees. The purpose of the meeting was to enable the staff to obtain additional information supporting TVA's request for American Society of Mechanical Engineers (ASME) Code, Section XI inservice inspection relief, dated April 23, 1999. The public was notified of the meeting through an announcement dated August 31, 1999. That meeting announcement included an attached list of draft discussion questions.

## BACKGROUND

By letter dated April 23, 1999, TVA proposed an alternative Risk-Informed Inservice Inspection (RI-ISI) Program for Browns Ferry Unit 3 (BFN-3) piping systems. The form and content of the request was based on discussions of a March 31, 1999 meeting between TVA, its contractors and the staff. (NOTE: No meeting summary was prepared for that meeting.) The staff performed an acceptance review and, in a letter dated August 12, 1999, notified TVA of acceptance of the April 23, 1999 application.

The proposed RI-ISI program is described by TVA as "consistent with the methodology described in ASME Section XI, Code Case N-577 and WCAP-14572, Revision 1, as modified by the September 30, 1998, letter to the Commission from the Westinghouse Owners Group (WOG). . . ." with described deviations. The licensee desires relief in time for implementation in Spring 2000 refueling outage (approval needed by December 31, 1999).

## MEETING SUMMARY



Attachment 2 is a record of the discussions. Two other issues were raised by the staff: (1) the staff indicated that it needs information regarding "feedback mechanisms" and the review and approval process of future changes to the RI-ISI program, and (2) the matter of TVA's request

for fee waiver was briefly mentioned. TVA was advised by the Nuclear Reactor Regulation Project Manager that the staff is having difficulty making a 10 CFR 170.11(b) determination and may need additional justification for "pilot plant status." These items will be the subject of future discussions and/or correspondence.

Original signed by:

William O. Long, Senior Project Manager, Section 2
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-296

Attachments: 1. List of Meeting Attendees
2. Licensee's Handout

cc w/atts: See next page

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for fee waiver was briefly mentioned. TVA was advised by the Nuclear Reactor Regulation Project Manager that the staff is having difficulty making a 10 CFR 170.11(b) determination and may need additional justification for "pilot plant status." These items will be the subject of future discussions and/or correspondence.

William O. Long, Senior Project Manager, Section 2
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## LIST OF ATTENDEES

| NAME | AFFILIATION |
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| Edmund Sullivan | NRR/EMCB |
| Syed Ali | NRR/EMCB |
| Richard M. Emrath | TVA/Corp. Engr'g |
| Robin Graybill | TVA/Enertech |
| L.J. Victory | TVA/Enertech |
| Jim White | TVA/Curtis Wright Flow Control (CWFC) |
| Henry L. Jones | TVA/Browns Ferry |
| Joseph Napoleon | CWFC |
| George McDonald | CWFC |
| Tim Abney | TVA/Browns Ferry Licensing & Ind Affairs |
| John Sparks | TVA/Components Engineering |

***Attachment 1***

September 20, 1999, Meeting Discussion

**Probabilistic Safety Assessment Branch Questions on Browns Ferry Unit 3 (BFN3) Risk-Informed Inservice Inspection (RI-ISI)**

1. Staff Question: The "Westinghouse Owners' Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report WCAP-14572" (WCAP) methodology estimates a segment failure probability by estimating the failure probability of a single weld, in which all the degradation mechanisms found in the segment are simultaneously assumed to exist at the single weld, e.g., an aggregate worst-case weld. This technique was agreed upon because the staff did not consider simply selecting the "highest" weld probability in a segment to be sufficiently representative of the segment's failure probability, and the Westinghouse Owners Group (WOG) did not believe that the calculation and addition of the failure probability of all welds in the segment is necessary. Your submittal states that the weld failure probabilities were calculated for all the welds in the segment, yet only the highest probability was selected and used to represent the failure probability of the segments. Your methodology is questionable because it appears to violate the calculus of probabilities which states that the segment failure probability is the sum of the weld probabilities, and does not provide reasonable confidence that all the degradation mechanisms in the segment are represented in the segment failure probability. Please provide an analysis where the sum of the welds failure frequencies in each segment is used as the segment failure frequency.

Licensee Response: TVA stated that the technique for using the failure probability of the single weld most likely to fail was done to prevent an artificially high failure rate for a segment from masking another segment which would have a resultantly lower risk reduction worth (RRW), while providing assurance that the locations most likely to affect core damage frequency (CDF) and/or large early release frequency (LERF) are identified. The calculation for each weld includes the capability to incorporate the various degradation mechanisms to which the weld could be subjected. The quantified element selection process assures that each individual location which could contribute significantly to CDF/LERF is identified for inspection, even if it is not the highest failure rate element in the segment. To validate the effectiveness of the technique, additional studies have been performed:

- Bounding failure rates for each segment incorporating the combination of worst case parameters have been used to perform a risk ranking with RRW calculations. In many cases, the worst individual case also represented the worst aggregate parameters.

- A similar study has been performed using the sum of the individual weld failure rates in a segment as the rate for the segment.

In both studies, a higher total CDF/LERF resulted, which would reduce the RRW for any segments with borderline parameters. When the ranking with aggregate failure rates and the ranking with the sum of the failure rates for each segment were done, the same segments were identified as High Safety Significant as the original analysis, with the same resultant inspections. The variations in RRW only appeared in the segments which were significant, regardless of the technique used. Also, there were no additions to the segments classified as "Medium" significance that called for additional consideration by the expert panel.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

2. Staff Question: The approved WOG methodology and your methodology both calculate segment and total risk without inspections, that is, a no-inspection base case. The results of this base case are used to identify the high safety significance segments that should be inspected. The WOG methodology is aimed at improving the selection process for American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME) Section XI and thus excludes augmented inspection from consideration. It includes the impact of augmented inspections in the base case without inspection failure probability. That is, the failure probability of welds currently inspected in the augmented programs credits the augmented inspection in the base case (without inspection) resulting in a lower segment failure probability than when no inspection is credited. Your methodology, however, appears to calculate the no-inspection base case by not crediting the Intergranular Stress Corrosion Cracking (IGSCC) inspections. That is, in your base case, the weld's failure frequency estimate assumes the weld is never tested, even under the IGSCC program. Is this true?

If it is true, then the total dominance of the IGSCC and flow accelerated corrosion (FAC) segments in your high-risk category is a direct result of the assumption built into your computer model that IGSCC and FAC have much higher failure probabilities than other welds. The RRW values are relative values and if a small number of segments dominate the risk, all other segments will necessarily have very small RRWs. Therefore, your use of the RRW cutoff is inconsistent with that approved for the WOG and with the staff's current position on the Electric Power Research Institute (EPRI) methodology. The staff does not believe that the purpose of RI-ISI is to eliminate Section XI inspections and retain only augmented inspections. The one nonaugmented program weld inspection in your submittal does not "provide a substantive ongoing assessment of piping condition." Please develop a base line without inspection but including the IGSCC and FAC inspections in your base case without inspection calculations, perform a sensitivity study for IGSCC similar to the study you performed for FAC as described on page E-15, or develop some other systematic proposal such that your RI-ISI program will provide confidence that potential degradation mechanisms, other than just FAC and IGSCC, will not threaten the integrity of your piping system.

Licensee Response: TVA stated that the risk-informed methodology applied at BFN 3 is also aimed at improving the selection basis of inspection elements as compared to ASME Section XI. The risk-informed methodology does include consideration of mitigating measures such as induction heat and mechanical stress improvement and water chemistry control. It also credits the pre-service examination following these measures in the failure rate estimates. The effects of future augmented examinations on estimated failure rates are relatively insignificant when compared to the effects of the mitigating measures discussed above.

A high failure rate due to the presence of the parameters indicative if IGSCC is not assumed in the computer model. The calculation incorporates the specific conditions for each weld and returns the specific failure likelihood for that weld. In cases where material replacement, stress improvements, chemistry changes, repairs, etc., have taken place, those factors are included in the calculation. The resultant failure rate is an accurate representation of the potential for CDF/LERF for that location. The RRW cutoff values are not inconsistent with the active failure

mechanisms present and the mitigating measures that have been implemented for the inspection elements

As referenced, a sensitivity study was done for FAC; however, this was done because the failure rate for FAC was developed deterministically, and the sensitivity study was required to provide a level of confidence in the assumptions which went into that deterministic process. IGSCC is a known factor in Boiling Water Reactors, and the failure rate is based on actual parameters, not assumptions. As such, it would be inaccurate to conduct a study that totally disregarded the existence of such a contributory mechanism. Every system was evaluated for all potential degradation mechanisms, and each determination was considered in the risk-ranking process.

The proposed risk-informed inspection program does provide "a substantive ongoing assessment of piping condition" by considering the failure mechanisms dominant in the plant, and by tailoring the inspection program to the specific techniques which will accurately detect those failure mechanisms. The program does not take credit for the augmented program for IGSCC, but refines the inspection technique specified in the N-577 ASME program which has been developed to satisfy the requirements of NUREG-0313.

Staff Response: The Staff noted that this appears to be a significant deviation from the WOG methodology.

3. Staff Question: Section 2.2 of the proposed alternative inspection program indicates the program contains alternate inspection requirements for the augmented Generic Letter (GL) 88-01 IGSCC Category "A" welds only, but Table 5-1 in the submittal indicates some C, E and G welds are also being included as part of the RI-ISI program. Please clarify.

Licensee Response: TVA stated that the Category designations in the R1.16 column of Table 5-1 indicate the category per GL 88-01 of welds selected for inspection in accordance with the RI-ISI Examination program. These welds and the remaining Category C through G welds are all still subject to the requirements of the GL. Per Section 2.2, relief from the requirements of the GL is only sought for Category "A" welds.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

4. Staff Question: In Section 3.4, Failure Assessment, of the submittal, sensitivity studies are performed to bound failure rates due to FAC. Were any similar sensitivity studies performed to bound failure rates due to IGSCC to ensure that no other segment failure mechanisms were masked by the IGSCC contribution?

Licensee Response: TVA stated that the failure rate due to FAC was developed deterministically. For this reason, the sensitivity studies were performed to gain assurance that the assumptions which went into the deterministic process did not produce inaccurate or misleading results. Since failure rates due to IGSCC were determined by specific analysis of each weld for the conditions affecting that weld rather than by assuming conditions, no sensitivity study was required to validate assumptions.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

5. Staff Question: What is the frequency of the IGSCC categories B through G examinations under your proposed program?

Licensee Response: TVA stated that the frequency of examinations performed on IGSCC Category B through G examinations is in accordance with BFN's commitment to GL 88-01.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

6. Staff Question: Page E-11 of your submittal states that, "Normal operator actions were considered in the Operational Interface Review in determining the appropriate resulting initiating events and impacts. Results both with and without operator action were identified where applicable. Operator recovery (i.e., isolation of failed pipe segments, etc.) was considered and the most likely action was used as the applicable case."

The treatment of operator actions approved during the WOG review had two parts.

A) Recovery actions credited in the base line probabilistic risk assessment (PRA) such as starting pumps and remotely opening valves following signal failure were reviewed. For example, the base line PRA might include the probability that an operator starts a pump following failure of an actuation signal, but, if the pump is underwater, it is no longer possible to start the pump. Actions no longer recoverable when the component failure is caused by the spatial effects of pipe rupture were removed from the baseline PRA before quantification.

B) Some specific recovery actions were identified. For example, following a rupture, it may be possible for an operator to remotely close a valve, cutting off the water to the ruptured pipe which may both allow more water to flow where it should, and stop the environmental effects of the ruptured pipe. These actions were evaluated both with and without operator action calculations in the WOG methodology.

It is not clear from the description in your submittal how operator actions are considered. Please clarify how you included operator action with reference to A) and B) above.

Licensee Response: A) TVA stated that the BFN Probabilistic Safety Assessment (PSA) does not take credit for equipment if it is unrecoverable (e.g., flooded ). Operator recovery, such as manually starting pumps or operating valves following signal failure are generally modeled within the top event (i.e., at the basic event level), such that this form of recovery is intrinsically addressed by the model structure (i.e., there is not another, later, recovery modeled).

In the case of top event ORP, which allows manual operator actuation of emergency core cooling system (ECCS) (residual heat removal (RHR) pumps, core spray pumps), success of the operator action is overridden by failing the pump top event in the model.

In the electric power model, short term and long term recovery of offsite power remain viable options. Also, there is a top event (R480) that allows the operator to shift 480VAC buses to

the alternate supply. This top event was specifically reviewed for the spatial interactions, so that recovery was not applied to a panel that had been failed by water/steam intrusion.

Where operator isolation of the flooding event was judged to be feasible, both cases were evaluated to determine the bounding case, which was usually the unisolated condition.

Licensee Response: B) TVA stated that specific potential recovery actions were analyzed for each segment failure. These included such things as isolating the failure, eliminating the flow through the failed segment (pump trip, etc.) or activating alternate sources of flow to the affected component. Included in the analysis was the actual possibility of the action taking place; i.e., would the isolation valve be accessible or operable following the failure, etc. For instance, it could be possible to isolate a failure, but the time to accomplish the isolation would be too long to prevent the postulated consequence.

Each potential operator action was analyzed and the action most likely to actually occur was designated the Applicable Case. This is similar to the results presented in Table 3.5-3 of the Surry Unit 1 submittal.

The consequence analysis at BFN was reviewed extensively by the Expert Panel. An additional review was conducted for the Expert Panel by a former Operations Supervisor (SRO)/Maintenance Manager, which included simulating some failures on the plant operations training simulator to ascertain response. There are cases where the applicable action is with operator action, but has a lower CDF. An example of this case would be if no actions were taken to isolate a leak or stop a flow source and allow the basement of the reactor building to flood until mitigating systems were disabled with the plant still in operation. This would call for multiple operator errors and omissions and was determined not to be the applicable case.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

7. Staff Question: When an operator does a "walkaround," what types of failures can he detect. If the pipe is under static pressure, such as attached to a storage tank, the results of a pipe rupture should be quickly observable even without a walkaround. If the pipe is under no pressure, such as between a closed motor-operated valve and a check valve, a walkdown would not reveal the flaw. How was and how much credit was given to operators discovering flaws on walkarounds?

Licensee Response: TVA stated that the walkarounds are credited to reduce the exposure time. Only fourteen segments receive credit for operators discovering flaws during walkaround. Of these, twelve have a consequence of loss of a mitigating system, and all of these segments are pressurized. The two remaining segments are discharge lines with a consequence of a flooding event, such that a failure that would result in the postulated consequence would be readily detectable. A given piping system may have some segments where operator walkaround is credited and other segments where it is not credited because a check valve or normally closed isolation valve prevents the pressurization effects from being seen.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

8. Staff Question: Your discussion of shutdown cooling on page E-14 is unclear. From your submittal, it appears that the loss of shutdown cooling (SDC) represented by top event SDC represents the loss of cooling capability following some transient which involves, among other events, a rector trip from full power. If this is so, does this mean that you use a one-week mission time for the SDC analysis as opposed to the customary 24 hours?

Licensee Response: TVA stated that the intent of the discussion of shutdown cooling on page E-14 was not clearly communicated. It was intended merely to show the relationship of Top Event SDC to exposure time during a refueling outage and to illustrate that there was no impact when changing from 18-month cycles to 24 month cycles.

The shutdown cooling system is modeled as a backup means of long term decay heat removal following reactor depressurization. The mission time for this top event is 24 hours. In essence, this top event models the use of RHR pumps and heat exchangers with suction from the reactor vessel, rather than from the suppression pool (i.e., LPCI mode), such that top event SDC only introduces the piping segments and valves that allow this shift of flowpath. This portion of the RHR system was also identified as non-risk significant for the maintenance rule.

The PSA assumes that plant-initiating events occur from full power. The use of shutdown cooling for decay heat removal in the model is not to imply that the plant model includes a specific shutdown PSA evaluation.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

9. Staff Question: Generally when we refer to risk during shutdown, we mean the risk during the different plant configurations that occur during a refueling outage. In these shutdown configurations, substantially more equipment is inoperable than during normal operation, but which might be operable for a post-trip shutdown condition. Also, there are a number of configurations particular to shutdown which result in initiators unique to shutdown configurations and which place dependance on a limited set of equipment. Unless your PRA models the plant configuration during shutdown and which only credits equipment which is expected to be available during shutdown, risk informed applications have required that the expert panel explicitly and systematically evaluate the shutdown configurations and available equipment to determine if the plant depends heavily on this equipment. Please provide your position.

Licensee Response: TVA stated that as referenced in the response to question 8, the BFN plant model does not specifically address plant configuration during shutdown. The piping segments and functions required to maintain the plant in a shutdown configuration were explicitly and systematically considered in the development of failure consequences as reviewed by the Expert Panel.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

10. Staff Question: Staff and industry PRA's of shutdown tend to indicate that shutdown risks are comparable with operating risks when averaged over the operating cycle. That is, the risk during a 3-week shutdown, when expressed on a per-year basis, is comparable to the risk from an operating plant also expressed on a per-year basis. These results are obtained also for an 18-month operating cycle. Please reconcile your use of the exposure time factors of 1.28E-02 to apparently claim that the CDF due to loss of shutdown cooling is actually about [(1.117E-05)(1.28E-02)] or 14E-7/yr.

Licensee Response: TVA stated that the exposure factor of 1.28E-02 was only intended to illustrate the relative value of an 18-month cycle to a 24-month cycle. CDF of 1.117E-05 was used for SDC on all risk ranking calculations.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

11. Staff Question: In your submittal you refer to the "High Energy Pipe Rupture Evaluation." In your reference section there are several pipe rupture evaluation reports. Please identify the reports referenced, why the evaluations were done, and provide some indication on the methodology (e.g., were walkdowns performed?). What is the relationship between flooding analysis and these high energy line break studies?

Licensee Response: TVA stated that early in plant life, the BFN units were subject to an extended shutdown. In preparation for restart, the two referenced evaluations were performed. The "Pipe Rupture Evaluation for Inside and Outside Primary Containment for the BFN Units 2 and 3" was the original evaluation. The "Pipe Rupture Evaluation for BFN, Unit 3 restart" was the update following Unit 2 restart and immediately prior to the Unit 3 restart. The evaluations included walkdowns, listing of each target and each protective device, a description of the postulated interaction, and an evaluation and classification of each interaction. These evaluations were used in the determination of indirect effects.

There is no relationship between these evaluations and the flooding analysis for the RI-ISI program development.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

12. Staff Question: In Section 3.3, Consequence Evaluation, there is no mention of a plant walkdown being accomplished to evaluate the direct and indirect effects of the postulated pipe segment failures. Where are effects of High Energy Pipe Rupture Evaluations and flooding initiators described?

Licensee Response: TVA stated that the corrective actions resulting from the referenced Pipe Rupture Evaluations reconciled all potential effects. The flooding initiators are incorporated in the identified Initiating Events and/or Mitigating System Effects. The evaluation for low pressure piping failures included a walkdown of the potential locations, with the results shown in Table 3.3-3.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

13. Staff Question: There were no segments selected due to LERF considerations. However, failure of a valve to close for a number of segments would result in a loss-of-coolant accident outside containment. Failure of some valves to close is on the order of 1E-2 per demand. Please discuss how failure of isolation valves to close was evaluated in your methodology.

Licensee Response: TVA stated that all segments that were high safety significant (HSS) due to LERF considerations were already declared HSS due to CDF considerations; i.e., there were no segments selected due solely to LERF considerations. Top Event ISO in the PRA analysis incorporates the failure of valves to close on demand, and is included in the calculation which provides the value of LERF.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

14. Staff Question: In Table 3.10-2, no operator actions, your CDF decreased by 2.2E-6/yr and your LERF decreased by 1.8E-6/yr. Since you are only adding one inspection not previously being done, please explain where the decreases in CDF and LERF are coming from.

Licensee Response: TVA stated that Table 3.10-2 indicates the amount of CDF/LERF that is detected by the subject program, not the decrease in CDF/LERF.

Staff Response: The Staff noted that this appears to be a significant deviation from the approved WOG methodology.

15. Staff Question: Page E-9 discusses "portions of a system" to be included. Which systems had portions excluded? What is the basis for excluding portions? Are any inspections currently performed in the excluded portions and, if so, what happens to these inspections?

Licensee Response: TVA stated that section 3.2 of WCAP-14572 provides three criteria for selecting systems:

- All Class 1, 2, and 3 systems currently within the ASME Section XI program;
- Piping systems modeled in the PSA; or
- Various balance of plant fluid systems determined to be of importance (mainly based on Maintenance Rule ranking).

These criteria were applied as described in the first paragraph of 3.1 of the submittal. The basis for determination of importance with respect to the Maintenance Rule was Appendix B to Browns Ferry Procedure 0-TI-346, which describes each system and defines the portion of each system to be considered significant. The portions excluded are:

- Those portions of Condensate and Demineralized water that do not (a) provide a water source and heat sink for EOPs and to mitigate accidents, or (b) condense steam from the reactor vessel/main turbine, or (c) deliver water to the suction of

feedwater, or (d) provide stored condensate and a flow path for use by HPCI and/or RCIC.

- Those portions of Condenser Circulating Water that do not provide cooling water to the main condenser to condense steam.

There are no current inspections performed in the excluded portions.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review, however, requested that TVA address the consequences of the spatial effects of piping failures in the excluded portions of the systems. TVA agreed to provide the requested information in a follow-up submittal.

16. Staff Question: Table 3.10-2 provides a comparison of CDF/LERF detected by current programs and that of the risk-informed program. It is not clear from this table why, in the current Section XI program, significantly more of the CDF and LERF are addressed by the operators taking no action to isolate the break than the cases where operator action is assumed to be successful, but the reverse is true when augmented inspections are considered.

Licensee Response: TVA stated that Table 3.10-1 must be considered to determine the basis for the conclusion presented in Table 3.10-2. Comparison of the CDF detected by current augmented programs in Table 3.10-1 shows that there is no difference with respect to operator action.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

17. Staff Question: From the PRA, the Raw Cooling Water (RCW) system importance is 11% of total core damage frequency. In reviewing the top accident sequences, Loss of RCW as an initiator constitutes the 4th and 6th highest contributors to overall core damage. Therefore, given an active degradation mechanism such as microbiologically-induced corrosion (MIC), why are there no HSS segments for the RCW? Of the 20 RCW segments, are there no failures that can result in total loss of RCW? A similar question could be raised for the Residual Heat Removal Service Water (RHRSW) system.

Licensee Response: TVA stated that eleven RCW segments result in initiating event LRCW with a conditional core damage probability (CCDP) of 3.04E-5. The degradation mechanism analysis performed for every system identified RHRSW as having exhibited indications of MIC; however, both that system and RCW are subject to TVA program SSP-13.5, Raw Water Fouling and Corrosion Control Program. This program implements requirements for Microbiologically Induced, General, Localized, and Galvanic Corrosion. The program prevents or mitigates new corrosion, monitors for degradation or effectiveness of chemical treatment, and develops and maintains documentation for baselines, history, and trending. This program was reviewed by the Expert Panel and the System Engineers and found to be effective in addressing MIC. In addition, each system was reviewed for thermal fatigue, which was failure mechanism that contributes to CDF for these systems. The resultant CDF gives a RRW of 1.000 for all segments in these systems. No other conditions caused the Expert Panel to consider these segments HSS.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

18. Staff Question: In Section 3, Structural Element Selection, what is meant by the statement that for some elements in Region 2 of the matrix, the calculated failure rate was zero? Does this mean that the calculated value was less than some truncation level? An earlier statement indicated that failure rates were quantified for each individual element in a segment, and the highest individual rate was used for segment risk; does this mean all of the elements in that segment were not quantifiable? Which system segments and elements comprise the two segments that fell into Region 2? How many elements were selected using existing Section XI criteria? For segments in Region 2 that are not amenable to statistical evaluation, the WOG methodology requires that a determination of any potential secondary degradation mechanisms be made and if of concern, then examination of at least one location in the segment for that mechanism be included in the RI-ISI program. To what extent were secondary mechanisms evaluated?

Licensee Response: TVA stated that there was no set truncation level. A failure rate of zero for a segment means that all elements in the segment have a quantified failure rate of zero.

The Region 2 segments are 3-068-003 and 3-068-015. These are the two reactor recirculation ring headers. There are two welds in each segment, and each of those welds has a calculated failure rate of 0.00. The two segments were selected to be HSS because their failure would result in a large loss-of-coolant accident. One weld was selected in each segment, representing 50% of the welds. Only these two elements were selected using the Section XI criteria.

Each system was analyzed for the parameters indicative of all known degradation mechanisms, based on the method described in the EPRI White Paper Report, "Risk-Based Inservice Inspection Evaluation Procedure", prepared for the ASME Section XI Working Group on Implementation of Risk-Based Inservice Inspection, May 1996. All identified degradation mechanisms were evaluated.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

19. Staff Question: In section 3.2, Segment Definition, clarify what is meant by piping segments defined as a run of piping whose failure would result in the same loss of function, as determined from the plant PSA or other considerations (functions which do not impact CDF).

Licensee Response: TVA stated that loss of function for piping segments was determined from the plant PSA by reviewing each event tree in the PSA documentation and listing the top events that would directly result from failure of each piping segment. The Piping and Instrumentation Drawings were reviewed to determine what other loss of function would result from segment failure, including Initiating Events and effects on Mitigating Systems. A more accurate description would be ". . . other considerations (functions which are not specifically represented in the PSA)."

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

20. Staff Question: Are there any systems modeled in PSA that were not included in the scope of the RI-ISI program and if so, what was the rationale for exclusion?

Licensee Response: TVA stated that in accordance with section 3.2 of WCAP-14572, all piping systems modeled in the PSA are included in the scope of the RI-ISI program.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

21. Staff Question: In Section 3.4, Failure Assessment, the report indicates pipe failure frequency was performed using the WinPRAISE program; if not applicable, deterministic methods were used. Describe these deterministic methods and how many segments were subject to these. Please describe why WinPraise was considered to be not applicable for those segments, e.g., due to material properties.

Licensee Response: TVA stated that a deterministic method was used to determine a failure rate due to FAC, which is applicable to 67 segments. The fail rate for FAC segments was determined by estimating one failure due to FAC in the US each year (approximately 1 in 100 units, or 1E-02) and distributing that failure rate across the 67 segments. This resulted in a value of 1.49E-04 per segment per year. Because of the approximations used in this calculation, the sensitivity studies were performed to ascertain the effect of these uncertainties on the analysis. These sensitivity studies are described in Section 3.4 of the submittal. WinPRAISE is not intended to calculate a failure rate due to FAC.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

22. Staff Question: To what extent were degradation mechanisms considered, other than known augmented inspections?

Licensee Response: TVA stated that, as described in the response to question 18, each system was analyzed for the parameters indicative of all known degradation mechanisms, based on the method described in the EPRI White Paper Report "Risk-Based Inservice Inspection Evaluation Procedure" prepared for the ASME Section XI Working Group on Implementation of Risk-Based Inservice Inspection, May 1996.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

23. Staff Question: In Table 3.5-1, please explain what is meant by the "Applicable CDF" in relation to with or without operator error, and why a given case is chosen, especially when it is not the highest CDF of the two cases.

Licensee Response: TVA stated that as discussed in the response to question 6, each recovery action identified in the Operator Action analysis was also analyzed for whether the

action would be likely to actually occur. For instance, it could be possible to isolate a failure, but the time to accomplish the isolation would be too long to prevent the postulated consequence. Each potential operator action was analyzed and the action most likely to actually occur was designated the Applicable Case.

Staff Question: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

24. Staff Question: Comparing Table 3.7-3 to 3.7.2, for the recirculation system, it would appear that there should be four medium and three low risk segments categorized based on RRW values rather than the three medium and four low shown in Table 3.7-2.

Licensee Response: TVA stated that there is a typographical error in Table 3.7-2. RRW for 3-068-009 should be 1.000. There is no impact on designation of the segment as HSS.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

25. Staff Question: In Section 3.8 of the submittal, it is noted that the Code Case N-577 allows that when a postulated failure mode for an element is being addressed by a program already in place, that program may be used to satisfy the requirements of Table 1, subject to certain conditions. Except for one High Pressure Coolant Injection system element that was in the current Section XI program, you are proposing use of existing FAC and IGSCC inspection programs to satisfy all of the examination requirements under the new RI-ISI program. Please confirm that the proposed program meets the criteria specified in paragraph I.6.1(a), (b), and (c).

Licensee Response: TVA stated that only the examinations conducted under the augmented program for FAC are credited toward the RI-ISI examinations. These are in addition to the examinations specified under Item Numbers R1.11 and R1.16. While the examinations for IGSCC (R1.16) utilize a method which must be demonstrated to comply with the requirements of NUREG-0313, these examinations are conducted under all rules applying to the Section XI program, and are considered part of the Section XI Program. The proposed program meets all of the referenced criteria.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

26. Staff Question: Table D-1 in Appendix D of the Unit 3 PSA indicates a total CDF of 9.19E-06 with an unaccounted frequency of 9.18E-04. Does this imply that there are a great number of low frequency sequences that, when summed, would be two orders of magnitude greater than the baseline CDF? Since the PSA CDF results are being used to evaluate various aspects of the RI-ISI program, and accident scenarios involving pipe failure initiators are also low-probability events, please describe the potential impact on the results of the evaluation by ignoring these nontrivial contributions.

Licensee Response: TVA's response was no, and they stated that the unaccounted frequency would more accurately be identified as "unresolved frequency" due to truncation. This is a

byproduct of the complexity of the BFN risk model and the retention of success frequency by Riskman. That is, in the case where a large number of success terms (i.e., 1 - x, where x is customarily less than 0.01) are retained, the "rare event approximation" (i.e., 1 - x is approximately equal to 1.0) no longer applies.

In an effort to resolve this question, the BFN risk model was evaluated at a truncation level of 1E-12, rather than 1E-10. Unresolved frequency dropped by approximately a decade. While some of the unresolved frequency went to core damage, most of it went to the success endstate. Review of the results from this evaluation confirmed that the conclusions of the baseline PSA remain valid.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

27. Staff Question: Section 3.9 of the submittal indicates some limitations for exams to provide greater than 90% coverage will not be known since some locations will be examined for the first time by the specified techniques. The licensee should clarify the reason for this statement since all locations to be examined are already examined under an existing program.

Licensee Response: TVA stated that, as stated in the third paragraph of 3.9 of the submittal, all locations that have been selected provide >90%. The instance where a location might be found to not meet >90% coverage would be if an additional examination was required in accordance with -2430 of Code Case N-577.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

28. Staff Question: Although TVA states that WinPRAISE is a Microsoft Windows-based version of the PRAISE code, and that the PRAISE code was used as the benchmark for SRRA in WCAP-14572, Supplement 1, evaluation of these codes for failure probability determinations is beyond the scope of this evaluation. It is recommended that the licensee provide further analyses to demonstrate similar results would be obtained from application of the WinPRAISE and SRRA codes, as used in support of an RI-ISI program.

Licensee Response: TVA stated that WinPRAISE is pc-PRAISE with a Windows input deck. The comparison between pc-PRAISE and WinPRAISE is contained within Technical Report TR-97-12-01, Engineering Mechanics Technology, Inc. This comparison is documented by example problems in Section 11 of the Technical Report. The Technical Report took example problems from NUREG/CR-5864, "Theoretical and User's Manual for pc-PRAISE" and performed a comparison between the outputs of pc-PRAISE and WinPRAISE. These problems represented the major degradation mechanisms considered in pc-PRAISE. This demonstrates that WinPRAISE properly constructs an input deck for pc-PRAISE and validates WinPRAISE. Since WinPRAISE and SRRA were both validated against pc-PRAISE, comparing WinPRAISE to SRRA would be redundant.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

**Materials and Chemical Engineering Branch Questions on BFN3 RI-ISI**

1. Staff Question: Section 2.2 states that augmented program inspections, with the exception of IGSCC Category "A" welds, remain unchanged. Please describe if the augmented inspection program inspections are credited toward the samples required using the RI-ISI sample selection criteria. If so, please specify the percentage of inspections in the RI-ISI program that are included in the current augmented inspection programs. Also, Section 3.8 states that all locations identified for examination are locations already identified under existing programs, either Section XI, IGSCC, or FAC. The staff has a concern that the following issues should be addressed:

- The inspection samples should include a reasonable representation of material conditions (e.g., stainless steel and carbon steel).

  Licensee Response: TVA stated that the samples include 16 carbon steel segments and 22 stainless steel segments.

- Each degradation mechanism type existing in HSS locations should be inspected.

  Licensee Response: TVA stated that each degradation mechanism that contributes to the significance of a HSS segment is inspected in this program.

- Typically no more than one half of the N-577 inspections should be taken from the augmented inspection program.

  Licensee Response: TVA stated that only the examinations for FAC are credited toward the RI-ISI examinations. These represent 15/84 examinations (17.8%). While the examinations for IGSCC utilize a method which must be demonstrated to comply with the requirements of NUREG-0313, these examinations are conducted under all rules applying to the Section XI Program, and are considered part of the Section XI Program.

Staff Responses: The Staff agreed that TVA's responses provide sufficient information to enable it to proceed with the review, but, requested that Table 5-1 of the submittal be revised to show the number of "dual credit" examinations by system and class. TVA agreed to provide the requested information in a follow-up submittal.

2. Staff Question: In the WOG methodology process, the failure probability of a segment is characterized by the failure potential of the worst-case situation in each segment. This was calculated by inputting the most limiting or bounding conditions for the entire piping segment. This was the justification for using a single bounding value of failure probability rather than combining failure probabilities of various welds in the segment. The BFN3 submittal states (Section 3, "Determination of Failure Rate for a Segment") that failure rates were quantified for each segment by using the calculated worst result when failure rates were determined for more than one point. Please provide the justification for ignoring the number of welds or not combining the failure rates for various welds in the segment.

Licensee Response: See response to PSA Branch question 1.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

3. Staff Question: The structural element selection criteria described in Section 3 needs clarification. Specifically, the following items should be clarified:

- The submittal states that for those elements with a quantified failure rate, that failure rate was used to select elements. Please describe how this criterion is implemented.

  Licensee Response: TVA stated that risk for an individual element is calculated by multiplying the quantified failure rate for that specific element by the (CCDP) for the segment which contains the element. In accordance with I-4.2.9 of ASME Code Case N-577, elements with RRW > 1.001 (calculated with respect to the base risk level from piping pressure boundary failures) are considered More (High) Safety Significant and selected for examination.

- The alternative selection criterion described is the one used in ASME Section XI, i.e., 25% for Class 1 and 7.5% for Class 2. What criteria are used for non-ASME piping systems?

  Licensee Response: TVA stated that non-ASME piping systems would be subject to the same criteria as ASME Class 2; i.e., 7.5%.

- What structural element criteria are used for segments in Region 1(B)?

  Licensee Response: TVA stated that they are the same as region 2.

Staff Responses: The Staff agreed that TVA's responses provide sufficient information to enable it to proceed with the review.

4. Staff Question: The segment definition in Section 3.2 is based on a combination of consequence and failure probability. Although acceptable, this is a deviation from the WOG methodology and should be listed as such.

Licensee Response: TVA agreed with the Staff and stated that this will be provided in a follow-up submittal.

Staff Responses: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

5. Staff Question: Section 3.4 describes sensitivity studies performed to bound failure rates due to FAC. Please describe sensitivity studies performed to bound failure rates due to other failure mechanisms.

Licensee Response: TVA stated that all other failure rates were determined quantitatively; therefore, no other failure rate sensitivity studies were required to validate assumptions.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

6. Staff Question: Section 3.6 states that the expert panel included members of the expert panel that had been established to implement the Maintenance Rule. However, in the WOG methodology, the panel should also include members that have expertise in related areas, such as inservice inspection, nondestructive examination (NDE), and stress and material considerations, as specified in Section 3.6.3 of the WCAP-14572. Please specify if the expert panel that reviewed and approved the RI-ISI program at the BFN3 included members with these qualifications.

Licensee Response: TVA stated that the Component Engineering Supervisor is a member/Chairman of the Expert Panel. He supervises the ISI NDE program. The ISI Program Engineer reports directly to the Component Engineering supervisor. The ISI Program Engineer and Component Engineer were intimately involved in the RI-ISI submittal. The Maintenance representative is familiar with implementation of ISI-NDE requirements. The Maintenance Rule coordinator previously served as NDE, Code, and Programs supervisor in Nuclear Assurance where ISI program requirements were established. The PSA Engineers who worked daily on the RI-ISI submittal were also on the Expert Panel. The Corporate ISI expert also contributed to the Expert Panel process. Civil Engineering provided pipe stress expertise during submittal preparation.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

7. Staff Question: Section 3.7 states that segments with RRW greater than 1.001 are considered for examination. Please clarify if these segments are classified as HSS.

Licensee Response: All segments with an RRW greater than 1.001 are classified as HSS.

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

8. Staff Question: The effort to benchmark piping failure probabilities for the WOG methodology was accomplished for pressurized-water reactors and, therefore, did not include IGSCC. Since BFN 3 is a boiling-water reactor (BWR), what efforts were made to benchmark and validate failure probabilities due to IGSCC?

Licensee Response: TVA stated that the failure probability due to IGSCC has been validated in BWRs and is documented in Section 3 of NUREG/CR-4792, "Probability of Failure in BWR Reactor Coolant Piping".

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

9. Staff Question: Section 3.8 provides structural element and nondestructive examination selection details. The current ASME Section XI requires volumetric examination of a sample of 25% of Categories B-J welds. Please provide the percentage of welds that are to be

examined under the BFN3 RI-ISI program. Please provide a justification of this sample size if this percentage is smaller than 10%, as permitted by ASME Code Case N-560.

Licensee Response: TVA stated that the Browns Ferry Procedure 3-SI-4.6.G, "Inservice Inspection Program", lists a total population of 17 B-F welds and 435 B-J welds (452 total). The RI-ISI program requires volumetric examination of 10 B-F welds (58.8%) and 59 B-J welds (13.6%). For the combination of all Class 1 welds (B-F and B-J) the RI-ISI program examines 69 of 452 welds (15.2%).

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

10. Staff Question Section 3.8 states that there are 35 segments in Region 1. Please describe how many of these are in Region 1A and in Region 1B. Also, please provide the methodology for selecting elements from Regions 1B and Region 2. These are the regions for which the WOG methodology uses Purdue-Abramson method.

Licensee Response: TVA stated that of the 35 segments in Region 1, 34 are subject to either FAC or IGSCC and are in Region 1A. The remaining segment is subject to thermal fatigue; therefore, this segment is considered Region 1B. The methodology for selecting elements in Region 1B is the same as that described for Region 2 in Section 3 of the submittal.

Staff Response The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

11. Staff Question: Section 5 states that the current ASME Section XI selects 222 locations while the proposed RI-ISI program selects 70 locations. How many of these 70 locations are already included in the current augmented programs, such as FAC and/or IGSCC? The staff has a concern that if major portions of these 70 locations are already covered by the current augmented programs, such as FAC and/or IGSCC, then the implication is that the current ASME program is being entirely eliminated under the RI-ISI program.

> Licensee Response: TVA stated that as referenced in the response to NRC, PSA Branch question 25, only the examinations conducted under the augmented program for FAC are credited toward the RI-ISI examinations. These are in addition to the examinations specified under Item Numbers R1.11 and R1.16. While the examinations for IGSCC (R1.16) utilize a method which must be demonstrated to comply with the requirements of NUREG-0313, these examinations are conducted under all rules applying to the Section XI program, and are considered part of the Section XI Program. The ASME Program is not being eliminated; but the examination techniques specified under the Program are being made more stringent to assure detection of the identified degradation mechanism.

Staff Question (cont'd): Section 5 also states that the IGSCC locations are being reduced from 164 to 137. Please verify that this reduction is only applicable to IGSCC Category A welds.

Licensee Response: TVA stated that all examinations to satisfy the requirements of GL 88-01 in Categories C through G remain unchanged. All reductions are in Category A only (Current 67, proposed 40 for a difference of 27).

Staff Response: The Staff agreed that TVA's response provides sufficient information to enable it to proceed with the review.

**Additional Items Identified In The Meeting**

1. The Staff requested TVA to further describe the process discussed in Section 4 of the Submittal whereby feedback of new relevant information to ensure that the program is appropriately adjusted.

TVA agreed to provide the requested information in a follow-up submittal.

2. The Staff requested TVA to address weaknesses in the Unit 3 PRA as described in the Staff's letter to TVA dated May 4, 1999, BFN 3 Individual Plant Examination GL 88-20

3. The staff informed TVA that it had not fully evaluated the use of the WINPRAISE program and may have additional questions at a later date.