WBN2Public Resource

From: Lyon, Fred
Sent: Wednesday, February 09, 2011 10:39 AM
To: wdcrouch@tva.gov; garent@tva.gov
Cc: Campbell, Stephen; Milano, Patrick; Raghavan, Rags; WBN2HearingFile Resource
Subject: Draft RAI for Chapters 11 and 12
Attachments: DRAFT RAI for Chapters 11 and 12.docx

Attached fyi is the draft form of the RAI that we are preparing to send to you for Chapters 11 and 12.

In an effort to complete the NRC staff review in a timely manner, we've not separated the RAI questions from the draft safety evaluation input, as we normally do with an RAI. Instead, the draft chapters include open items that should be addressed by your staff in the form of responses to RAIs from the NRC staff. The draft chapters are being provided to you only so that your staff can see the RAIs in context to aid in your timely response. The draft chapters are not intended to convey final NRC conclusions and are not otherwise for comment.

We will be requesting a response within 15 days of the date of the letter.

Thanks, Fred Lyon (301-415-2296)

Hearing Identifier: Watts_Bar_2_Operating_LA_Public
Email Number: 258

Mail Envelope Properties (A56E37EC1CBC8045910287CEF5E7AE6C9665A9D250)

Subject: Draft RAI for Chapters 11 and 12
Sent Date: 2/9/2011 10:38:37 AM
Received Date: 2/9/2011 10:38:40 AM
From: Lyon, Fred

Created By: Fred.Lyon@nrc.gov

Recipients:
"Campbell, Stephen" <Stephen.Campbell@nrc.gov>
Tracking Status: None
"Milano, Patrick" <Patrick.Milano@nrc.gov>
Tracking Status: None
"Raghavan, Rags" <Rags.Raghavan@nrc.gov>
Tracking Status: None
"WBN2HearingFile Resource" <WBN2HearingFile.Resource@nrc.gov>
Tracking Status: None
"wdcrouch@tva.gov" <wdcrouch@tva.gov>
Tracking Status: None
"garent@tva.gov" <garent@tva.gov>
Tracking Status: None

Post Office: HQCLSTR01.nrc.gov

Files	**Size**	**Date & Time**
MESSAGE	792	2/9/2011 10:38:40 AM
DRAFT RAI for Chapters 11 and 12.docx	54128	

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

DRAFT REQUEST FOR ADDITIONAL INFORMATION

FSAR CHAPTERS 11 AND 12

TENNESSEE VALLEY AUTHORITY

WATTS BAR NUCLEAR PLANT, UNIT 2

DOCKET NO. 50-391

By Amendment Nos. 92, 95, and 97 through 102, the Tennessee Valley Authority (TVA) provided updates to the Final Safety Analysis Report (FSAR) for Watts Bar Nuclear Plant (WBN), Unit 2. The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the information provided by TVA in the above FSAR amendments.

In an effort to complete the NRC staff review in a timely manner, enclosed is the draft safety evaluation input for portions of Chapters 11 and 12 of the supplemental safety evaluation report related to the operation of WBN Unit 2. These draft chapters include open items that should be addressed by your staff in the form of responses to requests for additional information (RAIs) from the NRC staff. The draft chapters are being provided to you only so that your staff can see the RAIs in context to aid in your timely response. The draft chapters are not intended to convey final NRC conclusions and are not otherwise for comment.

11 RADIOACTIVE WASTE MANAGEMENT

By Amendments 92 95, 98, 99, 100, 101, and 102, the Tennessee Valley Authority (TVA) revised Chapter 11, “Radioactive Waste Management,” of the Final Safety Analysis Report (FSAR) principally to conform the Unit 2 design basis to the design basis of the currently operating Unit 1. The staff reviewed these amendments against the criteria in the Standard Review Plan (SRP), Section 11 (NUREG-0800); the staff's conclusions in the original Watts Bar Safety Evaluation Report (SER, 1982); TVA’s Supplemental Environmental Impact Statement (February 15, 2008); and the staff’s conclusions in the Final Environmental Impact Statement (Draft NUREG-0498).

The multiple revisions to the FSAR have renumbered, and renamed, many of Chapter 11 tables and paragraphs. Since renumbering the tables within Chapter 11 does not in itself affect the staff’s previous safety conclusions, these changes are acceptable. By letter dated November 9, 2010, TVA provided a reference table showing the Chapter 11 changes from the Amendment 91 version of the FSAR to the current (Amendment 100) table and paragraph designations. This reference table was provided for information to aid in following the development of Chapter 11 of the FSAR. Unless indicated, this Supplemental Safety Evaluation references tables and paragraph as they appear in Amendment 100. **[This closes followup RAI 11-4]**

The license application for WBN was tended prior to June 4, 1976. Therefore, consistent with the provisions of 10 CFR 50 Appendix I, Paragraph D, TVA has committed to demonstrating compliance with the dose based criteria of RM 50-2 in lieu of providing a WBN liquid and gaseous effluent systems cost-benefit analysis. **[This closes RAI 11-8]**

11.1 Source Terms

Amendments 92 and 95 revised the text to several subsections of the WBN, Unit 2, FSAR Section 11.1. These changes are editorial in nature and did not affect the technical information presented Tables 11.1-1 through 11.1-7. Therefore, these changes did not affect the staff's original safety conclusion and are acceptable.

11.2 Liquid Waste Management System

The NRC staff reviewed Section 11.2 of Amendments 95, 98, 101, and 102 to the WBN, Unit 2, FSAR, submitted by the TVA, submitted by the TVA, in support of the operating license application for WBN Unit 2. The NRC staff's acceptance criteria for Section 11.2 are based on the applicant meeting the relevant requirements of the following regulations: (1) 10 CFR 50.34(a) as it relates to sufficient design information being provided to demonstrate that design objectives for equipment necessary to control releases of radioactive liquid effluents to the environment have been met; (2) 10 CFR Part 20 as it relates to radioactivity in effluents released into unrestricted areas; (3) 10 CFR Part 50, Appendix I as it relates to the numerical guides for design objectives and limiting conditions for operation to meet the "as low as is reasonably achievable" criterion given; (4) General Design Criterion 60 of Appendix A to 10 CFR Part 50, as it relates to the radioactive waste management systems being designed to control releases of liquid radioactive materials to the environment; and (5) General Design Criterion 61 as it relates to radioactive waste systems to be designed to assure adequate safety under normal and postulated accident conditions. The criteria used by the NRC staff to evaluate whether an applicant has met the aforementioned regulations can be found in Section 11.2 of NUREG-0800 Rev. 2, July 1981 (the Standard Review Plan or SRP).

FSAR Table 11.2-4 represents the total annual discharge of liquid effluent prior to any liquid waste processing. Amendments 95 and 102 made some inconsequential revisions to this table. These changes did not affect the staff's previous safety conclusion and are therefore acceptable.

Columns 4 through 8 of Table 11.2-5 present five different liquid effluent isotopic spectrums, and the total annual radioactivity, released in liquid effluents with, or without, processing of the different waste streams. These total annual releases are compared to the 5 Ci release limit for each reactor in RM 50-2, as annexed to 10 CFR 50, Appendix I. Amendment 95 made minor adjustments to the activities listed in columns 4 and 5 of Table 11.2-5, and added columns 6, 7, and 8 to include releases from unprocessed steam generator blowdown effluent. Amendment 101 revised Section 11.2.6.5 to describe the radwaste process configurations represented by each column of Table 11.2-5. Amendment 102 added column headers and a footnote to Table 11.2-5 explaining each column. All five of the activity columns (columns 4 through 8) of Table 11.2-5 contain liquid waste contributions from the Tritiated Drain Collector Tank, processed by the CVCS Demineralizer (Demin.) and the Mobil Demin.; the Reactor Coolant Drain tank, processed by the Mobil Demin.; the unprocessed Laundry and Hot Shower Drain Tank; and the unprocessed Turbine Building drains. In addition to these, Column 4 includes Condensate Demin. regeneration backwash and steam generator blowdown effluents that have had Condensate Demin. decontamination factors **[RAI 11-13 & 14, RAI 11-1 is OPEN]** applied. Column 5 also applies the decontamination factors for the Mobile Demin. to the Condensate Demin. backwash and steam generator blowdown process streams. Column 6 represents no

processing of, nor release restrictions on, the Condensate Demin. and blowdown effluent streams. Columns 7 and 8 present the annual activity release if the steam generator untreatedeffluent concentrations are maintained below 5 E-7 uCi/cc and 3.65E-5 uCi/cc, respectively. However, column 7 and column 8 do not include Condensate Demin. backwash wastes. **It is unclear how TVA intends to operate WBN Unit 2 without performing this routine maintenance of the Condensate Demin. System [RAI 11-10].**

Tables 11.2-5a, 11.2-5b, 11.2-5c, and 11.2-5d, calculates the design basis liquid effluent isotopic concentrations from the nominal annual release activity values given in Table 11.2-5, Columns 4, 5, 7, and 8, respectively. To determine whether these design basis effluent activities are within the limits of 10 CFR 20, the sum of the ratios of each isotope concentration (C) to its corresponding Effluent Concentration Limit (ECL as listed in 10 CFR 20, Appendix B, table 2, Column 2) is calculated. Consistent with the requirements of 10 CFR 20.1302(b)(2)(i), a C/ECL sum of less than 1.0 indicates that this annual average effluent release is within the limits of 10 CFR 20.1301.

Amendment 98 made minor revisions to the values in Tables 11.2-5a and 11.2-5b. These revisions did not affect the final results presented in Tables 11.2-5a and 11.2-5b, e.g., that extended effluent releases without processing the Condensate Demin. regeneration waste through the Mobile Demin. will not meet the limits of 10 CFR 20 and is not acceptable. To insure that the limits of Part 20 are met, Amendment 98 also revised Section 11.2.6.5 of the FSAR to include the statement that "no untreated wastes are released unless they are below the Lower Limit of Detection (LLD=5E-7 uCi/cc gross gama [sic])." **[This closes RAI 11-2] However, it is unclear how this statement is consistent with the calculational basis for Table 11.2-5 column 8, which assumes the release of untreated Steam Generator Blowdown effluents at concentrations up to 3.65E-5 uCi/cc. [RAI 11-16].**

Tables 11.2-5c and 11.2-5d, added by Amendment 101, purport to demonstrate that the limits of 10 CFR 20 can be met without processing steam generator blowdown effluents. Amendment 102 revised these tables by editing their titles, and adding clarifying footnotes to Tables 11.2-5a, 11.2-5b, 11.2-5c, and 11.2-5d.

The staff concurs with TVA's conclusion that operating for an extended period of time without processing the Condensate Demin. backwash or steam generator blowdown, as represented by column 6 of Table 11.2-5, is not acceptable. However, the **staff cannot agree that the total activities represented by columns 7 and 8 of Table 11.2-5, meet the activity limit of Rm 50-2** since neither includes the effluent (backwash) from the routine regeneration of the Condensate Demineralizers. **[RAI 11- 15]** Similarly, the **staff cannot conclude that Tables 11.2-5c and 11.2-5d demonstrate that 10 CFR 20 can be met with untreated steam generator blowdown effluents**, since they do not include Condensate Demin. regeneration backwash effluents. **[RAI 11-11 &12; Followup RAI 11-1 and 11-2 are OPEN pending resolution]**

Amendment 95 updated population on usage data listed in Table 11.2-6. Amendments 95 and 100, update the whole body and organ doses for the maximum exposed individual in each critical age group listed in Table 11.2-7. These updates resulted in minor changes to the calculated doses, which still meet the design criteria for liquid effluents in 10 CFR 50 Appendix I. As discussed below, the staff performed independent dose calculations to verify the acceptability of the applicant's dose assessment. The staff determined that there is sufficient

agreement between the TVA's and the staff's results to conclude that the WBN Unit 2 design meets the design criteria of 10 CFR 50 Appendix I and is therefore acceptable. **However, it is not clear which source term was used as the basis for these calculations. [RAI 11-9; RAI 11-3 OPEN pending resolution of the source term assumption]**

FOLLOW-UP RAIs

9. **Verify that the changes made to Table 11.2-7 are to conform this table with TVA's the re-evaluation of the offsite doses, as presented in the February 15, 2008, environmental Impact Assessment. If not, describe the liquid isotopic release values use to calculate these doses.**

10. **Amendment 101 revised Section 11.2.6.5, and Amendment 102 added a footnote, explaining the radwaste process configurations represented by each column of Table 11.2-5. Columns 7 and 8 do not include effluents from the Condensate Demineralizer regeneration (backwash) operations. Since Table 11.2-5 represents total annual curies released, how does TVA intend to operate WBN Unit 2 for an entire year without backwashing the Condensate Demineralizers? If not then justify the position that annual releases consistent with Column 8 will meet the 5 Ci limit of RM 50-2 Paragraph A.2 or demonstrate WBN meets the alternate criteria in RM 50-2, Paragraph A.3.**

11. **Similarly, justify the position that Tables 11.2-5b, 11.2-5c, and 11.2-5d demonstrate compliance with 10 CFR 20 when Table 11.2-5b does not include steam generator blowdown effluents, and Tables 11.2-5c and11.2-5d, do not include condensate demineralizer backwash effluents.**

12. **In addition, Tables 11.2-5b, 11.2-5c, and 11.2-5d, only represent one unit operation. Provide an analysis that demonstrates that the effluents from WBN will not result in a member of the public exceeding the dose limits in Part 20 with both WBN units in operation.**

13. **The footnote added to Table 11.2-5 by Amendment 102 appears to have some typographical errors. Verify that the term "F/H1D" in the formulation of Column 5 and "Mobi"le" in the definition of "D" should be, "F/H/D" and "Mobile" respectively.**

14. **In addition the definitions of the terms "F" and "H" used in columns 4, 5, and 6 are somewhat confusing. A plain reading of the footnote would indicate that the entire condensate flow that is processed by the Condensate Demineralizer is released from WBN as liquid effluent. Reading this in the context paragraph 11.2.6.5, as revised by Amendment 101, would indicate that the term "F" represents the total annual activity in the effluent waste from Condensate Demineralizer regeneration operations, not the Condensate Demineralizer flow. Verify that this is the case. If it is, identify the demineralizer (who's decontamination factors are represented by "H" in the terms "F/H" and "F/H/D") that the regeneration waste is processed through prior to processing with the Mobile Demineralizer. If it is not the case, provide additional clarification of the terms "F/H" and "F/H/D" in the footnote.**

15. Provide information that demonstrates that operating WBN Units 1 and 2 will meet the liquid effluent criteria in RM 50-2, Paragraph A.1 (e.g., 5 mrem to the total body or to any organ per site).

16. Resolve the apparent conflict between the statement in Section 11.2.6.5 that no untreated wastes are released unless they are below the Lower Limit of Detection of 5E-7 uCi/cc, and the calculational basis for Table 11.2-5, Column 8 (and Table 11.2-5d) that concludes that untreated releases up to 3.65E-5 uCi/cc are acceptable.

11.3 Gaseous Waste Management System

The NRC staff reviewed Section 11.3 of Amendments 95, 98, 99, and 100 to the WBN, Unit 2, FSAR, submitted by the TVA in support of the operating license application for WBN Unit 2. The NRC staff's acceptance criteria for Section 11.3 are based on the applicant meeting the relevant requirements of the following regulations: (1) 10 CFR 50.34(a) as it relates to sufficient design information being provided to demonstrate that design objectives for equipment necessary to control releases of gaseous radioactive effluents to the environment have been met.; (2) 10 CFR Part 20 as it relates to radioactivity in effluents to unrestricted areas; (3) 10 CFR Part 50, Appendix I as it relates to the numerical guides for design objectives and limiting conditions for operation to meet the criterion "as low as is reasonably achievable" given in the Appendix I; (4) General Design Criterion 60 of Appendix A to 10 CFR Part 50, as it relates to the radioactive waste management systems being designed to control releases of gaseous radioactive materials to the environment; and (5) General Design Criterion 61 as it relates to radioactive waste systems to be designed to assure adequate safety under normal and postulated accident conditions. The criteria used by the NRC staff to evaluate whether an applicant has met the aforementioned regulations can be found in Section 11.3 of NUREG-0800 Rev. 2, July 1981 (the Standard Review Plan or SRP).

Amendments 95 and 98 made several revisions to the descriptions of the WBN gaseous radioactive waste processing systems (GWPS) design. In addition, Amendment 95 deleted references to the Boron Recycle System (BRS) from Section 11.3-2, Table 11.3-3, and Table 11.3-4. These changes did not affect TVA's expected annual gaseous release from the GWPS as presented in Table 11.3-5 of the FSAR. Therefore, these revisions did not affect the staff's previous safety conclusion and are acceptable.

Amendments 95 and 98 also made several revisions to the gaseous effluent release analysis parameters presented in Table 11.3-6 with resulting minor changes to the resulting radioactive releases in Table 11.3-7. The radioactive releases listed in Tables 11.3-7 are based on the radioactive source term assumptions in NUREG-0017, adjusted for WBN specific parameters. Table 11.3-7 represent operations with containment purge, while Table 11.3-7c assumes that containment is continuously vented through a filtered release. **[RAI 11-18]** Section 11.3.7.5 of the FSAR indicates that the estimated releases in Table 11.3-7c were used by TVA in calculating the site boundary doses presented in Table 11.3-10 to demonstrate compliance with 10 CFR 50 Appendix I. **However it is unclear if the source term used for Table 11.3-7c (i.e., 1/8% failed fuel) is comparable to the NUREG-0017 source term [RAI 11-19]. Also, as discussed below, it is unclear if the basis for the doses presented in Table 11.3-10 is the isotopic releases listed in Table 11.3-7c or Table 11.3-7. [RAI 11-17; RAI 11-7 OPEN]**

Tables 11.3-7a and 11.3-7b adjust the isotopic values from Tables 11.3-7 and 11.3-7c respectively, to those expected while operating with 1% failed fuel, then calculated the sum of the C/CEL values to demonstrate that operating under these assumed conditions will meet the public dose limits in 10 CFR 20. Amendment 95 added a new column to each table representing the C/CEL values for two WBN units operating. The sums of the C/CEL ratios are below 1.0 for two unit operations demonstrating that the limits of 10 CFR 20 are met, and are therefore acceptable. **[RAI 11-5 & 11-6 CLOSED]**

Amendments 95, 98, and 99 revised Table 11.3-11 significantly lowing the calculated doses and presenting them in the table on a per-unit basis instead of on a per-site (2 units operating) basis. **[RAI 11-24]** It appears that these changes were made to conform Chapter 11 of the WBN Unit 2 FSAR with the re-evaluation of public doses presented in TVA's "Watts Bar Nuclear Plant (WBN) – Unit 2-Final Supplemental Environmental Impact Statement," (FSEIS - submitted to the NRC by letter dated February 15, 2008). **[RAI 11-16]** The revised doses contained in the doses in FSAR Table 11.3-10 (Amendment 98), exactly match the doses presented in Table 3-21 of the FSEIS. In response to the staff's questions (RAI 11-7 and Follow-up question 11-3), TVA stated that the revised (lower) doses were the result of several changes TVA made to the calculation input parameters, and presenting the doses on a single-unit, versus a duel-unit, basis. TVA stated they updated the X/Q, D/Q and joint frequency tables used in their calculations to reflect updated meteorology (e.g., data from January 1986 to December 2005, versus previous based on January 1974 to December 1993 data). In addition, the feeding factors used to adjust the fraction of the time cows are grazing on exposed pasture, was significantly lowered for all sectors with a milk cow. Amendment 100 revised the Table 11.3-8 to reflect the revised input parameters. Several compass sectors, distances, and terrain adjustment factors in Table 11.3-8 were also changed to reflect an updated land-use census.

The staff reviewed the changes in Amendments 95, 98, 99, and 100, against the information in the FSEIS and Appendix I of NUREG-0498, Supplement 2, and identified several discrepancies. The FSEIS states that the doses in FSEIS Table 3-21 are based on the FSEIS Table 3-20, which is consistent with Table 11.3-7 of the FSAR. This seems inconsistent with the statement noted above, that the doses in FSAR Table 11.3-10 (identical to FSEIS Table 3-21) are based on the significantly different radioactive quantity values in FSAR Table 11.3-7c. **[RAI 11-17 & 18]** In addition, although the doses listed in FSEIS Table 3-21 are identical to those in FSAR Table 11.3-10, the former indicates that the maximum thyroid dose was based on a cow feeding factor of 0.65, while the later indicates that the dose was based on a cow feeding factor of 0.33 (also listed as 0.33 in Amendment 100 to FSAR Table 11.3-8). Neither of these values agrees with the 0.70 feeding factor given in FSAR Section 11.3.10.1. **[RAI 11-20]** Several of the distances and directions for the locations of the calculated doses given in FSAR Table 11.3-8 (Amendment 100) do not agree with the information in the FSEIS. **[RAI 11-23; RAI 11-4, 11-7, and Follow-up question 11-3 OPEN]**

The staff performed independent dose calculations to verify TVA's dose results. The details of the staff's calculations and input parameters assumptions can be found in Appendix I of NUREG-0498, Supplement 2. With the exception of the iodine/thyroid doses, the staff's results generally agree with the TVA's calculations. Bases on its conservative assumptions, the staff's calculations determined that the maximum exposed organ expected from radioactive iodine and particulates in gaseous effluents, is 10.78 mrem. Although both TVA's and the staff's calculations indicate that the design criteria in 10 CFR 50 Appendix I are met (15 mrem per year per unit), they are not sufficient to determine if the criteria in RM 50-2 are met (15 mrem per

year "*from all light-water-cooled nuclear power reactors at a site*"). **Therefore, the staff cannot confirm that the WBN Unit 2 can be operated within the dose restrictions of RM 50-2. [RAI 11-3 OPEN]**

FOLLOW-UP RAIs

17. **Verify that the basis for the Amendment 98 changes to Table 11.3-10 is the revised TVA analysis of the offsite radiation doses as presented in the Final Supplemental Environmental Impact Statement (FSEIS), submitted by letter dated February 15, 2008. If this is not the case, describe the basis for the revised values in Table 11.3-10.**

18. **FSAR Section 11.3.7.5 indicates that the site boundary doses presented in Table 11.3-10 are based on the annual radioactive gaseous releases listed in Table 11.3.7c. However, the FSEIS indicates that these dose values are based on a source term consistent with FSAR Table 11.3.7. Verify the gaseous release values used to calculate the site boundary doses, and/or explain how two significantly different source terms arrive at the exact same calculated doses.**

19. **The Continuous Filtered Containment Vent case (Table 11.3-7c) has significantly lower activities for all of the Krypton, Xenon, and Iodine isotopes, than those estimated for the "containment purge" case listed in Tables 11.3-7, while the other particulate activities released from the Containment Building remain the same. Describe the filter that selectively removes noble gases and iodine species but not other particulates from the Containment Building Vent gaseous effluents. Provide a basis for assuming normal operations with the containment vent continuously open. Provide, and justify, the Decontamination Factors (by each isotope class) assumed for continuous containment vent filter.**

20. **Verify that the 1/8% failed fuel source term used as the basis for Table 11.3-7c is comparable to the source term specified in NUREG-0017. If not justify the use of this source term for determining nominal effluent release values.**

21. **The response to RAI 11-4, and the revisions to Table 11.3-8 (Amendment 100) are inconsistent with the text in the FSAR and the FSEIS. Section 11.3.10.1 indicates that the doses are based on the 1994 land-use survey and that a cow feeding factor of 70% was used. In addition, FSEIS Table 3-21 indicates that a cow feeding factor of 0.65 was used to evaluate the iodine/particulate maximum organ dose value. Resolve these conflicts.**

22. **Provide a justification for each of the cow feeding factors listed in Table 11.3-8.**

23. **Describe how the revised (Amendment 100) terrain factors in Table 11.3-8 were determined.**

24. **Footnote 4 to Table 11.3-10 (Amendment 98) indicates that the maximum thyroid dose is for an infant at 3353 meters in the SSW sector. However, the revised (Amendment 100) Table 11.3-8 data indicates that the 0.33 feeding factor is applied to the location at 3353 meters in the SW direction. In addition, Table I-9 of the**

25. FSEIS indicates that the max thyroid/iodine dose is for an individual at 1.42 miles (2285 meters) in the SSW direction. Resolve these conflicts. Provide information describing how two unit operations at WBN will be within all of the dose criteria in RM 50-2 for gaseous releases.

12 RADIATION PROTECTION

12.1 General

In the SER and its supplements, the NRC staff reviewed the WBN Radiation Protection Program to verify that doses to personnel will be maintained within the regulatory limits of 10 CFR Part 20. In its review, the staff also compared TVA's radiation protection designs and program features to the guidelines of Regulatory Guide (RG) 8.8, Revision 3, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be as Low as Is Reasonably Achievable." RG 8.8 provides staff guidance in areas such as (1) use of shielding to reduce levels of radiation, (2) use of ventilation to control the flow of potentially contaminated air, (3) use of radiation monitoring systems to measure levels of radiation in potentially occupied areas and to measure airborne radioactivity throughout the plant, (4) implementation of a health physics program for plant personnel and visitors during reactor operations, maintenance, refueling, radiological waste handling, and in-service inspection.

WBN Units 1 and 2 FSAR Amendment 91, dated October 24, 1995, was the last combined FSAR for WBN Units 1 and 2, due to TVA halting construction of Unit 2. In WBN Unit 2 FSAR Amendments 92, 95, 97, 98, and 101, TVA revised the FSAR, principally to conform the Unit 2 design basis to the design basis of the currently operating WBN Unit 1. The NRC staff reviewed these amendments against the criteria in Section 12 of the Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR [Light-Water Reactor] Edition (NUREG-0800)," Revision 2, dated July 1981 (SRP); NUREG-0737, "Clarification of TMI Action Plan Requirements," Item II.B.2; and the staff's conclusions in the SER and its supplements.

12.2 Ensuring That Occupational Radiation Exposures Are As Low As Reasonably Achievable (ALARA)

In WBN Unit 2 FSAR Amendment 92, Section 12.1.3, TVA made minor editorial changes to the description of ALARA operational considerations. These changes were not substantive and did not affect the NRC staff's previous conclusion in Sections 12.2 of the SER and of SSER 14, dated December 1994, that FSAR Section 12.1 is acceptable.

12.3 Radiation Sources

The NRC staff reviewed the changes made by TVA in Amendments 92, 95, and 97 to Section 12.2 of the WBN Unit 2 FSAR, and evaluated the changes using the relevant requirements of the following regulations: (1) 10 CFR 50.34(b)(3) as it pertains to the kinds and quantities of radioactive materials expected to be produced in the operation of WBN Unit 2; (2) 10 CFR Part 20, Subparts C and D, as they pertain to maintaining exposures to radioactive materials within the occupational and public dose limits respectively; (3) 10 CFR Part 20, Subpart H, as it relates to the control of airborne radioactivity areas; and (4) General Design Criterion (GDC) 61 of Appendix A to 10 CFR Part 50, as it relates to systems that contain radioactive materials. The staff also referred to the acceptance criteria provided in the guidance of the SRP, Section 12.2, Revision 2, "Radiation Sources."

In WBN Unit 2 FSAR Amendments 92 and 95, TVA revised Tables 12.2-19, "Estimated Average Airborne Radioactivity Concentrations in the Containment Building," and 12.2-22, "Estimated Average Airborne Radioactivity Concentrations in the Instrument Room," with re-calculated

values for expected airborne radioactivity. TVA re-calculated the values to account for an error in the radioactive liquid leak rate assumed in the original calculations, and a revised assumption of the temperature difference between the upper and lower levels of containment. The increased temperature difference increases natural circulation flow from the lower to the upper containments, resulting in a somewhat lower expected concentration in the lower containment and a correspondingly higher concentration of airborne radioactivity in the upper containment. These re-calculations did not significantly change the expected overall airborne concentrations in their respective plant areas. The total DAC fractions for the upper containment and the instrument room are still each calculated to be a fraction of the concentrations which would require controlling them as an airborne radioactivity area. Therefore, these changes are acceptable to the staff.

In WBN Unit 2 FSAR Amendment 95, TVA revised Section 12.2.1.3, “Sources During Refueling,” to include a discussion of the incore instrumentation thimble assemblies (IITAs) as important radioactive sources during refueling operations. The discussion replaced the previous discussion of the incore detector bottom-mounted instrumentation (BMI) thimble tubes in FSAR Section 12.2.1.3 and Table 12.2-3, “Chemical and Volume Control System Seal Water Return Filter.” In its letter dated June 3, 2010, responding to NRC staff questions (RAI 12-1), TVA stated that the IITAs and BMI thimble tubes would be exposed to the same neutron flux during power operations and therefore would exhibit radiation dose rates of similar magnitude. The radiological hazards posed by this source term change should be no greater than previously described. Therefore, these changes are acceptable to the staff. TVA should provide an update to the FSAR replacing Table 12.2-3 with the expected source strength values of the freshly irradiated IITAs. This is **Open Item 49** (Appendix HH).

12.4 Radiation Protection Design Features

The NRC staff reviewed the changes made by TVA in Amendments 97 and 98 to Section 12.3 of the WBN Unit 2 FSAR, and evaluated the changes using the relevant requirements of the following regulations: (1) 10 CFR 50.34(b)(3) as it pertains to the kinds and quantities of radioactive materials expected to be produced in the operation of WBN Unit 2, and the means for controlling and limiting radioactive effluents and radiation exposures within the limits of 10 CFR Part 20; (2) 10 CFR Part 20, Subpart F, as it pertains to providing adequate radiation survey and monitoring equipment and facilities sufficient to support maintaining doses from exposures to radioactive materials within the occupational and public dose limits, respectively; (3) 10 CFR Part 20, Subpart G, as it pertains to controlling access to high and very high radiation areas; (4) 10 CFR Part 20, Subpart H, as it relates to the control of airborne radioactivity areas; and (5) General Design Criterion (GDC) 61 of Appendix A to 10 CFR Part 50, as it relates to systems that contain radioactive materials. The staff also referred to the acceptance criteria provided in the guidance of the SRP, Section 12.3/4, Revision 2, “Radiation Protection Design Features.”

In FSAR Amendment 97, TVA revised the description of the ventilation system in FSAR Section 12.3.1, “Facility Design Features,” in the last paragraph of page 12.3-1 to read, "Typically, cleaner areas are exhausted to areas of higher potential airborne radioactivity..." [emphasis added]. In response to an NRC staff question (RAI 12-3), TVA responded in its letter to the NRC dated June 3, 2010, that the revised wording in FSAR Amendment 97 was a non-conservative change and not consistent with the text in FSAR Sections 9.4.2.1 and 9.4.3.1

which clearly states that, "To control airborne activity, ventilation air is supplied to clean areas, then routed to areas of progressively greater contamination potential." TVA revised the wording of the paragraph in FSAR Amendment 98 to restore the original intent and to be consistent with FSAR Sections 9.4.2.1 and 9.4.3.1. The corrected wording to the FSAR is acceptable to the staff.

In FSAR Amendment 97, TVA revised the description of the radiation source terms in Section 12.3.1 used in the facility design at WBN Unit 2 in to conform to the Unit 1 design basis. TVA provided clarifying information to the staff (RAI 12-5) in its letter to the NRC dated June 3, 2010. The radiation source terms in plant systems and components during normal operation (tabulated system sources contained in Section 12.2 of the FSAR) are based on the methodology in ANSI/ANS-18.1-1984, “Radioactive Source Terms for Normal Operation of Light Water Reactors.” The change to the FSAR text does not impact the staff’s previous safety conclusion, as documented in SSER 18, dated October 1995, and is acceptable.

In FSAR Amendment 97, TVA reformatted the description in Section 12.3.2.2, ‘Design Description,” of the radiation protection design features employed for plant valves and valve operation stations. This was an extensive editorial change, but no substantial changes were made to the technical information. In addition, several editorial changes were made to descriptions of the plant radiation shielding, but no substantial changes were made to the technical information. Since the changes to Section 12.3.2.2 were not substantive, they are acceptable to the NRC staff.

In FSAR Amendment 97, TVA deleted FSAR Figures 12.3-18 and 19. These figures contained the drawings of WBN radiation protection design features, including controlled access areas, decontamination areas, and onsite laboratories and counting rooms. In lieu of providing drawings depicting these radiation protection design features, TVA provided a description of each. In response to a staff question (RAI 12-7) regarding the FSAR changes, TVA provided clarifying information in its letters dated June 3 and October 4, 2010. In its October 4, 2010, letter, TVA stated that the WBN Unit 2 access controls to radiological areas (including contaminated areas), personnel and equipment decontamination facilities, onsite laboratories and counting rooms, and Health Physics facilities (including dosimetry issue, respiratory protection bioassay, and Radiation Protection Management and technical staff) are all common to Unit 1. Furthermore, TVA stated that these facilities are sized and situated properly to support two operating units. Based on TVA’s response, the staff concluded that the FSAR changes did not impact the staff’s previous safety conclusion, as documented in SSER 18, dated October 1995. Therefore, the changes are acceptable. TVA should provide an update to the FSAR reflecting the information provided in its letter dated October 4, 2010. This is **Open Item 50** (Appendix HH).

In FSAR Amendment 97, TVA revised the frequency of the radiation monitor channel operability tests from quarterly to “periodically.” In its letter dated June 3, 2010, TVA responded to a staff question (RAI 12-8) about what frequency was meant by “periodically.” In its response, TVA provided a WBN Unit 1 FSAR change package as justification for relaxing the interval between monitor channel operability tests from quarterly to 9 months (a “calculated” 18 months with a margin factor of two). The staff reviewed TVA’s response and the change package, but could not conclude that TVA has provided adequate technical justification to relax the quarterly operability tests. This is **Open Item 51** (Appendix HH).

In FSAR Amendment 97, TVA also revised the description of the airborne monitoring channels in Section 12.3.4.2.4, “Component Descriptions,” to reflect the replacement of the seven (7) channels of airborne monitors previously indicated for the Auxiliary Building with four (4) portable airborne monitors. TVA stated in the FSAR that the portable airborne monitors will have a sufficient sensitivity to detect a 10 derived air concentration (DAC)-hour change in airborne radioactivity. In response to a staff question (RAI 12-10), TVA provided additional information in its letter to the NRC dated June 3, 2010, regarding the replacement of the airborne monitors. The use of portable airborne monitors reflects the current operational configuration of Unit 1, and is acceptable to the staff. However, the revised FSAR Section 12.3 contains no discussion of the calibration and operability testing of the portable airborne radiation monitors that replace the seven channels of fixed airborne monitors. The staff lacks sufficient information to determine that these monitors meet the acceptance criteria in the SRP and thus will provide adequate airborne monitoring at WBN Unit 2, consistent with the requirements of Subpart F, “Surveys and Monitoring,” of 10 CFR Part 20, § 20.1501. This is contained in **Open Item 51** (Appendix HH).

In FSAR Amendment 101, TVA further revised the description in Section 12.3.4.1.3, “Area Monitor Calibration and Maintenance,” addressing the calibration and operability testing of area radiation monitors. Rather than specifying appropriate testing frequencies, the revision refers to “licensing or TVA program requirements.” The staff lacks sufficient information to determine that these licensing or TVA program requirements are sufficient to meet the regulatory requirements of Subpart F of 10 CFR Part 20, § 20.1501. This is contained in **Open Item 51** (Appendix HH).

In FSAR Amendment 97, TVA added a description of two area radiation monitors for the Spent Fuel Pit (ORE 90-102 and 103) to the list of monitors in Table 12.3-4, “Location of Plant Area Radiation Monitors.” In response to a question from the staff (RAI 12-9), TVA responded in its letter dated June 3, 2010, that it would provide information to demonstrate compliance with the requirements of 10 CFR 70.24 and 10 CFR 50.68. At this time, the staff lacks sufficient information to determine that these monitors meet the criteria in 10 CFR 70.24, “Criticality accident requirements,” and 10 CFR 50.68, “Criticality accident requirements,” for radiation monitoring in areas where fuel is handled or stored. This is **Open Item 52** (Appendix HH).

12.5 Dose Assessment

The NRC staff reviewed the changes made by TVA in Amendment 95 to Section 12.4 of the WBN Unit 2 FSAR, and evaluated the changes using the relevant requirements of 10 CFR 50.34(b)(3) as it pertains to the kinds and quantities of radioactive materials expected to be produced in the operation of WBN Unit 2, and the means for controlling and limiting radioactive effluents and radiation exposures within the limits of 10 CFR Part 20. The staff also referred to the acceptance criteria provided in the guidance of the SRP, Section 12.3/4, Revision 2, “Radiation Protection Design Features,” and the specific guidance on radiation exposure dose assessments provided in Regulatory Guide (RG) 8.19, Revision 1, “Occupational Radiation Dose Assessment in Light-Water Reactor Power Plants - Design Stage Man-Rem Estimates.”

In FSAR Amendment 95, TVA revised Section 12.4, "Dose Assessment," to estimate the radiation exposure expected with the operation of WBN Unit 2. Consistent with the guidance RG 8.19, in lieu of a detailed prospective estimation of occupational radiation exposures, TVA estimated the expected annual collective dose for Unit 2 based on the actual radiation exposures experienced at Unit 1 during eleven years of operation. Since WBN Units 1 and 2

are nearly identical designs that share many radiation protection facilities, as well as program infrastructure, the NRC staff concludes that the use of the experience at Unit 1 to estimate the expected dose impact from operating Unit 2 is technically sound and, therefore, is acceptable.

Occupational radiation exposure data from 1997 to 2007 for WBN Unit 1 as reported by TVA to the NRC in its annual occupational radiation exposure reports (available in ADAMS) show an annual average of 82 person-rem, or 98 person-rem if the 180 person-rem expended for the steam generator replacement during the 2006 refueling outage is included. This exposure history is comparable to the average collective dose for all PWRs during that same time period, 91 person-rem, as derived from Table 4.2 of NUREG-0713, Volume 29, "Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities, 2007, Fortieth Annual Report."

In response to a staff question (RAI 12-12), TVA stated in its letter dated June 3, 2010, that it expects WBN Unit 2 exposures to be lower than the Unit 1 experience due to a number of design changes that will be implemented for Unit 2 prior to power operations. By implementing these design changes before power operations, Unit 2 will benefit from the associated lower radiation levels in the pre-operational plant. In addition, many of these design changes will be implemented in whole or in part specifically for dose reduction purposes during normal plant operations. These changes include (1) removal of the reactor coolant system resistance temperature detector bypass system, (2) installation of reactor vessel head shielding, (3) implementation of reactor coolant zinc injection, (4) steam generator channel head polishing/electro-polishing, (5) restoration of shield wall penetrations with high density elastomeric sealant, (6) re-routing chemical and volume control system letdown piping from accessible areas, and (7) addition of polar crane wall door shielding.

Based on the information provided by TVA in its letter to the NRC dated June 3, 2010, and because historical experience has demonstrated that the average annual collective dose to operate WBN Unit 1 was less that 100 person-rem, the staff concludes that there is reasonable assurance that WBN Unit 2 can be operated at or below 100 person-rem average annual collective dose. Therefore, FSAR Section 12.4 is acceptable. TVA should update the FSAR to reflect the information provided in its letter the NRC dated June 3, 2010. This is **Open Item 53** (Appendix HH).

12.6 Health Physics Program

The NRC staff reviewed the changes made by TVA in Amendments 97 and 98 to Section 12.5, "Radiation Protection Program," of the WBN Unit 2 FSAR, and evaluated the changes using the relevant requirements of the following regulations: (1) 10 CFR 50.34(b)(3) as it pertains to the kinds and quantities of radioactive materials expected to be produced in the operation of WBN Unit 2, and the means for controlling and limiting radioactive effluents and radiation exposures within the limits of 10 CFR Part 20; (2) 10 CFR 20.1101 as it pertains to implementing radiation protection programs sufficient to ensure compliance with 10 CFR Part 20 requirements and that occupational doses and doses to members of the public are ALARA; (3) 10 CFR Part 20, Subpart F, as it pertains to providing adequate radiation survey and monitoring programs sufficient to support maintaining doses from exposures to radioactive materials within the occupational and public dose limits; (4) 10 CFR Part 20, Subpart G, as it pertains to controlling access to high and very high radiation areas; (5) 10 CFR Part 20, Subpart H, as it relates to the control of airborne radioactivity areas. The staff also referred to the acceptance criteria provided

in the guidance of the SRP, Section 12.5, Revision 2, "Operational Radiation Protection Program."

In FSAR Amendment 95, TVA made several editorial changes to FSAR Section 12.5 resulting from organizational changes at WBN. With the exception of the following two issues, these did not impact the staff's previous safety conclusion, as documented in SSER 14, dated December 1994, and are therefore acceptable. The remaining two issues are related to the Radiation Protection Manager (RPM) qualifications. FSAR Section 12.5.1 states that, "The minimum qualification requirements for the Radiation Protection Manager are stated in Section 13.1.3." FSAR Section 13.1.3 states that, "Nuclear Power (NP) personnel at the Watts Bar plant will meet the qualification and training requirements of NRC Regulatory Guide 1.8 with the alternatives as outlined in the Nuclear Quality Assurance Plan, TVA-NQA-PLN89-A." Specifically, TVA modified its commitment to the personnel qualification standards in Regulatory Guide (RG) 1.8, "Qualification and Training of Personnel for Nuclear Power Plants," by adding the caveat, "with the alternatives as outlined in the Nuclear Quality Assurance Plan." It was unclear to the staff whether or not TVA was committed to (1) the requirement that the RPM have five years of "professional experience," and 2) the three month time limit on "temporarily" assigning an RPM who doesn't meet the RPM qualifications (ANSI/ANS 3.1-1981, as referenced in RG 1.8). In response to staff questions (RAIs 12-13 and 12-14), TVA clarified in its letter to the NRC dated October 4, 2010, that it will meet the requirements of RG 1.8, Revision 2, and ANSI/ANS 3.1-1981, for all new personnel qualifying on positions identified in RG 1.8, Regulatory Position C.1, after January 1, 1990. These changes are consistent with the staff's acceptance criteria 12.5.A of Section 12.5 of the SRP as they pertain to staff qualifications and are, therefore, acceptable. TVA should update the FSAR to reflect the qualification standards of the RPM as provided in its letter to the NRC dated October 4, 2010. This is **Open Item 54** (Appendix HH).

12.7 NUREG-0737 Items

12.7.1 Plant Shielding (Item II.B.2)

NUREG-0737, Item II.B.2, states, in part, that "Each licensee shall provide for adequate access to vital areas and protection of safety equipment by design changes, increased permanent or temporary shielding, or postaccident procedural controls." GDC 19, "Control room," of Appendix A to 10 CFR Part 50, requires, in part, that, "Adequate radiation protection shall be provided to permit access and occupancy of the control room under accident conditions...Equipment at appropriate locations outside the control room shall be provided (1) with a design capability for prompt hot shutdown of the reactor..."

In FSAR Amendment 97, TVA revised the list in FSAR Section 12.3.2.2, "Design Description," of post accident activities that need to be accomplished, adding three and deleting the activities at the post accident sampling facility. The staff requested information (RAI 12-6) regarding the dose consequences of these vital missions, including plant layout drawings depicting radiation zones during accident conditions and access/egress routes. By letters dated June 3, 2010, and December 10, 2010, TVA provided dose calculations and plant layout drawings depicting the WBN vital area access/egress routes. The staff noted a number of inconsistencies and deficiencies in the information provided by TVA. These include, but are not limited to:

1) There is not a good correlation between the list of vital areas in FSAR Section 12.3.3, the calculations provided, and the layout drawings, e.g.,

a. Not all vital areas listed in Section 12.3.3 have corresponding calculations or maps (i.e., TSC, control room access/egress).
b. Not all vital areas indicated in the calculations and maps are listed in the FSAR (e.g., OSC, WBNTSR-114, WBNTSR-084).
c. Not all calculations (i.e., WBNTSR -086) have corresponding maps.

2) Several calculations and maps included in the response clearly demonstrate that GDC 19 dose criteria will not be met during the proposed vital area missions.

3) The source term used in the evaluation of a steam generator tube rupture (WBNTSR-084) is not consistent with the source term required in the Design Basis Accident analysis in Chapter 15 of the FSAR (e.g., does not consider an iodine spike in the primary coolant).

4) Several calculations do not address whether the GDC 19 dose criteria are met, but instead calculate a maximum staytime before exceeding a pre-determined limit, with no indication if the identified access/egress vital action can be performed within the calculated results or whether the pre-determined criteria ensures that GDC 19 will be met.

5) Several calculations identify an alternate, more limiting accident scenario (labeled EGTS PCO Control Loop Single Failure) without identifying what this scenario is, or why it is the limiting case. In at least two of the calculations (WBNAPSR 87 and 94) this limiting case is only calculated for Unit 1, with a note that the Unit 2 impact will have to be evaluated at a later date.

6) Several of the calculations have lists of operational restrictions (i.e., WBNAPS3 - 124 and 125) with no indication of whether the vital action can be completed within these restrictions, nor is there any indication of how TVA will insure these restrictions will be met.

7) Several of the dose calculation conclusions state, “Therefore, the mission can be performed as long as the sum of occupancy, ingress/egress, and mission doses, for the entire duration of the accident, does not exceed the stated limit.” It is unclear to the staff whether or not these mission doses comply with GDC 19. If this statement is intended to indicate that each of the mission dose calculations assumes that the operator has no prior accident-related dose, there should be an assurance that sufficient operators are available to complete all of the necessary missions to mitigate the consequences of the accident.

Based on the above, the NRC staff has insufficient information to conclude that TVA has taken appropriate actions to reduce radiation levels and increase the capability of operators to control and mitigate the consequences of an accident at WBN Unit 2, in accordance with the guidance of NUREG-0737, Item II.B.2, or can maintain occupational doses to plant operators within the requirements of GDC 19. Therefore, the staff cannot conclude that the plant shielding for WBN Unit 2 is acceptable. This is **Open Item 55** (Appendix HH).