TVA

Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381-2000

May 20, 2011

10 CFR 50.4(b)(6)
10 CFR 50.34(b)

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555-0001

Watts Bar Nuclear Plant, Unit 2
NRC Docket No. 50-391

Subject: **WATTS BAR NUCLEAR PLANT (WBN) UNIT 2 - RESPONSE TO FINAL SAFETY ANALYSIS REPORT (FSAR), CHAPTER 11 AND FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT (FSEIS) REQUEST FOR ADDITIONAL INFORMATION**

References:

1. NRC Letter to TVA dated April 13, 2011, "Watts Bar Nuclear Plant Unit 2 - Status of Operating License Application Review and Project Schedule Implications (TAC No. ME0853)"
2. TVA letter to NRC dated February 15, 2008, "Watts Bar Nuclear Plant (WBN) - Unit 2 - Final Supplemental Environmental Impact Statement for the Completion and Operation of Unit 2"
3. TVA letter to NRC dated December 17, 2010, "Watts Bar Nuclear Plant (WBN) - Unit 2 - Final Safety Analysis Report (FSAR), Amendment 102"
4. TVA letter to NRC dated February 25, 2011, "Watts Bar Nuclear Plant (WBN) Unit 2 – Final Safety Analysis Report (FSAR) – Response to Chapters 11 and 12 Request for Additional Information"
5. E-mail from Justin C. Poole, U.S. Nuclear Regulatory Commission to William D. Crouch, TVA dated March 4, 2011

The purpose of this letter is for the Tennessee Valley Authority (TVA) to respond to the NRC regarding the status of Unit 2 FSAR Chapter 11 and Chapter 3 of the FSEIS (Reference 2).

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Enclosure 1 provides the responses to RAIs received via email on March 4, 2011 (Reference 5), with respect to Reference 4. The NRC questions and associated numbering are retained herein. Attachments 1 and 2 to this enclosure provide excerpted supporting information regarding liquid and gaseous release tables for the FSAR and FSEIS. The Enclosure 1, Attachments 1 and 2 tables are repeated in Enclosure 2, Attachments 2 through 5.

Enclosure 2, Attachment 1, provides a summary of proposed changes to FSAR and FSEIS text and tables. The purpose of this document is to provide a summary description of the changes that have been proposed. Two of the primary issues addressed are Terrain Adjustment Factors and Feeding Factors. A summary of these issues is specifically addressed describing TVA's research and proposed resolutions to address these issues. Attachment 2 provides proposed markups of the FSAR pages and tables, followed by Attachment 3, which incorporates these changes to clean copy of FSAR Sections 11.1, 11.2 and 11.3. Attachment 4 provides similar markups for the FSEIS, followed by Attachment 5, which also incorporates these proposed revisions into a clean copy of FSEIS, Chapter 3.

The proposed FSAR revision (Enclosure 2, Attachment 3) will be included in FSAR Amendment A104. The proposed FSEIS revisions will be issued by June 20, 2011.

TVA will not meet all 10 CFR 50, Appendix I addendum RM 50-2 dose limits for the site. As a result, TVA will complete a Cost Benefit Analysis per Regulatory Guide 1.110 by July 29, 2011. TVA also received additional request for information at a public meeting on May 11, 2011, regarding inputs for the dose calculations. This additional information will be provided by May 27, 2011. Enclosure 3 provides the commitments as described in this submittal.

Should you have any questions, please contact Bill Crouch at (423) 365-2004.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 20th day of May, 2011.

Respectfully,

David Stinson
Watts Bar Unit 2 Vice President

Enclosures:

1. Response to Chapter 11 RAIs
   a. Attachment 1 - Gaseous Tables (FSAR and FSEIS)
   b. Attachment 2 - Liquid Tables (FSAR and FSEIS)

2. Document Revisions
   a. Attachment 1 - Summary of Proposed Changes to FSAR Chapter 11 and FSEIS Chapter 3, Text and Tables
   b. Attachment 2 - Proposed Markups for FSAR Chapter 11, Text and Tables
   c. Attachment 3 - Proposed Clean Copy of FSAR Sections 11.1, 11.2 and 11.3.
   d. Attachment 4 - Proposed Markups to FSEIS, Chapter 3
   e. Attachment 5 - Proposed Clean Copy of FSEIS, Chapter 3

3. List of Commitments

cc (Enclosures):

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Enclosure 1
Response to FSAR Chapter 11 and FSEIS Chapter 3
Request For Additional Information

Response to Chapter 11 RAIs

ENCLOSURE 1

**WATTS BAR NUCLEAR PLANT UNIT 2
RESPONSE TO FINAL SAFETY ANALYSIS REPORT
CHAPTER 11 AND FSEIS CHAPTER 3 REQUEST FOR ADDITIONAL INFORMATION**

NRC Requested Clarification 1

The biggest issues are associated with the calculation of offsite doses from gaseous effluent releases (Table 11.3-10 FSAR Section 11.3). TVA has not provided an adequate basis for the changes they made to the feeding factor (in Amendment 98) nor the terrain adjustment factors (and X/Q, D/Q) in Amendment 100 and in the mark up Amendment 103 included in their response. The information in the responses to questions (22), and (23) in Enclosure 1 (& 11.3.a in Enclosure 2), respectively, do not provide an adequate basis for either. These changes form the basis for the complete revision to Table 11.3-10 that is included in the Amendment 103 mark up (Enclosure 3). The TVA re-analysis of the offsite doses may impact their Environmental Impact Statement (EIS), as well as the NRC's draft EIS.

TVA Response

Land Use Data Correction

Prior to Amendment 100, Unit 2 FSAR Table 11.3-8 in Section 11.3 contained the same Land Use Survey (LUS) data as the Unit 1 FSAR Table 11.3-9. In Amendment 100, Unit 2 FSAR Table 11.3-8 was revised to match the 2007 LUS data listed in Table 3-19 of the Final Supplemental Environmental Impact Statement (FSEIS), as a result the Terrain Adjustment Factor (TAF), Atmospheric Dispersion Coefficients (X/Q), and Atmospheric Deposition Coefficients (D/Q) for each receptor also changed. See excerpted FSAR Table 11.3-8 and FSEIS Table 3-19 in Enclosure 1, Attachment 1.

Feeding Factor Correction

TVA has revised FSAR Table 11.3-8 "Data on Points of Interest near Watts Bar Nuclear Plant" to show the use of a feeding factor of 0.65 for all cow receptors in the 2007 LUS. The value is taken from a chart in NUREG/CR-4653 that provides the growing season across the US. The value chosen is on the high end for the middle Tennessee Valley. This a conservative value as land use survey data for two of the three farms showed that supplemental feed is used almost exclusively. The third farm is unwilling to participate in the survey; however there is public information available as to the size of the farm and number of cattle. This information would support a much lower feeding factor than is being used. Table 3-19 of the FSEIS is being revised to match FSAR Table 11.3-8. See excerpted FSAR Table 11.3-8 and FSEIS Table 3-19 in Enclosure 1, Attachment 1.

Supplemental feed is assumed to be grown in the vicinity of Watts Bar and have the same nuclide source as the pasture. The approach used for decay is similar to that provided in Regulatory Guide 1.109 as described in FSAR Section 11.3.10.1.

Terrain Adjustment Factor Correction

The computer code titled Gaseous Effluent Licensing Code (GELC) was used to perform routine dose assessments for WBN. During Unit 1 licensing, terrain adjustment factors (TAF) were developed to account for recirculation effects due to the river valley location of the plant. The results in Unit 2 FSAR Table 11.3-8 were revised to use TAFs developed on the same basis that were used for Unit 1 licensing.

Unit 2 FSAR Table 11.3-8 was revised to match the data listed in Table 3-19 of the FSEIS and as a result the TAF, X /Q, and D/Q for each receptor also changed. Table 3-19 of the FSEIS only lists the receptor, the sector, and the distance. See excerpted FSAR Table 11.3-8 and FSEIS Table 3-19 in Enclosure 1, Attachment 1.

Sector Distance Correction

Although not specifically questioned in this RAI, the sector distances listed in Table 3-19 of the FSEIS were reviewed and compared to the values in FSAR Table 11.3-8. It was discovered that Table 3-19 contained several errors. These have been fixed in and the data is now consistent in both the FSEIS and the FSAR. See excerpted FSAR Table 11.3-8 and FSEIS Table 3-19 in Enclosure 1, Attachment 1.

Doses from Gaseous Effluents

A vegetable pathway has supplanted the milk pathway as the primary pathway since a local resident has established a garden near or almost on the site boundary. This resulted in a revision to Table 11.3-10 and FSEIS Table 3-21. See excerpted FSAR Table 11.3-10 and FSEIS Table 3-21 in Enclosure 1, Attachment 1.

Conclusion

The doses listed in Table 11.3-10 Unit 2 FSAR Section 11.3 were recalculated using the 2007 LUS with a feeding factor of 0.65, GELC with TAFs developed on the same basis that was used for Unit 1 licensing, and updated X/Q, and D/Q values for each receptor. The FSAR text in Section 11.3 has been revised to reflect the changes discussed in this RAI response. These changes form the basis for a revision to Unit 2 FSAR Chapter 11 and the FSEIS Chapter 3.

NRC Requested Clarification 2

TVA still has not cleared up the uncertainty over which source term was used to calculate the offsite doses (both the liquid effluent doses in Table 11.2-7 and the gaseous doses in Table 11.3-10). [1]The answer to question (9) in Enclosure 1, concerning the source term used for liquid effluent doses, appears inconsistent with the answer to question (3.c) in Enclosure 2. [2]In addition, answer to questions (18) and (20) in Enclosure 1 appear incorrect. The answer to (18) states that table 3-20 of TVA's FSEIS is in error and that the correct source term that was used to calculate the offsite doses is given in FSAR Table 11.3-7c. [3]The answer to (20) indicates that Table 11.3-7c is based on the normal values in NUREG-0017 adjusted for WBN. However, the isotopic source term in Table 11.3-7c reflects a 1% failed fuel maximum design basis, not the normal release assumption of NUREG-0017 which are the appropriate source term assumption for demonstrating that the design criteria of 10 CFR 50 Appendix A are met.

TVA Response

There are multiple parts to this requested clarification. Numbering has been added to the individual parts. The individual questions and answers are provided below.

ENCLOSURE 1

WATTS BAR NUCLEAR PLANT UNIT 2
RESPONSE TO FINAL SAFETY ANALYSIS REPORT
CHAPTER 11 AND FSEIS CHAPTER 3 REQUEST FOR ADDITIONAL INFORMATION

1. *The answer to question (9) in Enclosure 1, concerning the source term used for liquid effluent doses, appears inconsistent with the answer to question (3.c) in Enclosure 2.*

Response to 1

There have been a number of RAIs concerning FSAR Table 11.2-5 due to its complexity and lack of description of the planned operational modes for the liquid radwaste system in the text of FSAR Section 11.2 and thus what source term was used to develop the doses provided in FSAR Table 11.2-7. Section 11.2.6.5 has been revised to provide a description of the various plant operational modes. In addition, two operational modes discussed have been removed as they were either never used or were non-limiting. Columns 6, 7, and 8 of the table were revised to provide the source term for the liquid release, the steam generator blowdown release and the total release for the normal plant operational alignment of the liquid radwaste system. The source term from Column 8 is used to calculate the doses presented in FSAR Table 11.2-7.

The Column labeled "1 Unit LWR" in Table 3-16 of the FSEIS is now the same as FSAR Table 11.2-5 Column 6 for the liquid release. The Column labeled "1 Unit SGB" in Table 3-16 of the FSEIS is now the same as FSAR Table 11.2-5 Column 7. The Column labeled "1 Unit Totals" in Table 3-16 of the FSEIS is now the same as FSAR Table 11.2-5 Column 8. The table in Enclosure 2 of TVA's Reference 4 response to NRC Question 3.c is now the same as the first three source term columns of Table 3-16 in the FSEIS. Thus, all three tables (i.e., FSAR Table 11.2-5, FSEIS Table 3-16 and the table in TVA's February 25, 2011 letter) are consistent. Enclosure 1, Attachment 1 provides the three tables discussed.

2. *In addition, answer to questions (18) and (20) in Enclosure 1 appear incorrect. The answer to (18) states that table 3-20 of TVA's FSEIS is in error and that the correct source term that was used to calculate the offsite doses is given in FSAR Table 11.3-7c.*

Response to 2

NRC Question 18 identified that there was a significant inconsistency between the gaseous release source term shown in the FSEIS (Table 3-20) and FSAR Table 11.3-7c. The FSAR table contained the correct values. The FSEIS table needed to be updated. WBN uses the continuous containment vent as the normal operational mode. The necessary changes have been made and now the two tables will show the same values. As stated in the response to NRC Question 20 (Reference 4), the source term used for the gaseous releases as shown in FSAR Table 11.3-7c were based on ANSI 18.1-1984 as adjusted for plant specific conditions. The nominal values in the ANSI standard are the same values used in NUREG-0017. The title of FSAR Table 11.3-7c is being changed to make it clear that the values are based on ANSI-18.1-1984 and will be included in Amendment 104. See excerpted FSAR Table 11.3-7c in Enclosure 1, Attachment 1.

3. *The answer to (20) indicates that Table 11.3-7c is based on the normal values in NUREG-0017 adjusted for WBN. However, the isotopic source term in Table 11.3-7c reflects a 1% failed fuel maximum design basis, not the normal release assumption of NUREG-0017 which are the appropriate source term assumption for demonstrating that the design criteria of 10 CFR 50 Appendix A are met.*

Response to 3

The isotopic source term provided in FSAR Table 11.3-7c is based on ANSI-18.1-1984 (NUREG-0017). The data in the Table is much lower than would be the case if a 1% failed fuel assumption had been used. FSAR Table 11.3-7b provides the 1% failed fuel design case. The second column of Table 11.3-7b labeled "Exp. Rel." is the ANSI values. The fourth column labeled "Design" provides the 1% failed fuel values. Enclosure 1, Attachment 1 provides FSEIS table 3-20, FSAR Tables 11.3-7b and 11.3-7c.

Enclosure 1, Attachment 1
Response to FSAR Chapter 11 and FSEIS Chapter 3
Request For Additional Information

Gaseous Release Tables

(includes 11.3-7b, 11.3-7c, 11.3-8, 11.3-10, 11.3-11; FSEIS Tables 3-19, 3-20, 3-21)

FSAR, Table 11.3-7b Design (For 1% Failed Fuel) Expected Gas Release Concentration/ (Effluent Concentration Limit) With Continuous Filtered Containment Vent (Sheet 1 of 2)

	Exp. Rel. (Ci/yr)	Des/Exp	Design (Ci/yr)	Design(µCi/cc)	10CFR 20 (ECL)	**Single Unit Operation** C/ECL	**Dual Unit Operation** C/ECL
Kr-85m	9.48E+00	12.28	1.16E+02	4.02E-11	1.0E-07	0.0004024	0.0008048
Kr-85	6.78E+02	33.08	2.24E+04	7.75E-09	7.0E-07	0.0110743	0.0221486
Kr-87	5.81E+00	7.45	4.33E+01	1.50E-11	2.0E-08	0.0007480	0.0014960
Kr-88	1.32E+01	12.33	1.63E+02	5.63E-11	9.0E-09	0.0062505	0.0125010
Xe-131m	1.09E+03	2.91	3.18E+03	1.10E-09	2.0E-06	0.0005489	0.0010978
Xe-133m	4.31E+01	43.24	1.86E+03	6.44E-10	6.0E-07	0.0010735	0.0021470
Xe-133	2.90E+03	111.07	3.22E+05	1.11E-07	5.0E-07	0.2227110	0.4454220
Xe-135m	4.68E+00	5.04	2.36E+01	8.15E-12	4.0E-08	0.0002038	0.0004076
Xe-135	8.88E+01	6.97	6.19E+02	2.14E-10	7.0E-08	0.0030561	0.0061122
Xe-138	4.34E+00	5.43	2.36E+01	8.15E-12	2.0E-08	0.0004073	0.0008146
Br-84	5.07E-02	2.50	1.27E-01	4.38E-14	8.0E-08	0.0000005	0.0000010
I-131	1.53E-01	52.41	8.00E+00	2.77E-12	2.0E-10	0.0138277	0.0276554
I-132	6.73E-01	4.00	2.69E+00	9.30E-13	2.0E-08	0.0000465	0.0000930
I-133	4.57E-01	26.85	1.23E+01	4.24E-12	1.0E-09	0.0042433	0.0084866
I-134	1.07E+00	1.65	1.77E+00	6.10E-13	6.0E-08	0.0000102	0.0000204
I-135	8.42E-01	7.91	6.66E+00	2.30E-12	6.0E-09	0.0003837	0.0007674
Cs-134	2.27E-03	40.60	9.20E-02	3.18E-14	2.0E-10	0.0001589	0.0003178
Cs-136	8.01E-05	165.20	1.32E-02	4.57E-15	9.0E-10	0.0000051	0.0000102
Cs-137	3.48E-03	153.22	5.33E-01	1.84E-13	2.0E-10	0.0009203	0.0018406
Cr-51	5.92E-04	0.29	1.73E-04	5.96E-17	3.0E-08	0.0000000	0.0000000
Mn-54	4.31E-04	0.47	2.03E-04	7.01E-17	1.0E-09	0.0000001	0.0000002
Fe-59	7.70E-05	3.48	2.68E-04	9.27E-17	5.0E-10	0.0000002	0.0000004
Co-58	2.32E-02	5.37	1.24E-01	4.30E-14	1.0E-09	0.0000430	0.0000860
Co-60	8.74E-03	1.38	1.21E-02	4.17E-15	5.0E-11	0.0000833	0.0001666
Sr-89	2.98E-03	22.45	6.69E-02	2.31E-14	1.0E-09	0.0000231	0.0000462
Sr-90	1.14E-03	13.49	1.54E-02	5.33E-15	6.0E-12	0.0008877	0.0017754
Zr-95	1.00E-03	1.71	1.71E-03	5.92E-16	4.0E-10	0.0000015	0.0000030
Nb-95	2.45E-03	2.34	5.73E-03	1.98E-15	2.0E-09	0.0000010	0.0000020
Ba-140	4.00E-04	0.31	1.26E-04	4.34E-17	2.0E-09	0.0000000	0.0000000
H-3	1.39E+02	1	1.39E+02	4.80E-11	1.0E-07	0.0004811	0.0009622
H-3 (TPC)	3.70E+02	1	3.70E+02	1.28E-10	1.0E-07	0.0012775	0.0012775
1 rod	1.53E+03	1	1.53E+03	5.29E-10	1.0E-07	0.0052869	0.0052869
2 rod	2.69E+03	1	2.69E+03	9.30E-10	1.0E-07	0.0092962	0.0092962
C-14	7.30E+00	1	7.30E+00	2.52E-12	3.0E-09	0.0008410	0.0016820
Ar-41	3.40E+01	1	3.40E+01	1.18E-11	1.0E-08	0.0011752	0.0023504
Total						0.2696131	0.5392262
Total (TPC)						0.2704095	0.5400226
1 rod						0.2744189	0.5440320
2 rod						0.2784283	0.5480413

FSAR, Table 11.3-7b Design (For 1% Failed Fuel) Expected Gas Release Concentration/(Effluent Concentration Limit) With Continuous Filtered Containment Vent (Sheet 2 of 2)

Note: The "Dual Unit Operation" column in the above calculation considers dual unit operation. Based on the evaluation done for Revision 7, the per unit concentrations are the same for both units. Therefore, the last column is twice the preceding column except in the case of TPC.

Note: Dual unit operation considers only Unit 1 with TPC.

FSAR, Table 11.3-7c Total Releases (based on ANSI 18.1-1984 in Ci/yr), with Continuous Filtered Containment Vent (Sheet 1 of 1)

Table based on operation of one unit

Nuclide	Containment Building	Auxiliary Building	Turbine Building	Total
Kr-85m	3.72E+00	4.53E+00	1.23E+00	9.48E+00
Kr-85	6.69E+02	7.05E+00	1.86E+00	6.78E+02
Kr-87	4.48E-01	4.27E+00	1.09E+00	5.81E+00
Kr-88	3.10E+00	7.95E+00	2.13E+00	1.32E+01
Xe-131m	1.07E+03	1.73E+01	4.53E+00	1.09E+03
Xe-133m	4.07E+01	1.90E+00	5.21E-01	4.31E+01
Xe-133	2.82E+03	6.70E+01	1.77E+01	2.90E+03
Xe-135m	2.26E-02	3.68E+00	9.80E-01	4.68E+00
Xe-135	5.83E+01	2.40E+01	6.46E+01	8.88E+01
Xe-137	3.76E-04	9.67E-01	2.58E-01	1.23E+00
Xe-138	1.69E-02	3.42E+00	9.06E-01	4.34E+00
Ar-41	3.40E+01	0.00E+00	0.00E+00	3.40E+01
Br-84	8.16E-07	5.02E-02	4.81E-04	5.07E-02
I-131	6.74E-03	1.39E-01	7.08E-03	1.53E-01
I-132	1.36E-04	6.56E-01	1.70E-02	6.73E-01
I-133	2.36E-03	4.35E-01	2.03E-02	4.57E-01
I-134	4.26E-05	1.06E+00	1.47E-02	1.07E+00
I-135	8.80E-04	8.10E-01	3.13E-02	8.42E-01
H-3	1.39E+02	0.00E+00	0.00E+00	1.39E+02
Cr-51	9.21E-05	5.00E-04	0.00E+00	5.92E-04
Mn-54	5.30E-05	3.78E-04	0.00E+00	4.31E-04
Co-57	8.20E-06	0.00E+00	0.00E+00	8.20E-06
Co-58	2.50E-04	2.29E-02	0.00E+00	2.32E-02
Co-60	2.61E-05	8.71E-03	0.00E+00	8.74E-03
Fe-59	2.70E-05	5.00E-05	0.00E+00	7.70E-05
Sr-89	1.30E-04	2.85E-03	0.00E+00	2.98E-03
Sr-90	5.22E-05	1.09E-03	0.00E+00	1.14E-03
Zr-95	4.80E-08	1.00E-03	0.00E+00	1.00E-03
Nb-95	1.80E-05	2.43E-03	0.00E+00	2.45E-03
Ru-103	1.60E-05	6.10E-05	0.00E+00	7.70E-05
Ru-106	2.70E-08	7.50E-05	0.00E+00	7.50E-05
Sb-125	0.00E+00	6.09E-05	0.00E+00	6.09E-05
Cs-134	2.53E-05	2.24E-03	0.00E+00	2.27E-03
Cs-136	3.21E-05	4.80E-05	0.00E+00	8.01E-05
Cs-137	5.58E-05	3.42E-03	0.00E+00	3.48E-03
Ba-140	2.30E-07	4.00E-04	0.00E+00	4.00E-04
Ce-141	1.30E-05	2.64E-05	0.00E+00	3.95E-05
C-14	2.80E+00	4.50E+00	0.00E+00	7.30E+00

FSAR, Table 11.3-8 Data On Points Of Interest Near Watts Bar Nuclear Plant (Page 1 of 2)

	Sector	Distance (Meters)	Chi-over (s/m^3)	D-over-Q (1/m^2)	Terrain Adjustment Factor	Milk Feeding Factor
Unrestricted Area Boundary	N	1550	5.12e-06	8.13e-09	1.70	
Unrestricted Area Boundary	NNE	1980	6.35e-06	1.23e-08	1.80	
Unrestricted Area Boundary	NE	1580	1.05e-05	1.10e-08	2.10	
Unrestricted Area Boundary	ENE	1370	1.23e-05	8.77e-09	1.70	
Unrestricted Area Boundary	E	1280	1.37e-05	9.66e-09	1.60	
Unrestricted Area Boundary	ESE	1250	1.43e-05	1.16e-08	1.80	
Unrestricted Area Boundary	SE	1250	1.11e-05	9.49e-09	1.50	
Unrestricted Area Boundary	SSE	1250	6.04e-06	8.21e-09	1.50	
Unrestricted Area Boundary	S	1340	5.33e-06	1.17e-08	1.90	
Unrestricted Area Boundary	SSW	1550	4.14e-06	1.05e-08	2.00	
Unrestricted Area Boundary	SW	1670	4.46e-06	7.34e-09	2.10	
Unrestricted Area Boundary	WSW	1430	5.47e-06	6.37e-09	1.80	
Unrestricted Area Boundary	W	1460	2.11e-06	2.07e-09	1.20	
Unrestricted Area Boundary	WNW	1400	2.49e-06	2.38e-09	2.50	
Unrestricted Area Boundary	NW	1400	2.05e-06	2.13e-09	1.70	
Unrestricted Area Boundary	NNW	1460	2.68e-06	3.08e-09	1.60	
Nearest Resident	N	2134	2.84e-06	4.21e-09	1.50	
Nearest Resident	NNE	3600	2.69e-06	4.41e-09	1.80	
Nearest Resident	NE	3353	3.84e-06	3.22e-09	2.20	
Nearest Resident	ENE	2414	6.26e-06	3.83e-09	1.90	
Nearest Resident	E	3268	3.97e-06	2.14e-09	1.70	
Nearest Resident	ESE	4416	2.64e-06	1.46e-09	1.90	
Nearest Resident	SE	1372	9.66e-06	8.16e-09	1.50	
Nearest Resident	SSE	1524	4.18e-06	5.56e-09	1.40	
Nearest Resident	S	1585	3.91e-06	8.42e-09	1.80	
Nearest Resident	SSW	1979	2.76e-06	6.64e-09	1.90	
Nearest Resident	SW	4230	1.15e-06	1.43e-09	2.00	
Nearest Resident	WSW	1829	3.61e-06	4.03e-09	1.70	
Nearest Resident	W	2896	7.30e-07	6.01e-10	1.10	
Nearest Resident	WNW	1646	2.26e-06	2.12e-09	2.90	
Nearest Resident	NW	2061	1.03e-06	9.95e-10	1.50	
Nearest Resident	NNW	4389	3.50e-07	2.97e-10	1.00	
Nearest Garden	N	7664	3.13e-07	3.00e-10	1.00	
Nearest Garden	NNE	6173	1.06e-06	1.42e-09	1.50	
Nearest Garden	NE	3353	3.84e-06	3.22e-09	2.20	
Nearest Garden	ENE	4927	2.01e-06	9.39e-10	1.60	
Nearest Garden	E	6372	1.35e-06	5.42e-10	1.40	
Nearest Garden	ESE	4758	2.26e-06	1.21e-09	1.80	
Nearest Garden	SE	4633	1.58e-06	8.97e-10	1.30	
Nearest Garden	SSE	7454	3.73e-07	2.80e-10	1.10	
Nearest Garden	S	2254	2.50e-06	4.94e-09	1.90	

FSAR, Table 11.3-8 Data On Points Of Interest Near Watts Bar Nuclear Plant (Page 2 of 2)

	Sector	Distance (Meters)	Chi-over (s/m^3)	D-over-Q (1/m^2)	Terrain Adjustment Factor	Milk Feeding Factor
Nearest Garden	SSW	1979	2.76e-06	6.64e-09	1.90	
Nearest Garden	SW	8100	4.28e-07	4.03e-10	1.80	
Nearest Garden	WSW	4667	8.70e-07	7.11e-10	1.50	
Nearest Garden	W	5120	3.03e-07	2.03e-10	1.00	
Nearest Garden	WNW	5909	1.72e-07	1.05e-10	1.30	
Nearest Garden	NW	3170	4.13e-06	3.50e-10	1.10	
Nearest Garden	NNW	4602	3.28e-07	2.74e-10	1.00	
Milk Cow	ESE	6706	1.35e-06	6.18e-10	1.70	0.65
Milk Cow	SSW	2286	2.24e-06	5.20e-09	1.90	0.65
Milk Cow	SSW	3353	1.36e-06	2.84e-09	2.00	0.65

FSAR, Table 11.3-10 Watts Bar Nuclear Plant- Individual Doses From Gaseous Effluents (For 1 Unit without TPC)

Effluent	Pathway	Guideline*	Location	Dose
Noble Gases	γ Air dose	10 mrad	Maximum Exposed Individual[1]	0.801 mrad/yr
	β Air dose	20 mrad	Maximum Exposed Individual[1]	2.710 mrad/yr
	Total body	5 mrem	Maximum Residence[2,3]	0.571 mrem/yr
Iodines/ Particulate	Skin	15 mrem	Maximum Residence[2,3]	1.540 mrem/yr
	Bone (critical organ)	15 mrem	Maximum Real Pathway[4]	9.15 mrem/yr

<u>Breakdown of Iodine/Particulate Doses (mrem/yr)</u>

Total Vegetable Ingestion	6.57
Inhalation	0.0704
Ground Contamination	0.0947
Submersion	0.130
Beef Ingestion[5]	2.28
Total	9.145 mrem/yr

*Guidelines are defined in Appendix I to 10 CFR Part 50.

[1]Maximum exposure point is at 1250 meters in the ESE sector.

[2]Dose from air submersion.

[3]Maximum exposed residence is at 1372 meters in the SE sector.

[4]Maximum exposed individual is a child at 1979 meters in the SSW sector.

[5]Maximum dose location for all receptors is 1250 in the ESE sector.

FSAR, Table 11.3-11 Summary of Population Doses

THYROID					
	Infant	Child	Teen	Adult	Total
Submersion	1.26e-02	1.41e-01	1.28e-01	5.57e-01	8.38e-01
Ground	2.31e-03	2.59e-02	2.36e-02	1.03e-01	1.54e-01
Inhalation	6.62e-02	1.24e+00	6.64e-01	2.36e+00	4.33e-00
Cow Milk Ingestion	3.22e-01	1.57e+00	6.63e-01	1.25e+00	3.81e+00
Beef Ingestion	0.00e+00	3.17e-01	1.59e-01	8.04e-01	1.28e+00
Vegetable Ingestion	0.00e+00	1.04e+00	4.16e-01	1.09e+00	2.55e+00
Total man-rem	4.04e-01	4.34e+00	2.05e+00	6.17e+00	1.30e+01
TOTAL BODY					
	Infant	Child	Teen	Adult	Total
Submersion	1.26e-02	1.41e-01	1.28e-01	5.57e-01	8.38e-01
Ground	2.31e-03	2.59e-02	2.36e-02	1.03e-01	1.54e-01
Inhalation	3.93e-03	1.05e-01	6.65e-02	2.76e-01	4.52e-01
Cow Milk Ingestion	1.04e-01	5.73e-01	2.17e-01	3.85e-01	1.28e+00
Beef Ingestion	0.00e+00	3.06e-01	1.53e-01	7.74e-01	1.23e+00
Vegetable Ingestion	0.00e+00	1.05e+00	4.40e-01	1.21e+00	2.70e+00
Total man-rem	1.23e-01	2.20e+00	1.03e+00	3.31e+00	6.66e+00

FSEIS, Table 3-19 - Receptors from Actual Land Use Survey Results Used for Potential Gaseous Releases From WBN Unit 2

Receptor Number	Receptor Type	Sector	Distance (meters)
1.	Nearest Resident	N	2134
2.	Nearest Resident	NNE	3600
3.	Nearest Resident	NE	3353
4.	Nearest Resident	ENE	2414
5.	Nearest Resident	E	3268
6.	Nearest Resident	ESE	4416
7.	Nearest Resident	SE	1372
8.	Nearest Resident	SSE	1524
9.	Nearest Resident	S	1585
10.	Nearest Resident	SSW	1979
11.	Nearest Resident	SW	4230
12.	Nearest Resident	WSW	1829
13.	Nearest Resident	W	2896
14.	Nearest Resident	WNW	1646
15.	Nearest Resident	NW	2061
16.	Nearest Resident	NNW	4389
17.	Nearest Garden	N	7664
18.	Nearest Garden	NNE	6173
19.	Nearest Garden	NE	3353
20.	Nearest Garden	ENE	4927
21.	Nearest Garden	E	6372
22.	Nearest Garden	ESE	4758
23.	Nearest Garden	SE	4633
24.	Nearest Garden	SSE	7454
25.	Nearest Garden	S	2254
26.	Nearest Garden	SSW	1979
27.	Nearest Garden	SW	8100
28.	Nearest Garden	WSW	4667
29.	Nearest Garden	W	5120
30.	Nearest Garden	WNW	5909
31.	Nearest Garden	NW	3170
32.	Nearest Garden	NNW	4602
33.	Milk Cow	ESE	6706
34.	Milk Cow	SSW	2286
35.	Milk Cow	SSW	3353

FSEIS, Table 3-20 - WBN Total annual Gaseous discharge Per Operating Unit (curies/year/reactor)

Nuclide	Containment Building	Auxiliary Building	Turbine Building	Total
Kr-85m	3.72E+00	4.53E+00	1.23E+00	9.48E+00
Kr-85	6.69E+02	7.05E+00	1.86E+00	6.78E+02
Kr-87	4.48E-01	4.27E+00	1.09E+00	5.81E+00
Kr-88	3.10E+00	7.95E+00	2.13E+00	1.32E+01
Xe-131m	1.07E+03	1.73E+01	4.53E+00	1.09E+03
Xe-133m	4.07E+01	1.90E+00	5.21E-01	4.31E+01
Xe-133	2.82E+03	6.70E+01	1.77E+01	2.90E+03
Xe-135m	2.26E-02	3.68E+00	9.80E-01	4.68E+00
Xe-135	5.83E+01	2.40E+01	6.46E+01	8.88E+01
Xe-137	3.76E-04	9.67E-01	2.58E-01	1.23E+00
Xe-138	1.69E-02	3.42E+00	9.06E-01	4.34E+00
Ar-41	3.40E+01	0.00E+00	0.00E+00	3.40E+01
Br-84	8.16E-07	5.02E-02	4.81E-04	5.07E-02
I-131	6.74E-03	1.39E-01	7.08E-03	1.53E-01
I-132	1.36E-04	6.56E-01	1.70E-02	6.73E-01
I-133	2.36E-03	4.35E-01	2.03E-02	4.57E-01
I-134	4.26E-05	1.06E+00	1.47E-02	1.07E+00
I-135	8.80E-04	8.10E-01	3.13E-02	8.42E-01
H-3	1.39E+02	0.00E+00	0.00E+00	1.39E+02
H-3 (TPC)	3.70E+02	0.00E+00	0.00E+00	3.70E+02
Cr-51	9.21E-05	5.00E-04	0.00E+00	5.92E-04
Mn-54	5.30E-05	3.78E-04	0.00E+00	4.31E-04
Co-57	8.20E-06	0.00E+00	0.00E+00	8.20E-06
Co-58	2.50E-04	2.29E-02	0.00E+00	2.32E-02
Co-60	2.61E-05	8.71E-03	0.00E+00	8.74E-03
Fe-59	2.70E-05	5.00E-05	0.00E+00	7.70E-05
Sr-89	1.30E-04	2.85E-03	0.00E+00	2.98E-03
Sr-90	5.22E-05	1.09E-03	0.00E+00	1.14E-03
Zr-95	4.80E-08	1.00E-03	0.00E+00	1.00E-03
Nb-95	1.80E-05	2.43E-03	0.00E+00	2.45E-03
Ru-103	1.60E-05	6.10E-05	0.00E+00	7.70E-05
Ru-106	2.70E-08	7.50E-05	0.00E+00	7.50E-05
Sb-125	0.00E+00	6.09E-05	0.00E+00	6.09E-05
Cs-134	2.53E-05	2.24E-03	0.00E+00	2.27E-03
Cs-136	3.21E-05	4.80E-05	0.00E+00	8.01E-05
Cs-137	5.58E-05	3.42E-03	0.00E+00	3.48E-03
Ba-140	2.30E-07	4.00E-04	0.00E+00	4.00E-04
Ce-141	1.30E-05	2.64E-05	0.00E+00	3.95E-05
C-14	2.80E+00	4.50E+00	0.00E+00	7.30E+00

A tabulation of the resulting calculated gaseous doses to individuals per operational unit is given in Table 3-21.

FSEIS, Table 3-21 WBN Doses From Gaseous Effluent for Unit 2 Without Tritium Production for Year 2040

Effluent	Pathway	Guideline*	Location	Dose
Noble Gases	γ Air dose	10 mrad	Maximum Exposed Individual[1]	0.801 mrad/year
	β Air dose	20 mrad	Maximum Exposed Individual[1]	2.710 mrad/year
	Total body	5 mrem	Maximum Residence[2,3]	0.571 mrem/year
Iodines/ Particulate	Skin	15 mrem	Maximum Residence[2,3]	1.540 mrem/year
	Bone (critical organ)	15 mrem	Maximum Real Pathway[4]	9.15 mrem/year

Breakdown of Iodine/Particulate Doses (mrem/yr)

Total Vegetable Ingestion	6.57
Inhalation	0.0704
Ground Contamination	0.0947
Submersion	0.130
Beef Ingestion[5]	2.28
Total	9.145

*Guidelines are defined in Appendix I to 10 CFR Part 50.
[1]Maximum exposure point is at 1250 meters in the ESE sector.
[2]Dose from air submersion.
[3]Maximum exposed residence is at 1372 meters in the SE sector.
[4]Maximum exposed individual is a child at 1979 meters in the SSW sector.
[5]Maximum dose location for all receptors is 1250 meters in the ESE Sector.

The estimated annual airborne releases and resulting doses as presented by the 1972 FES, the WBN Unit 1 FSAR, Unit 2, Unit 1 and 2 totals, and recent historical data from WBN Unit 1 (as submitted in the Annual Radioactive Effluent Reports to the NRC) with NRC guidelines given in 10 CFR 50 Appendix I are compared in Table 3-22. These guidelines are designed to assure that releases of radioactive material from nuclear power reactors to unrestricted areas during normal conditions, including expected occurrences, are kept as low as practicable.

Enclosure 1, Attachment 2
Response to FSAR Chapter 11 and FSEIS Chapter 3
Request For Additional Information

Liquid Source Term Tables

(includes in addition to the table from TVA's 2/25/2011 letter (Reference 4), FSEIS Table 3-16, FSAR Tables 11.2-5 and 11.2-7)

(Excerpt from TVA Letter to NRC dated February 25, 2011)
Liquid Source Term Table from Response to NRC Question 3c

Nuclide	Single Unit Liquid Radwaste Ci/yr	Single Unit Steam Generator Blowdown Ci/yr	Single Unit Totals Ci/yr
Br-84	1.65E-04	5.23E-04	6.88E-04
I-131	2.63E-02	1.14E+00	1.16E+00
I-132	1.32E-02	1.08E-01	1.21E-01
I-133	5.29E-02	8.57E-01	9.10E-01
I-134	6.26E-03	2.65E-02	3.28E-02
I-135	4.75E-02	4.22E-01	4.70E-01
Rb-88	6.89E-03	7.84E-04	7.68E-03
Cs-134	2.93E-02	1.68E-01	1.98E-01
Cs-136	2.55E-03	1.72E-02	1.98E-02
Cs-137	4.03E-02	2.21E-01	2.61E-01
Na-24	1.86E-02	0.0E+00	1.86E-02
Cr-51	7.03E-03	9.27E-02	9.98E-02
Mn-54	4.99E-03	5.10E-02	5.59E-02
Fe-55	8.09E-03	0.0E+00	8.09E-03
Fe-59	2.42E-03	9.05E-03	1.15E-02
Co-58	2.20E-02	1.44E-01	1.66E-01
Co-60	1.44E-02	1.72E-02	3.16E-02
Zn-65	3.82E-04	0.0E+00	3.82E-04
Sr-89	1.92E-04	4.33E-03	4.52E-03
Sr-90	2.20E-05	3.88E-04	4.10E-04
Sr-91	2.84E-04	2.18E-03	2.47E-03
Y-91m	1.68E-04	0.0E+00	1.68E-04
Y-91	9.00E-05	3.00E-04	3.90E-04
Y-93	1.27E-03	0.0E+00	1.27E-03
Zr-95	1.39E-03	1.20E-02	1.34E-02
Nb-95	2.10E-03	8.98E-03	1.11E-02
Mo-99	4.20E-03	9.95E-02	1.04E-01
Tc-99m	3.35E-03	0.0E+00	3.35E-03
Ru-103	5.88E-03	0.0E+00	5.88E-03
Ru-106	7.63E-02	0.0E+00	7.63E-02
Te-129m	1.41E-04	0.0E+00	1.41E-04
Te-129	7.30E-04	0.0E+00	7.30E-04
Te-131m	8.05E-04	0.0E+00	8.05E-04
Te-131	2.03E-04	0.0E+00	2.03E-04
Te-132	1.11E-03	2.93E-02	3.05E-02
Ba-140	1.02E-02	3.48E-01	3.58E-01
La-140	1.62E-02	4.98E-01	5.14E-01
Ce-141	3.41E-04	0.0E+00	3.41E-04
Ce-143	1.53E-03	0.0E+00	1.53E-03
Ce-144	6.84E-03	1.26E-01	1.33E-01
Np-239	1.37E-03	0.0E+00	1.37E-03
H-3	1.25E+03	0.0E+00	1.25E+03
Totals w/o H-3	**4.38E-01**	**4.40E+00**	**4.84E+00**
Totals w/ H-3	**1.25E+03**	**4.40E+00**	**1.26E+03**

FSEIS, Table 3-16 - WBN Total Annual Discharge-Liquid Waste Processing System for Two Unit Operation

Nuclide	1 Unit LRW1	1 Unit SGB2	1 Unit Totals	2 Unit Totals
Br-84	1.65E-04	5.23E-04	6.88E-04	1.38E-03
I-131	2.63E-02	1.14E+00	1.16E+00	2.33E+00
I-132	1.32E-02	1.08E-01	1.21E-01	2.43E-01
I-133	5.29E-02	8.57E-01	9.10E-01	1.82E+00
I-134	6.26E-03	2.65E-02	3.28E-02	6.55E-02
I-135	4.75E-02	4.22E-01	4.70E-01	9.39E-01
Rb-88	6.89E-03	7.84E-04	7.68E-03	1.54E-02
Cs-134	2.93E-02	1.68E-01	1.98E-01	3.95E-01
Cs-136	2.55E-03	1.72E-02	1.98E-02	3.96E-02
Cs-137	4.03E-02	2.21E-01	2.61E-01	5.23E-01
Na-24	1.86E-02	0.0E+00	1.86E-02	3.72E-02
Cr-51	7.03E-03	9.27E-02	9.98E-02	2.00E-01
Mn-54	4.99E-03	5.10E-02	5.59E-02	1.12E-01
Fe-55	8.09E-03	0.0E+00	8.09E-03	1.62E-02
Fe-59	2.42E-03	9.05E-03	1.15E-02	2.29E-02
Co-58	2.20E-02	1.44E-01	1.66E-01	3.31E-01
Co-60	1.44E-02	1.72E-02	3.16E-02	6.32E-02
Zn-65	3.82E-04	0.0E+00	3.82E-04	7.65E-04
Sr-89	1.92E-04	4.33E-03	4.52E-03	9.03E-03
Sr-90	2.20E-05	3.88E-04	4.10E-04	8.19E-04
Sr-91	2.84E-04	2.18E-03	2.47E-03	4.94E-03
Y-91m	1.68E-04	0.0E+00	1.68E-04	3.37E-04
Y-91	9.00E-05	3.00E-04	3.90E-04	7.80E-04
Y-93	1.27E-03	0.0E+00	1.27E-03	2.54E-03
Zr-95	1.39E-03	1.20E-02	1.34E-02	2.68E-02
Nb-95	2.10E-03	8.98E-03	1.11E-02	2.22E-02
Mo-99	4.20E-03	9.95E-02	1.04E-01	2.07E-01
Tc-99m	3.35E-03	0.0E+00	3.35E-03	6.70E-03
Ru-103	5.88E-03	0.0E+00	5.88E-03	1.18E-02
Ru-106	7.63E-02	0.0E+00	7.63E-02	1.53E-01
Te-129m	1.41E-04	0.0E+00	1.41E-04	2.82E-04
Te-129	7.30E-04	0.0E+00	7.30E-04	1.46E-03
Te-131m	8.05E-04	0.0E+00	8.05E-04	1.61E-03
Te-131	2.03E-04	0.0E+00	2.03E-04	4.06E-04
Te-132	1.11E-03	2.93E-02	3.05E-02	6.09E-02
Ba-140	1.02E-02	3.48E-01	3.58E-01	7.16E-01
La-140	1.62E-02	4.98E-01	5.14E-01	1.03E+00
Ce-141	3.41E-04	0.0E+00	3.41E-04	6.81E-04
Ce-143	1.53E-03	0.0E+00	1.53E-03	3.05E-03

FSEIS, Table 3-16 - (continued)

Nuclide	1 Unit LRW1	1 Unit SGB2	1 Unit Totals	2 Unit Totals
Ce-144	6.84E-03	1.26E-01	1.33E-01	2.66E-01
Np-239	1.37E-03	0.0E+00	1.37E-03	2.75E-03
H-3	1.25E+03	0.0E+00	1.25E+03	2.51E+03
H-3 (TPC)	3.33E+03	0.0E+00	3.33E+03	4.58E+03
Totals w/o H-3	**4.38E-01**		**4.84E+00**	**9.68E+00**
Totals w H-3	**1.25E+03**		**1.26E+03**	**2.52E+03**
Total w H-3 (TPC3)	**3.33E+03**		**3.33E+03**	**4.59E+03**

[1] Liquid Radwaste
[2] Steam Generator Blowdown
[3] Tritium Production Core (single unit)

FSAR, Table 11.2-5 Total Annual Discharge Liquid Waste Processing System
Annual Discharge (Ci) After Processing
Total Releases Per Unit (TPC Unit 1 Only)***
(Page 1 of 3)

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
CD = Condensate Polishing Demineralizer, MD = Mobile Demineralizer			OTHER OPERATIONAL MODES		EXPECTED OPERATION		
	MD DF	CVCS DF	SGB processed by CD	SGB processed by CD and MD	LRW No SGB	SGB with no CD process	∑ Column 6 and Column 7
Br-84	1000	50	0.0003696	0.000165534	1.65E-04	5.23E-04	6.88E-04
I-131	1000	50	0.471244	0.0267889	2.63E-02	1.14E+00	1.16E+00
I-132	1000	50	0.055475	0.01319732	1.32E-02	1.08E-01	1.21E-01
I-133	1000	50	0.388058	0.0531932	5.29E-02	8.57E-01	9.10E-02
I-134	1000	50	0.0166222	0.00627256	6.26E-03	2.65E-02	3.26E-03
I-135	1000	50	0.212508	0.047673	4.75E-02	4.22E-01	4.70E-01
Rb-88	1000	2	0.0071992	0.006893007	6.89E-03	7.84E-04	7.68E-03
Cs-134	1000	2	0.095136	0.02934186	2.93E-02	1.68E-01	1.98E-01
Cs-136	1000	2	0.0092913	0.00255804	2.55E-03	1.72E-02	1.98E-02
Cs-137	1000	2	0.126735	0.04035147	4.03E-02	2.21E-01	2.61E-01
Na-24	1000	50	0.089752	0.01867315	1.86E-02	0.00E+00	1.86E-02
Cr-51	1000	50	0.0432857	0.00706196	7.03E-03	9.27E-02	9.98E-02
Mn-54	1000	50	0.0249083	0.0050082	4.99E-03	5.10E-02	5.59E-02
Fe-55	1000	50	0.0232248	0.00810991	8.09E-03	0.00E+00	8.09E-03
Fe-59	1000	50	0.0059574	0.002422938	2.42E-03	9.05E-03	1.15E-02
Co-58	100	50	0.078189	0.0225906	2.20E-02	1.44E-01	1.66E-01
Co-60	1000	50	0.021121	0.014406681	1.44E-02	1.72E-02	3.16E-02
Zn-65	1000	50	0.0065754	0.000388573	3.82E-04	0.00E+00	3.82E-04

FSAR, Table 11.2-5 Total Annual Discharge Liquid Waste Processing System
Annual Discharge (Ci) After Processing
Total Releases Per Unit (TPC Unit 1 Only)***
(Page 2 of 3)

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
CD = Condensate Polishing Demineralizer, MD = Mobile Demineralizer			OTHER OPERATIONAL MODES		EXPECTED OPERATION		
	MD DF	CVCS DF	SGB processed by CD	SGB processed by CD and MD	LRW No SGB	SGB with no CD process	∑ Column 6 and Column 7
Sr-89	1000	50	0.0018825	0.000193215	1.92E-04	4.33E-03	4.52E-03
Sr-90	1000	50	0.0001736	2.21026E-05	2.20E-05	3.88E-04	4.10E-04
Sr-91	1000	50	0.0011378	0.000284704	2.84E-04	2.18E-03	2.47E-03
Y-91m	1000	50	0.0006694	0.000168895	1.68E-04	0.00E+00	1.68E-04
Y-91	1000	50	0.0002072	9.00858E-05	9.00E-05	3.00E-04	3.90E-04
Y-93	1000	50	0.0051829	0.001273833	1.27E-03	0.00E+00	1.27E-03
Zr-95	1000	50	0.0060943	0.001395024	1.39E-03	1.20E-02	1.34E-02
Nb-95	1000	50	0.0056138	0.002108301	2.10E-03	8.98E-03	1.11E-02
Mo-99	1000	50	0.0430858	0.00423469	4.20E-03	9.95E-02	1.04E-01
Te-99m	1000	50	0.0386898	0.00338514	3.35E-03	0.00E+00	3.35E-03
Ru-103	1000	50	0.0975742	0.00597589	5.88E-03	0.00E+00	5.88E-03
Ru-106	1000	50	1.184324	0.077432	7.63E-02	0.00E+00	7.63E-02
Te-129m	1000	50	0.0023849	0.000143146	1.41E-04	0.00E+00	1.41E-04
Te-129	1000	50	0.0030182	0.000732508	7.30E-04	0.00E+00	7.30E-04
Te-131m	1000	50	0.0056795	0.000809335	8.05E-04	0.00E+00	8.05E-04
Te-131	1000	50	0.0011229	0.00020385	2.03E-04	0.00E+00	2.03E-04
Te-132	1000	50	0.0125817	0.00112321	1.11E-03	2.93E-02	3.05E-02
Ba-140	1000	50	0.1461456	0.0103815	1.02E-02	3.48E-01	3.58E-01

FSAR, Table 11.2-5 Total Annual Discharge Liquid Waste Processing System
Annual Discharge (Ci) After Processing
Total Releases Per Unit (TPC Unit 1 Only)***
(Page 3 of 3)

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
CD = Condensate Polishing Demineralizer, MD = Mobile Demineralizer			OTHER OPERATIONAL MODES		EXPECTED OPERATION		
	MD DF	CVCS DF	SGB processed by CD	SGB processed by CD and MD	LRW No SGB	SGB with no CD process	$\sum$ Column 6 and Column 7
La-140	1000	50	0.2108406	0.0164352	1.62E-02	4.98E-01	5.14E-01
Ce-141	1000	50	0.0021085	0.000342306	3.41E-04	0.00E+00	3.41E-04
Ce-143	1000	50	0.0114277	0.00153622	1.53E-03	0.00E+00	1.53E-03
Ce-144	1000	50	0.0560926	0.00689185	6.84E-03	1.26E-01	1.33E-01
Np-239	1000	50	0.0135434	0.00138559	1.37E-03	0.00E+00	1.37E-03
H3 (TPC)	1	1	1252.80 (3326.4)	1252.80 (3326.4)			1257.64 (3326.4)
Unplanned Releases**			0.16	0.16	0.16		0.16
Total (w/o H3) w/unplanned			3.5252328 3.685	0.4416449 0.602	0.438 0.598	4.402	4.84 5.000
Total (w/H3) w/unplanned			1256.33 (3329.93) 1256.49 (3330.09)	1253.24 (3326.84) 1253.40 (3327.00)			1257.64 (3331.24) 1257.80 (3331.40)

FSAR. Table 11.2-5 Total Annual Discharge Liquid Waste Processing System Annual Discharge (Ci) After Processing Total Releases Per Unit (TPC Unit 1 Only)***

Notes:

(TPC) The values within the parentheses () represent the tritium values due to the Tritium Production Core.

*** Total Release = $[\text{Tank} + \frac{\text{CVCS}}{\text{CVCS DF}}]$/MD DF + LHST + TB + cond. demin/MD DF

- MD = Mobile Demineralizer (Processes Tanks, CVCS)
- DF = Decontamination Factor
- CVCS DF = Decontamination Factor of CVCS prior to treatment with MD.
- Cond. demin. = condensate demineralizer regeneration waste

** 0.16 Ci/yr is the unplanned release from NUREG-0017

Column 1: Source term isotopes
Column 2: Decontamination factors for the Mobile Demineralizer
Column 3: CVCS Demineralizer decontamination factors
Column 4: ((A+B/C)/D) + E + F/H + G
Column 5: ((A+B/C)/D) + E + F/H/D + G
Column 6: ((A+B/C)/D) + E + F + G
Column 7: J
Column 8: ((A+B/C)/D) + E + G + J
(See below definition for items A thru J

A (Ci/yr)	=	Reactor Coolant Drain Tank + Tritiated Drain Collector Tank + Floor Drain Collector Tank
B (Ci/yr)	=	Chemical & Volume Control System (CVCS) Letdown
C	=	CVCS Demineralizer decontamination factor
D	=	Mobile Demineralizer decontamination factor
E(Ci/yr)	=	Laundry and Hot Shower Drain Tank
F (Ci/yr)	=	Condensate Demineralizer flow = (Condensate flow + Steam Generator Blow Down six day collection volume)
G(Ci/yr)	=	Turbine Building drains
H	=	Condensate Demineralizer decontamination factors (2 for Rb-88, Cs-134,-136, -137, & 10 for all other isotopes-ref. 1)
J (Ci/yr)	=	Steam Generator Blow down at max allowable untreated concentration of 3.65E-5 uCi/cc. This calculated value is based on an average of 365 days but does not represent a constraint on the plant since the actual value for individual releases may be greater. However, the total of all yearly releases must remain < 5CI.

FSAR, Table 11.2-7 Watts Bar Nuclear Plant
Doses from Liquid Effluents For Year 2040

Individual Dose (mrem)							
Adult Total Body 0.72	Bone 0.56	GI Tract 0.132	Thyroid 0.88	Liver 0.96	Kidney 0.352	Lung 0.136	Skin 0.031
Teen Total Body 0.44	Bone 0.60	GI Tract 0.104	Thyroid 0.80	Liver 1.00	Kidney 0.356	Lung 0.152	Skin 0.031
Child Total Body 0.188	Bone 0.76	GI Tract 0.06	Thyroid 0.92	Liver 0.88	Kidney 0.312	Lung 0.128	Skin 0.031
Infant Total Body 0.032	Bone 0.036	GI Tract 0.033	Thyroid 0.264	Liver 0.036	Kidney 0.034	Lung 0.032	Skin 0.031
Population Dose (Person-rem)							
Total Body 1.619	Bone 1.761	GI Tract 1.420	Thyroid 15.336	Liver 2.130	Kidney 1.392	Lung 1.037	Skin 0.315

Enclosure 2
Response to FSAR Chapter 11 and FSEIS Chapter 3
Request For Additional Information

FSAR Chapter 11 and FSEIS Chapter 3 Changes

Attachment 1 - Summary of Proposed Changes to FSAR and FSEIS Text and Tables

Attachment 2 - Proposed Markups for FSAR Chapter 11, Text and Tables

Attachment 3 - Proposed Clean Copy of FSAR Sections 11.1, 11.2 and 11.3

Attachment 4 - Proposed Markups for FSEIS Chapter 3

Attachment 5 - Proposed Clean Copy of FSEIS Chapter 3

Enclosure 2, Attachment 1
Response to FSAR Chapter 11 and FSEIS Chapter 3
Request For Additional Information

Summary of Proposed Changes to FSAR and FSEIS Text and Tables

ENCLOSURE 2, ATTACHMENT 1

WATTS BAR NUCLEAR PLANT UNIT 2
SUMMARY OF PROPOSED CHANGES TO
FSAR CHAPTER 11 AND FSEIS CHAPTER 3

The following provides a summary of proposed changes to the Watts Bar Unit 2 Final Safety Analysis Report and Final Supplemental Environmental Impact Statement (FSEIS). The changes described in this enclosure are for the primary changes resulting from discussions with the NRC, review of the NRC Requests for Additional Information (RAIs) and review of the results of an independent third party assessment of the Watts Bar Unit 2 licensing documentation. Additional minor changes may have been made to provide clarity or correct inconsistencies.

This summary document was developed to provide an overview of changes that have been made to FSAR sections and tables and FSEIS Tables. Two of the primary issues addressed are Feeding Factors and Terrain Adjustment Factors. Accordingly, a summary of these issues including the TVA resolution to address them, are specifically addressed below.

Feeding Factors

NRC staff review of the operating license application for Watts Bar Nuclear Plant (WBN) Unit 2 discovered inconsistencies in the usage of feeding factors amongst various TVA documents. The feeding factor inconsistency and the value itself are questioned in several NRC RAIs on Chapter 11 of the Unit 2 FSAR.

Regulatory guidance concerning feeding factors is found in Regulatory Guide 1.109 [Ref. 1], and NUREG/CR-4653 [Ref. 2]. These documents provide guidance on determination of annual doses. The dose equations used to calculate annual doses include the feeding factor.

The documents encourage the use of site-specific values. However, to use site-specific values, the guidance indicates that the assumptions and methods used to obtain these values should be fully described and documented. These site-specific values are typically based on data collected during annual land use surveys performed by the licensee. NUREG/CR-4653 provides default values that may be used in lieu of site-specific information provided in the annual land use census report.

NUREG/CR-4653 provides a figure that determines the feeding factors based on pasture growing seasons. Assuming the cattle feed completely on pasture grass while on pasture, the feeding factor is in the range of 0.58 to 0.67 (7 to 8 months per year). TVA has determined that a feeding factor value of 0.65 based on NUREG/CR-4653 "GASPAR II – Technical Reference and User Guide," 1987 will be used. Changes to Table 11.3-8 and 11.3-10 have been proposed to reflect the use of the revised feeding factor.

<u>REFERENCES</u>

1. Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Rev. 1, October 1977.
2. NUREG/CR-4653 "GASPAR II – Technical Reference and User Guide," 1987.

Terrain Adjustment Factors

The NRC has always been cognizant and recognized the potential need to account for the impact of terrain effects on meteorological dispersion. A terrain correction factor need be applied only if the spatial and temporal variations in the airflow in the site vicinity would result in an underestimate of the annual average χ/Q value.

ENCLOSURE 2, ATTACHMENT 1

WATTS BAR NUCLEAR PLANT UNIT 2 SUMMARY OF PROPOSED CHANGES TO FSAR CHAPTER 11 AND FSEIS CHAPTER 3

In a letter dated February 27, 1985, the NRC raised concerns regarding TVA's justification for use of a straight-line dispersion model without adjustment factors in the calculation of annual average atmospheric dispersion (χ/Q) values presented in the draft Watts Bar Offsite Dose Calculation Manual (ODCM) [Ref. 1]. The NRC presented two options:

(1) adopt χ/Q values calculated by NRC using default adjustment factors or

(2) provide a quantitative assessment of adjustments to the straight-line trajectory mode

The NRC described a method that other applicants and licensees used to develop site-specific adjustment factors. In those cases, the annual average χ/Q values are calculated using an appropriate variable-trajectory model with hourly meteorological data for a representative one year period and compared with those calculated using the straight-line model using the same data base. The results of the straight- line model (χ/Q and D/Q) are adjusted using a multi-year data base and the ratios generated by the comparison of the variable-trajectory and straight-line models.

TVA developed a methodology to compare the results of TVA's GELC code with results from the MESOPUFF II model. MESOPUFF II is a regional scale, variable trajectory, Gaussian puff model. MESOPUFF II simulates the deformation of a continuous plume by temporarily varying the wind field. TVA developed site-specific adjustment factors for the WBN site by comparing results from the GELC model with results from the MESOPUFF II model.

TVA will continue to use the methodology described in TVA Report TVA/ONRED/A&WR--87/24 [Ref. 2]. GELC will continue to be used with terrain adjustment factors based on comparison to MESOPUFF II. This approach retains existing licensing commitments for WBN Unit 1 and utilizes methodology that has been accepted by the NRC.

REFERENCES

1. Letter, Elinor G. Adensam [NRC] to H. G. Parris [TVA], "Comments on the Proposed Offsite Dose Calculation Manual (ODCM) - Watts Bar Units 1 and 2," February 27, 1985.
2. TVA Report TVA/ONRED/A&WR-87/24, "The Development of χ/Q Adjustment Factors for Potential Use in Routine Calculation of Annual Average χ/Q Values in the Watts Bar Nuclear Plant Offsite Dose Calculation Manual," 1987.

ENCLOSURE 2, ATTACHMENT 1

WATTS BAR NUCLEAR PLANT UNIT 2
SUMMARY OF PROPOSED CHANGES TO
FSAR CHAPTER 11 AND FSEIS CHAPTER 3

FSAR Section 11.1.2

1. Clarification was provided to assure that it was clear the Tritium Producing Burnable Absorber Rods are only applied to Watts Bar Unit 1.

FSAR Section 11.1.4

1. Clarification was provided to describe when the relief path from steam generator blowdowns to the river via the cooling tower blowdown line is used. The following text was added "This route is used primarily during periods when there is no significant primary to secondary leakage."

FSAR Section 11.2.6.5 and Tables 11.2-5, 11.2-5a, 11.2-5b, and 11.2-5d.

The previous FSAR Section 11.2.6.5 has been replaced with new Sections, 11.2.6.5, 11.2.6.5.1 and 11.2.6.5.2. The primary results of these revisions are described below.

1. The text has been revised to describe Table 11.2.5 columns that have been modified. Columns 6, 7 and 8 of this table have been revised. Column 6 provides the liquid radioactive waste source term. Column 7 provides the source term for steam generator blowdown assuming an annual untreated SG Blowdown concentration of 3.65E-5 uCi/cc. Column 8 is the combined source term from Column 6 and 7. In addition, FSAR Sections 11.2.6.5, 11.2.6.5.1 and 11.2.6.5.2 have been revised to assure the text describes the columns in Table 11.2.5.
2. The text has been revised to describe the untreated steam generator blowdown.
3. The text has been revised to discuss Tables 11.2-5a, 11.2-5b, and 11.2-5d. This description includes the steps taken to prevent exceeding 10 CFR Part 20.1302(b) limits.
4. The text has been revised to describe the scenarios associated with the columns presented in Table 11.2-5.
5. The text states the rationale and acceptability of operating without Condensate Demineralizer backwash and blowdown effluent considerations as long as primary-to-secondary leakage is insignificant.
6. Table 11.2-5c has been deleted due to the clarifications incorporated into Section 11.2.6.5.

FSAR Section 11.2.9.1

1. This section has been revised to reflect the use of a 1.42 growth factor based on the 2000 census, rather than 1.24 factor based on the 1990 census.

FSAR Section 11.3.7.4

1. Revised the table cited from "11.3-10" to "11.3-7"

ENCLOSURE 2, ATTACHMENT 1

WATTS BAR NUCLEAR PLANT UNIT 2
SUMMARY OF PROPOSED CHANGES TO
FSAR CHAPTER 11 AND FSEIS CHAPTER 3

<u>FSAR Section 11.3.7.5</u>

1. Clarification has been added to describe the basis for Table 11.3-7c (the basis is ANSI N18.1-1984).

<u>FSAR Table 11.3-6</u>

1. This table has been revised to more accurately describe the use of a continuous filtered containment vent.
2. Item 2 was revised to state that the activities are based on ANSI N18.1-1984.

<u>FSAR Table 11.3-7c</u>

1. The table has been revised to demonstrate it was based on ANSI 18.1-1984 and to delete Tritium Production Core value for H-3 (Unit 1 only).

<u>FSAR Section 11.3.8</u>

1. The description of the Turbine Building vents was revised to describe that non-radioactive ventilation air is exhausted from the Turbine Building rather than "ventilation air".

<u>Table 11.3-8</u>

1. TVA verified the validity of the land census used in FSAR Table 11.3-8.
2. The distance, χ/Q and D/Q were revised to be consistent with the Terrain Adjustment Factor determined using the methodology established in TVA/ONRED/A&WR--87/24. The table provides the Terrain Adjustment Factor used for each point of interest.
3. The Feeding Factors were revised to reflect the growing season. The table provides the Feeding Factor used for each point of interest.

<u>FSAR Section 11.3.9</u>

1. The Section has been revised to identify the date of the land-use census that is used and discusses the rationale and assumptions for the information used.
2. The section was revised to describe that TAFs, χ/Q and D/Q were calculated for the locations based on the 2007 Land Use Survey and 1984 through 2005 meteorology data. Reference is made to table 11.3-8 which provides the Terrain Adjustment Factor used for each point of interest.
3. Additional text was added describing that the computer code GELC was used with terrain adjustment factors to account for recirculation effects.

<u>FSAR Section 11.3.10.1</u>

1. The Section has been revised to identify the feeding factor that TVA has used and to provide the basis for its use. The tables cited at the end of the section have changed from "11.3-10 and 11.3-11" to "11.3-11 to 11.3-12". New text has been added to the end of the section describing the vegetable ingestion is the critical pathway.

ENCLOSURE 2, ATTACHMENT 1

WATTS BAR NUCLEAR PLANT UNIT 2
SUMMARY OF PROPOSED CHANGES TO
FSAR CHAPTER 11 AND FSEIS CHAPTER 3

FSAR Section 11.3.10.2

1. The section has been revised to update the annual total body dose for the population expected to live within a 50 mile radius of Watts Bar in the year 2040. It also revises the total body dose from effluents.

Table 11.3.9

1. This table has been revised to ensure consistency with other sections of the FSAR and the FSEIS. Population dose calculations have been revised.

Table 11.3.10

1. The individual doses listed in Table 11.3-10 were determined using each nuclide's total curies/year listed in Table 11.3-7c with Continuous Filtered Containment Vent.
2. The doses were revised to incorporate the latest parameters including use of updated Feeding Factor and Terrain Adjustment Factors.

Table 11.3.11

1. This table has been revised to describe the results of TVA's estimate of the radiological impact to regional population groups in the year 2040 from the normal operation of the Watts Bar Nuclear Plant.

FSEIS Table 3-19

1. FSEIS Table 3-19 was revised for receptor locations based on the 2007 Land Use Survey and is consistent with FSAR Table 11.3-8.

FSEIS Table 3-20

1. FSEIS Table 3-20 was revised to use the source term associated with Continuous Filtered Containment Vent.

FSEIS Table 3-21

1. The doses were revised to incorporate the latest parameters including use of updated Feeding Factors and Terrain Adjustment Factors.

FSEIS Table 3-22

1. Table 3-22 has been revised to reflect the comparison of Annual Releases from Unit 1 and Unit

Enclosure 2, Attachment 2
Response to FSAR Chapter 11 and FSEIS, Chapter 3
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Proposed Markups for FSAR Chapter 11, Text and Tables

B' = boron concentration reduction rate by feed and bleed, ppm per sec.

η = removal efficiency of purification cycle for nuclide

λ = radioactive decay constant

ν = escape rate coefficient for diffusion into coolant

t = elapsed time (seconds) since the beginning of cycle

subscripts:

C = refers to core

w = refers to coolant

i = refers to parent nuclide

j = refers to daughter

11.1.1.2 Volume Control Tank Historical Design Activity

Table 11.1-3 lists the activities in the volume control tank using the assumptions summarized in Table 11.1-1.

11.1.1.3 Pressurizer Historical Design Activity

The activities in the pressurizer are separated between the liquid and the steam phase and the results obtained are given in Table 11.1-4 using the assumptions summarized in Table 11.1-1.

11.1.1.4 Gaseous Waste Processing System Historical Design Activities

The activities to be found in the Gaseous Waste Processing System are given in Table 11.1-5.

11.1.1.5 Secondary Coolant Historical Design Activities

The secondary cleanup system design activities used for shielding design calculations are discussed in Subsection 12.2.1.5.

11.1.2 Realistic Model for Radioactivities in Systems and Components

This section and associated Tables 11.1-6 and 11.1-7 present results which supersede the calculations in the previous sections. The Tritium Producing Burnable Absorber Rods (TPBARs) are designed and fabricated to retain all the tritium produced within the TPBAR. Since the TPBAR produced tritium is chemically bonded within the TPBAR, virtually no tritium is available in a form that could permeate through the TPBAR cladding. However, it is assumed that while operating with a Tritium Production Core (TPC), some of the tritium inventory in the TPBARs may permeate the cladding

Insert

(Unit 1 only)

(4) Auxiliary Building Ventilation System

(5) Turbine Building Ventilation System

(6) Steam Generator Blowdown System

Estimates for the release of radioactive materials from sources: 1 through 5 (above) are presented in Section 11.3.7. The release paths and transport mechanism for these sources of radioactive material are also presented in Section 11.3.8.

The Steam Generator Blowdown System (SGBS) is another source of liquid radioactive material that is not normally considered part of the radioactive waste system. The system description, release paths, and flow rates are presented in Section 11.2 and in Section 10.4.8. The release path that is of concern in evaluating the radiological consequences of liquid releases from steam generator blowdowns is the path to the river via the cooling tower blowdown line. This route is used primarily during startups, when non-radioactive impurity levels are higher than normal and when SGBS is bypassing the condensate demineralizers. The normal route for the blowdown liquid is to the Turbine Building, where it is cooled, and then routed to either the condensate system upstream of the condensate demineralizers or cooling tower blowdown lines or condenser hotwell. The discharge to the river is monitored for radioactivity as specified in Section 11.4. An alarm in the Main Control Room alerts the operator of an increasing radioactivity level in the discharge. If the radiation setpoint is exceeded, the blowdown discharge is automatically diverted to the condensate demineralizers. The basis for the setpoint is presented in Section 11.4.

References

(1) ANSI/ANS-18.1-1984, "Radioactive Source Term For Normal Operation of Light Water Reactors," December 31, 1984.

(2) WCAP-8253, "Source Term Data for Westinghouse Pressurized Water Reactors", Westinghouse Electric Corporation, Pittsburgh, Pa. 15230, April 1974.

(3) WCAP-7664, R1 "Radiation Analysis Design Manual - 4-Loop Plant", October 1972.

Replace the two sentences with the following sentence:

"This route is used primarily during periods when there is no significant primary to secondary leakage."

11.2.6.4.2 Description

The TB drains are not normally radioactive.

The Turbine Building drainage consists of the following categories:

(a) Condensate Polishing Demineralizer System Drains

(b) Other TB drainage

(c) Oil and oily water drainage.

11.2.6.4.2.1 Condensate Polishing Demineralizer System Drains

The Condensate Polishing Demineralizer System (CPDS) area is serviced by separate floor and equipment drains. The drains for CPDS are routed to the Condensate Demineralizer sump where they are pumped to the Neutralization Tank (NT). These drains have a potential to be low-level radioactive during periods of primary to secondary leakage. The NT is provided with the capability of adjusting pH, and if the inventory is not radioactive or less than the dischargeable limit, it is normally discharged with a batch release to the CTB line. The NT is normally processed by a vendor if the inventory is above dischargeable limits. Any radioactive discharge from this release point is handled in accordance with the ODCM. Section 10.4.6 discusses the CPDS, and this chapter discusses the wastes from the system and their disposal under radioactive and non-radioactive conditions.

11.2.6.4.2.2 Other Turbine Building Drainage

Drainage from the Turbine Building areas other than the CPDS area is directed to the yard holding pond, normally, via the low volume waste treatment (LVWT) pond. Floor and equipment drainage in Turbine Building is first collected in the Turbine Building Station sump and is then pumped to the yard holding pond, normally, via the LVWT pond. Roof drainage flows by gravity directly to the yard holding pond.

11.2.6.4.2.3 Oil and Oily Water Drainage

Replace Section 11.2.6.5 with the insert from the following page.

Oil is drained directly to drums or tank trucks for reuse or removal fro[illegible] water drains are furnished in the Turbine Building and are routed to th[illegible] is located in the low point of the Turbine Building. Oil may be accumulated in the sump until a sufficient amount is collected to be pumped into tank trucks for offsite disposal.

11.2.6.5 Estimated Total Liquid Releases

The potential releases have been evaluated as indicated in the above sections. The expected liquid releases from Watts Bar are well below the limit of 5 Curies (Ci) per year as prescribed in 10 CFR 50, Appendix I as shown by the values given in column 4 and 5 of Table 11.2-5. Column 6 (no CD processing) indicates a yearly release of 30.03 Ci with no Condensate Demineralizer (CD) processing of waste and no limitations on steam generator blow down concentrations. This operational mode is not normally used since long term use results in exceeding the 5 Ci/yr limit in 10 CFR 50, Appendix I. Column 7 of Table 11.2-5 indicates that the total release, including

Replace Section 11.2.6.5 with the insert from the following page.

untreated steam generator blow down, is significantly below the 10 CFR 50, Appendix I limit of 5 Ci/yr if the steam generator blow down concentration is restricted to the Lower Limit of Detection (LLD) of 5E-7 uCi/cc gross gamma during the release and no other Condensate Demineralizer waste is processed during the release. However, column 7 does include other releases from waste holdup tanks which are treated using the Mobile Demineralizers. Column 8 of Table 11.2-5 indicates steam generator blow down can be released untreated and remain within the 10 CFR 50, Appendix I limit of 5 Ci/yr if the Steam Generator Blow down concentration is restricted to a maximum concentration of 3.65E-5 uCi/cc gross gamma during the release and no other Condensate Demineralizer waste is processed during the release. However, column 8 does include other releases from waste holdup tanks which are treated using the Mobile Demineralizers.

Tables 11.2-5a, 11.2-5b, 11.2-5c, and 11.2-5d describe liquid releases for 1% failed fuel for both treated and untreated waste relative to the requirements of 10 CFR 20.1302(b). The sum over all isotopes of the concentrations/ECL (C/ECL) value from the Table 11.2-5a is greater than unity for the case where all isotopes are at design values and the released liquid is not processed by the Mobile Demineralizers. This mode of operation is not normally used since the C/ECL value exceeds the requirements of 10 CFR 20.1302(b). The bulk of the release is due to the untreated condensate resin regeneration waste. In order to prevent exceeding the 10 CFR 20.1302(b) limits, the condensate regeneration waste is rerouted through the Mobile Demineralizers if the long term releases from the condensate regeneration waste is greater than the 10 CFR 20 concentration limits. With Mobile Demineralizer processing of condensate regeneration waste, the release concentrations are shown in Table 11.2-5b and are less than the limits specified in 10 CFR 20.1302(b). Table 11.2-5c shows releases remain within the 10CFR 20 limits if the steam generator blow down concentration is restricted to the Lower Limit of Detection (LLD) of 5E-7 uCi/cc gross gamma during the release and no other Condensate Demineralizer waste is processed during the release. However, these releases do include other releases from waste holdup tanks which are treated using the Mobile Demineralizers. Table 11.2-5d shows releases remain within the 10CFR 20 limits if the steam generator blow down concentration is restricted to a maximum concentration of 3.65E-5 uCi/cc gross gamma during the release and no other Condensate Demineralizer waste is processed during the release. However, these releases do include other releases from waste holdup tanks which are treated using the Mobile Demineralizers.

Based on the above, the releases from the plant are in accordance with the design objectives as outlined in Section 11.2.1 and the Offsite Dose Calculation Manual.

11.2.7 RELEASE POINTS

All radioactive liquid wastes are released from the plant through the cooling tower blowdown line. The discharge points from the waste disposal system are shown in Figure 11.2-1 and 11.2-2. The connection to the cooling tower blowdown line is shown in Figure 10.4-5.

Replace Section 11.2.6.5 with following two pages:

11.2.6.5 Estimated Total Liquid Releases

10 CFR 50 Appendix I and 10 CFR 20 prescribe the allowable limits of radionuclide liquid releases from Watts Bar. The Offsite Dose Calculation Manual is the process document that describes how releases are measured, monitored, controlled and reported. The liquid waste management system at Watts Bar can be operated in a variety of configurations depending on plant conditions and the amount and composition of radionuclides in the waste stream. Irrespective of the specific modes described, the annual releases are required to be equal to or less than the limits provided in the ODCM, Appendix I and 10CFR 20.

Table 11.2-5 provides the total annual discharge from the liquid waste processing system for four different levels of processing prior to discharge. The annual discharge for Unit 2 is expected to be similar to Unit 1 with the exception that tritium production is not currently planned. A value of 0.16 Ci/yr is included as an unplanned release in each of the plant alignment to provide conservatism as discussed in NUREG-0017. The discussions to follow are based on the fluid quantities and activities specified in Table 11.2-1.

11.2.6.5.1 Expected Normal Plant Operation

The expected plant alignment and the four resultant release paths are as follows:

- CVCS letdown waste processed by the CVCS demineralizers and then by the mobile demineralizer.
- The reactor coolant drain tank, the tritiated drain collector tank, and the floor drain collector tank discharges and processed using the mobile demineralizer
- Liquid releases from the Laundry and Hot Shower Drain Tank and the Turbine Building drains can be released without processing by mobile demineralizer.

This combination of above three paths is called liquid radwaste.

- Steam Generator Blowdown released without processing.

The results for this alignment are shown in Column 8 of Table 11.2-5. Column 8 is the combined source term from Column 6 and 7. Column 6 provides the liquid radwaste source term. Column 7 provides the source term for steam generator blowdown assuming an annual untreated SG Blowdown concentration of 3.65 E-5 uCI/cc. Concentrations above this value cannot be released continuously on an annual basis without additional processing. Unit 1 currently operates without the condensate demineralizers in service. The condensate demineralizers will not be utilized unless significant primary to secondary leakage occurs. Operating experience has shown that annual releases are below the values shown in Column 8 and thus that processing of SG Blowdown is not expected to be required. There is no condensate demineralizer blowdown or backwashing when the plant is operating under this set of conditions. SG Blowdown concentrations above 3.65E-5 uCi/cc can be released without processing by the condensate demineralizers for short periods of time and are acceptable as long as total releases from the site are below the ODCM and 10 CFR limits.

The expected liquid releases from Watts Bar based on the values in Column 8 are below the limit of 5 Curies per year as prescribed in 10 CFR 50, Appendix I. Tables 11.2-5c and 11.2-5d describe liquid releases for 1% failed fuel for both treated and untreated waste relative to the requirements of 10 CFR 20.1302(b). Table 11.2- 5d shows releases remain within the 10CFR

20 limits if the steam generator blow down concentration is restricted to a maximum concentration of 3.65E-5 uCi/cc gross gamma during the release.

11.2.6.5.2 Other Plant Alignment Evaluations

The values in Table 11.2-5 Column 4 assume the following:

- CVCS letdown waste processed by the CVCS demineralizers and then by the mobile demineralizer.
- The reactor coolant drain tank, the tritiated drain collector tank, and the floor drain collector tank discharges and processed using the mobile demineralizer
- Condensate Demineralizer Flow including SG Blowdown processed the condensate demineralizer
- Liquid releases from the Laundry and Hot Shower Drain Tank and the Turbine Building drains can be released without processing by mobile demineralizer.

. The values in Table 11.2-5 Column 5 assume the following:

- CVCS letdown waste processed by the CVCS demineralizers and then by the mobile demineralizer.
- The reactor coolant drain tank, the tritiated drain collector tank, and the floor drain collector tank discharges and processed using the mobile demineralizer
- Condensate Demineralizer Flow including SG Blowdown processed by the condensate demineralizer with additional processing by the mobile demineralizer.
- Liquid releases from the Laundry and Hot Shower Drain Tank and the Turbine Building drains can be released without processing by mobile demineralizer.

The expected liquid releases from Watts Bar based on the values in columns 4 and 5 are well below the limit of 5 Curies per year as prescribed in 10 CFR 50, Appendix I.

Tables 11.2-5a and 11.2-5b describe liquid releases for 1% failed fuel for both treated and untreated waste relative to the requirements of 10 CFR 20.1302(b). The sum over all isotopes of the concentrations/ECL (C/ECL) value from the Table 11.2-5a is greater than unity for the case where all isotopes are at design values and the released liquid is not processed by the Mobile Demineralizers. In order to prevent exceeding the 10 CFR 20.1302(b) limits, the condensate regeneration waste is rerouted through the Mobile Demineralizers if the long term releases from the condensate regeneration waste is greater than the 10 CFR 20 concentration limits. With Mobile Demineralizer processing of condensate regeneration waste, the release concentrations are shown in Table 11.2-5b and are less than the limits specified in 10 CFR 20.1302(b).

Based on the above, the releases from the plant are in accordance with the design objectives as outlined in Section 11.2.1 and the Offsite Dose Calculation Manual.

11.2.8 DILUTION FACTORS

The dosimetry calculations for drinking water are based on the assumption that the liquid effluent will be mixed with 10% of the river flow between the point of discharge and Tennessee River Mile (TRM) 510.0, where 100% dilution is assumed to occur. Further discussion of these calculations and dilution flows used is presented in section 11.2.9.1.

11.2.9 ESTIMATED DOSES FROM RADIONUCLIDES IN LIQUID EFFLUENTS

Doses from the ingestion of water, from the consumption of fish, and from shoreline recreation are calculated for exposures to radionuclides routinely released in liquid effluents.

11.2.9.1 Assumptions and Calculational Methods

Internal doses are calculated using methods outlined in NRC Regulatory Guide 1.109, Revision 1, October 1977. This model is used for estimating the doses to bone, gastro-intestinal (G.I.) tract, thyroid, liver, kidney, lung, skin, and total body of man from ingestion of water, consumption of fish, and from external exposures due to recreational activities. Population doses are estimated for the year 2040 based on the populations given in Table 2.1-12.

(1) Doses to Man from the Ingestion of Water

Replace with

2000 public water supply populations by a population growth factor of 1.42.

Data listed in Table 11.2-6 for public water supplies is used to calculate dose commitments from the consumption of Tennessee River water. The 2040 populations for the water supplies are estimated by multiplying the 1990 populations by a population growth factor of 1.24. This factor is the ratio of the 2040 population (Table 2.1-12) to the 1990 population. It is assumed that the plant effluent is mixed with one-tenth of the river flow in the 18-mile reach between the nuclear plant site and TRM 510.0. Although natural water turbulence will continue to increase the dispersion downstream, it is assumed that one-tenth dilution is maintained as far as TRM 510.0, where full-dilution is assumed.

Replace with

2000 population (Table 2.1-8).

Dilution is calculated using average annual flow data for the Tennessee River as measured during the 69-year period 1899-1968. The average flow past the site is approximately 28,000 ft^3/sec.

Radioactive decay between the time of intake in a water system and the time of consumption is handled in accordance with Regulatory Guide 1.109. Maximum and average consumption rates are those recommended by Regulatory Guide 1.109.

Due to a lack of definitive data, no credit is taken for removal of activity from the water through absorption on solids and sedimentation, by deposition in the biomass, or by processing within water treatment systems.

Replace with Insert A

Table 11.2-5 Total Annual Discharge Liquid Waste Processing System*
Annual Discharge (Ci) After Processing
Total Releases Per Unit (TPC Unit 1 Only)***
(Page 1 of 3)

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
CD = Condensate Polishing Demineralizer, MD = Mobile Demineralizer							
	MD DF	CVCS DF	w/o CD process by MD	w/CD processing by MD	no CD processing	no CD process, SGB rel=LLD	no CD process, SGB rel=max
Br-84	1000	50	0.0003696	0.000165534	0.00220833	0.00016533	0.0001653
I-131	1000	50	0.471244	0.0267889	4.475344	0.026344	0.026344
I-132	1000	50	0.055475	0.01319732	0.436355	0.013155	0.013155
I-133	1000	50	0.388058	0.0531932	3.404858	0.052858	0.052858
I-134	1000	50	0.0166222	0.00627256	0.1098622	0.0062622	0.0062622
I-135	1000	50	0.212508	0.047673	1.697508	0.047508	0.047508
Rb-88	1000	2	0.0071992	0.006893007	0.0075057	0.0068927	0.0068927
Cs-134	1000	2	0.095136	0.02934186	0.160996	0.029276	0.029276
Cs-136	1000	2	0.0092913	0.00255804	0.0160313	0.0025513	0.0025513
Cs-137	1000	2	0.126735	0.04035147	0.213205	0.040265	0.040265
Na-24	1000	50	0.089752	0.01867315	0.730102	0.018602	0.018602
Cr-51	1000	50	0.0432857	0.00706196	0.3696257	0.0070257	0.0070257
Mn-54	1000	50	0.0249083	0.0050082	0.20418828	0.00498828	0.0049883
Fe-55	1000	50	0.0232248	0.00810991	0.15939478	0.00809478	0.0080948
Fe-59	1000	50	0.0059574	0.002422938	0.0377994	0.0024194	0.0024194
Co-58	100	50	0.078189	0.0225906	0.583629	0.022029	0.022029
Co-60	1000	50	0.021121	0.014406681	0.08160996	0.01439996	0.0144
Zn-65	1000	50	0.0065754	0.000388573	0.06231238	0.00038238	0.0003824

Replace with Insert B

Table 11.2-5 Total Annual Discharge Liquid Waste Processing System*
Annual Discharge (Ci) After Processing
Total Releases Per Unit (TPC Unit 1 Only)***
(Page 2 of 3)

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
CD = Condensate Polishing Demineralizer, MD = Mobile Demineralizer							
	MD DF	CVCS DF	w/o CD process by MD	w/CD processing by MD	no CD processing	no CD process, SGB rel=LLD	no CD process, SGB rel=max
Sr-89	1000	50	0.0018825	0.000193215	0.01710152	0.00019152	0.0001915
Sr-90	1000	50	0.0001736	2.21026E-05	0.00153795	2.1951E-05	2.195E-05
Sr-91	1000	50	0.0011378	0.000284704	0.00882285	0.00028385	0.0002839
Y-91m	1000	50	0.0006694	0.000168895	0.00517839	0.00016839	0.0001684
Y-91	1000	50	0.0002072	9.00858E-05	0.00126197	8.9969E-09	8.997E-05
Y-93	1000	50	0.0051829	0.001273833	0.04039992	0.00126992	0.0012699
Zr-95	1000	50	0.0060943	0.001395024	0.04843032	0.00139032	0.0013903
Nb-95	1000	50	0.0056138	0.002108301	0.03719479	0.00210479	0.0021048
Mo-99	1000	50	0.0430858	0.00423469	0.3930958	0.0041958	0.0041958
Te-99m	1000	50	0.0386898	0.00338514	0.3567498	0.0033498	0.0033498
Ru-103	1000	50	0.0975742	0.00597589	0.9227842	0.0058842	0.0058842
Ru-106	1000	50	1.184324	0.077432	11.156324	0.076324	0.076324
Te-129m	1000	50	0.0023849	0.000143146	0.0225809	0.0001409	0.0001409
Te-129	1000	50	0.0030182	0.000732508	0.02361022	0.00073022	0.0007302
Te-131m	1000	50	0.0056795	0.000809335	0.04955446	0.00080446	0.0008045
Te-131	1000	50	0.0011229	0.00020385	0.00940293	0.00020293	0.0002029
Te-132	1000	50	0.0125817	0.00112321	0.11581174	0.00111174	0.0011117
Ba-140	1000	50	0.1461456	0.0103815	1.3692456	0.0102456	0.0102456

Replace with Insert C

Table 11.2-5 Total Annual Discharge Liquid Waste Processing System*
Annual Discharge (Ci) After Processing
Total Releases Per Unit (TPC Unit 1 Only)***
(Page 3 of 3)

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
CD = Condensate Polishing Demineralizer, MD = Mobile Demineralizer							
	MD DF	CVCS DF	w/o CD process by MD	w/CD processing by MD	no CD processing	no CD process, SGB rel=LLD	no CD process, SGB rel=max
La-140	1000	50	0.2108406	0.0164352	1.9622406	0.0162406	0.0162406
Ce-141	1000	50	0.0021085	0.000342306	0.01802054	0.00034054	0.0003405
Ce-143	1000	50	0.0114277	0.00153622	0.10054572	0.00152572	0.0015257
Ce-144	1000	50	0.0560926	0.00689185	0.4993426	0.0068426	0.0068426
Np-239	1000	50	0.0135434	0.00138559	0.12307342	0.00137342	0.0013734
H-3 (TPC)	1	1	1252.80 (3326.4)	1252.80 (3326.4)	1252.80 (3326.4)	1252.80 (3326.4)	1252.80 (3326.4)
unplanned			0.16	0.16	0.16	0.16	0.16
SGBD contribution						0.06	4.402 ****
total (w/o H3) w/unplanned			3.5252328 3.685	0.4416449 0.602	30.0348453 30.195	0.50 0.658	4.84 5.000
total (w/H3) w/unplanned			1256.33 (3329.93) 1256.49 (3330.09)	1253.24 (3326.84) 1253.40 (3327.00)	1282.83 (3356.43) 1283.00 (3356.60)	1253.30 (3326.90) 1253.46 (3327.06)	1257.64 (3331.24) 1257.80 (3331.40)

Insert A

Table 11.2-5 Total Annual Discharge Liquid Waste Processing System Annual Discharge (Ci) After Processing Total Releases Per Unit (TPC Unit 1 Only)* (Page 1 of 3)**

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
CD = Condensate Polishing Demineralizer, MD = Mobile Demineralizer			OTHER OPERATIONAL MODES		EXPECTED OPERATION		
	MD DF	CVCS DF	SGB processed by CD	SGB processed by CD and MD	LRW No SGB	SGB with no CD process	Σ Column 6 and Column 7
Br-84	1000	50	0.0003696	0.000165534	1.65E-04	5.23E-04	6.88E-04
I-131	1000	50	0.471244	0.0267889	2.63E-02	1.14E+00	1.16E+00
I-132	1000	50	0.055475	0.01319732	1.32E-02	1.08E-01	1.21E-01
I-133	1000	50	0.388058	0.0531932	5.29E-02	8.57E-01	9.10E-01
I-134	1000	50	0.0166222	0.00627256	6.26E-03	2.65E-02	3.28E-02
I-135	1000	50	0.212508	0.047673	4.75E-02	4.22E-01	4.70E-01
Rb-88	1000	2	0.0071992	0.006893007	6.89E-03	7.84E-04	7.68E-03
Cs-134	1000	2	0.095136	0.02934186	2.93E-02	1.68E-01	1.98E-01
Cs-136	1000	2	0.0092913	0.00255804	2.55E-03	1.72E-02	1.98E-02
Cs-137	1000	2	0.126735	0.04035147	4.03E-02	2.21E-01	2.61E-01
Na-24	1000	50	0.089752	0.01867315	1.86E-02	0.00E+00	1.86E-02
Cr-51	1000	50	0.0432857	0.00706196	7.03E-03	9.27E-02	9.98E-02
Mn-54	1000	50	0.0249083	0.0050082	4.99E-03	5.10E-02	5.59E-02
Fe-55	1000	50	0.0232248	0.00810991	8.09E-03	0.00E+00	8.09E-03
Fe-59	1000	50	0.0059574	0.002422938	2.42E-03	9.05E-03	1.15E-02
Co-58	100	50	0.078189	0.0225906	2.20E-02	1.44E-01	1.66E-01
Co-60	1000	50	0.021121	0.014406681	1.44E-02	1.72E-02	3.16E-02
Zn-65	1000	50	0.0065754	0.000388573	3.82E-04	0.0E+00	3.82E-04

Insert B

Table 11.2-5 Total Annual Discharge Liquid Waste Processing System*
Annual Discharge (Ci) After Processing
Total Releases Per Unit (TPC Unit 1 Only)***
(Page 2 of 3)

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
CD = Condensate Polishing Demineralizer, MD = Mobile Demineralizer			OTHER OPERATIONAL MODES		EXPECTED OPERATION		
	MD DF	CVCS DF	SGB processed by CD	SGB processed by CD and MD	LRW No SGB	SGB with no CD process	Σ Column 6 and Column 7
Sr-89	1000	50	0.0018825	0.000193215	1.92E-04	4.33E-03	4.52E-03
Sr-90	1000	50	0.0001736	2.21026E-05	2.20E-05	3.88E-04	4.10E-04
Sr-91	1000	50	0.0011378	0.000284704	2.84E-04	2.18E-03	2.47E-03
Y-91m	1000	50	0.0006694	0.000168895	1.68E-04	0.00E+00	1.68E-04
Y-91	1000	50	0.0002072	9.00858E-05	9.00E-05	3.00E-04	3.90E-04
Y-93	1000	50	0.0051829	0.001273833	1.27E-03	0.00E+00	1.27E-03
Zr-95	1000	50	0.0060943	0.001395024	1.39E-03	1.20E-02	1.34E-02
Nb-95	1000	50	0.0056138	0.002108301	2.10E-03	8.98E-03	1.11E-02
Mo-99	1000	50	0.0430858	0.00423469	4.20E-03	9.95E-02	1.04E-01
Tc-99m	1000	50	0.0386898	0.00338514	3.35E-03	0.00E+00	3.35E-03
Ru-103	1000	50	0.0975742	0.00597589	5.88E-03	0.00E+00	5.88E-03
Ru-106	1000	50	1.184324	0.077432	7.63E-02	0.00E+00	7.63E-02
Tc-129	1000	50	0.0023849	0.000143146	1.41E-04	0.00E+00	1.41E-04
Te-129	1000	50	0.0030182	0.000732508	7.30E-04	0.00E+00	7.30E-04
Te-131m	1000	50	0.0056795	0.000809335	8.05E-04	0.00E+00	8.05E-04
Te-131	1000	50	0.0011229	0.00020385	2.03E-04	0.00E+00	2.03E-04
Te-132	1000	50	0.0125817	0.00112321	1.11E-03	2.93E-02	3.05E-02
Ba-140	1000	50	0.1461456	0.0103815	1.02E-02	3.48E-01	3.58E-01

Insert C

Table 11.2-5 Total Annual Discharge Liquid Waste Processing System*
Annual Discharge (Ci) After Processing
Total Releases Per Unit (TPC Unit 1 Only)***
(Page 3 of 3)

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
CD = Condensate Polishing Demineralizer, MD = Mobile Demineralizer			OTHER OPERATIONAL MODES		EXPECTED OPERATION		
	MD DF	CVCS DF	SGB processed by CD	SGB processed by CD and MD	LRW No SGB	SGB with no CD process	Σ Column 6 and Column 7
La-140	1000	50	0.2108406	0.0164352	1.62E-02	4.98E-01	5.14E-01
Ce-141	1000	50	0.0021085	0.000342306	3.41E-04	0.00E+00	3.41E-04
Ce-143	1000	50	0.0114277	0.00153622	1.53E-03	0.00E+00	1.53E-03
Ce-144	1000	50	0.0560926	0.00689185	6.84E-03	1.26E-01	1.33E-01
Np-239	1000	50	0.0135434	0.00138559	1.37E-03	0.00E+00	1.37E-03
H-3 (TPC)	1	1	1252.80 (3326.4)	1252.80 (3326.4)			1257.64 (3326.4)
Unplanned Releases **			0.16	0.16	0.16		0.16
total (w/o H3) w/unplanned			3.5252328 3.685	0.4416449 0.602	0.438 0.598	4.402	4.84 5.000
total (w/H3) w/unplanned			1256.33 (3329.93) 1256.49 (3330.09)	1253.24 (3326.84) 1253.40 (3327.00)			1257.64 (3331.24) 1257.80 (3331.40)

Replace with Insert D

Table 11.2-5 Total Annual Discharge Liquid Waste Processing System* Annual Discharge (Ci) After Processing Total Releases Per Unit (TPC Unit 1 Only)***

Notes:
* The 0.16 Ci/yr is the unplanned release.
** MD = Mobile Demineralizer (Processes Tanks, CVCS)
DF = Decontamination Factor
CVCS DF = Decontamination Factor of CVCS prior to treatment with MD.
Cond. demin. = condensate demineralizer regeneration waste
*** Total Release = [Tank + $\frac{\text{CVCS}}{\text{CVCS DF}}$]/MD DF + LHST = TB + cond. demin/MD DF
**** This calculated value is based on an average of 365 days but does not represent a constraint on the plant since the actual value for individual releases may be greater. However, the total of all yearly releases must remain ≤ 5 Ci.
(TPC) The values within the parentheses () represent the tritium values due to the Trtium Production Core.

Column 1: Source term isotopes
Column 2: Decontamination factors for the Mobile Demineralizer
Column 3: CVCS Demineralizer decontamination factors
Column 4: ((A+B/C)/D) + E + F/H + G
Column 5: ((A+B/C)/D) + E + F/H1D + G
Column 6: ((A+B/C)/D) + E + F + G
Column 7: ((A+B/C)/D)+ E + G + I
Column 8: ((A+B/C)/D) + E + G + J
(See below definition for items A thru J

A (Ci/yr)	=	Reactor Coolant Drain Tank + Tritiated Drain Collector Tank + Floor Drain Collector Tank
B (Ci/yr)	=	Chemical & Volume Control System (CVCS) Letdown
C	=	CVCS Demineralizer decontamination factor
D	=	Mobi"le Demineralizer decontamination factor
E(Ci/yr)	=	Laundry and Hot Shower Drain Tank
F (Ci/yr)	=	Condensate Demineralizer flow = (Condensate flow + Steam Generator Blow Down six day collection volume)
G(Ci/yr)	=	Turbine Building drains
H	=	Condensate·Demineralizer decontamination factors (2 for Rb-88, Cs-134,-136,-137, & 10 for all other isotopes-ref. 1)
I(Ci/yr)	=	Steam Generator Blow Down at untreated lower limit of detect ability (LLD) concentration (5E-7 uCi/cc gross Gamma-ref.2)*
J (Ci/yr)	=	Steam Generator Blow down at ·max allowable untreated concentration of 3.65E-5 uCi/cc

* This is equal to 3E+04 lb/hr*453.59 g/lb*1 cc/g*24 hr/day*365 day/yr*5E-07 uCi/cc*1 E-06 Ci/UCi = 0.06 Ci/yr

Insert D

Table 11.2-5 Total Annual Discharge Liquid Waste Processing System Annual Disharge (Ci) After Processing Total Releases Per Unit (TPC Unit 1 Only)***

Notes:

(TPC) The values within the parentheses () represent the tritium values due to the Trtium Production Core.

*** Total Release = $[\text{Tank} + \frac{\text{CVCS}}{\text{CVCS DF}}]$/MD DF + LHST + TB + cond. demin/MD DF

- MD = Mobile Demineralizer (Processes Tanks, CVCS)
- DF = Decontamination Factor
- CVCS DF = Decontamination Factor of CVCS prior to treatment with MD.
- Cond. demin. = condensate demineralizer regeneration waste

** 0.16 Ci/yr is an unplanned release from NUREG-0017.

Column 1: Source term isotopes
Column 2: Decontamination factors for the Mobile Demineralizer
Column 3: CVCS Demineralizer decontamination factors
Column 4: ((A+B/C)/D) + E + F/H + G
Column 5: ((A+B/C)/D) + E + F/H/D + G
Column 6: ((A+B/C)/D) + E + F + G
Column 7: J
Column 8: ((A+B/C)/D) + E + G + J
(See below definition for items A thru J

A (Ci/yr) = Reactor Coolant Drain Tank + Tritiated Drain Collector Tank + Floor Drain Collector Tank
B (Ci/yr) = Chemical & Volume Control System (CVCS) Letdown
C = CVCS Demineralizer decontamination factor
D = Mobile Demineralizer decontamination factor
E(Ci/yr) = Laundry and Hot Shower Drain Tank
F (Ci/yr) = Condensate Demineralizer flow = (Condensate flow + Steam Generator Blow Down six day collection volume)
G(Ci/yr) = Turbine Building drains
H = Condensate·Demineralizer decontamination factors (2 for Rb-88, Cs-134,-136,-137, & 10 for all other isotopes-ref. 1)
J (Ci/yr) = Steam Generator Blow down at max allowable annual untreated concentration of 3.65E-5 uCi/cc. This calculated value is based on an average of 365 days but does not represent a constraint on the plant since the actual value for individual releases may be greater. However, the total of all yearly releases must remain < 5 Ci.

Table 11.2-5c
no CD process/ SGBD at LLD/ with 20000 gpm dilution other release paths at design limit:

	ANSI Ci/yr	Scaled to 0.06 Ci	des/ansi	Ci/yr	liquid uCi/cc	liquid 10CFR20	C/ECL
Br-84	0.00016533	7.122E-06	2.50	0.00042045	1.06E-11	4.0E-04	2.642E-08
I-131	0.026344	1.551E-02	52.41	1.39622267	3.51E-08	1.0E-06	0.0350911
I-132	0.013155	1.475E-03	4.00	0.05409534	1.36E-09	1.0E-04	1.36E-05
I-133	0.052858	1.169E-02	26.85	1.43069229	3.60E-08	7.0E-06	0.0051368
I-134	0.0062622	3.612E-04	1.65	0.01068347	2.69E-10	4.0E-04	6.713E-07
I-135	0.047508	5.752E-03	7.91	0.38171474	9.59E-09	3.0E-05	0.0003198
Rb-88	0.0068927	1.069E-05	18.14	0.12502534	3.14E-09	4.0E-04	7.856E-06
Cs-134	0.029276	2.296E-03	40.60	1.19076688	2.99E-08	9.0E-07	0.0332526
Cs-136	0.0025513	2.350E-04	165.20	0.42170523	1.06E-08	6.0E-06	0.0017664
Cs-137	0.040265	3.014E-03	153.22	6.17231989	1.55E-07	1.0E-06	0.155128
Cr-51	0.0070257	1.264E-03	0.29	0.00331144	8.32E-11	5.0E-04	1.665E-07
Mn-54	0.00498828	6.944E-04	0.47	0.00304012	7.64E-11	3.0E-05	2.547E-06
Fe-59	0.0024194	1.233E-04	3.48	0.0085453	2.15E-10	1.0E-05	2.148E-05
Co-58	0.022029	1.958E-03	5.37	0.12029542	3.02E-09	2.0E-05	0.0001512
Co-60	0.01439996	2.343E-04	1.38	0.02010522	5.05E-10	3.0E-06	0.0001684
Sr-89	0.000191524	5.895E-05	22.45	0.00435847	1.10E-10	8.0E-06	1.369E-05
Sr-90	0.000021951	5.285E-06	13.49	0.00030145	7.58E-12	5.0E-07	1.515E-05
Sr-91	0.00028385	2.977E-05	1.86	0.00055851	1.40E-11	2.0E-05	7.018E-07
Y-90	0	0.000E+00	15.87	0	0.00E+00	7.0E-06	0
Y-91	8.99686E-05	4.086E-06	1115.17	0.1003347	2.52E-09	8.0E-06	0.0003152
Zr-95	0.00139032	1.640E-04	1.71	0.00253771	6.38E-11	2.0E-05	3.189E-06
Nb-95	0.002104792	1.223E-04	2.34	0.0050454	1.27E-10	3.0E-05	4.227E-06
Mo-99	0.0041958	1.356E-03	785.19	3.29583576	8.28E-08	2.0E-05	0.0041417
Te-132	0.00111174	3.999E-04	145.25	0.16188165	4.07E-09	9.0E-06	0.0004521
Ba-140	0.0102456	4.738E-03	0.31	0.00795345	2.00E-10	8.0E-06	2.499E-05
La-140	0.0162406	6.784E-03	0.06	0.00770681	1.94E-10	9.0E-06	2.152E-05
Ce-144	0.0068426	1.717E-03	0.08	0.00226954	5.70E-11	3.0E-06	1.901E-05
Pr-144	0	0.000E+00	0.08	0	0.00E+00	6.0E-04	0
H-3	1252.80		1	1252.80	3.15E-05	1.0E-03	0.0314864
H-3 (TPC)	3326.40		1	3326.40	8.36E-05	1.0E-03	0.0836019
Total							0.2675585
Total (TPC)							0.319674

Note: This Table is based on column 7 of Table 11.2-5, ratioed up to 1% failed fuel with SGBD at lower limit of detection (LLD) (5E-7 uCi/cc gross gamma) (TPC Unit 1 only).

11.3.7.3 Expected Gaseous Waste Processing System Releases

Gaseous wastes consist of nitrogen and hydrogen gases purged from the Chemical Volume and Control System volume control tank when degassing the reactor coolant, and from the closed gas blanketing system. The gas decay tank capacity permits at least 60 days decay for waste gases before discharge during normal operation.

The quantities and isotopic concentration of gases discharged from the GWPS have been estimated. The analysis is based on input sources to the GWPS per NUREG–0017, modified to reflect WBN plant-specific parameters.

The expected gaseous releases in curies per year per reactor unit are given in Table 11.3-5.

11.3.7.4 Releases from Ventilation Systems

A detailed review of the entire plant has been made to ascertain those items that could possibly contribute to airborne radioactive releases.

During normal plant operations, airborne noble gases and/or iodines can originate from reactor coolant leakage, equipment drains, venting and sampling, secondary side leakage, condenser air ejector and gland seal condenser exhausts, and GWPS leakage.

The assumptions used to estimate the annual quantity of radioactive gaseous effluents are given in Table 11.3-6. These assumptions are in accordance with NUREG-0017. The noble gases and iodines discharged from the various sources are entered in Table 11.3-10. Replace with "7"

11.3.7.5 Estimated Total Releases

The estimated releases listed in Table 11.3-7c have been used in calculating the site boundary doses as shown in Table 11.3-10. Table 11.3-7a is the expected gases released for 1% failed fuel with containment purge. Table 11.3-7 is the annual releases with purge air filters. Table 11.3-7b is the expected gases released for 1% failed fuel with continuous filtered containment vent, and Table 11.3-7c for approximately 1/8% failed fuel with continuous filtered containment vent.

The dose calculations, based on the estimated total plant releases, show that the releases are in accordance with the design objectives in Section 11.3.1 and meet the regulations as outlined in Section 11.3.7.1. Further, the total plant releases are within the ODCM limits.

Replace with "based on ANSI N18.1-1984"

11.3.8 Release Points

Gaseous radioactive wastes are released to the atmosphere through vents located on the Shield Building, Auxiliary Building, Turbine Building, and Service Building. A brief description, including function and location of each type vent, is presented below.

No. 4 - Replace with:

Turbine Building Vents

Gaseous wastes from the condenser are discharged through the condenser vacuum exhaust vent. The vent, which is a 12-inch diameter pipe, discharges at approximately the 760-foot level. Under normal operating conditions the discharge flow rate will typically be less than 45 cfm.

Non-radioactive ventilation air is exhausted from the Turbine Building through the Turbine Building vents. There are eighteen vents at the 755-foot level and twenty vents at the 824-foot level (roof level). The effluent flow rates vary for each type of vent. Generally, the normal flow rates through a typical vent at the 755-foot level is 22,888 cfm and the flow rates through typical vent at the 824-foot level is 28,500 cfm. The general arrangement of vents on the Turbine Building is shown on Figure 1.2-1. The turbine building is shown on the main plant general plan, Figure 2.1-5.

Auxiliary Building Vent

Waste gases in the Auxiliary Building are discharged through the Auxiliary Building exhaust vent. In addition, containment atmosphere is continuously vented, during normal operation for pressure control, into the annulus after it is filtered through HEPA and charcoal filters, and subsequently, discharged into the Auxiliary Building exhaust vent. The vent is of the chimney type having a rectangular cross section of 10 by 30 feet. The top of the vent is located atop the Auxiliary Building and discharges approximately 106 feet above grade. Under normal operating conditions, gases are continuously discharged through the vent. Effluent flow rates can be near 224,000 cfm when two Auxiliary Building general exhaust fans and one fuel-handling area exhaust fan are operating at full capacity. Under accident conditions, the Auxiliary Building is isolated, and the Auxiliary Building gas treatment system (ABGTS) is used to treat gaseous effluents. When in service, the ABGTS discharges to the Shield Building exhaust vent. The location of the Auxiliary Building exhaust vent is shown in the equipment layout diagram, Figure 1.2-1. The Auxiliary Building is shown on the main plant general plan, Figure 2.1-5.

Turbine Building Vents

Ventilation air is exhausted from the Turbine Building through the Turbine Building vents. There are eighteen vents at the 755-foot level and twenty vents at the 824-foot level (roof level). The effluent flow rates vary for each type of vent. Generally, the normal flow rates through a typical vent at the 755-foot level is 22,888 cfm and the flow rates through typical vent at the 824-foot level is 28,500 cfm. The general arrangement of vents on the Turbine Building is shown on Figure 1.2-1. The turbine building is shown on the main plant general plan, Figure 2.1-5.

Condenser Vacuum Exhaust Vent

Gaseous wastes from the condenser are discharged through the condenser vacuum exhaust vent. The vent, which is a 12-inch diameter pipe, discharges at approximately the 760-foot level. Under normal operating conditions the discharge flow rate will typically be less than 45 cfm.

Insert the following: "The computer code titled Gaseous Effluent Licensing Code (GELC) was used to perform routine dose assessments for WBN. During Unit 1 licensing, terrain adjustment factors (TAF) were developed to account for recirculation effects due to the river valley location of the plant."

Radiologically monitored potentially radioactive waste gases from the radiochemical laboratory and the titration room are exhausted through HEPA filters via a common duct which discharges to the common Service Building roof exhaust plenum. Exhaust air from the general area discharges to the common Service Building roof exhaust plenum. Separate vents from the common roof exhaust plenum discharge to atmosphere approximately 24 feet above grade. The Service Building is shown on the site plot plan, Figure 2.1-5.

Replace with "batch"

11.3.9 Atmospheric Dilution

Calculations of atmospheric transport, dispersion, and ground deposition are based on the straight-line airflow model discussed in NRC Regulatory Guide 1.111 (Revision 1, July 1977). Releases are assumed to be continuous. Releases known to be periodic, e.g., those during containment purging and waste gas decay tank venting, are treated as continuous releases.

Releases from the Shield Building, Turbine Building (TB), and Auxiliary Building (AB) vents are treated as ground level. The ground level joint frequency distribution (JFD) is given in Section 2.3. Air concentrations and deposition rates were calculated considering radioactive decay and buildup during transit. Plume depletion was calculated using the figures provided in Regulatory Guide 1.111.

~~Estimates of normalized co~~ncentrations (X/Q) and normalized deposition rates (D/Q)

Insert the following as paragraph lead-in: "Table 11.3-8 provides the receptor locations for performing the dose assessments in this chapter. The data is based on the 2007 land use survey. The TAF, X/Q, and D/Q for each receptor are calculated for the locations based on this survey. The TAF presented in Table 11.3-8 were developed on the same basis that was used for Unit 1 licensing. Meteorology data from the 1986 to 2005 time period was used in the development of the X/Qs and D/Qs."

n ... xternal ... gestion ... identified which would contribute 10% or more to either individual or population doses.

Delete

11.3.10.1 Assumptions and Calculational Methods

Replace with "2007"

External air exposures are evaluated at points of potential maximum exposure (i.e., points at the unrestricted area boundary). External skin and total body exposures are evaluated at nearby residences. The dose to the critical organ from radioiodines, tritium (Unit 1 only) and particulates is calculated for real pathways existing at the site during a land use survey conducted in 1994.

To evaluate the potential critical organ dose, milk animals and nearest gardens were identified by a detailed survey within five miles of the plant (Table 11.3-8). Information on grazing seasons and feeding regimes are reflected in the feeding factor. The feeding factor is the fraction of the year an animal grazes on pasture. During the 1994 land use survey, there was one milk cow location identified in which information regarding the feeding regime for the animals, and the ages of onsite consumers of the milk could not be established. Because no specific information is known, it is conservatively assumed that the feeding factor for that location is equal to the worst-

Replace with insert from next page

case feeding factor identified during the 1994 land use census for any real cow location (i.e., 70% pasture feeding) and that all four age groups are present. Since specific data on beef animals were not available, the nearest beef animal was assumed to be at the point of maximum offsite exposure. Milk ingestion is the critical pathway.

TVA assumes that enough fresh vegetables are produced at each residence to supply annual consumption by all members of that household. TVA assumes that enough meat is produced in each sector annulus to supply the needs of that region. Watts Bar projected population distribution for the year 2040 is given in Table 11.3-9.

Doses are calculated using the dose factors and methodology contained in NRC Regulatory Guide 1.109 with certain exceptions as follows:

(1) Inhalation doses are based on the average individuals inhalation rates found in ICRP Publication 23 of 1,400; 5,500; 8,000; and 8,100 m^3/year for infant, child, teen, and adult, respectively.

(2) The milk ingestion pathway has been modeled to include specific information on grazing periods for milk animals obtained from a detailed farm survey. A feeding factor (FF) has been defined as that fraction of total feed intake a dairy animal consumes that is from fresh forage. The remaining portion of feed (1-FF) is assumed to be from stored feed. Doses calculated from milk produced by animals consuming fresh forage are multiplied by these factors. Concentrations of radioactivity in stored feed are adjusted to reflect radioactive decay during the maximum assumed storage period of 180 days by the factor:

Insert the following here and onto the preceding page: "The calculation assumes feeding factor of 0.65 for all cow receptors in the 2007 LUS. The value is taken from Figure 2.2 in NUREG/CR-4653 "GASPAR II - Technical Reference and User Guide," 1987 that provides the growing season across the US. The value chosen is on the high end for the middle Tennessee Valley. The LUS and publicly available information support that this is a conservative feeding factor. Supplemental feed is assumed to be grown in the vicinity of Watts Bar and have the same nuclide source as the pasture."

This factor replaces the factor exp $(-\lambda_i t_h)$ in equation C-10 of Regulatory Guide 1.109.

(3) The stored vegetable and beef ingestion pathways have been modeled to reflect more accurately the actual dietary characteristics of individuals. For stored vegetables the assumption is made that home grown stored vegetables are consumed when fresh vegetables are not available, i.e., during the 9 months of fall, winter, and spring. Rather than use a constant

Replace with "11.3-11 and 11.3-12"

Category	Ages (A)*	Fraction
Teen	13<A<19	0.153
Adult	19≤A	0.665

* e.g., someone who is 1 year, 11 months is an infant, while someone who is exactly two years old is a child.

Tables 11.3-10 and 11.3-11 provide the doses estimated for individuals and the population within 50 miles of the plant site.

11.3.10.2 Summary of Annual Population Doses

Replace with "1,500,000"

TVA has estimated the radiological impact to regional population groups in the year 2040 from the normal operation of the Watts Bar Nuclear Plant. Table 11.3-11 summarizes these population doses. The total body dose from background to individuals within the United States ranges from approximately 100 mrem to 250 mrem per year. The annual total body dose due to background for a population of about 1,100,000 persons expected to live within a 50 mile radius of the Watts Bar Nuclear Plant in the year 2040 is calculated to be approximately 154,000 man-rem assuming 140 mrem/year/individual. By comparison, the same population (excluding onsite radiation workers) will receive a total body dose of approximately 3.85 man-rem from effluents. Based on these results, TVA concludes that the normal operation of the Watts Bar Nuclear Plant will present minimal risk to the health and safety of the public.

REFERENCES

None

Replace with "210,000"

Replace with "6.66"

Insert with "TVA assumes that enough fresh vegetables are produced at each residence to supply annual consumption by all members of that household. TVA assumes that enough meat is produced in each sector annulus to supply the needs of that region. Watts Bar projected population distribution for the year 2040 is given in Table 11.3-9. Vegetable ingestion is the critical pathway."

Table 11.3-6 Radioactive Gaseous Effluent Parameters (Page 1 of 2)

1. Thermal Power Rating is 3582 MWt. (For Unit 1 only, Tritium releases based on 3425 MWt. Tritium isotope determination for the Non-Tritium Production Core based on 3480 MWt)
2. Primary and secondary side coolant and steam activities are based on NUREG-0017 and have been plant adjusted for WBN specific parameters.

   Replace with "ANSI N18.1"
3. RCS water parameters:

   Volume = 11,375 ft^3
   Press. = 2250 psia
   Temp. = 588.2 °F
   Spec. Vol. = 0.02265 ft^3/lb

   Replace with "WGDT"
4. Containment releases are filtered through a HEPA and charcoal filter with minimum filtration efficiencies of 99% and 70%, respectively.
5. Containment gaseous source terms are based on a 3%/day (noble gas) and 8.0E-4%/day (iodines) release of RCS coolant into the containment airborne atmosphere.
6. WCDT releases are based on a 173 ft^3/day (@ STP) input of RCS coolant offgas to the waste gas disposal system and a WGDT holdup time of 60 days.
7. Auxiliary Building (AB) ventilation noble gas source terms are based on a 160 lb/day release of RCS coolant activity into the AB atmosphere.
8. AB ventilation iodine releases are based on 1.85 Ci/yr per µCi/gm of RCS for 300 days and 6.8 Ci/yr per µCi/gm for 65 days.
9. Refueling Area iodine releases are based on 0.16 Ci/yr per µCi/gm of RCS for 300 days and 0.3 Ci/yr per µCi/gm for 65 days.
10. Turbine Building (TB) ventilation noble gas source terms are based on a 1700 lb/hr release of secondary steam into the TB atmosphere.
11. TB ventilation iodine source terms are based on 8500 Ci/yr per µCi/gm of secondary steam for 300 days and 1400 Ci/yr per µCi/gm for 65 days.
12. Condenser vacuum exhaust noble gas source terms are based on a steam flowrate to the condenser of 8.5E6 lb/hr at secondary steam activities.
13. Condenser vacuum exhaust iodine source terms are based on a 3500 Ci/yr per µCi/gm of secondary steam released to the condenser vacuum exhaust.
14. Steam generator blowdown flash tank source terms are based on a maximum steam generator blowdown flow of 12.5 gpm/steam generator. Iodines are further reduced in the offgases by applying a 0.05 partition factor. There are no noble gas releases from this path as there are no noble gas source terms in the secondary coolant.
15. Ar-41 releases are 34 Ci/yr.
16. Total tritium releases are based on 0.4 Ci/yr per MWt, with 10% of that available for release via gaseous pathways.
17. Total particulate releases are taken directly from Table 2-17 of NUREG-0017. Since these values are prior to treatment, the releases from the Containment Building either through the purge air, or containment vent filters, are reduced by applying a HEPA filtration factor of 0.01 (99% efficiency).

Table 11.3-6 Radioactive Gaseous Effluent Parameters (Page 2 of 2)

18.	C-14 releases are 1.6 Ci/yr from containment, 4.5 Ci/yr from the AB, and 1.2 Ci/yr from the GWPS for a total of 7.3 Ci/yr.
19.	The WGS discharge is filtered with a HEPA (efficiency of 99%) and charcoal (efficiency 70%) filter prior to release.
20.	NUREG-0017 suggests 22 containment purges a year during power operation, and 2 purges during refueling. However, one purge every two weeks will be used in the calculation. In addition, continuous containment vent with 100 cfm will be evaluated.

Replace with

"A continuous filtered containment vent of 100 cfm is the expected normal release and is evaluated. A separate evaluation assuming one purge every two weeks will be performed. NUREG-0017 suggests 22 containment purges a year during power operation, and 2 purges during refueling."

ANSI N18.1-1984

Table 11.3-7c Total Releases (≈ 1/8 failed fuel in Ci/yr), with Continuous Filtered Containment Vent (Sheet 1 of 1)

Table based on operation of one unit

Nuclide	Contain.(1) Building	Aux. Building	Turbine Building	Total
Kr-85m	3.72E+00	4.53E+00	1.23E+00	9.48E+00
Kr-85	6.69E+02	7.05E+00	1.86E+00	6.78E+02
Kr-87	4.48E-01	4.27E+00	1.09E+00	5.81E+00
Kr-88	3.10E+00	7.95E+00	2.13E+00	1.32E+01
Xe-131m	1.07E+03	1.73E+01	4.53E+00	1.09E+03
Xe-133m	4.07E+01	1.90E+00	5.21E-01	4.31E+01
Xe-133	2.82E+03	6.70E+01	1.77E+01	2.90E+03
Xe-135m	2.26E-02	3.68E+00	9.80E-01	4.68E+00
Xe-135	5.83E+01	2.40E+01	6.46E+01	8.88E+01
Xe-137	3.76E-04	9.67E-01	2.58E-01	1.23E+00
Xe-138	1.69E-02	3.42E+00	9.06E-01	4.34E+00
Ar-41	3.40E+01	0.00E+00	0.00E+00	3.40E+01
Br-84	8.16E-07	5.02E-02	4.81E-04	5.07E-02
I-131	6.74E-03	1.39E-01	7.08E-03	1.53E-01
I-132	1.36E-04	6.56E-01	1.70E-02	6.73E-01
I-133	2.36E-03	4.35E-01	2.03E-02	4.57E-01
I-134	4.26E-05	1.06E+00	1.47E-02	1.07E+00
I-135	8.80E-04	8.10E-01	3.13E-02	8.42E-01
H-3	1.39E+02	0.00E+00	0.00E+00	1.39E+02
H-3 (TPC)	3.70E+02	0.00E+00	0.00E+00	3.70E+02
Cr-51	9.21E-05	5.00E-04	0.00E+00	5.92E-04
Mn-54	5.30E-05	3.78E-04	0.00E+00	4.31E-04
Co-57	8.20E-06	0.00E+00	0.00E+00	8.20E-06
Co-58	2.50E-04	2.29E-02	0.00E+00	2.32E-02
Co-60	2.61E-05	8.71E-03	0.00E+00	8.74E-03
Fe-59	2.70E-05	5.00E-05	0.00E+00	7.70E-05
Sr-89	1.30E-04	2.85E-03	0.00E+00	2.98E-03
Sr-90	5.22E-05	1.09E-03	0.00E+00	1.14E-03
Zr-95	4.80E-08	1.00E-03	0.00E+00	1.00E-03
Nb-95	1.80E-05	2.43E-03	0.00E+00	2.45E-03
Ru-103	1.60E-05	6.10E-05	0.00E+00	7.70E-05
Ru-106	2.70E-08	7.50E-05	0.00E+00	7.50E-05
Sb-125	0.00E+00	6.09E-05	0.00E+00	6.09E-05
Cs-134	2.53E-05	2.24E-03	0.00E+00	2.27E-03
Cs-136	3.21E-05	4.80E-05	0.00E+00	8.01E-05
Cs-137	5.58E-05	3.42E-03	0.00E+00	3.48E-03
Ba-140	2.30E-07	4.00E-04	0.00E+00	4.00E-04
Ce-141	1.30E-05	2.64E-05	0.00E+00	3.95E-05
C-14	2.80E+00	4.50E+00	0.00E+00	7.30E+00

(TPC) Tritium values for a Tritium Production Core (Unit 1 only)

Delete

Table 11.3-8 Data On Points Of Interest Near Watts Bar Nuclear Plant (Page 1 of 2)

	Sector	Distance (Meters)	Chi-over-Q (s/m^3)	D-over-Q (1/m^2)	Terrain Adjustment Factor	Milk Feeding Factor
Unrestricted Area Boundary	N	1550	5.12e-06	8.13e-09	1.70	
Unrestricted Area Boundary	NNE	1980	6.35e-06	1.23e-08	1.80	
Unrestricted Area Boundary	NE	1580	1.05e-05	1.10e-08	2.10	
Unrestricted Area Boundary	ENE	1370	1.23e-05	8.77e-09	1.70	
Unrestricted Area Boundary	E	1280	1.37e-05	9.66e-09	1.60	
Unrestricted Area Boundary	ESE	1250	1.43e-05	1.16e-08	1.80	
Unrestricted Area Boundary	SE	1250	1.11e-05	9.49e-09	1.50	
Unrestricted Area Boundary	SSE	1250	6.04e-06	8.21e-09	1.50	
Unrestricted Area Boundary	S	1340	5.33e-06	1.17e-08	1.90	
Unrestricted Area Boundary	SSW	1550	4.14e-06	1.05e-08	2.00	
Unrestricted Area Boundary	SW	1670	4.46e-06	7.34e-09	2.10	
Unrestricted Area Boundary	WSW	1430	5.47e-06	6.37e-09	1.90	
Replace with "Nearest Garden"	NE	3353	3.84e-06	3.22e-09	2.20	
Replace with "Nearest Garden"	E	6372	1.35e-06	5.42e-10	1.40	
Replace with "Nearest Garden"	ESE	4758	2.26e-06	1.21e-09	1.80	
Replace with "Nearest Garden"	SSE	7454	3.73e-07	2.80e-10	1.10	
Resident	N	2134	2.84e-06	4.21e-09	1.50	
Resident	NNE	3600	2.69e-06	4.41e-09	1.80	
Resident	NE	3353	3.84e-06	3.22e-09	2.20	
Resident	ENE	2414	6.26e-06	3.83e-09	1.90	
Resident	E	3268	3.97e-06	2.14e-09	1.70	
Resident	ESE	4416	2.64e-06	1.46e-09	1.90	
Resident	SE	1372	9.66e-06	8.16e-09	1.50	
Resident	SSE	1524	4.18e-06	5.56e-09	1.40	
Resident	S	1585	3.91e-06	8.42e-09	1.80	
Resident	SSW	1979	2.76e-06	6.64e-09	1.90	
Resident	SW	4230	1.15e-06	1.43e-09	2.00	
Resident	WSW	1829	3.61e-06	4.03e-09	1.70	
Resident	W	2896	7.30e-07	6.01e-10	1.10	
Resident	WNW	1646	2.26e-06	2.12e-09	2.90	
Resident	NW	2061	1.03e-06	9.95e-10	1.50	
Resident	NNW	4389	3.50e-07	2.97e-10	1.00	
Garden	N	7664	3.13e-07	3.00e-10	1.00	
Garden	NNE	6173	1.06e-06	1.42e-09	1.50	
Garden	NE	3829	3.06e-06	2.44e-09	2.10	
Garden	ENE	4927	2.01e-06	9.39e-10	1.60	
Garden	E	4991	1.99e-06	9.02e-10	1.50	
Garden	ESE	6096	1.63e-06	7.77e-10	1.80	
Garden	SE	4633	1.58e-06	8.97e-10	1.30	
Garden	SSE	7454	4.74e-07	3.57e-10	1.40	
Garden	S	2254	2.50e-06	4.94e-09	1.90	

Insert "Nearest" in front of each listing.

Table 11.3-8 Data On Points Of Interest Near Watts Bar Nuclear Plant (Page 2 of 2)

	Sector	Distance (Meters)	Chi-over-Q (s/m^3)	D-over-Q (1/m^2)	Terrain Adjustment Factor	Milk Feeding Factor
Garden	SSW	8100	2.79e-07	4.16e-10	1.40	
Garden	SW	8100	4.28e-07	4.03e-10	1.80	
Garden	WSW	4667	9.86e-07	8.06e-10	1.70	
Garden	W	5120	3.33e-07	2.23e-10	1.10	
Garden	WNW	5909	1.85e-07	1.13e-10	1.40	
Garden	NW	3170	5.63e-07	4.78e-10	1.50	
Garden	NNW	4698	3.18e-07	2.64e-10	1.00	
Milk Cow	ESE	6096	1.63e-06	7.77e-10	1.80	0.25
Milk Cow	ESE	6706	1.35e-06	6.18e-10	1.70	0.03
Milk Cow	SSW	2286	2.24e-06	5.20e-09	1.90	0.05
Milk Cow	SSW	3353	1.36e-06	2.84e-09	2.00	0.33

Replace with "Nearest Garden"	SSW	1979	2.76e-06	6.64e-09	1.90	
Replace with "Nearest Garden"	SW	8100	4.28e-07	4.03e-10	1.80	
Replace with "Nearest Garden"	WSW	4667	8.70e-07	7.11e-10	1.50	
Replace with "Nearest Garden"	W	5120	3.03e-07	2.03e-10	1.00	
Replace with "Nearest Garden"	WNW	5909	1.72e-07	1.05e-10	1.30	
Replace with "Nearest Garden"	NW	3170	4.13e-06	3.50e-10	1.10	
Replace with "Nearest Garden"	NNW	4602	3.28e-07	2.74e-10	1.00	
Milk Cow	ESE	6706	1.35e-06	6.18e-10	1.70	0.65
Milk Cow	SSW	2286	2.24e-06	5.20e-09	1.90	0.65
Milk Cow	SSW	3353	1.36e-06	2.84e-09	2.00	0.65

Table 11.3-9 Projected 2040 Population Distribution Within 50 Miles Of Watts Bar Nuclear Plant Population Within Each Sector Element Distance From Site (Miles)

N	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
NNE	0	111	32	47	135	893	2071	2166	3453	4040
NE	0	25	25	76	43	796	8591	19187	9342	1194
ENE	0	0	130	208	130	861	3381	19210	30623	54111
E	0	2	55	53	78	252	2445	9497	38457	136395
ESE	0	2	7	53	38	482	9716	8837	10649	17404
SE	0	2	4	47	58	591	4514	12085	3420	300
SSE	0	0	16	35	29	505	17835	10818	3969	3756
S	12	23	3	27	24	714	4018	8056	3899	6362
SSW	0	54	14	24	257	1368	1141	34699	40812	11522
SW	0	34	7	19	32	739	5653	17523	25829	117868
WSW	0	0	5	2	0	519	6490	9411	68565	125338
W	0	10	40	38	30	1281	10369	2091	7134	6571
WNW	2	5	19	59	65	837	965	5337	2839	2035
NW	5	30	10	140	121	244	1461	2925	3440	17598
NNW	0	10	111	113	387	2279	314	7266	7004	9802
Total	0	0	62	87	98	2081	874	18279	4784	2983
	19	308	540	1028	1525	14442	79838	187387	264219	517279

Replace with attached revised table

Table 11.3-9
Projected 2040 Population Distribution
Within 50 Miles of Watts Bar Nuclear Plant Population
Within Each Sector Element Distance from Site (Miles)

Direction	0-10	10-20	20-30	30-40	40-50	Total
N	2,619	1,885	2,778	4,768	6,172	18,222
NNE	2,150	11,762	18,766	14,502	2,547	49,727
NE	1,441	3,783	16,734	29,838	78,334	130,130
ENE	1,110	3,553	29,539	63,798	253,831	351,832
E	1,915	11,352	18,647	30,063	44,013	105,990
ESE	135	6,230	20,120	5,068	3,280	34,833
SE	203	19,852	15,185	3,950	4,822	44,012
SSE	782	8,951	12,907	2,918	48,593	74,151
S	5,823	4,586	42,883	56,430	17,985	127,707
SSW	567	5,725	42,517	46,281	106,392	201,482
SW	1,051	12,978	14,499	62,307	111,795	202,630
WSW	938	12,791	2,837	2,840	3,372	22,778
W	937	3,406	5,555	2,944	5,474	18,316
WNW	717	2,091	4,372	5,654	20,511	33,345
NW	3,998	2,889	18,634	10,462	15,956	51,940
NNW	3,413	1,536	33,843	11,609	5,890	56,290
TOTAL	27,799	113,368	299,818	353,432	728,968	1,523,385

New Data for Table 11.3-9

Replace with

"Bone"

Table 11.3-10 Watts Bar Nuclear Plant- Individual Doses From Gaseous Effluents (For 1 Unit without TPC)

Effluent	Pathway	Guideline*	Location	Dose
Noble Gases	γ Air dose	10 mrad	Maximum Exposed Individual[1]	0.801 mrad/yr
	β Air dose	20 mrad	Maximum Exposed Individual[1]	2.710 mrad/yr
	Total body	5 mrem	Maximum Residence[2,3]	0.571 mrem/yr
	Skin	15 mrem	Maximum Residence[2,3]	1.540 mrem/yr
Iodines/ Particulates	Thyroid (critical organ)	15 mrem	Maximum Real Pathway[4]	2.715 mrem/yr

Replace with

9.15

Breakdown of Iodine/Particulate Doses (mrem/yr)

Replace with

Total Vegetable Ingestion

Cow Milk with Feeding Factor of 0.33	2.44
Inhalation	0.174
Ground Contamination	0.0405
Submersion	0.0603
Beef Ingestion[1]	0.0
Total	2.7148

Replace with "5"

Replace with

"6.57

0.0704

0.0947

0.130

2.28

9.145 mrem/yr"

*Guidelines are defined in Appendix I to 10 CFR Part 50.

[1]Maximum exposure point is at 1250 meters in the SE sector.

Replace with

"ESE"

[2]Dose from air submersion.

[3]Maximum exposed residence is at 1372 meters in the SE sector.

[4]Maximum exposed individual is an infant at 3353 meters in the SSW sector.

Replace with

"1979"

Replace with

"a child"

Insert the following: "[5]Maximum dose location for all receptors is 1250 meters in the ESE sector."

Table 11.3-11 Summary Of Population Doses

THYROID

	Infant	Child	Teen	Adult	Total
Submersion	8.28E-02	1.59E-01	1.44E-01	6.28E-01	9.45E-01
Ground	3.11E-03	3.49E-02	3.17E-02	1.38E-01	2.08E-01
Inhalation	7.45E-02	1.39E-00	7.44E-01	2.64E+00	4.85E+00
Cow Milk Ingestion	4.09E-01	1.98E-00	8.42E-01	1.60E-00	4.83E+00
Beef Ingestion	0.00E+00	3.52E-01	1.77E-01	8.93E-01	1.42E-00
Vegetable Ingestion	0.00E+00	1.18E-00	4.76E-01	1.26E-01	2.92E+00
Total man-rem	5.01E-01	5.10E+00	2.42E+00	7.15E+00	1.52E+01

TOTAL BODY

	Infant	Child	Teen	Adult	Total
Submersion	1.42E-02	1.59E-01	1.44E-01	6.28E-01	9.45E-01
Ground	3.11E-03	3.49E-02	3.17E-02	1.38E-01	2.08E-01
Inhalation	4.28E-03	1.14E-01	7.23E-02	2.99E-01	4.90E-01
Cow Milk Ingestion	1.14E-01	6.30E-01	2.39E-01	4.25E-01	1.41E-00
Beef Ingestion	0.00E+00	3.36E-01	1.69E-01	8.52E-01	1.36E-00
Vegetable Ingestion	0.00E+00	1.20E-00	5.08E-01	1.42E-00	3.12E+00
Total man-rem	1.36E-01	2.47E+00	1.16E-00	3.76E+00	7.53E+00

Replace with information provided by the following page

Table 11.3-11 Summary of Population Doses

THYROID

	Infant	Child	Teen	Adult	Total
Submersion	1.26e-02	1.41e-01	1.28e-01	5.57e-01	8.38e-01
Ground	2.31e-03	2.59e-02	2.36e-02	1.03e-01	1.54e-01
Inhalation	6.62e-02	1.24e+00	6.64e-01	2.36e+00	4.33e-00
Cow Milk Ingestion	3.22e-01	1.57e+00	6.63e-01	1.25e+00	3.81e+00
Beef Ingestion	0.00e+00	3.17e-01	1.59e-01	8.04e-01	1.28e+00
Vegetable Ingestion	0.00e+00	1.04e+00	4.16e-01	1.09e+00	2.55e+00
Total man-rem	4.04e-01	4.34e+00	2.05e+00	6.17e+00	1.30e+01

TOTAL BODY

	Infant	Child	Teen	Adult	Total
Submersion	1.26e-02	1.41e-01	1.28e-01	5.57e-01	8.38e-01
Ground	2.31e-03	2.59e-02	2.36e-02	1.03e-01	1.54e-01
Inhalation	3.93e-03	1.05e-01	6.65e-02	2.76e-01	4.52e-01
Cow Milk Ingestion	1.04e-01	5.73e-01	2.17e-01	3.85e-01	1.28e+00
Beef Ingestion	0.00e+00	3.06e-01	1.53e-01	7.74e-01	1.23e+00
Vegetable Ingestion	0.00e+00	1.05e+00	4.40e-01	1.21e+00	2.70e+00
Total man-rem	1.23e-01	2.20e+00	1.03e+00	3.31e+00	6.66e+00

Use this data to replace information in preceding table.

Enclosure 2, Attachment 3
Response to FSAR Chapter 11 and FSEIS, Chapter 3
Request For Additional Information

Proposed Clean Copy of FSAR Sections 11.1, 11.2 and 11.3

11.0 RADIOACTIVE WASTE MANAGEMENT

11.1 SOURCE TERMS

The fission product inventory in the reactor core and the diffusion to the fuel pellet/cladding gap are presented in Section 15.1.7.

11.1.1 Historical Design Model for Radioactivities in Systems and Components

This section and associated Tables 11.1-1 through 11.1-5 present results of the original Westinghouse Design Calculations using methodology in References [2] and [3]. The results are presented as background and are superseded by calculations described in Section 11.1.2 and Tables 11.1-6 and 11.1-7.

11.1.1.1 Reactor Coolant Historical Design Activity

The parameters used in the calculation of the reactor coolant fission product design inventories together with the pertinent information concerning the design reactor coolant cleanup flow rate and demineralizer effectiveness, are summarized in Table 11.1-1. The results of the calculations are presented in Tables 11.1-2 through 11.1-4. In these calculations the defective fuel rods are assumed to be present at the initial core loading and to be uniformly distributed throughout the core; thus, the fission product escape rate coefficient are based upon average fuel temperature.

For fuel failure and burnup experience, see Section 4.2.1.3.3.

The fission product activities in the reactor coolant during operation with small cladding defects (fuel rods containing pin-holes or fine cracks) are computed using the following differential equations:

for parent nuclides in the coolant:

$$\frac{dN_{wi}}{dt} = D\nu_i N_{c_i} - \left(\lambda_i + R\eta_i + \frac{B'}{B_o - tB'}\right) N_{wi}$$

for daughter nuclides in the coolant:

$$\frac{dN_{wj}}{dt} = D\nu_j N_{c_j} - \left(\lambda + R\eta_j + \frac{B'}{B_o - tB'}\right) N_{wj} + \lambda_i N_{wi}$$

symbols:

N = nuclide concentration

D = clad defects, as a fraction of rated core thermal power being generated by rods with clad defects

R = purification flow, coolant system volumes per sec.

B_o = initial boron concentration, ppm

B' = boron concentration reduction rate by feed and bleed, ppm per sec.

η = removal efficiency of purification cycle for nuclide

λ = radioactive decay constant

ν = escape rate coefficient for diffusion into coolant

t = elapsed time (seconds) since the beginning of cycle

subscripts:

C = refers to core

w = refers to coolant

i = refers to parent nuclide

j = refers to daughter

11.1.1.2 Volume Control Tank Historical Design Activity

Table 11.1-3 lists the activities in the volume control tank using the assumptions summarized in Table 11.1-1.

11.1.1.3 Pressurizer Historical Design Activity

The activities in the pressurizer are separated between the liquid and the steam phase and the results obtained are given in Table 11.1-4 using the assumptions summarized in Table 11.1-1.

11.1.1.4 Gaseous Waste Processing System Historical Design Activities

The activities to be found in the Gaseous Waste Processing System are given in Table 11.1-5.

11.1.1.5 Secondary Coolant Historical Design Activities

The secondary cleanup system design activities used for shielding design calculations are discussed in Subsection 12.2.1.5.

11.1.2 Realistic Model for Radioactivities in Systems and Components

This section and associated Tables 11.1-6 and 11.1-7 present results which supersede the calculations in the previous sections. The Tritium Producing Burnable Absorber Rods (TPBARs) (Unit 1 only) are designed and fabricated to retain all the tritium produced within the TPBAR. Since the TPBAR produced tritium is chemically bonded within the TPBAR, virtually no tritium is available in a form that could permeate through the TPBAR cladding. However, it is assumed that while operating with a Tritium Production Core (TPC), some of the tritium inventory in the TPBARs may permeate the cladding material and be released to the primary coolant. The design goal for this permeation process is less than 1000 Ci per 1000 TPBARs per year. Thus a single TPBAR may release more than 1 Ci/year, but the total release for 1,000 TPBARs will be less than 1000 Ci/year. As the TPC will contain up to 2,304 TPBARs at WBN (Unit 1 only), the total design basis tritium input from the maximum number of TPBARs is 2,304 Ci/year into the Reactor Coolant System.

The parameters used to describe Watts Bar are given in Table 11.1-6 together with the nominal values given in ANS-18.1-1984. In order to obtain primary coolant activities, the correction formula from ANSI/ANS-18.1-1984 [1], was applied to the activities listed in Reference [1]. Secondary side water and steam activities were similarly obtained from the values given in Reference [1].

The specific activities for primary and secondary sides are calculated by ANSI/ANS-18.1-1984 [1] methodology and given in Table 11.1-7.

11.1.3 Plant Leakage

As a necessary part of the effort to reduce effluent of radioactive liquid wastes, Westinghouse surveyed various PWR facilities which are in operation, to identify design and operating problems influencing reactor coolant and nonreactor grade leakage and hence the load on a waste processing system. Liquid leakage sources have been identified primarily in connection with pump shaft seals and valve stem leakage.

Where packed glands are provided, leakage may be anticipated, while mechanical shaft seals provide essentially zero leakage. Valve stem leakage was experienced where the originally specified packing was used. A combination of a graphite filament yarn packing sandwiched with asbestos sheet packing is used with improved results in several plants. For Watts Bar the majority of the valves used are diaphragm valves. This type of valve provides positive control stem leakage and is suitable for use as an isolation valve as well as a throttling valve.

Expected leakage rates of liquids to be treated in the liquid waste processing system are summarized in Table 11.2-1.

Total plant liquid and gaseous releases are discussed in Subsections 11.2.6 and 11.3.7, respectively.

11.1.4 Additional Sources

During normal operation, the sources of radioactive material not normally considered part of the radioactive waste system are as follows:

(1) Containment Purging System

(2) Turbine Gland Sealing System

(3) Main Condenser Evacuation System

(4) Auxiliary Building Ventilation System

(5) Turbine Building Ventilation System

(6) Steam Generator Blowdown System

Estimates for the release of radioactive materials from sources: 1 through 5 (above) are presented in Section 11.3.7. The release paths and transport mechanism for these sources of radioactive material are also presented in Section 11.3.8.

The Steam Generator Blowdown System (SGBS) is another source of liquid radioactive material that is not normally considered part of the radioactive waste system. The system description, release paths, and flow rates are presented in Section 11.2 and in Section 10.4.8. The release path that is of concern in evaluating the radiological consequences of liquid releases from steam generator blowdowns is the path to the river via the cooling tower blowdown line. This route is used primarily during periods when there is no significant primary to secondary leakage. The discharge to the river is monitored for radioactivity as specified in Section 11.4. An alarm in the Main Control Room alerts the operator of an increasing radioactivity level in the discharge. If the radiation setpoint is exceeded, the blowdown discharge is automatically diverted to the condensate demineralizers. The basis for the setpoint is presented in Section 11.4.

References

(1) ANSI/ANS-18.1-1984, "Radioactive Source Term For Normal Operation of Light Water Reactors," December 31, 1984.

(2) WCAP-8253, "Source Term Data for Westinghouse Pressurized Water Reactors", Westinghouse Electric Corporation, Pittsburgh, Pa. 15230, April 1974.

(3) WCAP-7664, R1 "Radiation Analysis Design Manual - 4-Loop Plant", October 1972.

Table 11.1-1 Parameters Used In The Calculation of Reactor Coolant Fission and Corrosion Product Historical Design Activities (Page 1 of 2)

1.	Core thermal power, MWt	3565
2.	Clad defects, as a percent of rated core thermal power being generated by rods with clad defects	1.0
3.	Reactor coolant liquid volume, ft^3	11,781
4.	Reactor coolant full power average temperature, °F	588
5.	Purification flow rate (normal) gpm	75
6.	Effective cation demineralizer flow, gpm	7.5
7.	Volume control tank volumes	
	a.Vapor, ft^3	240
	b.Liquid, ft^3	160
8.	Fission product escape rate coefficients:*	
	a.Noble gas isotopes, sec^{-1}	6.5×10^{-8}
	b.Br, I and Cs isotopes, sec^{-1}	1.3×10^{-8}
	c.Te isotopes, sec^{-1}	1.0×10^{-9}
	d.Mo isotopes, sec^{-1}	2.0×10^{-9}
	e.Sr and Ba isotopes, sec^{-1}	1.0×10^{-11}
	f.Y, La, Ce, Pr isotopes, sec^{-1}	1.6×10^{-12}
9.	Mixed bed demineralizer decontamination factors:	
	a.Noble gases and Cs-134, 136, 137 Y-90, 91 and Mo-99	1.0
	b.All other isotopes including corrosion products	10.0
10.	Cation bed demineralized decontamination factor for Cs-134, 136, 137, Y-90, 91, Mo-99	10.0

* Escape rate coefficients are based on fuel defect tests performed at the Saxton Reactor. Experience at two plants operating with fuel rod defects has verified the listed escape rate coefficients.

Table 11.1-1 Parameters Used In The Calculation of Reactor Coolant Fission and Corrosion Product Historical Design Activities (Page 2 of 2)

11. Volume control tank noble gas stripping fractions		
		Stripping Fraction
	Isotope	
	Kr-85	2.3×10^{-5}
	Kr-85m	2.7×10^{-1}
	Kr-87	6.0×10^{-1}
	Kr-88	4.3×10^{-1}
	Xe-131m	7.1×10^{-3}
	Xe-133	1.6×10^{-2}
	Xe-133m	3.7×10^{-2}
	Xe-135	1.8×10^{-1}
	Xe-135m	8.0×10^{-1}
	Xe-138	1.0
12. Boron concentration and reduction rates		
a. B_0 (initial cycle)		860
B' (initial cycle)		3.0 ppm/day
b. B_0 (equilibrium cycle)		1200 ppm
B' (equilibrium cycle)		4.0 ppm/day
13. Pressurizer volumes		
a. Vapor		720 ft^3
b. Liquid		1080 ft^3
14. Spray line flow		1.0 gpm
15. Pressurizer stripping fractions		
a. Noble gases		1.0
b. All other elements		0

Table 11.1-2 Reactor Coolant Equilibrium Fission And Corrosion Product Historical Design Activities

Isotope	Activity µCi/gm
Br-84	4.2×10^{-2}
Rb-88	3.7
Rb-89	1.0×10^{-1}
Sr-89	3.8×10^{-3}
Sr-90	1.1×10^{-4}
Sr-91	1.9×10^{-3}
Y-90	1.3×10^{-4}
Y-91	5.5×10^{-3}
Y-92	7.3×10^{-4}
Zr-95	6.7×10^{-4}
Nb-95	6.4×10^{-4}
Mo-99	5.3
I-131	2.5
I-132	9.0×10^{-1}
I-133	4.0
I-134	5.6×10^{-1}
I-135	2.2
Te-132	2.6×10^{-1}
Te-134	2.9×10^{-2}
Cs-134	2.1×10^{-1}
Cs-136	1.4×10^{-1}
Cs-137	1.0
Cs-138	9.5×10^{-1}
Ba-140	4.2×10^{-3}
La-140	1.5×10^{-3}
Ce-144	2.7×10^{-4}
Pr-144	2.7×10^{-4}
Kr-85	4.7 (Peak)
Kr-85m	2.2
Kr-87	1.2
Kr-88	3.7
Xe-131m	1.9
Xe-133	2.88×10^{2}
Xe-133m	3.2
Xe-135	6.3
Xe-135m	1.9×10^{-1}
Xe-138	6.8×10^{-1}
Mn-54*	7.7×10^{-4}
Mn-56*	2.9×10^{-2}
Co-58*	2.5×10^{-2}
Co-60*	7.4×10^{-4}
Fe-59*	1.0×10^{-3}
Cr-51*	9.3×10^{-4}

* Corrosion Product activities based on activity levels measured at operating reactors.

Table 11.1-3 Equilibrium Volume Control Tank Historical Design Activities
(Based on parameters given in Table 11.1-1)

Isotope	Vapor activity (Curies)
Kr-85	7.6
Kr-85m	5.6×10^{1}
Kr-87	2.2×10^{1}
Kr-88	1.1×10^{2}
Xe-131m	8.8×10^{1}
Xe-133	1.4×10^{4}
Xe-133m	1.5×10^{2}
Xe-135	2.5×10^{2}
Xe-135m	less than 1
Xe-138	4.6
	Liquid activity (Curies)
I-131	1.1
I-132	0.41
I-133	1.8
I-134	0.26
I-135	1.0

Table 11.1-4 Pressurizer Historical Design Activities

Isotope	Vapor activity (μ Ci/cc)
Kr-85	5.1×10^{1}
Kr-85m	1.0×10^{-1}
Kr-87	1.8×10^{-2}
Kr-88	1.2×10^{-1}
Xe-131m	4.7
Xe-133	3.6×10^{2}
Xe-133m	1.8
Xe-135	6.5×10^{-1}
Xe-135m	5.0×10^{-4}
Xe-138	2.2×10^{-3}
	Liquid activity (μ Ci/gm)
Rb-88	1.1×10^{-2}
Mo-99	2.2
I-131	1.6
I-132	2.0×10^{-2}
I-133	0.7
I-134	5.5×10^{-3}
I-135	0.14
Cs-137	1.3
Cs-138	5.5×10^{-3}

Table 11.1-5 Historical Design Inventory In The Gaseous Waste Processing System Single Unit

Isotope	Activity* (Curies)
Kr-85	4.4 x 10^{3}**
Kr-85m	6.2 x 10^{2}
Kr-87	3.3 x 10^{2}
Kr-88	1.1 x 10^{3}
Xe-131m	5.7 x 10^{2}
Xe-133	8.7 x 10^{4}
Xe-133m	9.7 x 10^{2}
Xe-135	1.9 x 10^{3}
Xe-135m	4.8 x 10^{1}
Xe-138	1.8 x 10^{2}

* For two units, the activities are doubled

** Represents the inventory of Kr-85 released to the reactor coolant during one year of full power operation. The remaining isotopes are equilibrium values.

Table 11.1-6 Parameters Used To Describe The Reactor Coolant System Realistic Basis

	Symbol	Units	Nominal ANS-18.1- 1984 Assumption	WBN Analysis Assumption
Thermal power	P	MWt	3400	3582
Steam flow rate	FS	lb/hr	1.5E+07	1.5E+07
Weight of water in all reactor coolant system	WP	lb	5.5E+05	5.4E+05
Weight of water in all steam generators	WS	lb	4.50E+05	3.48E+05
Reactor coolant letdown flow rate (purification)	FD	lb/hr	3.7E+04	3.7E+04
Reactor coolant letdown flow rate (yearly average for boron control)	FB	lb/hr	500	845
Steam generator blowdown flow (average total)	FBD	lb/hr	7.50E+04	3.00E+04
Fraction of radioactivity in blowdown stream which is not returned to the secondary coolant system	NBD	-	1.0	1.0
Flow through the purification system cation demineralizer	FA	lb/hr	3.7E+03	3.7E+03
Ratio of condensate demineralizer flow rate to the total steam flow rate	NC	-	0.0	0.55
Fraction of the noble gas activity in the letdown stream which is not returned to the reactor coolant system (not including the boron recovery system)	Y	-	0.0	0.0

Table 11.1-7 Specific Activities In Principal Fluid Streams Realistic Basis (μCi/gm) (Page 1 of 2)

Isotope	Reactor Coolant	Secondary Coolant Water	Secondary Coolant Steam
		Class 1 Noble Gases	
Kr-85m	1.71E-01	0.00E+00	3.63E-08
Kr-85	2.66E-01	0.00E+00	5.51E-08
Kr-87	1.61E-01	0.00E+00	3.22E-08
Kr-88	3.00E-01	0.00E+00	6.31E-08
Xe-131m	6.54E-01	0.00E+00	1.34E-07
Xe-133m	7.17E-02	0.00E+00	1.54E-08
Xe-133	2.53E+00	0.00E+00	5.25E-07
Xe-135m	1.39E-01	0.00E+00	2.90E-08
Xe-135	9.04E-01	0.00E+00	1.91E-07
Xe-137	3.65E-02	0.00E+00	7.62E-09
Xe-138	1.29E-01	0.00E+00	2.68E-08
		Class 2 Halogens	
Br-84	1.72E-02	9.56E-08	9.56E-10
I-131	4.77E-02	1.41E-06	1.41E-08
I-132	2.25E-01	3.37E-06	3.37E-08
I-133	1.49E-01	4.03E-06	4.03E-08
I-134	3.64E-01	2.93E-06	2.93E-08
I-135	2.78E-01	6.19E-06	6.19E-08
		Class 3 Cs, Rb	
Rb-88	2.04E-01	7.36E-07	3.61E-09
Cs-134	7.39E-03	4.58E-07	2.36E-09
Cs-136	9.08E-04	5.56E-08	2.78E-10
Cs-137	9.79E-03	6.11E-07	3.05E-09
		Class 4 Water Activation Products	
N-16	4.00E+01	1.29E-06	1.29E-07
		Class 5 Tritium	
H-3	1.00E+00	1.00E-03	1.00E-03

Table 11.1-7 Specific Activities In Principal Fluid Streams
Realistic Basis (µCi/gm)
(Page 2 of 2)

Class 6 Other Isotopes			
Na-24	4.99E-02	1.86E-06	9.30E-09
Cr-51	3.26E-03	1.56E-07	7.56E-10
Mn-54	1.68E-03	7.80E-08	3.96E-10
Fe-55	1.26E-03	5.88E-08	3.00E-10
Fe-59	3.16E-04	1.44E-08	7.32E-11
Co-58	4.84E-03	2.28E-07	1.13E-09
Co-60	5.58E-04	2.64E-08	1.32E-10
Zn-65	5.37E-04	2.52E-08	1.20E-10
Sr-89	1.47E-04	6.84E-09	3.48E-11
Sr-90	1.26E-05	5.88E-10	3.00E-12
Sr-91	1.02E-03	3.52E-08	1.76E-10
Y-90	1.26E-05	5.88E-10	3.00E-12
Y-91m	4.93E-04	4.34E-09	2.17E-11
Y-91	5.47E-06	2.52E-10	1.32E-12
Y-93	4.46E-03	1.50E-07	7.65E-10
Zr-95	4.10E-04	1.92E-08	9.48E-11
Nb-95	2.95E-04	1.32E-08	6.84E-11
Mo-99	6.75E-03	3.03E-07	1.45E-09
Tc-99m	5.01E-03	1.40E-07	7.27E-10
Ru-103	7.89E-03	3.72E-07	1.92E-09
Ru-106	9.47E-02	4.44E-06	2.16E-08
Rh-103	7.89E-03	3.72E-07	1.92E-09
Rh-106	9.47E-02	4.44E-06	2.16E-08
Ag-110m	1.37E-03	6.36E-08	3.24E-10
Te-129m	2.00E-04	9.36E-09	4.68E-11
Te-129	2.57E-02	2.96E-07	1.48E-09
Te-131m	1.59E-03	6.60E-08	3.30E-10
Te-131	8.26E-03	3.97E-08	2.05E-10
Te-132	1.79E-03	7.98E-08	3.99E-10
Ba-137m	9.79E-03	6.11E-07	3.05E-09
Ba-140	1.37E-02	6.25E-07	3.12E-09
La-140	2.64E-02	1.13E-06	5.60E-09
Ce-141	1.58E-04	7.32E-09	3.72E-11
Ce-143	2.96E-03	1.22E-07	6.23E-10
Ce-144	4.21E-03	1.92E-07	9.83E-10
Pr-143	2.96E-03	1.22E-07	6.23E-10
Pr-144	4.21E-03	1.92E-07	9.83E-10
W-187	2.65E-03	1.07E-07	5.40E-10
Np-239	2.32E-03	1.02E-07	5.09E-10

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11.2 LIQUID WASTE SYSTEMS

11.2.1 DESIGN OBJECTIVES

The Liquid Waste Processing System is designed to receive, segregate, process, and discharge liquid wastes. The system design considers potential personnel exposure and assures that quantities of radioactive releases to the environment are as low as reasonably achievable. Under normal plant operation, the activity from radionuclides leaving the cooling tower blowdown (CTB) line is a fraction of the limits in 10 CFR Parts 20 and 50.

The plant is designed to stay within 10 CFR 20 radiological criteria during normal operation, even assuming equipment faults which could occur with moderate frequency, including fuel cladding defects and failures of up to two TPBARs (Unit 1 only) in combination with such occurrences as:

(1) Steam Generator tube leaks

(2) Malfunction in Liquid Waste Processing System

(3) Excessive leakage in Reactor Coolant System Equipment

(4) Excessive leakage in Auxiliary System Equipment

The expected annual activity releases (by isotope) are presented in Subsection 11.2.6, and the estimated doses are presented in Subsection 11.2.9.

11.2.2 SYSTEMS DESCRIPTIONS

The Liquid Waste Processing System collects and processes potentially radioactive wastes for release to the river. Provisions are made to sample and analyze fluids before they are discharged. Based on the laboratory analysis, these wastes are either released under controlled conditions via the cooling tower blowdown or retained for further processing. A permanent record of liquid releases is provided by analyses of known volumes of waste. The system is shown on the Mechanical Flow Diagram (Figure 11.2-1.)

The radioactive liquids discharged from the Reactor Coolant System are processed by either the Chemical and Volume Control System (CVCS) holdup tanks or Tritiated Drain Collector Tank (TDCT). Expected volumes to be processed by the Waste Processing System are given in Table 11.2-1.

The liquid Waste Processing System (WPS) consists of two main sub-systems processing tritiated and non-tritiated water. A system is provided for handling laboratory samples which may be tritiated and may contain chemicals.

Much of the system is controlled or monitored from a central panel in the Auxiliary Building. Malfunction of the system actuates an alarm in the Auxiliary Building and a common alarm in the main control room (MCR). All liquid WPS equipment is located in or near the Auxiliary Building, except for the reactor coolant drain tank and drain tank pumps; containment pit sump and pumps; Reactor Building floor and equipment drain sump and pumps; Reactor Building floor and equipment drain pocket sump and pumps, which are located in the Reactor Building. A mobile demineralizer system is located and operated in the waste packaging area.

Fluid is sampled and analyzed to determine quantities of radioactivity, with an isotopic breakdown, if necessary, before processing or disposal is attempted.

At least two valves must be manually opened to permit discharge of liquid to the environment. One of these valves is normally locked closed. A control valve trips closed on a high effluent radioactivity level signal. Controls are provided to prevent discharge without adequate dilution.

The liquid waste processing system is partly shared by the two units. However, except for its containment isolation function, the system serves no primary safety function and the safety of either unit is not affected by such sharing. Liquid waste is processed, as necessary, through a mobile demineralizer.

The Liquid Waste Processing System components that are not shared consist of one reactor coolant drain tank with two pumps, the containment pit sump with one pump, the Reactor Building floor and equipment drain pocket sump with two pumps, and the Reactor Building floor and equipment drain sump with two pumps. All of this equipment is located inside the containment of each unit.

Shared Components

The following shared equipment is located inside the Auxiliary Building: one tritiated drain collector tank with two pumps and one filter, one floor drain collector tank with two pumps and one filter; three waste condensate tanks and two pumps; a chemical drain tank and pump; two laundry and hot shower tanks and pump; a spent resin storage tank; a cask decontamination collector tank with two pumps and two filters; monitor tank with two pumps; Auxiliary Building floor and equipment drain sump and pumps; one tritiated equipment drain sump with two pumps; Auxiliary Building passive sump; a mobile demineralizer system, and the associated piping, valves and instrumentation.

The following shared components are located in the Turbine Building for receiving, processing, and transferring wastes from the regeneration of condensate demineralizers: high crud tanks, pumps and filter, a neutralization tank and pumps, and a non-reclaimable waste tank and pumps.

The following shared components are located in the waste packaging area for receiving and processing liquid radwaste from the floor drain and tritiated drain collector tanks: a mobile demineralizer system, including cation and anion ion exchange resins, prefilter, associated pumps, a vendor supplied mobile demineralizer spent resin storage container, and associated piping and valves.

Separation of Tritiated and Non-Tritiated Liquids

Waste liquids are normally separated into tritiated and non-tritiated liquids. Waste liquids which are high in tritium content (reactor coolant leakoff/leakage) are routed to the tritiated drain collector tank, while liquids low in tritium content (non-reactor coolant/raw water) are routed to the floor drain collector tank. The tritiated and non-tritiated liquids are processed for release to the river.

Tritiated Water Processing

Tritiated water is processed for discharge to the river. The water enters the liquid waste disposal system from equipment leaks and drains, valve leakoffs, pump seal leakoffs, tank overflows, and other tritiated and aerated water sources.

The equipment provided in this subsystem consists of a TDCT, pumps and filter, reactor coolant drain tank and pumps; the containment pit sump and pump; the Reactor Building floor and equipment drain sump and pumps; the Reactor Building floor and equipment drain pocket sump; tritiated equipment drain sump, pumps and filter. The primary function of the tritiated drain collector tank is to provide sufficient surge capacity for the waste processing equipment. The waste is primarily processed by the mobile demineralizer system.

Non-Tritiated Water Processing

Non-tritiated water is processed for discharge to the river. The sources include floor drains, equipment drains containing non-tritiated water, certain sample room and radiochemical laboratory drains, laundry and hot shower drains and other non-tritiated sources. The equipment provided in this subsystem consists of pumps and filter; laundry and hot shower tanks and pump; laundry tank basket strainer; waste condensate tanks, pumps and filter; mobile demineralizer; chemical drain tank and pump; the Auxiliary Building floor and equipment drain sump and pumps; the Additional Equipment Building floor and equipment drain sump and pumps.

Liquids entering the floor drain collector tank are normally from low activity sources and are normally processed through a mobile demineralizer system.

The laundry and hot shower drains normally need no treatment for removal of radioactivity. This water is collected in the laundry and hot shower drain tanks. The inventory of these tanks may be discharged directly to the cooling tower blowdown (via the laundry tank strainer) or may be transferred to either the waste condensate tanks or the cask decontamination collector tank or to the monitor tank or the FDCT (via the laundry tank strainer) before final discharge to the cooling tower blowdown. Prior to discharge, a sample is taken and analyzed in accordance with plant procedures that implement the ODCM requirements, and the water is discharged if the activity level is below ODCM limits.

The blowdown from the steam generators is routed to the CPDS or the hotwell (refer to Subsection 10.4.8) or discharged directly to the cooling tower blowdown line.

Spent regenerant waste from the CPDS is addressed below.

Mobile Demineralizer System Processing of Tritiated and Non-Tritiated Waste

Flow from both the tritiated and nontritiated tanks is routed to a Mobile Demineralizer System by use of the floor drain collector tank pumps, tritiated drain collector tank pumps, and gas stripper feed pumps.

Processed water from the system is routed to either the monitor tank or the CDCT. The contents of these tanks are discharged as described in the two previous sections or processed further, as necessary, to meet ODCM limits. The Mobile Demineralizer System removes most soluble and suspended radioactive materials from the waste stream via ion exchange and filtration. Once the resin and filter media is expended, the spent resin is sluiced to either a liner for disposal or a Rad-Vault to accumulate enough resin for off-site disposal. The spent resin is dewatered to meet the disposal site criteria.The filters are stored in an appropriate container.

Laboratory Sample Waste Processing

The chemical drain tank receives inputs from the laboratory and the decontamination room. If the radioactivity level is low and the chemical content is suitable for release, the tank contents can be discharged to the cooling tower blowdown line for release to the environment. If analysis shows that there are no chemicals present which would be harmful to the demineralizer, the liquid is sent to the FDCT for processing. The tank contents may also be sent to the waste packaging area for solidification if required.

Processing of Waste from Regeneration of Condensate Polishing Demineralizer

Wastes produced in the regeneration of the CPDS are processed for discharge or reuse. The high crud tanks contain high crud, low conductivity waste (containing no regeneration chemicals) which are filtered and discharged when the radioactive level does not exceed ODCM limits. When limits are exceeded, the high crud, low conductivity waste may be processed by the mobile demineralizer. The high crud tanks may also contain regeneration chemicals if additional capacity is required. The tank would normally be processed by a vendor if it contains regeneration chemicals . The neutralization and non-reclaimable waste tanks contain low crud, high conductivity waste which is neutralized. If it contains radioactive material above ODCM limits, it is processed by a vendor.

Spent Resin Processing

Spent resins are processed in accordance with Section 11.5.

11.2.3 SYSTEM DESIGN

11.2.3.1 Component Design

A summary of principal design parameters are given in Table 11.2-2. Design codes for the components of the Liquid Waste Processing System are given in Chapter 3. Materials of the Liquid Waste Processing System are selected to meet the material requirements of the system and applicable codes. Parts of components in contact with borated water are normally fabricated or clad with austenitic stainless steel. In addition pumps are normally provided with vent and drain connections. The mobile waste demineralizer system is constructed to the applicable parts of Regulatory Guide 1.143, Revision 1, 1979.

Reactor Coolant Drain Tank (RCDT) and Pumps

The reactor coolant drain tank (one tank per unit) collects clean reactor coolant type water from inside the reactor containment. Two pumps per unit are provided to transfer the liquid from the drain tank to the Chemical and Volume Control System holdup tanks and to transfer water from the refueling canal to the refueling water storage tank or tritiated drain collector tank. The maximum load on the pumps occurs when the pressurizer relief tank drains and the excess letdown flow are imposed simultaneously or when the refueling canal is being drained. The normal load on the pumps is a small quantity, mainly from leakoffs, although the excess letdown flow can be expected for relatively long periods of time during plant heatup.

Chemical Drain Tank and Pump

The shared chemical drain tank receives radioactive wastes from the radiochemical laboratory drains and from the decontamination room. The pump is provided to transfer the tank contents to the waste packaging area for solidification, CTB line, or the FDCT.

Tritiated Equipment Drain Sump and Pumps

Tritiated Equipment Drain Sump and Pumps collect and transport tritiated liquid wastes from equipment and lower elevation drains, which cannot drain by gravity to the tritiated drain collector tank. Two pumps are furnished to transfer the liquid collected to the tritiated drain collector tank. The sump vents to the building exhaust system.

Tritiated Drain Collector Tank (TDCT) and Pumps

The shared tank collects radioactive liquids from the primary plant which may contain tritiated water, boric acid and fission products. The primary function of the tank is to provide sufficient surge capacity for the waste processing system. Pump A is provided to transfer the tank contents to the mobile waste demineralizer system or condensate demineralizer waste evaporator. Pump B is provided, as a spare, to also transfer the tank contents.

Floor Drain Collector Tank (FDCT) and Pumps

The tank retains primarily non-reactor grade type fluids and some non-recyclable reactor grade water from certain drains in the Auxiliary Building. The tank is equipped with three pumps. The tank contents may be sent through the FDCT discharge filters. The liquids are processed through the mobile waste demineralizers and then collected in either the cask decontamination collector tank (CDCT) or the monitor tank. After the liquids are collected in one of these tanks, the contents are recirculated, mixed, sampled, and analyzed. If the radioactivity is within the discharge limits, the liquids are routed to the cooling tower blowdown for discharge.

Laundry and Hot Shower Tanks and Pump

The laundry and hot shower tanks collect wastes from the radiologically controlled access area drains and hot shower drains. A pump is used to transfer the liquid. A recirculation line is provided to permit mixing the contents of the isolated tank before taking samples for activity analysis if the tank is to be discharged directly to the CTB.

If the activity level is within discharge limits, the contents may be routed through the laundry basket strainer and discharged via the CTB or the CDCT. If the activity level is above discharge limits, the contents are routed to the FDCT for routing to the mobile waste demineralizer for processing.

Spent Resin Storage Tank

This tank is supplied for the storage of used demineralizer resins. Resin is held in this tank to allow for decay of short-lived isotopes and to allow accumulation of enough resin for shipment. A layer of water is maintained over the resins to prevent degradation due to decay heat (see Section 11.5).

Filters

Table 11.2-2 lists the standard filters required, their nominal ratings, and the material of the filter media. The TDCT, FDCT, waste condensate tank, and CDCT filters may be removed and reinstalled as necessary to prevent crud traps and particles from building up in the piping.

The methods employed to change filters and screens are dependent on activity levels. If the radiation level of the filter is low enough, it is changed manually. If activity levels do not permit manual change, the spent cartridge is removed remotely with temporary shielding to reduce personnel exposure. The spent cartridge is placed in a shielded container for transport and storage prior to packaging for shipment.

Monitor Tank and Cask Decontamination Collector Tank (CDCT)

The Monitor Tank and the CDCT are used as release tanks for liquid disposal. These tanks receive processed liquid from either the floor drain collector tank, the tritiated drain collector tank, or the CVCS hold up tanks via the mobile demineralizer. The CDCT may also receive liquid directly from the laundry and hot shower tanks.

The CDCT may also receive water from the spent fuel shipping cask drain. The contents are pumped to the cooling tower discharge line via the radwaste line if the activity is sufficiently low, and to the floor drain collector tank or returned to the mobile demineralizer for processing if the activity is too high for discharge.

Monitor Tank Pump and Cask Decontamination Pump

Two pumps are provided for each tank to recirculate and pump liquid. The CDCT processes the liquid through the cask decontamination filter to the waste discharge line. Normally, only one pump is used.

Waste Condensate Tanks

The waste condensate tanks are available for additional capacity to process effluent liquid from the laundry and hot shower drain tanks. Each of three tanks are discharged to the waste condensate pumps. These tank are not normally used for Unit 1 or Unit 2 operation.

Waste Condensate Pumps

Two waste condensate pumps are available to receive liquid from the waste condensate tanks. This liquid may be processed to the CTB if it is below the ODCM limits. The discharge can be recirculated back to the waste condensate tanks, to the monitor tank, or to the cask decontamination collector tank.

Condensate Polishing Demineralizer Waste Processing Equipment High Crud (HC) Tanks

These tanks collect high crud, low conductivity waste produced during the backwash phase of condensate polishing demineralizer regeneration. The high crud, low conductivity waste is filtered and is normally discharged to the cooling tower blowdown, processed to the Turbine Building sump or waste disposal, by the mobile demineralizer. The discharge (after filtration) is very near condensate quality and is discharged only if permissible discharge concentrations are not exceeded. The high crud tanks may also contain regenerative chemicals if additional capacity is required. The tank would normally then be processed by a vendor.

High Crud Pumps

Two pumps are provided to circulate the contents of the high crud tanks for sampling, and to pump the tank contents through the high crud pre-filter and high crud filters. Normally, only one pump is used.

High Crud Pre-Filters

Three bag filters are arranged in parallel upstream of the high crud filter to filter the discharge stream, thus reducing the loading and clogging of the high crud filters. The vessels are constructed of stainless steel with replaceable filter elements. During normal operation two filters are in service. The third filter which is on standby and isolated may be placed in service while changing out the clogged filters. Each vessel has pressure gauges upstream and downstream of the filters.

Neutralization Tank

This tank collects spent regenerant chemicals and rinses from CPDS regeneration (low crud, high conductivity waste) miscellaneous waste from the condensate polishing demineralizer sump and has the capability to receive and neutralize waste from the cation and anion regeneration tanks. Sulfuric acid or sodium hydroxide is typically added to adjust the pH. The tank contents are circulated during pH adjustment. After neutralization to a desired pH value, the tank contents are either processed to the non-reclaimable waste tank or discharged to the environment.

Neutralization Tank Pumps

Two pumps are provided to circulate the contents of the neutralization tanks and to transfer the contents to the non-reclaimable waste tank or pump them to the environment. Normally, only one pump is used.

Non-Reclaimable Waste Tank

This tank receives neutralized waste from the neutralization tank. The tank contents are routed to discharge if the radioactivity content is sufficiently low. If not, the contents are processed by a vendor.

Non-Reclaimable Waste Pumps

Two pumps are provided to pump contents of the non-reclaimable waste tank to discharge, to a vendor for processing, or to the Turbine Building sump.

Liquid Waste Processing System Valves

The design code for the valves is ASME III Class 3 for ANS Safety Class 2b or 3 or Class 2 for ANS Safety Class 2a and ANSI B31.1, ANSI B16.5 or MSS-SP-66 for Non-Nuclear Safety (NNS) valves. The valves in the liquid waste processing system are stainless steel. The majority of the valves involved are diaphragm valves. This type of valve provides positive control of stem leakage and is suitable for use as an isolation valve or in throttling service. In several instances, globe valves are substituted for diaphragm valves because of their ability to control flow over a wider range.

Valves are supplied for isolation of each major equipment item for maintenance, to direct and control the flow of waste through the system and for isolation of tanks for decay.

For the purpose of containment isolation, trip valves are installed.

Liquid Waste Disposal Piping

The piping design code is ASME III Class 3 for ANS Safety Class 2b or 3 or Class 2 for ANS Safety Class 2a and ANSI B31.1 for NNS. The piping is normally austenitic stainless steel and the piping joints are normally welded, except where flanged connections are used at pump, valve and instrument connections to facilitate removal for maintenance.

Facilities for Venting and Draining

Normally provisions have been made for venting and draining equipment which may require maintenance during the plant life. Vents and drains are normally provided either on the components themselves or in the pipe lines between the isolation valves. In general, each pipe line and component vent and drain is provided with a valve plus a back-up leakage barrier of either a blank flange or a threaded screw cap.

Mobile Waste Demineralization System

The mobile waste demineralization system (MWDS) consists of several vessels with an associated pumping skid and level control system. The MWDS normally processes liquids at a feed rate of approximately 40 gpm. However, during peak flow rates, the MWDS may process higher flow rates (approximately 140 gpm). The vessel headers have influent and effluent isolation valves and all piping is welded with long radius bends. Demineralizer vessels are operated inside shielding in the waste packaging area with a remote control panel to insure that the dose to personnel is within acceptable limits. The system is designed to the applicable portions of Regulatory Guide 1.143, Revision 1, 1979.

The MWDS provides in-line processing of liquid radwaste through filtration and demineralization. The MWDS receives both tritiated liquid (the tritiated drain collector tank, high crud low conductivity waste, and CVCS holdup tank) and nontritiated liquids (the floor drain collector tank). Processed water from the MWDS is sent to either the monitor tank or the CDCT for release to the river.

The liquid radwaste is processed through ion exchange and filtration which remove soluble and suspended radioactive materials from the waste streams. The first vessel is normally loaded with a filter media, such as activated carbon, to provide initial filtration of the radwaste. This filter medium removes solids, cobalt isotopes, existing in the form of colloidal-sized suspended solids and cleaning agents, and other chemicals that can be removed by absorption of the activated carbon. A mechanical filter loaded with filter cartridges can be used for filtration. This conditions the radwaste for treatment in the subsequent tanks.

The subsequent demineralizer tanks contain beds (anions and cations) of ion-exchange resins, which remove the soluble constituents of the waste stream. Once the resin and filter media is expended, the resin is removed from the MWDS vessels to either a liner for disposal or a RAD-Vault to accumulate enough resin for off-site disposal, and the filters are placed in a shielded container for transport and storage prior to off-site disposal.

Since the equipment for the MWDS is supplied by a vendor and the selected vendor may change from time to time, a detailed description of the system is not possible. The specific treatment steps and equipment used can also vary somewhat from vendor to vendor.

11.2.3.2 Instrumentation Design

The Waste Disposal System panel, which is located in the Auxillary Building, contains some of the controls and indications necessary to operate the system. Other controls and indicators are mounted near the equipment.

Alarms are shown separately on the WPS panel.

Most pumps are protected against loss of suction pressure by a control setpoint on the level instrumentation for the respective vessels feeding the pumps.

Pressure indicators upstream and downstream of filters provide local indications of pressure drops across each component. The radioactive effluent release monitoring instrumentation is described in Section 11.4.

11.2.4 Operating Procedure

The equipment installed to reduce the activity of radioactive effluents is maintained in good operating order and is operated to as low as reasonably achievable criteria, as stated in the ODCM. In order to assure that these conditions are met, administrative controls are exercised on overall operation of the system; preventive maintenance is utilized to ensure equipment is in optimum condition; and applicable industry experience and vendor information available is used in planning for operation at Watts Bar Nuclear Plant.

Administrative controls are exercised through the use of instructions covering such areas as valve alignment for various operations, equipment operating instructions, and other instructions pertinent to the proper operation of the processing equipment. Discharge permits are utilized to assure proper procedures are followed in sampling and analyzing any radioactive liquid to be discharged and in assuring proper valve alignments and other operating conditions before a release. These permits are signed and verified by those personnel performing the analysis and approving the release.

Preventive maintenance is performed in accordance with approved plant maintenance program procedures developed, considering applicable operating and maintenance experience as well as vendor information.

Operation of the Liquid Waste Processing System is essentially the same during all phases of normal reactor plant operation; the only differences are in the load on the system. The following sections discuss the operation of the system in performing its various functions. In this discussion, the term 'normal operation' should be taken to mean all phases of operation except operation under emergency or accident conditions. The Liquid Waste Processing System's only primary safety function is containment isolation.

Liquid Waste Processing

Normal Operation

During normal plant operation the system processes liquid from the following sources:

(1) Equipment drains and leaks

(2) Radioactive chemical laboratory drains

(3) Radioactive laundry and shower drains

(4) Decontamination area drains

(5) Demineralizer flushing, backwashing and regeneration of resin

(6) Sampling system

The system also collects and transfers liquids from the following sources directly to the reactor coolant drain tank for processing in the CVCS.

(1) Reactor coolant loops

(2) Pressurizer relief tank

(3) Reactor coolant pump secondary seals

(4) Excess letdown during startup

(5) Accumulators

(6) Valve and reactor vessel flange leakoffs

(7) Refueling canal drains

The liquid flows to the reactor coolant drain tank and is discharged directly to the CVCS holdup tanks by the reactor coolant drain pumps which are operated automatically by a level controller in the tank. These pumps can also return water from the refueling cavity to the refueling water storage tank. There is one reactor coolant drain tank with two reactor coolant drain pumps located inside containment.

Normally, the reactor coolant drain pumps are operated in the automatic mode, which allows pump operation and reactor coolant drain tank level to be controlled. The pumps can also be operated manually to control the tank level.

Where possible, waste liquids drain to the waste disposal system and tritiated drain collector tanks by gravity flow.

Separation of Tritiated and Non-tritiated Liquids

Waste liquids which are high in tritium content are routed to the tritiated drain collector tank, while liquids low in tritium content are routed to the floor drain collector tank. The tritiated and non-tritiated liquids are processed for release to the river.

Tritiated Water

Tritiated water enters the liquid waste disposal system via equipment leaks and drains, valve leakoffs, pump seal leakoffs, tank overflows, and other tritiated and aerated water sources.

The tritiated liquids from equipment leaks and drains, and valve leak-offs which are below the tritiated drain collector tank, are drained to the sump and are pumped from there to the tritiated drain collector tank. Normally, the sump pumps are operated in the automatic mode, which allows tank level to be controlled. The pumps can also be operated manually.

The liquid collected in the tritiated drain collector tank contains boric acid and fission product activity. The liquid collected is normally demineralized by the mobile waste demineralizer and is then analyzed and discharged to the river.

Non-Tritiated Water

Non-tritiated water sources include floor drains, equipment drains containing non-tritiated water, certain sample room and radiochemical laboratory drains, laundry and hot shower drains and other non-tritiated sources.

The liquids entering the floor drain collector tank are primarily from low activity sources. The liquid collected is normally demineralized by the mobile waste demineralizer and is then analyzed and discharged to the river.

Laundry and Hot Shower Drains

One of the two laundry and hot shower tanks is valved to receive waste at all times. When one tank is filled, it is valved out and the other tank is valved in. The full tank is then aligned with the laundry pump to mix the waste by recirculation. A sample is taken (if required) from a local sample connection to determine what subsequent handling of the waste liquid is required. Normally no treatment is required for removal of radioactivity. This water is transferred to either CTB or FDCT or to CDCT or to the waste condensate tanks or to the monitor tank (all via the laundry tanks strainer). A sample is taken and, after analysis, the water is discharged in accordance with the ODCM limits.

Laboratory Samples

Laboratory samples which contain chemicals used in analysis are normally discarded in a fume hood sink which drains to the chemical drain tank.

The operation of the chemical drain tank pump and control of the tank level is manual, with the exception that the pump is shut off automatically on low tank level.

Low activity drains from the laboratory, such as flush water, are normally routed to the floor drain collector tank. Excess tritiated samples not contaminated by chemicals during analysis are normally directed to the tritiated drain collector tank.

Shipping Cask Drains

Liquid in this area is drained to the CDCT. The liquid is expected to be low enough in radioactivity content that it can be discharged without processing. Following analysis, the liquid is discharged. In the unlikely event that the radioactivity level is such that further processing is required, the liquid may be transferred to the floor drain collector tank or returned to the Mobile Waste Demineralizer System for further processing.

Condensate Polishing Demineralizer Waste

The condensate polishing demineralizer system (CPDS) is described in Section 10.4.6. Section 10.4.6 includes a discussion of the regeneration process. Treatment of regeneration wastes is described in this section.

The CPDS regeneration subsystem is designed to separate wastes into two fractions - one, a high-crud, low-conductivity liquid; and the other, a low-crud, high-conductivity liquid. These fractions are collected in separate tanks. The first fraction results from backwash which precedes chemical regeneration and from rinses which follow chemical regeneration. The second fraction consists of neutralized chemical regenerants plus displacement water. At each regeneration, the volume of the first fraction is about 23,000 gallons, and that of the second fraction is about 10,000 gallons.

Treatment of High-Crud, Low Conductivity (HCLC) Waste

The high-crud waste is normally low in conductivity. This waste is processed in equipment located in the Turbine Building. The slurry is filtered in the HC pre-filter or HC filter. The filtrate radioactivity is low enough to achieve adequate dilution in the cooling tower blowdown, in accordance with the ODCM, and is normally discharged. If the waste can not be properly diluted, it can be routed to the mobile demineralizers for further processing. Following a filter run in the HC filter, the filter is backwashed and the liquid is routed to the HC tank.

Treatment of Low-Crud, High-Conductivity (LCHC) Waste

The LCHC wastes, consisting of the spent regeneration chemicals is neutralized in a neutralizer tank and may be transferred to a non-reclaimable waste tank. The liquid is normally processed by a vendor if the radioactivity is above the ODCM limit. However, the liquid is circulated and sampled prior to processing. If the radioactivity level is below permissible discharge levels, it may be discharged directly without further treatment.

Discharge of Regeneration Wastes

Waste liquids from the CPDS regeneration that are to be discharged are sampled and analyzed as required per the ODCM to ensure that the activity level complies with requirements stated in the ODCM. The discharge line from the Turbine Building extends to the cooling tower blowdown line, and includes a locked-closed valve, a radiation monitor, and a radiation-controlled valve. The latter is arranged to close on a high radiation signal from the monitor. It is closed also by a signal from the flow meter in the cooling tower blowdown line on low flow, indicating inadequate dilution flow.

Spent Resin Handling

This portion of the system sluices resin from the demineralizers and transports resin from the spent resin storage tank to the railroad access bay to be dewatered or solidified by an offsite contractor.

CVCS Resin Sluicing

Spent resins are initially fluidized by backflushing with primary water. The backflush water is routed to the tritiated drain collector tank.

The resin is then drained and flushed to the spent resin storage tank. Fresh resin is then added and the demineralizer is filled with water, as a cover, over the resin. The valves are then realigned for normal process operation. A negligible amount, if any, of resin is expected to remain in a demineralizer after flushing, as the demineralizers are completely flushable.

Refueling

Operation of the Liquid Waste Processing System is the same during refueling as during normal operation. When refueling is complete, the water remaining in the refueling canal following normal drain-down by the Residual Heat Removal System is drained to the reactor coolant drain tank and pumped back to the refueling water storage tank with the reactor coolant drain tank pumps. The pumps normally operate in the automatic mode during this operation. Since there is oxygen in the refueling water, the drain tank is isolated from the vent header during this transfer and the tank is vented to the containment atmosphere. It is necessary to purge the tank with nitrogen before connecting it back to the vent header.

Faults of Moderate Frequency

The system is designed to handle the occurrence of equipment faults of moderate frequency such as:

(1) Malfunction in the Liquid Waste Processing System

Malfunction in this system could include such things as pump or valve failures. Because of pump standardization throughout the system, a spare pump can be used to replace most pumps in the system. There is sufficient surge capacity in the system to accommodate waste until the failures can be fixed and normal plant operation resumed.

(2) Excessive Leakage in Reactor Coolant System Equipment

The system is designed to handle a one gpm reactor coolant leak in addition to the expected leakage during normal operation. Operation of the system is almost the same as for normal operation except the load on the system is increased. A one gpm leak into the reactor coolant drain tank is handled automatically but will increase the load factor of the CVCS. If the one gpm leak enters the tritiated drain collector tank, operation is the same as normal except for the increased load on the system. Abnormal liquid volumes of reactor coolant resulting from excessive reactor coolant or auxiliary building equipment leakage (1 gpm) can also be accommodated by the floor drain collector tank and processed by the non-tritiated system. Valve and pump leakoffs are all processed through the tritiated drain collector tank and non-reusable reactor coolant entering the floor drain collector tank is processed for release to the river.

(3) Excessive Leakage in Auxiliary System Equipment

Leakage of this type could include water from steam side leaks inside the containment which are collected in the Reactor Building floor and equipment drain sump. Although the sump pump discharge is normally routed to the tritiated drain collector tank, the flow can be diverted to the floor drain collector tank upon discovery of a leak. Other sources could be component cooling water leaks, essential raw cooling water leaks, and secondary side leaks. This water enters the floor drain collector tank and will be processed and discharged as during normal operation.

(4) Steam Generator Tube Leaks

During periods of operation with fuel defects, coincident with steam generator tube leaks, radioactive liquid is discharged via the steam generator blowdown system. The releases from the secondary side will be within the ODCM limits.

Releases of Waste

Release of radioactive liquid out of the Liquid Waste Processing System is from the waste condensate tanks, cask decontamination collector tank, monitor tank, chemical drain tank, and laundry and hot shower tank to the blowdown line from the cooling towers. The cooling tower blowdown line discharges into the river through the diffuser pipes. Liquid wastes from the condensate polishing demineralizer system are released from the high-crud tanks, the non-reclaimable waste tank, and the neutralization tank.

The condenser circulating water system operates in the closed cycle mode. Water is recirculated between the cooling towers and the condenser. The cooling towers blowdown flows to the diffuser in order to maintain the solids in the water at an acceptable level.

Release of the radioactive liquids from the liquid waste system is made only after laboratory analysis of the tank contents. If the activity is not below ODCM limits, the liquid waste streams are returned to waste disposal system for further processing by the mobile demineralizer. Once the fluids are sampled, they are pumped to the discharge pipe through a normally locked closed manual valve and a remotely operated control valve, interlocked with a radiation monitor and a flow element in the cooling tower blowdown line. This assures that sufficient dilution flow is available for the discharge of radioactive liquids. The minimum dilution flow required for discharge of radioactivity into the cooling tower blowdown lines (CTBL) is 20,000 gpm.

A similar arrangement is provided for wastes discharged from the condensate polishing demineralizer system. A radiation monitor on this system and a flow element on the cooling tower blowdown are interlocked with a flow control valve in the system discharge line. Release of wastes is automatically stopped by either a high radiation signal or a signal which indicates that inadequate dilution flow is available. The CPDS and SGB may be released with the CTB flow less than 20,000 gpm provided the sum of the Effluent Concentration Limit (ECL) fractions (release concentrations/10 CFR 20 ECLs) for all isotopes released is less than or equal to 10 as required by the Technical Specifications and ODCM, and provided such releases are controlled and limited such that the 10 CFR 50, Appendix I limits are not exceeded.

The steam generator blowdown system also may discharge radioactive liquid. Liquid waste from this system is not collected in tanks for treatment, but is continuously monitored for radioactivity and may discharge to the cooling tower blowdown, or recirculated to the condensate system upstream of the condensate demineralizers. Refer to Section 10.4.8 for a description of the steam generator blowdown system operation.

The turbine building sump collects liquid entering the turbine building floor drain system. When the sump is nearly full (approximate usable capacity of 30,000 gallons), the liquid is pumped to either the low volume waste treatment (LVWT) pond or the yard holding pond. Water in the ponds drains by gravity to the river via the cooling tower blowdown line to the diffusers. If high concentrations of chemicals are present, it may be pumped to the lined or unlined chemical holdup ponds for treatment before release per the NPDES Permit.

Station Blackout

The Liquid Waste Processing System (except for containment isolation) does not normally operate during a blackout. If necessary, equipment with diesel backup power can be manually connected to the emergency power sources when they become available.

Loss-of-Coolant Accident

The Liquid Waste Processing System (except for containment isolation) is not required to operate during, or immediately following, a loss-of-coolant accident. Equipment may be started manually as required.

Operating Experience

Demineralizers

Operational data on CPDS decontamination factors (DF) is derived from NUREG–0017, Revision 1 [Ref. 1]. The DF for MWDS was supplied by a vendor.

11.2.5 PERFORMANCE TESTS

Initial performance tests were performed to verify the operability of the components, instrumentation and control equipment and applicable alarms and control setpoints.

The specific objectives were to demonstrate the following:

(1) Pumps are capable of producing flow rate and head as required.

(2) Waste filters are capable of passing required flow rate.

(3) Instrumentation, controllers, and alarms operate satisfactorily to maintain levels, pressures, and flow rates and indicates, records, and alarms, as required.

(4) Sampling points are available for sampling.

During reactor operation, the system is used at all times and hence is under surveillance. Data is taken periodically (if applicable) for use in determining decontamination factors of demineralizers.

11.2.6 ESTIMATED RELEASES

11.2.6.1 NRC Requirements

The following documents have been issued to provide regulations and guidelines for release of radioactive liquids:

(1) 10 CFR 20, Standards for Protection Against Radiation.

(2) 10 CFR 50, Licensing of Production and Utilization Facilities.

11.2.6.2 Westinghouse PWR Release Experience

The liquid releases are highly dependent upon administrative activities which control the use of water for decontamination, equipment and floor rinsing and other uses in the controlled areas.

Operating plants have reported liquid discharges as shown in Table 11.2-3.

11.2.6.3 Expected Liquid Waste Processing System Releases

The quantities and isotopic concentration in liquids assumed discharged to the liquid waste processing system, and hence the releases to the environment, are highly dependent upon the operation of the plant. The radionuclide concentrations and calculated doses are the principal focus of treatment activities. Volume released is a secondary focus. The analysis for Watts Bar is based on engineering judgement, with respect to the operation of the plant and the liquid waste processing system, and realistic estimation of the potential input sources. Hence, the results are representative of typical releases from the Watts Bar liquid waste processing system.

The input sources, the computational data and assumptions are summarized in Table 11.2-1. The isotopic composition of reactor coolant (RC) is based on ANSI/ANS-18.1-1984 and includes the projected tritium permeation from 2,304 TPBARs (Unit 1 only). The associated releases in curies per year per nuclide are given in Table 11.2-5.

The liquid waste processing system is assumed to operate as described in Subsection 11.2.4.

11.2.6.4 Turbine Building (TB) Drains

11.2.6.4.1 Purpose

The TB drainage system is designed to remove liquid drainage in the Turbine Building.

11.2.6.4.2 Description

The TB drains are not normally radioactive.

The Turbine Building drainage consists of the following categories:

(a) Condensate Polishing Demineralizer System Drains

(b) Other TB drainage

(c) Oil and oily water drainage.

11.2.6.4.2.1 Condensate Polishing Demineralizer System Drains

The Condensate Polishing Demineralizer System (CPDS) area is serviced by separate floor and equipment drains. The drains for CPDS are routed to the Condensate Demineralizer sump where they are pumped to the Neutralization Tank (NT). These drains have a potential to be low-level radioactive during periods of primary to secondary leakage. The NT is provided with the capability of adjusting pH, and if the inventory is not radioactive or less than the dischargeable limit, it is normally discharged with a batch release to the CTB line. The NT is normally processed by a vendor if the inventory is above dischargeable limits. Any radioactive discharge from this release point is handled in accordance with the ODCM. Section 10.4.6 discusses the CPDS, and this chapter discusses the wastes from the system and their disposal under radioactive and non-radioactive conditions.

11.2.6.4.2.2 Other Turbine Building Drainage

Drainage from the Turbine Building areas other than the CPDS area is directed to the yard holding pond, normally, via the low volume waste treatment (LVWT) pond. Floor and equipment drainage in Turbine Building is first collected in the Turbine Building Station sump and is then pumped to the yard holding pond, normally, via the LVWT pond. Roof drainage flows by gravity directly to the yard holding pond.

11.2.6.4.2.3 Oil and Oily Water Drainage

Oil is drained directly to drums or tank trucks for reuse or removal from the plant. Oily water drains are furnished in the Turbine Building and are routed to the oil sump which is located in the low point of the Turbine Building. Oil may be accumulated in the sump until a sufficient amount is collected to be pumped into tank trucks for offsite disposal.

11.2.6.5 Estimated Total Liquid Releases

10 CFR 50 Appendix I and 10 CFR 20 prescribe the allowable limits of radionuclide liquid releases from Watts Bar. The Offsite Dose Calculation Manual is the process document that describes how releases are measured, monitored, controlled and reported. The liquid waste management system at Watts Bar can be operated in a variety of configurations depending on plant conditions and the amount and composition of radionuclides in the waste stream. Irrespective of the specific modes described, the annual releases are required to be equal to or less than the limits provided in the ODCM, Appendix I and 10CFR 20.

Table 11.2-5 provides the total annual discharge from the liquid waste processing system for four different levels of processing prior to discharge. The annual discharge for Unit 2 is expected to be similar to Unit 1 with the exception that tritium production is not currently planned. A value of 0.16 Ci/yr is included as an unplanned release in each of the plant alignment to provide additional conservatism as discussed in NUREG-0017. The discussions to follow are based on the fluid quantities and activities specified in Table 11.2-1.

11.2.6.5.1 Expected Normal Plant Operation

The expected plant alignment and the resultant four release paths are as follows:

- CVCS letdown waste processed by the CVCS demineralizers and then by the mobile demineralizer.
- The reactor coolant drain tank, the tritiated drain collector tank, and the floor drain collector tank discharges and processed using the mobile demineralizer.
- Liquid releases from the Laundry and Hot Shower Drain Tank and the Turbine Building drains can be released without processing by mobile demineralizer.

The combination of the above three paths is called liquid radwaste.

- Steam Generator Blowdown released without processing.

The results for this alignment are shown in Column 8 of Table 11.2-5. Column 8 is the combined source term from Column 6 and 7. Column 6 provides the liquid radwaste source term. Column 7 provides the source term for steam generator blowdown assuming an annual untreated SG Blowdown concentration of 3.65 E-5 uCI/cc. Concentrations above this value cannot be released continuously on an annual basis without additional processing. Unit 1 currently operates without the condensate demineralizers in service. The condensate demineralizers will not be utilized unless significant primary to secondary leakage occurs. Operating experience has shown that annual releases are below the values shown in Column 8 and thus that processing of SG Blowdown is not expected to be required. There is no condensate demineralizer blowdown or backwashing when the plant is operating under this set of conditions. SG Blowdown concentrations above 3.65E-5 uCi/cc can be released without processing by the condensate demineralizers for short periods of time and are acceptable as long as total releases from the site are below the ODCM and 10 CFR limits.

The expected liquid releases from Watts Bar based on the values in Column 8 are below the limit of 5 Curies per year as prescribed in 10 CFR 50, Appendix I. Table 11.2- 5d shows releases remain within the 10CFR 20 limits if the steam generator blow down concentration is restricted to a maximum concentration of 3.65E-5 uCi/cc gross gamma during the release.

11.2.6.5.2 Other Plant Alignment Evaluations

The values in Table 11.2-5 Column 4 assume the following:

- CVCS letdown waste processed by the CVCS demineralizers and then by the mobile demineralizer.
- The reactor coolant drain tank, the tritiated drain collector tank, and the floor drain collector tank discharges and processed using the mobile demineralizer.
- Condenstate Demineralizer Flow including SG Blowdown processed by the condensate demineralizer.
- Liquid releases from the Laundry and Hot Shower Drain Tank and the Turbine Building drains can be released without processing by mobile demineralizer.

The values in Table 11.2-5 Column 5 assume the following:

- CVCS letdown waste processed by the CVCS demineralizers and then by the mobile demineralizer.
- The reactor coolant drain tank, the tritiated drain collector tank, and the floor drain collector tank discharges and processed using the mobile demineralizer.
- Condensate Demineralizer Flow including SG Blowdown processed by the condensate demineralizer with additional processing by the mobile demineralizer.
- Liquid releases from the Laundry and Hot Shower Drain Tank and the Turbine Building drains can be released without processing by mobile demineralizer.

The expected liquid releases from Watts Bar based on the values in columns 4 and 5 are well below the limit of 5 Curies per year as prescribed in 10 CFR 50, Appendix I.

Tables 11.2-5a and 11.2-5b describe liquid releases for 1% failed fuel for both treated and untreated waste relative to the requirements of 10 CFR 20.1302(b). The sum over all isotopes of the concentrations/ECL (C/ECL) value from the Table 11.2-5a is greater than unity for the case where all isotopes are at design values and the released liquid is not processed by the Mobile Demineralizers. In order to prevent exceeding the 10 CFR 20.1302(b) limits, the condensate regeneration waste is rerouted through the Mobile Demineralizers if the long term releases from the condensate regeneration waste is greater than the 10 CFR 20 concentration limits. With Mobile Demineralizer processing of condensate regeneration waste, the release concentrations are shown in Table 11.2-5b and are less than the limits specified in 10 CFR 20.1302(b).

Based on the above, the releases from the plant are in accordance with the design objectives as outlined in Section 11.2.1 and the Offsite Dose Calculation Manual.

11.2.7 RELEASE POINTS

All radioactive liquid wastes are released from the plant through the cooling tower blowdown line. The discharge points from the waste disposal system are shown in Figure 11.2-1 and 11.2-2. The connection to the cooling tower blowdown line is shown in Figure 10.4-5.

11.2.8 DILUTION FACTORS

The dosimetry calculations for drinking water are based on the assumption that the liquid effluent will be mixed with 10% of the river flow between the point of discharge and Tennessee River Mile (TRM) 510.0, where 100% dilution is assumed to occur. Further discussion of these calculations and dilution flows used is presented in section 11.2.9.1.

11.2.9 ESTIMATED DOSES FROM RADIONUCLIDES IN LIQUID EFFLUENTS

Doses from the ingestion of water, from the consumption of fish, and from shoreline recreation are calculated for exposures to radionuclides routinely released in liquid effluents.

11.2.9.1 Assumptions and Calculational Methods

Internal doses are calculated using methods outlined in NRC Regulatory Guide 1.109, Revision 1, October 1977. This model is used for estimating the doses to bone, gastro-intestinal (G.I.) tract, thyroid, liver, kidney, lung, skin, and total body of man from ingestion of water, consumption of fish, and from external exposures due to recreational activities. Population doses are estimated for the year 2040 based on the populations given in Table 2.1-12.

(1) Doses to Man from the Ingestion of Water

Data listed in Table 11.2-6 for public water supplies is used to calculate dose commitments from the consumption of Tennessee River water. The 2040 populations for the water supplies are estimated by multiplying the 2000 public water supply populations by a population growth factor of 1.42. This factor is the ratio of the 2040 population (Table 2.1-12) to the 2000 population (Table 2.1-8). It is assumed that the plant effluent is mixed with one-tenth of the river flow in the 18-mile reach between the nuclear plant site and TRM 510.0. Although natural water turbulence will continue to increase the dispersion downstream, it is assumed that one-tenth dilution is maintained as far as TRM 510.0, where full-dilution is assumed.

Dilution is calculated using average annual flow data for the Tennessee River as measured during the 69-year period 1899-1968. The average flow past the site is approximately 28,000 ft^3/sec.

Radioactive decay between the time of intake in a water system and the time of consumption is handled in accordance with Regulatory Guide 1.109. Maximum and average consumption rates are those recommended by Regulatory Guide 1.109.

Due to a lack of definitive data, no credit is taken for removal of activity from the water through absorption on solids and sedimentation, by deposition in the biomass, or by processing within water treatment systems.

Internal doses, D, for an organ for a single radionuclide are calculated using the relation

D = DCF x I (1)

where:

DCF = the dose commitment factor for the organ from the radionuclide (mrem/pCi).

Values used are from Regulatory Guide 1.109.

I = the activity of the radionuclide taken into the body annually via ingestion, (pCi).

(2) Dose to Man from the Consumption of Fish

Current estimates of the Tennessee River fish harvest are 3.04 lb/acre/year. It is assumed that the rates will increase with the population expansion, so the dose calculations are based on harvests of 3.77 lb/acre of fish in the year 2040. This is determined by multiplying the 1990 harvest by the population growth factor. The Tennessee River, within 50 miles downstream of WBN, is segmented into 4 regions (Table 11.2-6) in order to facilitate the calculations of fish harvests and radioactivity concentrations. The radioactivity levels in the fish from each region are estimated by the product of an average activity concentration in the reach and a concentration factor for each radionuclide. The population dose is calculated using the assumption that all of the 3.77 lb/acre of fish caught is edible weight, and that the total harvest from each portion of the river is consumed by humans.

Dose commitments are calculated with Equation 1, which is discussed for water ingestion in the previous section.

Calculations indicate that there would be no significant radiological impact from human utilization of shellfish. Shellfish are not currently being harvested commercially in the Tennessee River; and consumption of shellfish by humans is assumed to be negligible.

(3) Doses to Man due to Shoreline Recreation

Estimates of the doses from shoreline recreation along the Tennessee River are calculated for each radionuclide using the following equation:

D = RDCF x C x T (mrem),

where:

RDCF = The shoreline recreation dose commitment factor, mrem/hour per pCi/m^2, from Regulatory Guide 1.109, Table E-6.

T = exposure time, hours.

C = Concentration of the radionuclide in the sediment, pCi/m^2; calculated using NRC Regulatory Guide 1.109 methodology. A shoreline width factor of 0.2 is used.

Doses to the population are calculated using estimates for shoreline visits (1990 values) multiplied by the population growth factor.

11.2.9.2 Summary of Dose from Radionuclides in Liquid Effluents

Radiation doses calculated for releases of radionuclides in liquid effluents during normal operation of the Watts Bar Nuclear Plant are summarized in Table 11.2-7. Liver tissues are expected to receive the greatest doses for the maximum individual; however, the thyroid tissues are expected to receive the greatest dose for the Tennessee Valley population.

REFERENCES

(1) NUREG-0017, R1, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors," a PWR-GALE Code, Published April, 1985.

Table 11.2-1 Liquid Waste Processing System Calculation Basis (Page 1 of 2)

1.0 Inputs (2 Units)[4]

1.1 Reactor Coolant Drain Tank
Tank Volume: 350 gal/unit
Input: 40 gpd
14,600 gal/yr
Activity: 0.1 PCA
Collection Time: 24 hrs
Processing Time: neglected

1.2 Tritiated Drain Collector Tank
Tank Volume: 24,700 gal
Input: 2,980 gpd
1,087,000 gal/yr
Activity: See Section 3.0
Collection Time: 24 hrs
Processing Time: 6 hrs

1.3 Floor Drain Collector Tank
Tank Volume: 23,000 gal
Input: 3,200 gpd
1,168,000 gal/yr
Activity: See Section 3.0
Collection Time: 24 hrs
Processing Time: 6 hrs

1.4 CVCS Letdown
Input: 4,863 gpd
1,775,107 gal/yr
Activity: 1.0 PCA
Collection Time:24 hrs
Processing Time:6 hrs

1.5 Chemical Drain Tank & Laundry and Hot Shower Tank
Input: 1080 gal/day (NUREG-0017 Table 1-3)
394,200 gal/yr
Activity: NUREG-0017 Table 2-27
Released without processing or decay

1.6 Condensate Polisher Regeneration Waste
Input: 6,800 gpd of waste (NUREG-0017 Table 1-3)
2,482,000 gal/yr
Activity: See Section 3.0

1.7 Steam Generator Blowdown
Input: 60,000 lb/hr (365 days)

Activity: See Section 3.0

Table 11.2-1 Liquid Waste Processing System Calculation Basis
(Page 2 of 2)

1.8 Gaseous Activity
All noble gases vent to gaseous waste processing system. All halogens remain in liquid.

2.0 Processing

2.1 Decontamination Factors except mobile demineralizer system based on NUREG-0017 Rev 1; Table 1-4

2.2 CVCS letdown first processed through CVCS mixed bed and cation demineralizers
DF = 20 for Cs & Rb
DF = 100 for all others

2.3 All processing through mobile demineralizer system
DF = 1000 for all isotopes except Cobalt 58 based on five (5) beds. The first is loaded with ion specific filtration media/activated carbon, followed by another ion specific media, a cation bed, and then two (2) mixed beds in series.
Flow rate: 40 gpm
DF = 100 for Co58

3.0 Leakage[1]

a) Reactor coolant pump seal leakage, 20 gal/day @ 0.1 PCA
b) Reactor containment cooling system, 500 gal/day @ 0.001 PCA[2]
c) Other leaks and drains, 10 gal/day @ 1.67 PCA[2]
d) Primary coolant equipment drains, 80 gal/day @ 1.0 PCA[2]
e) Reactor coolant sampling, 200 gal/day @ 0.05 PCA[2]
f) Spent fuel pit liner drains, 700 gal/day @ 0.001 PCA[2]
g) Auxiliary Building floor drains, 200 gal/day @ 0.1 PCA[3]
h) Secondary system sampling, 1400 gal/day @ 1 PCA(of SSC)(Note: NUREG-0017 uses 1E-4 PCA (RC), this calculation uses actual SSC activities, therefore PCA = 1 SSC)[3]
i) CVCS letdown (via holdup tanks), 845 lb/hr (2431.654 gal/day) @ 1 PCA
j) Input into the condensate resin regeneration waste (with resin DF=2 for Cs, Rb, and DF=10 for others) collected over a 6-day time period consisting of:
1) SGBD blowdown = 3E4 lb/hr (86330.93 gal/day) @ 1 PCA (of SSC)
2) Condensate flow = 1.5E7 lb/hr (steam flow)*0.55(flow split)=8.25E6 lb/hr @ 1 PCA (of SSS)
k) Turbine Building floor drains, 7200 gal/day @ 1 PCA (of SSC) (Note: no reactor coolant in Turbine Building).
l) LHST release taken directly from NUREG-0017 Table 2-27.

1. The leakage values are for 1 Unit.
2. Normally processed to TDCT.
3. Normally processed to FDCT.
4. Tabulated inputs are based on dual unit system use unless otherwise noted.

Table 11.2-2 Component Design Parameters*
(Page 1 of 7)

Reactor Coolant Drain Tank	
Number per unit	1
Type	Horizontal
Volume, gal	350
Design pressure, internal, psig	25
Design pressure, external, psig	60
Design temperature, °F	267
Normal operating pressure, range, psig	0.5-2.0
Normal operating temperature range, °F	50-200
Material of construction	Austenitic SS
Reactor Coolant Drain Tank Pumps	
Number per unit	2
Type	open face horizontal, centrifugal
Design flow rate, gpm	
Pump A	50
Pump B	150
Design head, ft	175
Design pressure, psig	150
Design temperature, °F	300
Required NPSH at design flow, ft	
Pump A	6
Pump B	6
Material, wetted surfaces	Austenitic SS
Chemical Drain Tank	
Number (shared)	1
Type	Vertical
Volume, gal	600
Design pressure	Atmospheric
Design temperature, °F	180
Normal operating pressure	Atmospheric
Normal operating temperature, °F	50-140
Material of construction	Austenitic SS

* For design codes and safety classes see Section 3.2

Table 11.2-2 Component Design Parameters*
(Page 2 of 7)

Chemical Drain Pump		
Number (shared)	1	
Type	Horizontal, centrifugal, mechanical seal	
Design flow rate, gpm	20	
Design head, ft	100	
Design pressure, psig	150	
Design temperature, °F	180	
Required NPSH at design flow, ft	5	
Material	Austenitic SS	
Tritiated Drain Collector Tank		
Number (shared)	1	
Type	Horizontal	
Volume, gal	24,700	
Design pressure, psig	Atmospheric	
Design temperature, °F	180	
Normal operating pressure	Atmospheric	
Normal operating temperature, °F	50-140	
Material of construction	Austenitic SS	
Tritiated Drain Collector Tank Pumps		
Number (shared)	2	
Type	Horizontal, centrifugal, mechanical seal	
	Pump A	**Pump B**
Design flowrate, gpm	100	20
Design head, ft	100	100
Design pressure, psig	150	150
Design temperature, °F	180	180
Required NPSH at design flow, ft	20	5
Material	Austenitic SS	
Floor Drain Collector Tank		
Number (shared)	1	
Type	Horizontal	
Volume, gal	23,000	
Design pressure	Atmospheric	
Design temperature, °F	180	
Normal operating pressure	Atmospheric	
Normal operating temperature, °F	50-140	
Material of construction	Austenitic SS	

* For design codes and safety classes see Section 3.2

Table 11.2-2 Component Design Parameters*
(Page 3 of 7)

Floor Drain Collector Tank Pumps		
Number (shared)	2	
Type	Horizontal, centrifugal, mechanical seal	
	Pump A	**Pump B**
Design flow rate, gpm	100	20
Design head, ft	110	100
Design pressure, psig	150	150
Design temperature, °F	180	180
Required NPSH at design flow, ft	15	5
Material	Austenitic SS	
Waste Condensate Tanks		
Number (shared)	3	
Type	Vertical	
Volume, each, gal	1500	
Design pressure	Atmospheric	
Design temperature, °F	180	
Normal operating pressure	Atmospheric	
Material	Austenitic SS	
Waste Condensate Pumps		
Number (shared)	2	
Type	Horizontal, centrifugal	
Design flow rate, gpm	20	
Design head, ft	100	
Design pressure, psig	150	
Design temperature, °F	180	
Material, wetted surfaces	Austenitic SS	
Laundry and Hot Shower Tanks		
Number (shared)	2	
Type	Vertical	
Design temperature, °F	180	
Design pressure	Atmospheric	
Volume, gal	600	
Material	Stainless steel	
Laundry and Hot Shower Pump		
Number (shared)	1	
Design temperature, °F	180	
Design pressure, psig	150	

* For design codes and safety classes see Section 3.2

Table 11.2-2 Component Design Parameters*
(Page 4 of 7)

Laundry & Hot Shower Pump (Cont'd)	
Design head, ft	100
Design flow, gpm	20
Material contacting fluid	Stainless steel
Type	Horizontal, centri- fugal, mechanical seal
Monitor Tank (shared)	
Number	1
Capacity, gal.	20,462
Design pressure	Atmospheric
Design Temperature, °F	200
Material	Austenitic stainless steel
Monitor Tank Pumps (shared)	
Number	2
Design pressure, psig	150
Design Temperature, °F	200
Design flow, gpm	150
Design head, ft	200
Material	Austenitic stainless steel
Cask Decontamination Collector Tank	
Number (shared)	1
Volume, gal	15,000
Design pressure	Atmospheric
Design temperature, °F	180
Material	Carbon steel
Cask Decontamination Collector Tank Pumps	
Number (shared)	2
Flow rate, gpm	100
Design pressure, psig	150
Design temperature, °F	180
Material	Stainless steel
Cask Decontamination Collector Tank Filters	
Number (shared)	2
Flow rate, gpm	40
Design pressure, psig	200
Design temperature, °F	250
Material	304 stainless steel

* For design codes and safety classes see Section 3.2

Table 11.2-2 Component Design Parameters*
(Page 5 of 7)

Spent Resin Storage Tank	
Number (shared)	1
Type	Vertical
Volume, each, ft^3	300
Design pressure, psig	100
Design temperature, °F	180
Normal operating pressure, psig	0.5 - 15
Normal operating temperature	Ambient
Material of construction	Austenitic SS
TDCT and FDCT Discharge Filters, Waste Condensate Tank Filter, and Waste Condenser Filter**	
Number (shared)	1
Type	Disposable synthetic cartridge
Design pressure, psig	200
Design temperature, °F	250
Flow rate, gpm	35
Pressure drop at 20 gpm, clean filter, psi	5
Maximum differential pressure, 100% fouled, psi	20
Retention for 25-micron particles, %	98
Materials	
Housing	Stainless steel
Filter element	Nylon
Laundry Tank Basket Strainer	
Number (shared)	1
Type	Perforated stainless steel sheet
Design flow rate, gpm	20
Design pressure, psig	150
Design temperature, °F	180
Diameter of perforation, in.	1/16
Pressure drop at design flow when clean, psi	0.5
Radiation levels outside	Negligible
Material, wetted surfaces	Austenitic SS

* For design codes and safety classes see Section 3.2

**Other filter media are allowed per vendor technical manual if they are equal or finer.

Table 11.2-2 Component Design Parameters*
(Page 6 of 7)

FDCT Discharge Pumps Strainer	
Number	1
Design flow rate, gpm	100
Design pressure, psig	150
Design temperature, °F	180
Diameter of perforation, in.	3/16
Pressure drop at design flow when clean, psi	2
Material	Stainless steel
High-Crud, Low-Conductivity Tanks	
Number (shared)	2
Volume of each tank, gal.	19,000
Design pressure	Atmospheric
Design temperature, °F	140
Material	Rubber lined carbon steel
High-Crud, Low-Conductivity Pumps	
Number (shared)	2
Flow rate, gpm	150
Design pressure, psig	150
Design temperature, °F	140
Material	Stainless steel
Head, ft. water	330

* For design codes and safety classes see Section 3.2

Table 11.2-2 Component Design Parameters*
(Page 7 of 7)

High-Crud Pre-Filters	
Number	3
Type	Bag Filter
Design pressure, psig	220
Design Temperature, °F	140
Flow rate, gpm	150
Material	304 Stainless steel
High-Crud, Low-Conductivity Filter	
Number (shared)	1
Type	Etched Disc-type
Design pressure, psig	375
Design temperature, °F	140
Flow rate, gpm	100 (dirty)
Maximum differential pressure, 100% fouled, psi	75
Materials	Stainless steel
Neutralization Tank	
Number (shared)	1
Volume, gal	20,000
Design pressure	Atmospheric
Design temperature, °F	140
Material	Rubber lined carbon steel
Neutralization Pumps	
Number (shared)	2
Flow rate, gpm	100
Design pressure, psig	150
Design temperature, °F	140
Material	Stainless steel
Head, ft. water	135
Non-Reclaimable Waste Tank	
Number (shared)	1
Volume, gal	10,000
Design pressure	Atmospheric
Design temperature, °F	140
Material	Rubber lined carbon steel
* For design codes and safety classes see Section 3.2	
Non-Reclaimable Waste Pumps	
Number (shared)	2
Flow rate, gpm	115
Design pressure, psig	150
Design temperature, °F	140
Material	Nickel Alloy
Head, ft. water	300
* For design codes and safety classes see Section 3.2	

Table 11.2-3 Radioactive Liquid Releases From Westinghouse Designed PWR Plants Historical Information

Plant	Year	Cladding	Average 2 Fuel Defects	Total Released Curies	Avg. Discharge Concentration Ci/ml	Fraction 10 CFR 20 Concentration
Yankee Rowe	1970	Stainless Steel	Neg.	0.036	1.5×10^{-10}	1.5×10^{-3}
	1971	- 0 -	0.001	0.0034	1.25×10^{-12}	1.25×10^{-5}
	1972			0.0013	4.7×10^{-12}	4.71×10^{-5}
Connecticut	1970	Stainless Steel	0.01	29.5	4.02×10^{-8}	4.02×10^{-1}
Yankee	1971	- 0 -	0.03	5.85	7.75×10^{-9}	7.75×10^{-2}
	1972			12.26	1.61×10^{-8}	1.61×10^{-1}
San Onofre	1970	Stainless Steel	0.007	3.41	6.1×10^{-9}	6.1×10^{-2}
	1971	- 0 -	0.015	9.21	1.34×10^{-8}	1.34×10^{-1}
	1972			28.5	4.11×10^{-8}	4.1×10^{-1}
R. E. Ginna	1970	Zircaloy	0.4	9.35	1.43×10^{-8}	1.43×10^{-1}
	1971	- 0 -	0.26	0.96	1.45×10^{-9}	1.45×10^{-2}
	1972			0.38	5.69×10^{-10}	5.7×10^{-3}
H. B. Robinson 2	1970	Zircaloy				
	1971	- 0 -	0.001	0.74	1.01×10^{-9}	1.01×10^{-2}
	1972			0.39	5.57×10^{-10}	5.6×10^{-3}
Point Beach	1970	Zircaloy				
	1971	- 0 -	0.01	0.14	2.48×10^{-10}	2.48×10^{-3}
	1972			1.53	2.68×10^{-9}	2.7×10^{-2}

Table 11.2-4 Total Annual Discharge Liquid Waste Processing System* Prior to Treatment

	Combined Tanks (Aux. Bldg)	CVCS	LHST	(Ci/yr) Con. Demin.	TB
Br-84	0.09825	1.84		2.043E-04	3.028E-05
I-131	8.21	153.7	0.0016	4.449E-01	1.346E-02
I-132	5.778	108.2		4.232E-02	5.213E-03
I-133	18.39	344.4		3.352E-01	2.758E-02
I-134	3.439	64.41		1.036E-02	1.535E-03
I-135	18.21	340.9		1.650E-01	2.248E-02
Rb-88	0.6522	12.22		3.065E-04	1.305E-04
Cs-134	1.325	24.8	0.011	6.586E-02	4.551E-03
Cs-136	0.1586	2.969	0.00037	6.740E-03	5.382E-04
Cs-137	1.756	32.87	0.016	8.647E-02	6.074E-03
Na-24	5.408	101.2		7.115E-02	1.117E-02
Cr-51	0.5775	10.81	0.0047	3.626E-02	1.532E-03
Mn-54	0.301	5.634	0.0038	1.992E-02	7.746E-04
Fe-55	0.2259	4.229	0.0072	1.513E-02	5.843E-04
Fe-59	0.05624	1.053	0.0022	3.538E-03	1.421E-04
Co-58	0.8639	16.17	0.0079	5.616E-02	2.256E-03
Co-60	0.1001	1.873	0.014	6.721E-03	2.624E-04
Zn-65	0.09618	1.8		6.193E-03	2.502E-04
Sr-89	0.02619	0.4902	0.000088	1.691E-03	6.753E-05
Sr-90	0.00226	0.0423	0.000013	1.516E-04	5.845E-06
Sr-91	0.08633	1.616		8.539E-04	1.652E-04
Y-91m	0.05313	0.9947		5.010E-04	9.537E-05
Y-91	0.001647	0.03083	0.000084	1.172E-04	3.705E-06
Y-93	0.3921	7.341		3.913E-03	7.310E-04
Zr-95	0.07314	1.369	0.0011	4.704E-03	1.898E-04
Nb-95	0.05311	0.9941	0.0019	3.509E-03	1.318E-04
Mo-99	1.071	20.04	0.00006	3.889E-02	2.664E-03
Tc-99m	0.9414	17.62		3.534E-02	2.056E-03
Ru-103	1.403	26.26	0.00029	9.169E-02	3.666E-03
Ru-106	16.97	317.7	0.0089	1.108E+00	4.410E-02
Te-129m	0.03551	0.6646		2.244E-03	9.210E-05
Te-129	0.3423	6.411		2.288E-03	2.597E-04
Te-131m	0.2189	4.098		4.875E-03	5.036E-04
Te-131	0.07575	1.418		9.200E-04	9.882E-05
Te-132	0.2891	5.412		1.147E-02	7.144E-04
Ba-140	2.392	44.78	0.00091	1.359E-01	6.048E-03
La-140	4.315	80.78		1.946E-01	1.031E-02
Ce-141	0.02804	0.5249	0.00023	1.768E-03	7.200E-05
Ce-143	0.417	7.806		9.902E-03	9.526E-04
Ce-144	0.7542	14.12	0.0039	4.925E-02	1.906E-03
Np-239	0.3604	6.746		1.217E-02	8.781E-04
Total	95.94	1796.34	0.086	3.09	0.17

* Per unit in accordance with 10CFR20, Appendix I.

Table 11.2-5 Total Annual Discharge Liquid Waste Processing System
Annual Discharge (Ci) After Processing
Total Releases Per Unit (TPC Unit 1 Only)***
(Page 1 of 3)

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
CD = Condensate Polishing Demineralizer, MD = Mobile Demineralizer			OTHER OPERATIONAL MODES		EXPECTED OPERATION		
	MD DF	CVCS DF	SGB processed by CD	SGB processed by CD and MD	LRW No SGB	SGB with no CD process	Σ Column 6 and Column 7
Br-84	1000	50	0.0003696	0.000165534	1.65E-04	5.23E-04	6.88E-04
I-131	1000	50	0.471244	0.0267889	2.63E-02	1.14E+00	1.16E+00
I-132	1000	50	0.055475	0.01319732	1.32E-02	1.08E-01	1.21E-01
I-133	1000	50	0.388058	0.0531932	5.29E-02	8.57E-01	9.10E-01
I-134	1000	50	0.0166222	0.00627256	6.26E-03	2.65E-02	3.28E-02
I-135	1000	50	0.212508	0.047673	4.75E-02	4.22E-01	4.70E-01
Rb-88	1000	2	0.0071992	0.006893007	6.89E-03	7.84E-04	7.68E-03
Cs-134	1000	2	0.095136	0.02934186	2.93E-02	1.68E-01	1.98E-01
Cs-136	1000	2	0.0092913	0.00255804	2.55E-03	1.72E-02	1.98E-02
Cs-137	1000	2	0.126735	0.04035147	4.03E-02	2.21E-01	2.61E-01
Na-24	1000	50	0.089752	0.01867315	1.86E-02	0.00E+00	1.86E-02
Cr-51	1000	50	0.0432857	0.00706196	7.03E-03	9.27E-02	9.98E-02
Mn-54	1000	50	0.0249083	0.0050082	4.99E-03	5.10E-02	5.59E-02
Fe-55	1000	50	0.0232248	0.00810991	8.09E-03	0.00E+00	8.09E-03
Fe-59	1000	50	0.0059574	0.002422938	2.42E-03	9.05E-03	1.15E-02
Co-58	100	50	0.078189	0.0225906	2.20E-02	1.44E-01	1.66E-01
Co-60	1000	50	0.021121	0.014406681	1.44E-02	1.72E-02	3.16E-02
Zn-65	1000	50	0.0065754	0.000388573	3.82E-04	0.0E+00	3.82E-04

**Table 11.2-5 Total Annual Discharge Liquid Waste Processing System
Annual Discharge (Ci) After Processing
Total Releases Per Unit (TPC Unit 1 Only)***
(Page 2 of 3)**

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
CD = Condensate Polishing Demineralizer, MD = Mobile Demineralizer			OTHER OPERATIONAL MODES		EXPECTED OPERATION		
	MD DF	CVCS DF	SGB processed by CD	SGB processed by CD and MD	LRW No SGB	SGB with no CD process	Σ Column 6 and Column 7
Sr-89	1000	50	0.0018825	0.000193215	1.92E-04	4.33E-03	4.52E-03
Sr-90	1000	50	0.0001736	2.21026E-05	2.20E-05	3.88E-04	4.10E-04
Sr-91	1000	50	0.0011378	0.000284704	2.84E-04	2.18E-03	2.47E-03
Y-91m	1000	50	0.0006694	0.000168895	1.68E-04	0.00E+00	1.68E-04
Y-91	1000	50	0.0002072	9.00858E-05	9.00E-05	3.00E-04	3.90E-04
Y-93	1000	50	0.0051829	0.001273833	1.27E-03	0.00E+00	1.27E-03
Zr-95	1000	50	0.0060943	0.001395024	1.39E-03	1.20E-02	1.34E-02
Nb-95	1000	50	0.0056138	0.002108301	2.10E-03	8.98E-03	1.11E-02
Mo-99	1000	50	0.0430858	0.00423469	4.20E-03	9.95E-02	1.04E-01
Tc-99m	1000	50	0.0386898	0.00338514	3.35E-03	0.00E+00	3.35E-03
Ru-103	1000	50	0.0975742	0.00597589	5.88E-03	0.00E+00	5.88E-03
Ru-106	1000	50	1.184324	0.077432	7.63E-02	0.00E+00	7.63E-02
Te-129m	1000	50	0.0023849	0.000143146	1.41E-04	0.00E+00	1.41E-04
Te-129	1000	50	0.0030182	0.000732508	7.30E-04	0.00E+00	7.30E-04
Te-131m	1000	50	0.0056795	0.000809335	8.05E-04	0.00E+00	8.05E-04
Te-131	1000	50	0.0011229	0.00020385	2.03E-04	0.00E+00	2.03E-04
Te-132	1000	50	0.0125817	0.00112321	1.11E-03	2.93E-02	3.05E-02
Ba-140	1000	50	0.1461456	0.0103815	1.02E-02	3.48E-01	3.58E-01

Table 11.2-5 Total Annual Discharge Liquid Waste Processing System Annual Discharge (Ci) After Processing Total Releases Per Unit (TPC Unit 1 Only)* (Page 3 of 3)**

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
CD = Condensate Polishing Demineralizer, MD = Mobile Demineralizer			OTHER OPERATIONAL MODES		EXPECTED OPERATION		
	MD DF	CVCS DF	SGB processed by CD	SGB processed by CD and MD	LRW No SGB	SGB with no CD process	Σ Column 6 and Column 7
La-140	1000	50	0.2108406	0.0164352	1.62E-02	4.98E-01	5.14E-01
Ce-141	1000	50	0.0021085	0.000342306	3.41E-04	0.00E+00	3.41E-04
Ce-143	1000	50	0.0114277	0.00153622	1.53E-03	0.00E+00	1.53E-03
Ce-144	1000	50	0.0560926	0.00689185	6.84E-03	1.26E-01	1.33E-01
Np-239	1000	50	0.0135434	0.00138559	1.37E-03	0.00E+00	1.37E-03
H-3 (TPC)	1	1	1252.80 (3326.4)	1252.80 (3326.4)			1257.64 (3326.4)
Unplanned			0.16	0.16	0.16		0.16
total (w/o H3) w/unplanned			3.5252328 3.685	0.4416449 0.602	0.438 0.598	4.402	4.84 5.000
total (w/H3) w/unplanned			1256.33 (3329.93) 1256.49 (3330.09)	1253.24 (3326.84) 1253.40 (3327.00)			1257.64 (3331.24) 1257.80 (3331.40)

Table 11.2-5 Total Annual Discharge Liquid Waste Processing System* Annual Discharge (Ci) After Processing Total Releases Per Unit (TPC Unit 1 Only)***

Notes:

(TPC) The values within the parentheses () represent the tritium values due to the Trtium Production Core.

*** Total Release = $[\text{Tank} + \frac{\text{CVCS}}{\text{CVCS DF}}]$/MD DF + LHST + TB + cond. demin/MD DF

- MD = Mobile Demineralizer (Processes Tanks, CVCS)
- DF = Decontamination Factor
- CVCS DF = Decontamination Factor of CVCS prior to treatment with MD.
- Cond. demin. = condensate demineralizer regeneration waste
- 0.16 Ci/yr is the unplanned release from NUREG-0017

Column 1: Source term isotopes
Column 2: Decontamination factors for the Mobile Demineralizer
Column 3: CVCS Demineralizer decontamination factors
Column 4: ((A+B/C)/D) + E + F/H + G
Column 5: ((A+B/C)/D) + E + F/H/D + G
Column 6: ((A+B/C)/D) + E + F + G
Column 7: J
Column 8: ((A+B/C)/D) + E + G + J
(See below definition for items A thru J

A (Ci/yr) = Reactor Coolant Drain Tank + Tritiated Drain Collector Tank + Floor Drain Collector Tank
B (Ci/yr) = Chemical & Volume Control System (CVCS) Letdown
C = CVCS Demineralizer decontamination factor
D = Mobile Demineralizer decontamination factor
E(Ci/yr) = Laundry and Hot Shower Drain Tank
F (Ci/yr) = Condensate Demineralizer flow = (Condensate flow + Steam Generator Blow Down six day collection volume)
G(Ci/yr) = Turbine Building drains
H = Condensate Demineralizer decontamination factors (2 for Rb-88, Cs-134,-136,-137, & 10 for all other isotopes-ref. 1)
J (Ci/yr) = Steam Generator Blow down at max allowable untreated concentration of 3.65E-5 uCi/cc. This calculated value is based on an average of 365 days but does not represent a constraint on the plant since the actual value for individual releases may be greater. However, the total of all yearly releases must remain < 5 Ci

Table 11.2-5a
DESIGN (FOR 1% FAILED FUEL) LIQUID RELEASES
CONCENTRATION/(EFFLUENT CONCENTRATION LIMIT)

BASELINE DATA WITH NO PROCESSING
(Sheet 1 of 1)

	Exp. Rel. Ci/yr	Des/Exp Ratio	Design Ci/yr	Design uCi/cc	10CFR20 ECL	C/ECL
Br-84	3.696E-04	2.500E+00	9.241E-04	2.320E-11	4.000E-04	5.806E-08
I-131	4.712E-01	5.241E+01	2.470E+01	6.210E-07	1.000E-06	6.207E-01
I-132	5.548E-02	4.000E+00	2.219E-01	5.580E-09	1.000E-04	5.577E-05
I-133	3.881E-01	2.685E+01	1.042E+01	2.620E-07	7.000E-06	3.740E-02
I-134	1.662E-02	1.650E+00	2.740E-02	6.890E-10	4.000E-04	1.722E-06
I-135	2.125E-01	7.910E+00	1.682E+00	4.230E-08	3.000E-05	1.409E-03
Rb-88	7.199E-03	1.814E+01	1.306E-01	3.280E-09	4.000E-04	8.204E-06
Cs-134	9.514E-02	4.060E+01	3.862E+00	9.710E-08	9.000E-07	1.079E-01
Cs-136	9.291E-03	1.652E+02	1.535E+00	3.860E-05	6.000E-06	6.429E-03
Cs-137	1.267E-01	1.532E+02	1.942E+01	4.880E-07	1.000E-06	4.880E-01
Cr-51	4.329E-02	2.900E-01	1.261E-02	3.170E-10	5.000E-04	6.340E-07
Mn-54	2.491E-02	4.700E-01	1.171E-02	2.940E-10	3.000E-05	9.813E-06
Fe-59	5.957E-03	3.480E+00	2.074E-02	5.210E-10	1.000E-05	5.212E-05
Co-58	7.819E-02	5.370E+00	4.200E-01	1.060E-08	2.000E-05	5.278E-04
Co-60	2.112E-02	1.380E+00	2.915E-02	7.330E-10	3.000E-06	2.442E-04
Sr-89	1.883E-03	2.245E+01	4.226E-02	1.060E-09	8.000E-06	1.328E-04
Sr-90	1.736E-04	1.349E+01	2.342E-03	5.890E-11	5.000E-07	1.177E-04
Sr-91	1.138E-03	1.860E+00	2.119E-03	5.330E-11	2.000E-05	2.663E-06
Y-90	0.000E+00	1.567E+01	0.000E+00	0.000E+00	7.000E-06	0.000E+00
Y-91	2.072E-04	1.115E+03	2.310E-01	5.810E-09	8.000E-06	7.258E-04
Zr-95	6.094E-03	1.710E+00	1.040E-02	2.620E-10	2.000E-05	1.308E-05
Nb-95	5.614E-03	2.340E+00	1.313E-02	3.300E-10	3.000E-05	1.100E-05
Mo-99	4.309E-02	7.852E+02	3.383E+01	8.500E-07	2.000E-05	4.251E-02
Te-132	1.258E-02	1.453E+02	1.828E+00	4.590E-08	9.000E-06	5.103E-03
Ba-140	1.461E-01	3.100E-01	4.587E-02	1.150E-09	8.000E-06	1.441E-04
La-140	2.108E-01	6.000E-02	1.198E-02	3.010E-10	9.000E-06	3.345E-05
Ce-144	5.609E-02	8.000E-02	4.530E-03	1.140E-10	3.000E-06	3.795E-05
Pr-144	0.000E+00	8.000E-02	0.000E+00	0.000E+00	6.000E-04	0.000E+00
H-3	1.253E+03	1.000E+00	1.253E+03	3.150E-05	1.000E-03	3.149E-02
H-3 (TPC)	3.326E+03	1.000E+00	3.326E+03	8.360E-05	1.000E-03	8.360E-02
Total						1.3430832
Total (TPC)						1.3957987

Note: The above numbers are based on one unit operation.
This Table is based on column 4 of Table 11.2-5 ratioed up to 1% failed fuel.

Table 11.2-5b
DESIGN (FOR 1% FAILED FUEL) LIQUID RELEASES
CONCENTRATION/(EFFLUENT CONCENTRATION LIMIT)

WASTE PROCESSED BY MOBILE DEMINERALIZERS
(Sheet 1 of 1)

	Exp. Rel. Ci/yr	Des/Exp Ratio	Design Ci/yr	Design uCi/cc	10CFR20 ECL	C/ECL
Br-84	1.655E-04	2.500E+00	4.138E-04	1.040E-11	4.000E-04	2.600E-08
I-131	2.679E-02	5.241E+01	1.404E+00	3.530E-08	1.000E-06	3.529E-02
I-132	1.320E-02	4.000E+00	5.279E-02	1.330E-09	1.000E-04	1.327E-05
I-133	5.319E-02	2.685E+01	1.428E+00	3.590E-08	7.000E-06	5.127E-03
I-134	6.273E-03	1.650E+00	1.034E-02	2.600E-10	4.000E-04	6.496E-07
I-135	4.767E-02	7.910E+00	3.773E-01	9.480E-09	3.000E-05	3.161E-04
Rb-88	6.893E-03	1.814E+01	1.250E-01	3.140E-09	4.000E-04	7.855E-06
Cs-134	2.934E-02	4.060E+01	1.191E+00	2.990E-08	9.000E-07	3.326E-02
Cs-136	2.558E-03	1.652E+02	4.226E-01	1.060E-08	6.000E-06	1.770E-03
Cs-137	4.035E-02	1.532E+02	6.183E+00	1.550E-07	1.000E-06	1.554E-01
Cr-51	7.062E-03	2.900E-01	2.058E-03	5.170E-11	5.000E-04	1.034E-07
Mn-54	5.008E-03	4.700E-01	2.355E-03	5.920E-11	3.000E-05	1.973E-06
Fe-59	2.423E-03	3.480E+00	8.434E-03	2.120E-10	1.000E-05	2.120E-05
Co-58	2.259E-02	5.370E+00	1.214E-01	3.050E-09	2.000E-05	1.525E-04
Co-60	1.441E-02	1.380E+00	1.988E-02	5.000E-10	3.000E-06	1.665E-04
Sr-89	1.932E-04	2.245E+01	4.337E-03	1.090E-10	8.000E-06	1.363E-05
Sr-90	2.210E-05	1.349E+01	2.982E-04	7.490E-12	5.000E-07	1.499E-05
Sr-91	2.847E-04	1.860E+00	5.303E-04	1.330E-11	2.000E-05	6.664E-07
Y-90	0.000E+00	1.587E+01	0.000E+00	0.000E+00	7.000E-06	0.000E+00
Y-91	9.009E-05	1.115E+03	1.005E-01	2.520E-09	8.000E-06	3.156E-04
Zr-95	1.395E-03	1.710E+00	2.382E-03	5.990E-11	2.000E-05	2.993E-06
Nb-95	2.108E-03	2.340E+00	4.931E-03	1.240E-10	3.000E-05	4.131E-06
Mo-99	4.235E-03	7.852E+02	3.325E+00	8.360E-08	2.000E-05	4.178E-03
Te-132	1.123E-03	1.453E+02	1.631E-01	4.100E-09	9.000E-06	4.556E-04
Ba-140	1.038E-02	3.100E-01	3.258E-03	8.190E-11	8.000E-06	1.024E-05
La-140	1.644E-02	6.000E-02	9.338E-04	2.350E-11	9.000E-06	2.608E-06
Ce-144	6.892E-03	8.000E-02	5.566E-04	1.400E-11	3.000E-06	4.663E-06
Pr-144	0.000E+00	8.000E-02	0.000E+00	0.000E+00	6.000E-04	0.000E+00
H-3	1.253E+03	1.000E+00	1.253E+03	3.150E-05	1.000E-03	3.149E-02
H-3 (TPC)	3.326E+03	1.000E+00	3.326E+03	8.360E-05	1.000E-03	8.360E-02
Total						2.680E-01
Total (TPC)						3.201E-01

Note: The above calculations are for 1 unit operation.
This Table is based on column 5 of Table 11.2-5 ratioed up to 1% failed fuel.

Table 11.2-5c
Deleted by Amendment

Table 11.2-5d
no CD process/ SGBD at max Allowable Concentration with 20000 gpm dilution:

	ANSI Ci/yr	Ci/yr scaled to 4.402 Ci	des/ansi	des Ci/yr	liquid des uCi/cc	liquid 10CFR20	C/ECL
Br-84	0.00016533	0.000522532	2.50	0.00093586	2.35E-11	4.0E-04	5.88E-08
I-131	0.026344	1.137908188	52.41	2.51862098	6.33E-08	1.0E-06	0.0633001
I-132	0.013155	0.108240671	4.00	0.16086067	4.04E-09	1.0E-04	4.043E-05
I-133	0.052858	0.857331591	26.85	2.2763383	5.72E-08	7.0E-06	0.008173
I-134	0.0062622	0.02649748	1.65	0.03681979	9.25E-10	4.0E-04	2.313E-06
I-135	0.047508	0.422015849	7.91	0.79797844	2.01E-08	3.0E-05	0.0006685
Rb-88	0.0068927	0.000783926	18.14	0.12579858	3.16E-09	4.0E-04	7.904E-06
Cs-134	0.029276	0.168448265	40.60	1.35691917	3.41E-08	9.0E-07	0.0378925
Cs-136	0.0025513	0.017238708	165.20	0.43870897	1.10E-08	6.0E-06	0.0018377
Cs-137	0.040265	0.221161881	153.22	6.3904673	1.61E-07	1.0E-06	0.1606107
Cr-51	0.0070257	0.09274118	0.29	0.09478855	2.38E-09	5.0E-04	4.765E-06
Mn-54	0.00498828	0.050948822	0.47	0.0532945	1.34E-09	3.0E-05	4.465E-05
Fe-59	0.0024194	0.009049043	3.48	0.017471	4.39E-10	1.0E-05	4.391E-05
Co-58	0.022029	0.143638849	5.37	0.26197645	6.58E-09	2.0E-05	0.0003292
Co-60	0.01439996	0.017190112	1.38	0.03706102	9.31E-10	3.0E-06	0.0003105
Sr-89	0.000191524	0.004325023	22.45	0.00862454	2.17E-10	8.0E-06	2.709E-05
Sr-90	0.000021951	0.000387743	13.49	0.00068391	1.72E-11	5.0E-07	3.438E-05
Sr-91	0.00028385	0.002183996	1.86	0.00271274	6.82E-11	2.0E-05	3.409E-06
Y-90	0	0	15.87	0	0.00E+00	7.0E-06	0
Y-91	8.99686E-05	0.000299759	1115.17	0.10063037	2.53E-09	8.0E-06	0.0003161
Zr-95	0.00139032	0.012031288	1.71	0.01440501	3.62E-10	2.0E-05	1.81E-05
Nb-95	0.002104792	0.00897487	2.34	0.01389794	3.49E-10	3.0E-05	1.164E-05
Mo-99	0.0041958	0.099467857	785.19	3.39394786	8.53E-08	2.0E-05	0.004265
Te-132	0.00111174	0.029336496	145.25	0.19081828	4.80E-09	9.0E-06	0.0005329
Ba-140	0.0102456	0.347587599	0.31	0.35080337	8.82E-09	8.0E-06	0.0011021
La-140	0.0162406	0.497722934	0.06	0.4986457	1.25E-08	9.0E-06	0.0013925
Ce-144	0.0068426	0.125965337	0.08	0.12651795	3.18E-09	3.0E-06	0.0010599
Pr-144	0	0	0.08	0	0.00E+00	6.0E-04	0
H-3	1252.80		1	1252.80	3.15E-05	1.0E-03	0.0314864
H-3 (TPC)	3326.40		1	3326.40	8.36E-05	1.0E-03	0.0836019
Total							0.3135157
Total (TPC)							0.3656312

Note: This Table is based on column 8 of Table 11.2-5, ratioed up to 1% failed fuel with SGBD at maximum allowable concentration of 3.65E-5 uCi/cc gross gamma) (TPC Unit 1 only).

Table 11.2-6 Tennessee River Reaches Within 50 Mile Radius Downstream of WBN

Name	Beginning TRM	Ending TRM	Size (acres)	Recreation visits/y
Chickamauga Lake below WBN	528.0	510.0[1]	4799	120,986
Chickamauga Lake above Sequoyah Nuclear Plant	510.0[1]	484.0	22101	1,297,880
Chickamauga Lake below Sequoyah Nuclear Plant	484.0	471.0	9889	7,421,905
Nickajack Lake (Part 1)	471.0	460.0	1799	284,000

TRM - Tennessee River Mile

[1]100% Mixing Point

Public Water Supplies Within 50 Mile Radius Downstream of WBN		
Name	**TRM**	**Estimated 2040 Population**
Dayton, TN	504	19,170
East Side Utility, TN	473.0	49,700
Chattanooga, TN	465	237,048
Soddy-Daisy/Falling Water Utility District, TN	487	11,452

Table 11.2-7 Watts Bar Nuclear Plant
Doses From Liquid Effluents For Year 2040

Individual Dose (mrem)							
Adult							
Total Body	Bone	GI Tract	Thyroid	Liver	Kidney	Lung	Skin
0.72	0.56	0.132	0.88	0.96	0.352	0.136	0.031
Teen							
Total Body	Bone	GI Tract	Thyroid	Liver	Kidney	Lung	Skin
0.44	0.60	0.104	0.80	1.00	0.356	0.152	0.031
Child							
Total Body	Bone	GI Tract	Thyroid	Liver	Kidney	Lung	Skin
0.188	0.76	0.06	0.92	0.88	0.312	0.128	0.031
Infant							
Total Body	Bone	GI Tract	Thyroid	Liver	Kidney	Lung	Skin
0.032	0.036	0.033	0.264	0.036	0.034	0.032	0.031
Population Dose (Person-rem)							
Total Body	Bone	GI Tract	Thyroid	Liver	Kidney	Lung	Skin
1.619	1.761	1.420	15.336	2.130	1.392	1.037	0.315

11.3 GASEOUS WASTE SYSTEMS

11.3.1 Design Bases

The Gaseous Waste Processing System (GWPS) is designed to remove fission product gases from the Nuclear Steam Supply System and to permit operation with periodic discharges of small quantities of fission gases through the monitored plant vent. This is accomplished by internal recirculation of radioactive gases and holdup in the nine waste gas decay tanks to reduce the concentration of radioisotopes in the released gases.

The plant gaseous effluent releases during normal operation of the plant are limited at the site boundary not to exceed 10 CFR 50 Appendix I and 40 CFR 190 limits as specified in the Offsite Dose Calculation Manual (ODCM).

Although plant operating procedures, equipment inspection, and preventive maintenance are performed during plant operations to minimize equipment malfunction, overall radioactive release limits have been established as a basis for controlling plant discharges during operation with the occurrence of a combination of equipment faults. A combination of equipment faults which include operation with fuel defects and failure of up to two TPBARs (Unit 1 only) in combination with such occurrences as:

(1) Steam generator tube leaks.

(2) Leakage in Liquid Waste Processing System.

(3) Leakage of Gaseous Waste Processing System.

(4) Leakage in Reactor Coolant System equipment.

(5) Leakage in auxiliary system equipment.

The radioactive releases from the plant resulting from equipment faults of moderate frequency are within 10 CFR 50 Appendix I and 40 CFR 190 limits as specified in the ODCM.

11.3.2 SYSTEM DESCRIPTIONS

The GWPS consists of two waste gas compressor packages, nine waste gas decay tanks, auxiliary services, and the associated piping, valves and instrumentation. The equipment serves both units. The system is shown on the Process Flow and Electrical Control Diagrams, Figure 11.3-1 and Figure 11.3-2.

Table 11.3-4 gives process parameters and system activities for key locations in the system.

Table 11.3-5 gives the expected annual gaseous releases from the GWPS.

The bases used for estimating the system activities and gaseous releases are given in Table 11.3-3.

Gaseous wastes are received from the following: degassing of the reactor coolant and purging of the volume control tank prior to a cold shutdown, displacing of cover gases caused by liquid accumulation in the tanks connected to the vent header, purging of some equipment, sampling and gas analyzer operation.

Auxiliary Services

The auxiliary services portion of the GWPS consists of two automatic gas analyzers and its instrumentation, valves, and tubing, a nitrogen and a hydrogen supply manifold and the necessary instrumentation, valves, and piping.

One automatic sequential gas analyzer determines the quantity of oxygen in the gas space of the volume control tank, pressurizer relief tank, holdup tanks, gas decay tanks, reactor coolant drain tank, and spent resin storage tank and provides a local and main control room (MCR) alarm on 2% oxygen concentration (hi-alarm), and 4% concentration (hi-hi alarm). Hydrogen (H_2) concentration may be monitored by the sequential analyzer. However, the H_2 concentration is assumed to exceed the lower flammability limit. Therefore, operator action for the sequential analyzer is based primarily on the O_2 concentration. If the H_2 concentration is low (i.e, less than or equal to 4%), this may be considered a mitigating factor when determining contingency actions for high or high-high O_2 concentration. A second oxygen monitor is installed to continuously sample the discharge of the operating gas compressor. This monitor sounds an alarm at 2% oxygen (hi-alarm) and 4% oxygen (hi-hi alarm) in the MCR. Operator action is relied upon to prevent the formation of a combustible gas mixture in the GWPS. This is accomplished by reducing oxygen concentrations on a hi-alarm and suspending additions to the Waste Gas System and reducing oxygen concentrations on a hi-hi alarm. For the sequential analyzer on a hi-alarm, the operator determines the source of the high oxygen and reduces the oxygen concentration. For a sequential analyzer hi-hi alarm, the operator minimizes an increase in vent header pressure, suspends additions to the waste gas system, and reduces oxygen concentration.

As protection against an uncontrolled release of radioactive materials from the GWPS, grab sampling and analysis are performed when either the waste disposal system waste gas sequential or continuous oxygen analyzer is inoperable. Grab sampling and analysis are performed for the continuous analyzer only during periods of compressor operation for batch transfers.

The nitrogen and hydrogen supply packages are designed to provide a supply of gas to the Nuclear Steam Supply System. Two headers are provided for each package: one for operation and one for backup. The pressure regulator (nitrogen only) in the backup header is set slightly lower than that in the operating header. When the operating header is exhausted, its discharge pressure falls below the set pressure of the backup header, which comes into service automatically to ensure a continuous supply of nitrogen gas. An alarm alerts the operator that one header (nitrogen or hydrogen) is exhausted. A two header (low and high pressure) liquid nitrogen (N_2) supply is provided to supplement the N_2 package.

Nitrogen is supplied for the following: spent resin storage tank, reactor coolant drain tank, pressurizer relief tank, volume control tank, waste gas decay tanks, and Chemical and Volume System (CVCS) holdup tanks. In addition, there is a truck fill connection in the nitrogen supply header for the direct filling of the safety injection system accumulators. Makeup nitrogen for the accumulators is supplied from the package. Hydrogen is supplied for the volume control tank.

The design and material of valves and manifolds are the same as for the main GWPS.

11.3.3 SYSTEM DESIGN

11.3.3.1 Component Design

The GWPS equipment parameters are given in Table 11.3-1. For further information on design codes and safety classes see Section 3.2.

Waste Gas Compressors

The two waste gas compressors are provided for removal of gases discharging to the vent header. One unit is supplied for normal operation and is capable of handling the gas from a holdup tank which is receiving letdown flow at the maximum rate. The second unit is provided for backup during peak load conditions, such as when degassing the reactor coolant or for service when the first unit is down for maintenance. Operation of the backup unit can be controlled manually or automatically by vent header pressure. The compressors are of the water sealed centrifugal type and are provided with mechanical seals to minimize leakage. Construction is of cast iron external and bronze internals with a stainless steel shaft.

Gas Decay Tanks

Nine tanks are provided to hold radioactive waste gases for decay or contain nitrogen gas as and inert. This arrangement is adequate for a plant operating with one percent fuel defects. Nine tanks are provided so that during normal operation, a minimum of 60 days are available for decay. The 60 days define the design characteristics, not an operational parameter.

Valves

The valves handling gases are selected to minimize leakage.

Piping

The piping for gaseous waste is typically carbon steel. All piping joints are welded except where flanged connections are necessary for maintenance.

11.3.3.2 Instrumentation Design

The system instrumentation is shown on Flow Diagrams and Electrical Control Diagrams, Figures 11.3-1 and 11.3-2. Adequate instrumentation is provided to monitor appropriate system parameters.

The instrumentation readout is located mainly on the Waste Processing System panel in the Auxiliary Building. Some instruments have local readout at the equipment location.

Most alarms are shown separately on the WPS panel and further relayed to one common WPS annunciator on the waste disposal panel (0-L-2). An oxygen analyzer alarm on the waste gas compressor discharge is in the main control room. The continuous oxygen analyzer on the waste gas compressor is provided to alert the operator that oxygen is present, and to stop processing and manually switch to the standby gas decay tank.

An automatic sequential gas analyzer is provided to monitor oxygen concentrations. The analyzer records the oxygen concentrations and alarms at high oxygen level. The instrumentation diagram and sample collection points are shown in Figure 11.3-2. Hydrogen (H_2) concentration may be monitored by the sequential analyzer. However, the H_2 concentration is assumed to exceed the lower flammability limit so that only O_2 concentration is used to determine the need for operation action.

11.3.4 Operating Procedure

Equipment installed to reduce radioactive effluents to the minimum practicable level will be maintained in good operating order and will be operated to the maximum extent practicable. In order to assure that these conditions are met, administrative controls are exercised on overall operation of the system; preventive maintenance is utilized to maintain equipment in optimum condition; and experience available from similar plants is used in planning for operation at Watts Bar Nuclear Plant.

Administrative controls are exercised through the use of instructions covering such areas as valve alignment for various operations, equipment operating instructions, and other instructions pertinent to the proper operation of the processing equipment. Discharge permit forms are utilized to assure proper procedures are followed and in assuring proper valve alignments and other operating conditions before a release. These forms are signed and verified by those personnel performing the analysis and approving the release.

Preventive maintenance is carried out on all equipment as described in the plant's maintenance program.

Gaseous wastes are received from degassing of the reactor coolant, purging of VCT, and nitrogen from the closed cover gas system. The components connected to the vent header are limited to those which normally contain no air or aerated liquids to prevent formation of a combustible mixture of hydrogen and oxygen.

Waste gases discharged to the vent header are pumped to a waste gas decay tank by one of the two waste gas compressors.

The standby compressor is started automatically when high pressure occurs in the vent header. The standby compressor can be started manually. The compressors may also be used to transfer gas between gas decay tanks.

To compress gas into the gas decay tanks, the operator selects two tanks at the auxiliary control panel, one to receive gas, and one for standby. When the tank in service is pressurized to 100 psig, flow is automatically switched to the standby tank and an alarm alerts the operator to select a new standby tank.

The discharge of the running waste gas compressor is sampled automatically by the continuous gas analyzer as it is being transferred to the tank being filled and an alarm alerts the operator to a high oxygen content. On high oxygen signal, the tank must be isolated and operator action is required to direct flow to the standby tank and to select a new standby tank.

If it should become necessary to transfer gas from one decay tank to another, the tank to be emptied is discharged to the holdup tank return line. The tank to receive gas is opened to the inlet header and the return line pressure regulator setpoint is increased above setpoint. The return line isolation valve is closed and the crossover between the return line and the compressor suction is opened. With this arrangement, gas is transferred by the compressor which is in service.

As the Chemical and Volume Control System holdup tanks' liquid is withdrawn, gas from the gas decay tanks is returned to the holdup tanks. The gas decay tank selected to supply the returning cover gas is attached to the return header from the auxiliary control board by manually opening the appropriate valve.

To maximize residence time for decay in the decay tanks, the last tank filled should be the first tank attached to the header. A backup supply of gas for the holdup tanks is provided by the nitrogen header.

Before a gas decay tank is discharged to the atmosphere via the plant vent, a gas sample is taken to determine activity concentration of the gas and total activity inventory in the tank. Total tank activity inventory is determined from the activity concentration and pressure in the tank.

To release the gas, the appropriate local manual stop valve is opened to the plant vent and the gas discharge modulating valve is opened at the auxiliary control panel. The plant vent activity level is also indicated on the panel to aid in setting the valve properly. If there should be a high activity level in the vent during release, the modulating valve closes.

Refueling

When preparing the plant for a cold shutdown prior to re-fueling, it is necessary to degas the reactor coolant to reduce the hydrogen concentration to a desired level of 5 cc/kg and a desired activity concentration of Xe-133 to 1 μCi/cc. At the start of the de-gassing operation, the volume control tank gas space contains H_2 and traces of fission gases. This atmosphere is replaced with nitrogen by raising and lowering the tank liquid level while venting and introducing nitrogen, until the above hydrogen and Xe-133 desired limits above are met.

Gas evolved from the volume control tank during this operation is pumped by the waste-gas compressors to the gas-decay tanks.

Operation of the gaseous side of the GWPS is the same during the actual refueling operation as during normal operation.

Auxiliary Services

During normal operation the GWPS supplies nitrogen and hydrogen from standard cylinders to primary plant components. Two headers are provided, one for operation and one for backup. The pressure regulator in the nitrogen operating header is set above the backup header pressure and an alarm alerts the operator when this pressure falls below setpoint. The standby header for nitrogen comes into service automatically to ensure a continuous supply of gas. After the exhausted header has been replaced, the operator manually sets the operating pressure and the backup pressure to their respective set points. When the supply header pressure for the hydrogen falls below the setpoint, an alarm alerts the operator to manually select the backup. A two header (low and high) liquid nitrogen (N_2) supply is provided to supplement the N_2 cylinders and headers. This liquid N_2 supply is normally used to maintain a charge on both the cylinders and headers. If the liquid supply is depleted, then the cylinders supply the N_2 for the headers.

11.3.5 Performance Tests

Initial performance tests are performed to verify the operability of the components, instrumentation and control equipment.

During reactor operation the system is used at all times and hence is monitored.

11.3.6 Deleted by Amendment 77

11.3.7 Radioactive Releases

11.3.7.1 NRC Requirements

The following documents have been issued by the NRC to provide regulations and guidelines for radioactive releases:

(1) 10 CFR 20, Standards for Protection Against Radiation

(2) 10 CFR 50, Licensing of Production and Utilization Facilities

The total plant gaseous releases meet these regulations by providing assurance that the exposures to individuals in unrestricted areas are as low as reasonably achievable during normal plant operation and during anticipated operational occurrences.

11.3.7.2 Westinghouse PWR Experience Releases

A survey has been performed of gaseous discharges from different Westinghouse PWR plants for one calendar year. The results are presented in Table 11.3-2.

11.3.7.3 Expected Gaseous Waste Processing System Releases

Gaseous wastes consist of nitrogen and hydrogen gases purged from the Chemical Volume and Control System volume control tank when degassing the reactor coolant, and from the closed gas blanketing system. The gas decay tank capacity permits at least 60 days decay for waste gases before discharge during normal operation.

The quantities and isotopic concentration of gases discharged from the GWPS have been estimated. The analysis is based on input sources to the GWPS per NUREG–0017, modified to reflect WBN plant-specific parameters.

The expected gaseous releases in curies per year per reactor unit are given in Table 11.3-5.

11.3.7.4 Releases from Ventilation Systems

A detailed review of the entire plant has been made to ascertain those items that could possibly contribute to airborne radioactive releases.

During normal plant operations, airborne noble gases and/or iodines can originate from reactor coolant leakage, equipment drains, venting and sampling, secondary side leakage, condenser air ejector and gland seal condenser exhausts, and GWPS leakage.

The assumptions used to estimate the annual quantity of radioactive gaseous effluents are given in Table 11.3-6. These assumptions are in accordance with NUREG-0017. The noble gases and iodines discharged from the various sources are entered in Table 11.3-7.

11.3.7.5 Estimated Total Releases

The estimated releases listed in Table 11.3-7c have been used in calculating the site boundary doses as shown in Table 11.3-10. Table 11.3-7a is the expected gases released for 1% failed fuel with containment purge. Table 11.3-7 is the annual releases with purge air filters. Table 11.3-7b is the expected gases released for 1% failed fuel with continuous filtered containment vent, and Table 11.3-7c based on ANSI 18.1-1984 with continuous filtered containment vent.

The dose calculations, based on the estimated total plant releases, show that the releases are in accordance with the design objectives in Section 11.3.1 and meet the regulations as outlined in Section 11.3.7.1. Further, the total plant releases are within the ODCM limits.

11.3.8 Release Points

Gaseous radioactive wastes are released to the atmosphere through vents located on the Shield Building, Auxiliary Building, Turbine Building, and Service Building. A brief description, including function and location of each type vent, is presented below.

Shield Building Vent

Waste gases from containment purge and the waste gas decay tanks are discharged to the environment through a Shield Building vent. Each Shield Building has one vent. The vent is of rectangular cross section (dimension - 2 feet by 7 feet 6 inches) and discharges approximately 130 feet above ground level. The location of the Reactor Building vents is shown in the equipment layout drawings, Figure 1.2-1. The location of the Shield Building in relation to the site is shown on the main plant general plan, Figure 2.1-5. All releases from the Shield Building vent except containment purge air exhaust monitor discharges are passed through HEPA filters and charcoal adsorbers prior to release. The effluent discharge rate through the vent is variable; occasionally, during containment purge, the rate may approach the value which is listed in Figure 9.4-28. The flow path for waste gases exhausted through the vent from the waste gas decay tanks is shown in Figure 11.3-1.

Auxiliary Building Vent

Waste gases in the Auxiliary Building are discharged through the Auxiliary Building exhaust vent. In addition, containment atmosphere is continuously vented, during normal operation for pressure control, into the annulus after it is filtered through HEPA and charcoal filters, and subsequently, discharged into the Auxiliary Building exhaust vent. The vent is of the chimney type having a rectangular cross section of 10 by 30 feet. The top of the vent is located atop the Auxiliary Building and discharges approximately 106 feet above grade. Under normal operating conditions, gases are continuously discharged through the vent. Effluent flow rates can be near 224,000 cfm when two Auxiliary Building general exhaust fans and one fuel-handling area exhaust fan are operating at full capacity. Under accident conditions, the Auxiliary Building is isolated, and the Auxiliary Building gas treatment system (ABGTS) is used to treat gaseous effluents. When in service, the ABGTS discharges to the Shield Building exhaust vent. The location of the Auxiliary Building exhaust vent is shown in the equipment layout diagram, Figure 1.2-1. The Auxiliary Building is shown on the main plant general plan, Figure 2.1-5.

Turbine Building Vents

Gaseous wastes from the condenser are discharged through the condenser vacuum exhaust vent. The vent, which is a 12-inch diameter pipe, discharges at approximately the 760-foot level. Under normal operating conditions the discharge flow rate will typically be less than 45 cfm.

Non-radioactive ventilation air is exhausted from the Turbine Building through the Turbine Building vents. There are eighteen vents at the 755-foot level and twenty vents at the 824-foot level (roof level). The effluent flow rates vary for each type of vent. Generally, the normal flow rates through a typical vent at the 755-foot level is 22,888 cfm and the flow rates through typical vent at the 824-foot level is 28,500 cfm. The general arrangement of vents on the Turbine Building is shown on Figure 1.2-1. The turbine building is shown on the main plant general plan, Figure 2.1-5.

Condenser Vacuum Exhaust Vent

Gaseous wastes from the condenser are discharged through the condenser vacuum exhaust vent. The vent, which is a 12-inch diameter pipe, discharges at approximately the 760-foot level. Under normal operating conditions the discharge flow rate will typically be less than 45 cfm.

Service Building Vent

Radiologically monitored potentially radioactive waste gases from the radiochemical laboratory and the titration room are exhausted through HEPA filters via a common duct which discharges to the common Service Building roof exhaust plenum. Exhaust air from the general area discharges to the common Service Building roof exhaust plenum. Separate vents from the common roof exhaust plenum discharge to atmosphere approximately 24 feet above grade. The Service Building is shown on the site plot plan, Figure 2.1-5.

11.3.9 Atmospheric Dilution

Calculations of atmospheric transport, dispersion, and ground deposition are based on the straight-line airflow model discussed in NRC Regulatory Guide 1.111 (Revision 1, July 1977). Releases are assumed to be continuous. Releases known to be periodic, e.g., those during containment purging and waste gas decay tank venting, are treated as batch releases.

Releases from the Shield Building, Turbine Building (TB), and Auxiliary Building (AB) vents are treated as ground level. The computer code titled Gaseous Effluent Licensing Code (GELC) was used to perform routine dose assessments for WBN. During Unit 1 licensing, terrain adjustment factors (TAF) were developed to account for recirculation effects due to the river valley location of the plant. The ground level joint frequency distribution (JFD) is given in Section 2.3. Air concentrations and deposition rates were calculated considering radioactive decay and buildup during transit. Plume depletion was calculated using the figures provided in Regulatory Guide 1.111.

Table 11.3-8 provides the receptor locations for performing the dose assessments in this chapter. The data was based on the 2007 land use survey. The TAF, X/Q, and D/Q for each receptor were calculated for the locations based on this survey. The TAF values presented in Table 11.3-8 were developed on the same basis that was used for the Unit 1 licensing. Meteorology data from the 1986 to 2005 time period was used in the development of the X/Qs and D/Qs. Estimates of normalized concentrations (X/Q) and normalized deposition rates (D/Q) for gaseous releases at points where potential dose pathways exist are listed in Table 11.3-8.

11.3.10 Estimated Doses from Radionuclides in Gaseous Effluents

Individuals are exposed to gaseous effluents via the following pathways: (1) external radiation from radioactivity in the air and on the ground; (2) inhalation; and (3) ingestion of beef, vegetables, and milk. No other additional exposure pathway has been identified which would contribute 10% or more to either individual or population doses.

11.3.10.1 Assumptions and Calculational Methods

External air exposures are evaluated at points of potential maximum exposure (i.e., points at the unrestricted area boundary). External skin and total body exposures are evaluated at nearby residences. The dose to the critical organ from radioiodines, tritium and particulates is calculated for real pathways existing at the site during a land use survey conducted in 2007.

To evaluate the potential critical organ dose, milk animals and nearest gardens were identified by a detailed survey within five miles of the plant (Table 11.3-8). Information on grazing seasons and feeding regimes are reflected in the feeding factor. The feeding factor is the fraction of the year an animal grazes on pasture. The calculation assumes feeding factor of 0.65 for all cow receptors in the 2007 LUS. The value is taken from Figure 2.2 in NUREG/CR-4653 "GASPAR II - Technical Reference and User Guide," 1987 that provides the growing season across the US. The value chosen is on the high end for the middle Tennessee Valley. The LUS and publicly available information support that this is a conservative feeding factor. Supplemental feed is assumed to be grown in the vicinity of Watts Bar and have the same nuclide source as the pasture.

Doses are calculated using the dose factors and methodology contained in NRC Regulatory Guide 1.109 with certain exceptions as follows:

(1) Inhalation doses are based on the average individuals inhalation rates found in ICRP Publication 23 of 1,400; 5,500; 8,000; and 8,100 m^3/year for infant, child, teen, and adult, respectively.

(2) The milk ingestion pathway has been modeled to include specific information on grazing periods for milk animals obtained from a detailed farm survey. A feeding factor (FF) has been defined as that fraction of total feed intake a dairy animal consumes that is from fresh forage. The remaining portion of feed (1-FF) is assumed to be from stored feed. Doses calculated from milk produced by animals consuming fresh forage are multiplied by these factors. Concentrations of radioactivity in stored feed are adjusted to reflect radioactive decay during the maximum assumed storage period of 180 days by the factor:

$$\frac{1}{180}\int_0^{180}\exp(-\lambda_i t)dt = \frac{1-\exp(-\lambda_i 180)}{180\lambda_i}$$

This factor replaces the factor exp ($-\lambda_i t_h$) in equation C-10 of Regulatory Guide 1.109.

(3) The stored vegetable and beef ingestion pathways have been modeled to reflect more accurately the actual dietary characteristics of individuals. For stored vegetables the assumption is made that home grown stored vegetables are consumed when fresh vegetables are not available, i.e., during the 9 months of fall, winter, and spring. Rather than use a constant storage period of 60 days, radioactive decay is accounted for explicitly during the 275-day consumption period. The radioactive decay correction is calculated by:

$$\frac{1}{275}\int_{0}^{275} \exp(-\lambda_i t)dt = \frac{1-\exp(-\lambda_i 275)}{275\lambda_i}$$

This replaces the term exp ($-\lambda_i t_h$) in Equation C-5 of Regulatory Guide 1.109.

(4) The beef consumption pathways can be divided into either commercial sales or home use pathways. Dose calculations are made for individuals consuming meat produced for home use. The normal processing route is for an individual to slaughter the beef animal, package and freeze the meat, and then consume the meat during the next 3-month period. Radioactive decay is calculated during the 3-month period by

$$\frac{1}{90}\int_{0}^{90} \exp(-\lambda_i t)dt = \frac{1-\exp(-\lambda_i 90)}{90\,\lambda_i}$$

The term is multiplied into Equation C-12 in Regulatory Guide 1.109. If the beef animals are sold commercially, then individuals would not be exposed continuously to meat containing radioactivity from the same farm. It is expected that this pathway will not cause significant individual exposures.

Population doses were based on U.S. Population distribution of:

Category	Ages (A)*	Fraction
Infant	A<2	0.015
Child	2≤A≤13	0.167
Teen	13<A<19	0.153
Adult	19≤A	0.665

* e.g., someone who is 1 year, 11 months is an infant, while someone who is exactly two years old is a child.

Tables 11.3-11 and 11.3-12 provide the doses estimated for individuals and the population within 50 miles of the plant site.

TVA assumes that enough fresh vegetables are produced at each residence to supply annual consumption by all memebers of that household. TVA assumes that enough meat is produced in each sector annulus to supply the needs of that region. The Watts Bar projected poplulation distribution for the year 2040 is given in Table 11.3-9. Vegetable injestion is the critical pathway.

11.3.10.2 Summary of Annual Population Doses

TVA has estimated the radiological impact to regional population groups in the year 2040 from the normal operation of the Watts Bar Nuclear Plant. Table 11.3-11 summarizes these population doses. The total body dose from background to individuals within the United States ranges from approximately 100 mrem to 250 mrem per year. The annual total body dose due to background for a population of about 1,500,000 persons expected to live within a 50 mile radius of the Watts Bar Nuclear Plant in the year 2040 is calculated to be approximately 210,000 man-rem assuming 140 mrem/year/individual. By comparison, the same population (excluding onsite radiation workers) will receive a total body dose of approximately 6.66 man-rem from effluents. Based on these results, TVA concludes that the normal operation of the Watts Bar Nuclear Plant will present minimal risk to the health and safety of the public.

REFERENCES

None

Table 11.3-1 Gaseous Waste Processing System Component Data[1]

Waste Gas Compressors	
Number	2
Type	Water Sealed Centrifugal
Design flow rate, N2 (at 140°F, 2 psig) cfm	40
Design pressure, psig	150
Design temperature, °F	180
Normal operating pressure, psig	
Suction	2.0 - 3.5
Discharge	0 - 100
Normal operating temperature, °F	70 - 130
Gas Decay Tanks	
Number	9
Volume, each, ft^3	600
Design pressure, psig	150
Design temperature, °F	180
Normal operating pressure, psig	0 - 110
Normal operating temperatures, °F	50 - 140
Material of construction	Carbon steel
Type	Vertical Cylindrical
Sequential Automatic Gas Analyzer	
Oxygen	Electrochemical Sensor of the Polargraphic Type, 0 - 20% O_2
Hydrogen[2]	By Thermal Conductivity, 0 - 100% H2
Automatic stepping switch	8 steps
Recorded Readout	8 points
Temperature, °F	120
Number (Shared)	1

1. For design codes and safety classes, see Section 3.2.

2. Hydrogen is quantified to determine if it exceeds lower flammability limit.

Table 11.3-2 *Historical Data* Airborne Radioactive Noble Gas Releases For 1973 From Westinghouse Designed Operating Reactors

	Plant	Total Released Curies
1.	Yankee Rowe	3.5×10^1
2.	Connecticut Yankee (Haddam Neck)	3.2×10^1
3.	San Onofre	1.1×10^4
4.	R. E. Ginna	5.76×10^2
5.	H. B. Robinson	3.1×10^3
6.	Point Beach Units 1 and 2	5.75×10^3

Table 11.3-3 Bases Used In Calculating Expected System Activities and Releases From The GWPS

A. EXPECTED SYSTEM ACTIVITY

1. The major inputs to the gas system during normal operation are vents on the CVCS Holdup Tanks (HUT) and Reactor Coolant Drain Tanks (RCDT). Inputs from the gas analyzer sampling system and CVCS volume control tank are assumed to be negligible.
2. Reactor coolant gaseous activities are based on NUREG-0017 as modified to reflect Watts Bar plant parameters.
3. Twenty-five percent of dissolved radiogases in the reactor coolant entering the RCDT's and HUT's leave solution and enter the vapor space.
4. Radioactive decay was assumed while the CVCS HUT, RCDT's and gas decay tanks were filling. No additional decay was assumed in the evaporator.
5. The CVCS HUT is assumed to be filled to 80% capacity before processing by the waste disposal system. The RCDT's are assumed to be filled to 300 gallons before draining.
6. Values for liquid flow rates to the tanks were based on estimates of annual average flows.

CVCS HUT flow	4 gpm	(2 gpm per unit)
RCDT flow	300 gpd	(per each unit)

7. Plant capacity factor 0.8
8. Iodine partition coefficient in the RCDT's and CVCS HUT was

$$\frac{7.5 \times 10^{-3}\ \mu\text{Ci/cc in vapor}}{\mu\text{Ci/cc in liquid}} \qquad \text{(Based on NUREG-0017)}$$

9. Hydrogen concentration in the primary coolant was assumed 35 cc/kg.

B. ANNUAL RELEASES

Per NUREG-0017, the following assumptions were used in calculating expected annual releases

1. 173 ft^3/day (at STP) of reactor coolant offgas is input into the waste gas disposal system.
2. WGDT inventory is assumed to be at RCS coolant concentrations, after correcting for standard temperature and pressure (273.2°K and 14.7 psia)
3. RCS coolant is at 588.2°F and 2250 psia.
4. GWPS releases are based on a 60 day hold-up time.
5. Particulate releases are taken from Table 2-17 of NUREG-0017.

Table 11.3-4 Process Parameters And Expected Activities In Gaseous Waste System (Concentrations In µCi/Gm) (Sheet 1 of 2)

		Pressure (PSIG)	Flow Temp. (°F)	Rate (cc/day)	KR83M	KR85M	KR85	KR87	KR88	KR89	XE131M	XE133M	XE133	XE135M
1.	Unit 1 RCDT Vent	1.5	170 max.	1.14(+6)	0.0E+06	1.5E-03	3.2E-02	1.4E-02	1.3E-02	0.0E+00	7.3E-02	3.9E-04	2.9E-01	7.5E-04
2.	Unit 2 RCDT Vent	1.5	170 max.	1.14(+6)	0.0E+06	1.5E-03	3.2E-02	1.4E-02	1.3E-02	0.0E+00	7.3E-02	3.9E-04	2.9E-01	7.5E-04
3.	Sampling System VCT Vent Unit 1	1.5	115	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
4.	Sampling System VCT Vent Unit 2	1.5	115	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
5.	CVCS HUT Vent	-	-	2.18(+7)	0.0E+00	9.0E-05	2.9E-02	2.3E-03	1.0E-03	0.0E+00	5.6E-02	2.4E-05	1.7E-01	4.6E-05
6.	Gas Analyzer	-	-	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
7.	Waste Disposal System SRST Vent	-	-	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
8.	CVCS VCT Vent Unit 1	1.5	115	0	0.0E+00	4.1E-01	3.5E+00	1.4E-01	5.3E-01	0.0E+00	5.3E-00	4.8E-01	2.0E+01	2.5E-02
9.	CVCS VCT Vent Unit 2	1.5	115	0	0.0E+00	4.1E-01	3.5E+00	1.4E-01	5.3E-01	0.0E+00	5.3E-00	4.8E-01	2.0E+01	2.5E-02
10.	Combination of Normal 1/p to WPS(G)	1.5	VAR	2.48(+7)	0.0E+00	3.9E-04	2.0E-01	8.5E-03	4.2E-03	0.0E+00	3.3E-01	1.0E-04	8.8E-01	2.0E-04
11.	Compressor Recirculation Line	1.5	140	0	0.0E+00	3.9E-04	2.0E-01	8.5E-03	4.2E-03	0.0E+00	3.3E-01	1.0E-04	8.8E-01	2.0E-04
12.	Compressor Inlet	3.5	VAR	2.48(+7)	0.0E+00	3.9E-04	2.0E-01	8.5E-03	4.2E-03	0.0E+00	3.3E-01	1.0E-04	8.8E-01	2.0E-04
13.	Compressor Inlet	2.0	VAR	2.48(+7)	0.0E+00	3.9E-04	2.0E-01	8.5E-03	4.2E-03	0.0E+00	3.3E-01	1.0E-04	8.8E-01	2.0E-04
14.	Downstream of Compressor	100	140	2.48(+7)	0.0E+00	1.8E-03	9.6E-01	4.0E-02	2.0E-02	0.0E+00	1.6E+00	4.8E-04	4.1E+00	1.0E-03
15.	Compressor Outlet to GDT's	-	-	0	0.0E+00	1.8E-03	9.6E-01	4.0E-02	2.0E-02	0.0E-02	1.6E+00	4.8E-04	4.1E+00	1.0E-03
16.	Inlets to Filling GDT's	100	140	2.48(+7)	0.0E+00	1.8E-03	9.6E-01	4.0E-02	2.0E-02	0.0E-02	1.6E+00	4.8E-04	4.1E+00	1.0E-03
17.	Line to GDT Header	100	AMB	VAR	0.0E+00	1.0E-05	9.6E-01	6.0E-0	6.5E-04	0.0E+00	1.4E+00	1.5E-06	3.1E+00	3.0E-06
18.	Discharge Line	20	AMB	VAR	0.0E+00	0.0E+00	4.6E-01	0.0E+00	0.0E+00	0.0E+00	2.1E-02	0.0E+00	5.6E-04	0.0E+00
19.	Discharge Line	1	AMB	VAR	0.0E+00	0.0E+00	4.6E-01	0.0E+00	0.0E+00	0.0E+00	2.1E-02	0.0E+00	5.6E-04	0.0E+00
20.	Gas Analyzer	2	AMB	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
21.	From GDT's to Compressor Inlet	100	AMB	2.48(+7)	0.0E+00	1.0E-05	9.6E-01	6.0E-03	6.5E-04	0.0E+00	1.4E+00	1.5E-06	3.1E+00	3.0E-06
22.	From GDT's to BRS HT's	3	AMB	2.48(+7)	0.0E+00	1.0E-05	9.6E-01	6.0E-03	6.5E-04	0.0E+00	1.4E+00	1.5E-06	3.1E+00	3.0E-06

Table 11.3-4 PROCESS PARAMETERS AND EXPECTED ACTIVITIES IN GASEOUS WASTE SYSTEM (CONCENTRATIONS IN μCi/gm) (Sheet 2 of 2)

		Pressur e (PSIG)	Temp. (°F)	Flow Rate (cc/day)	XE135	XE137	XE138	I130	I131	I132	I133	I134	I135
1.	Unit 1 RCDT Vent	1.5	170 max.	1.14(+6)	7.0E-02	5.0E-05	7.5E-04	0.0E+00	3.4E-04	3.8E-04	8.9E-04	2.7E-04	1.0E-03
2.	Unit 2 RCDT Vent	1.5	170 max.	1.14(+6)	7.0E-02	5.0E-05	7.5E-04	0.0E+00	3.4E-04	3.8E-04	8.9E-04	2.7E-04	1.0E-03
3.	Sampling System VCT Vent Unit 1	1.5	115	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
4.	Sampling System VCT Vent Unit 2	1.5	115	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
5.	CVCS HUT Vent	-	-	2.18(+7)	9.7E-03	3.0E-06	4.7E-05	0.0E+00	2.4E-05	2.8E-06	1.7E-05	1.8E-06	1.0E-05
6.	Gas Analyzer	-	-	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
7.	Waste Disposal System SRST Vent	-	-	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
8.	CVCS VCT Vent Unit 1	1.5	115	0	3.2E+00	1.7E-03	2.5E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
9.	CVCS VCT Vent Unit 2	1.5	115	0	3.2E+00	1.7E-03	2.5E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
10.	Combination of Normal 1/p to WPS(G)	1.5	VAR	2.48(+7)	3.9E-02	1.3E-05	2.0E-04	0.0E+00	5.3E-05	3.8E-05	4.6E-05	2.5E-05	1.0E-04
11.	Compressor Recirculation Line	1.5	140	0	3.5E-02	1.3E-05	2.0E-04	0.0E+00	5.3E-05	3.8E-05	9.6E-05	2.5E-05	1.0E-04
12.	Compressor Inlet	3.5	VAR	2.48(+7)	3.5E-02	1.3E-05	2.0E-04	0.0E+00	5.3E-05	3.8E-05	9.6E-05	2.5E-05	1.0E-04
13.	Compressor Inlet	2.0	VAR	2.48(+7)	3.5E-02	1.3E-05	2.0E-04	0.0E+00	5.3E-05	3.8E-05	9.6E-05	2.5E-05	1.0E-04
14.	Downstream of Compressor	100	140	2.48(+7)	1.7E-01	6.1E-05	9.6E-04	0.0E+00	2.6E-04	1.8E-04	4.4E-04	1.2E-04	4.9E-04
15.	Compressor Outlet to GDT's	-	-	0	1.7E-01	6.1E-05	9.6E-04	0.0E+00	2.6E-04	1.8E-04	4.4E-04	1.2E-04	4.9E-04
16.	Inlet to Filling GDT's	100	140	2.48(+7)	1.7E-01	6.1E-05	9.6E-04	0.0E+00	2.6E-04	1.8E-04	4.4E-04	1.2E-04	4.9E-04
17.	Line to GDT Header	100	AMB	VAR	1.8E-02	3.1E-08	3.1E-06	0.0E+00	2.0E-04	4.8E-06	1.1E-04	1.3E-06	3.9E-05
18.	Discharge Line	20	AMB	VAR	0.0E+00	0.0E+00	0.0E+00	0.0E+00	6.0E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00
19.	Discharge Line	1	AMB	VAR	0.0E+00	0.0E+00	0.0E+00	0.0E+00	6.0E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00
20.	Gas Analyzer	2	AMB	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
21.	From GDT's to Compressor Inlet	100	AMB	2.48(+7)	1.8E-03	3.1E-08	3.1E-06	0.0E+00	2.0E-04	4.8E-06	1.1E-04	1.3E-06	3.9E-05
22.	From GDT's to BRS HT's	3	AMB	2.48(+7)	1.8E-02	3.1E-08	3.1E-06	0.0E+06	2.0E-04	4.8E-06	1.1E-04	1.3E-06	3.9E-05

Table 11.3-5 Expected Annual Gaseous Releases From The GWPS - Per Reactor Unit

	GWPS Gas release (Ci/Yr)
Kr-85m	0.00E+00
Kr-85	4.63E+00
Kr-87	0.00E+00
Kr-88	0.00E+00
Xe-131M	3.52E-01
Xe-133M	1.14E-08
Xe-133	1.72E-02
Xe-135M	0.00E+00
Xe-135	6.01E-47
Xe-137	0.00E+00
Xe-138	0.00E+00
Ar-41	0.00E+00
Br-84	0.00E+00
I-131	1.44E-03
I-132	0.00E+00
I-133	1.16E-21
I-134	0.00E+00
I-135	4.08E-66
H-3	0.00E+00
Cr-51	1.40E-07
Mn-54	2.10E-08
Co-57	0.00E+00
Co-58	8.70E-08
Co-60	1.40E-07
Fe-59	1.80E-08
Sr-89	4.40E-07
Sr-90	1.70E-07
Zr-95	4.80E-08
Nb-95	3.70E-08
Ru-103	3.20E-08
Ru-106	2.70E-08
Sb-125	0.00E+00
Cs-134	3.30E-07
Cs-136	5.30E-08
Cs-137	7.70E-07
Ba-140	2.30E-07
Ce-141	2.20E-08
C-14	1.20E+00

Table 11.3-6 Radioactive Gaseous Effluent Parameters (Page 1 of 2)

1. Thermal Power Rating is 3582 MWt. (For Unit 1 only, Tritium releases based on 3425 MWt. Tritium isotope determination for the Non-Tritium Production Core based on 3480 MWt)
2. Primary and secondary side coolant and steam activities are based on ANSI N18.1 and have been plant adjusted for WBN specific parameters.
3. RCS water parameters:

   Volume = 11,375 ft^3
   Press. = 2250 psia
   Temp. = 588.2 °F
   Spec. Vol. = 0.02265 ft^3/lb
4. Containment releases are filtered through a HEPA and charcoal filter with minimum filtration efficiencies of 99% and 70%, respectively.
5. Containment gaseous source terms are based on a 3%/day (noble gas) and 8.0E-4%/day (iodines) release of RCS coolant into the containment airborne atmosphere.
6. WGDT releases are based on a 173 ft^3/day (@ STP) input of RCS coolant offgas to the waste gas disposal system and a WGDT holdup time of 60 days.
7. Auxiliary Building (AB) ventilation noble gas source terms are based on a 160 lb/day release of RCS coolant activity into the AB atmosphere.
8. AB ventilation iodine releases are based on 1.85 Ci/yr per µCi/gm of RCS for 300 days and 6.8 Ci/yr per µCi/gm for 65 days.
9. Refueling Area iodine releases are based on 0.16 Ci/yr per µCi/gm of RCS for 300 days and 0.3 Ci/yr per µCi/gm for 65 days.
10. Turbine Building (TB) ventilation noble gas source terms are based on a 1700 lb/hr release of secondary steam into the TB atmosphere.
11. TB ventilation iodine source terms are based on 8500 Ci/yr per µCi/gm of secondary steam for 300 days and 1400 Ci/yr per µCi/gm for 65 days.
12. Condenser vacuum exhaust noble gas source terms are based on a steam flowrate to the condenser of 8.5E6 lb/hr at secondary steam activities.
13. Condenser vacuum exhaust iodine source terms are based on a 3500 Ci/yr per µCi/gm of secondary steam released to the condenser vacuum exhaust.
14. Steam generator blowdown flash tank source terms are based on a maximum steam generator blowdown flow of 12.5 gpm/steam generator. Iodines are further reduced in the offgases by applying a 0.05 partition factor. There are no noble gas releases from this path as there are no noble gas source terms in the secondary coolant.
15. Ar-41 releases are 34 Ci/yr.
16. Total tritium releases are based on 0.4 Ci/yr per MWt, with 10% of that available for release via gaseous pathways.
17. Total particulate releases are taken directly from Table 2-17 of NUREG-0017. Since these values are prior to treatment, the releases from the Containment Building either through the purge air, or containment vent filters, are reduced by applying a HEPA filtration factor of 0.01 (99% efficiency).

Table 11.3-6 Radioactive Gaseous Effluent Parameters (Page 2 of 2)

18.	C-14 releases are 1.6 Ci/yr from containment, 4.5 Ci/yr from the AB, and 1.2 Ci/yr from the GWPS for a total of 7.3 Ci/yr.
19.	The WGS discharge is filtered with a HEPA (efficiency of 99%) and charcoal (efficiency 70%) filter prior to release.
20.	A continuous filtered containment vent of 100 cfm is the expected normal release and is evaluated. A separate evaluation assuming one purge every two weeks will be performed. NUREG-0017 suggests 22 containment purges a year during power operation, and 2 purges during refueling.

Table 11.3-7 Annual Radioactive Releases With Purge Air Filters (Curies/Year/Reactor)

Table based on operation of one unit.

Nuclide	Contain.[(1)] Building	Aux. Building	Turbine Building	Total
Kr-85m	2.00E+01	4.53E+00	1.23E+00	2.58E+01
Kr-85	6.90E+02	7.05E+00	1.86E+00	6.99E+02
Kr-87	1.09E+01	4.27E+00	1.09E+00	1.62E+01
Kr-88	2.84E+01	7.95E+00	2.13E+00	3.85E+01
Xe-131m	1.17E+03	1.73E+01	4.53E+00	1.19E+03
Xe-133m	4.63E+01	1.90E+00	5.21E-01	4.88E+01
Xe-133	3.12E+03	6.70E+01	1.77E+01	3.20E+03
Xe-135m	3.86E+00	3.68E+00	9.80E-01	8.52E+00
Xe-135	1.55E+02	2.40E+01	6.46E+00	1.85E+02
Xe-137	3.18E-01	9.67E-01	2.58E-01	1.54E+00
Xe-138	3.33E+00	3.42E+00	9.06E-01	7.66E+00
Ar-41	3.40E+01	0.00E+00	0.00E+00	3.40E+01
Br-84	6.00E-05	5.02E-02	4.81E-04	5.07E-02
I-131	7.29E-03	1.39E-01	7.08E-03	1.53E-01
I-132	1.61E-03	6.56E-01	1.70E-02	6.75E-01
I-133	3.55E-03	4.35E-01	2.03E-02	4.58E-01
I-134	1.66E-03	1.06E+00	1.47E-02	1.08E+00
I-135	3.16E-03	8.10E-01	3.13E-02	8.45E-01
H-3	1.39E+02	0.00E+00	0.00E+00	1.39E+02
H-3 (TPC)[(3)] Unit 1 Only	3.70E+02	0.00E+00	0.00E+00	3.70E+02
Cr-51	9.21E-05	5.00E-04	0.00E+00	5.92E-04
Mn-54	5.30E-05	3.78E-04	0.00E+00	4.31E-04
Co-57	8.20E-06	0.00E+00	0.00E+00	8.20E-06
Co-58	2.50E-04	2.29E-02	0.00E+00	2.32E-02
Co-60	2.61E-05	8.71E-03	0.00E+00	8.74E-03
Fe-59	2.70E-05	5.00E-05	0.00E+00	7.70E-05
Sr-89	1.30E-04	2.85E-03	0.00E+00	2.98E-03
Sr-90	5.22E-05	1.09E-03	0.00E+00	1.14E-03
Zr-95	4.80E-08	1.00E-03	0.00E+00	1.00E-03
Nb-95	1.80E-05	2.43E-03	0.00E+00	2.45E-03
Ru-103	1.60E-05	6.10E-05	0.00E+00	7.70E-05
Ru-106	2.70E-08	7.50E-05	0.00E+00	7.50E-05
Sb-125	0.00E+00	6.09E-05	0.00E+00	6.09E-05
Cs-134	2.53E-05	2.24E-03	0.00E+00	2.27E-03
Cs-136	3.21E-05	4.80E-05	0.00E+00	8.01E-05
Cs-137	5.58E-05	3.42E-03	0.00E+00	3.48E-03
Ba-140	2.30E-07	4.00E-04	0.00E+00	4.00E-04
Ce-141	1.30E-05	2.64E-05	0.00E+00	3.95E-05
C-14	2.80E+00	4.50E+00	0.00E+00	7.30E+00

(1) Includes release from GWPS
(2) 4.28E+02 = 4.28 X 10^2
(3) Tritium values for a Tritim Production Core

Table 11.3-7a Design (For 1% Failed Fuel) Expected Gas Release Concentration/(Effluent Concentration Limit) With Containment Purge (Sheet 1 of 2)

	Exp. Rel. (Ci/yr)	Des/Exp	Design (Ci/yr)	Design (μCi/cc)	10CFR20 (ECL)	**Single Unit Operation** C/ECL	**Dual Unit Operation** C/ECL
Kr-85m	2.58E+01	12.28	3.17E+02	1.10E-10	1.0E-07	0.0010951	0.0021902
Kr-85	6.99E+02	33.08	2.31E+04	7.99E-09	7.0E-07	0.0114124	0.0228248
Kr-87	1.62E+01	7.45	1.21E+02	4.18E-11	2.0E-08	0.0020906	0.0041812
Kr-88	3.85E+01	12.33	4.75E+02	1.64E-10	9.0E-09	0.0182306	0.0364612
Xe-131m	1.19E+03	2.91	3.45E+03	1.19E-09	2.0E-06	0.0005971	0.0011942
Xe-133m	4.88E+01	43.24	2.11E+03	7.29E-10	6.0E-07	0.0012142	0.0024284
Xe-133	3.20E+03	111.07	3.55E+05	1.23E-07	5.0E-07	0.2456675	0.4913350
Xe-135m	8.52E+00	5.04	4.29E+01	1.48E-11	4.0E-08	0.0003710	0.0007420
Xe-135	1.85E+02	6.97	1.29E+03	4.46E-10	7.0E-08	0.006375	0.012750
Xe-138	7.66E+00	5.43	4.16E+01	1.44E-11	2.0E-08	0.0007188	0.0014376
Br-84	5.07E-02	2.50	1.27E-01	4.38E-14	8.0E-08	5.478E-07	1.096E-06
I-131	1.53E-01	52.41	8.03E+00	2.77E-12	2.0E-10	0.013875	0.027750
I-132	6.75E-01	4.00	2.70E+00	9.33E-13	2.0E-08	4.67E-05	0.0000934
I-133	4.58E-01	26.85	1.23E+01	4.25E-12	1.0E-09	0.0042535	0.0085070
I-134	1.08E+00	1.65	1.78E+00	6.14E-13	6.0E-08	1.023E-05	2.046E-05
I-135	8.45E-01	7.91	6.69E+00	2.31E-12	6.0E-09	0.0003851	0.0007702
Cs-134	2.27E-03	40.60	9.20E-02	3.18E-14	2.0E-10	0.0001589	0.0003178
Cs-136	8.01E-05	165.20	1.32E-02	4.57E-15	9.0E-10	5.079E-06	1.016E-05
Cs-137	3.48E-03	153.22	5.33E-01	1.84E-13	2.0E-10	0.0009203	0.0018406
Cr-51	5.92E-04	0.29	1.73E-04	5.96E-17	3.0E-08	1.988E-09	3.976E-09
Mn-54	4.31E-04	0.47	2.03E-04	7.01E-17	1.0E-09	7.005E-08	1.401E-07
Fe-59	7.70E-05	3.48	2.68E-04	9.27E-17	5.0E-10	1.853E-07	3.706E-07
Co-58	2.32E-02	5.37	1.24E-01	4.30E-14	1.0E-09	4.298E-05	8.596E-05
Co-60	8.74E-03	1.38	1.21E-02	4.17E-15	5.0E-11	8.333E-05	1.667E-04
Sr-89	2.98E-03	22.45	6.69E-02	2.31E-14	1.0E-09	2.313E-05	4.626E-05
Sr-90	1.14E-03	13.49	1.54E-02	5.33E-15	6.0E-12	0.0008877	0.0017754
Zr-95	1.00E-03	1.71	1.71E-03	5.92E-16	4.0E-10	1.481E-06	2.962E-06
Nb-95	2.45E-03	2.34	5.73E-03	1.98E-15	2.0E-09	9.895E-07	1.979E-06
Ba-140	4.00E-04	0.31	1.26E-04	4.34E-17	2.0E-09	2.171E-08	4.342E-08
H-3	1.39E+02	1	1.39E+02	4.80E-11	1.0E-07	0.0004811	0.0009622
H-3 (TPC)	3.70E+02	1	3.70E+02	1.28E-10	1.0E-07	0.0012775	0.0012775
1 rod	1.53E+03	1	1.53E+03	5.29E-10	1.0E-07	0.0052869	0.0052869
2 rod	2.69E+03	1	2.69E+03	9.30E-10	1.0E-07	0.0092962	0.0092962
C-14	7.30E+00	1	7.30E+00	2.52E-12	3.0E-09	0.000841	0.001682
Ar-41	3.40E+01	1	3.40E+01	1.18E-11	1.0E-08	0.0011752	0.0023504
Total						0.3109694	0.6219388
Total (TPC)						0.3117657	0.6227352
1 rod						0.3157751	0.6267446
2 rod						0.3197845	0.6307539

Table 11.3-7a Design (For 1% Failed Fuel) Expected Gas Release Concentration/(Effluent Concentration Limit) With Containment Purge (Sheet 2 of 2)

Note: The "Dual Unit Operation" column in the above calculation considers dual unit operation. Based on the evaluation done for Revision 7, the per unit concentrations are the same for both units. Therefore, the last column is twice the preceeding column except in the case of TPC.

Note: Dual unit operation considers only Unit 1 with TPC.

Table 11.3-7b Design (For 1% Failed Fuel) Expected Gas Release Concentration/(Effluent Concentration Limit) With Continuous Filtered Containment Vent (Sheet 1 of 2)

	Exp. Rel. (Ci/yr)	Des/Exp	Design (Ci/yr)	Design (µCi/cc)	10CFR20 (ECL)	Single Unit Operation C/ECL	Dual Unit Operation C/ECL
Kr-85m	9.48E+00	12.28	1.16E+02	4.02E-11	1.0E-07	0.0004024	0.0008048
Kr-85	6.78E+02	33.08	2.24E+04	7.75E-09	7.0E-07	0.0110743	0.0221486
Kr-87	5.81E+00	7.45	4.33E+01	1.50E-11	2.0E-08	0.0007480	0.0014960
Kr-88	1.32E+01	12.33	1.63E+02	5.63E-11	9.0E-09	0.0062505	0.0125010
Xe-131m	1.09E+03	2.91	3.18E+03	1.10E-09	2.0E-06	0.0005489	0.0010978
Xe-133m	4.31E+01	43.24	1.86E+03	6.44E-10	6.0E-07	0.0010735	0.0021470
Xe-133	2.90E+03	111.07	3.22E+05	1.11E-07	5.0E-07	0.2227110	0.4454220
Xe-135m	4.68E+00	5.04	2.36E+01	8.15E-12	4.0E-08	0.0002038	0.0004076
Xe-135	8.88E+01	6.97	6.19E+02	2.14E-10	7.0E-08	0.0030561	0.0061122
Xe-138	4.34E+00	5.43	2.36E+01	8.15E-12	2.0E-08	0.0004073	0.0008146
Br-84	5.07E-02	2.50	1.27E-01	4.38E-14	8.0E-08	0.0000005	0.0000010
I-131	1.53E-01	52.41	8.00E+00	2.77E-12	2.0E-10	0.0138277	0.0276554
I-132	6.73E-01	4.00	2.69E+00	9.30E-13	2.0E-08	0.0000465	0.0000930
I-133	4.57E-01	26.85	1.23E+01	4.24E-12	1.0E-09	0.0042433	0.0084866
I-134	1.07E+00	1.65	1.77E+00	6.10E-13	6.0E-08	0.0000102	0.0000204
I-135	8.42E-01	7.91	6.66E+00	2.30E-12	6.0E-09	0.0003837	0.0007674
Cs-134	2.27E-03	40.60	9.20E-02	3.18E-14	2.0E-10	0.0001589	0.0003178
Cs-136	8.01E-05	165.20	1.32E-02	4.57E-15	9.0E-10	0.0000051	0.0000102
Cs-137	3.48E-03	153.22	5.33E-01	1.84E-13	2.0E-10	0.0009203	0.0018406
Cr-51	5.92E-04	0.29	1.73E-04	5.96E-17	3.0E-08	0.0000000	0.0000000
Mn-54	4.31E-04	0.47	2.03E-04	7.01E-17	1.0E-09	0.0000001	0.0000002
Fe-59	7.70E-05	3.48	2.68E-04	9.27E-17	5.0E-10	0.0000002	0.0000004
Co-58	2.32E-02	5.37	1.24E-01	4.30E-14	1.0E-09	0.0000430	0.0000860
Co-60	8.74E-03	1.38	1.21E-02	4.17E-15	5.0E-11	0.0000833	0.0001666
Sr-89	2.98E-03	22.45	6.69E-02	2.31E-14	1.0E-09	0.0000231	0.0000462
Sr-90	1.14E-03	13.49	1.54E-02	5.33E-15	6.0E-12	0.0008877	0.0017754
Zr-95	1.00E-03	1.71	1.71E-03	5.92E-16	4.0E-10	0.0000015	0.0000030
Nb-95	2.45E-03	2.34	5.73E-03	1.98E-15	2.0E-09	0.0000010	0.0000020
Ba-140	4.00E-04	0.31	1.26E-04	4.34E-17	2.0E-09	0.0000000	0.0000000
H-3	1.39E+02	1	1.39E+02	4.80E-11	1.0E-07	0.0004811	0.0009622
H-3 (TPC)	3.70E+02	1	3.70E+02	1.28E-10	1.0E-07	0.0012775	0.0012775
1 rod	1.53E+03	1	1.53E+03	5.29E-10	1.0E-07	0.0052869	0.0052869
2 rod	2.69E+03	1	2.69E+03	9.30E-10	1.0E-07	0.0092962	0.0092962
C-14	7.30E+00	1	7.30E+00	2.52E-12	3.0E-09	0.0008410	0.0016820
Ar-41	3.40E+01	1	3.40E+01	1.18E-11	1.0E-08	0.0011752	0.0023504
Total						0.2696131	0.5392262
Total (TPC)						0.2704095	0.5400226
1 rod						0.2744189	0.5440320
2 rod						0.2784283	0.5480413

Table 11.3-7b Design (For 1% Failed Fuel) Expected Gas Release Concentration/(Effluent Concentration Limit) With Continuous Filtered Containment Vent (Sheet 2 of 2)

Note: The "Dual Unit Operation" column in the above calculation considers dual unit operation. Based on the evaluation done for Revision 7, the per unit concentrations are the same for both units. Therefore, the last column is twice the preceeding column except in the case of TPC.

Note: Dual unit operation considers only Unit 1 with TPC.

Table 11.3-7c Total Releases (based on ANSI 18.1-1984 in Ci/yr), with Continuous Filtered Containment Vent (Sheet 1 of 1)

Table based on operation of one unit

Nuclide	Contain.(1) Building	Aux. Building	Turbine Building	Total
Kr-85m	3.72E+00	4.53E+00	1.23E+00	9.48E+00
Kr-85	6.69E+02	7.05E+00	1.86E+00	6.78E+02
Kr-87	4.48E-01	4.27E+00	1.09E+00	5.81E+00
Kr-88	3.10E+00	7.95E+00	2.13E+00	1.32E+01
Xe-131m	1.07E+03	1.73E+01	4.53E+00	1.09E+03
Xe-133m	4.07E+01	1.90E+00	5.21E-01	4.31E+01
Xe-133	2.82E+03	6.70E+01	1.77E+01	2.90E+03
Xe-135m	2.26E-02	3.68E+00	9.80E-01	4.68E+00
Xe-135	5.83E+01	2.40E+01	6.46E+01	8.88E+01
Xe-137	3.76E-04	9.67E-01	2.58E-01	1.23E+00
Xe-138	1.69E-02	3.42E+00	9.06E-01	4.34E+00
Ar-41	3.40E+01	0.00E+00	0.00E+00	3.40E+01
Br-84	8.16E-07	5.02E-02	4.81E-04	5.07E-02
I-131	6.74E-03	1.39E-01	7.08E-03	1.53E-01
I-132	1.36E-04	6.56E-01	1.70E-02	6.73E-01
I-133	2.36E-03	4.35E-01	2.03E-02	4.57E-01
I-134	4.26E-05	1.06E+00	1.47E-02	1.07E+00
I-135	8.80E-04	8.10E-01	3.13E-02	8.42E-01
H-3	1.39E+02	0.00E+00	0.00E+00	1.39E+02
Cr-51	9.21E-05	5.00E-04	.00E+00	5.92E-04
Mn-54	5.30E-05	3.78E-04	0.00E+00	4.31E-04
Co-57	8.20E-06	0.00E+00	0.00E+00	8.20E-06
Co-58	2.50E-04	2.29E-02	0.00E+00	2.32E-02
Co-60	2.61E-05	8.71E-03	0.00E+00	8.74E-03
Fe-59	2.70E-05	5.00E-05	0.00E+00	7.70E-05
Sr-89	1.30E-04	2.85E-03	0.00E+00	2.98E-03
Sr-90	5.22E-05	1.09E-03	0.00E+00	1.14E-03
Zr-95	4.80E-08	1.00E-03	0.00E+00	1.00E-03
Nb-95	1.80E-05	2.43E-03	0.00E+00	2.45E-03
Ru-103	1.60E-05	6.10E-05	0.00E+00	7.70E-05
Ru-106	2.70E-08	7.50E-05	0.00E+00	7.50E-05
Sb-125	0.00E+00	6.09E-05	0.00E+00	6.09E-05
Cs-134	2.53E-05	2.24E-03	0.00E+00	2.27E-03
Cs-136	3.21E-05	4.80E-05	0.00E+00	8.01E-05
Cs-137	5.58E-05	3.42E-03	0.00E+00	3.48E-03
Ba-140	2.30E-07	4.00E-04	0.00E+00	4.00E-04
Ce-141	1.30E-05	2.64E-05	0.00E+00	3.95E-05
C-14	2.80E+00	4.50E+00	0.00E+00	7.30E+00

Table 11.3-8 Data On Points Of Interest Near Watts Bar Nuclear Plant (Page 1 of 2)

	Sector	Distance (Meters)	Chi-over-Q (s/m^3)	D-over-Q (1/m^2)	Terrain Adjustment Factor	Milk Feeding Factor
Unrestricted Area Boundary	N	1550	5.12e-06	8.13e-09	1.70	
Unrestricted Area Boundary	NNE	1980	6.35e-06	1.23e-08	1.80	
Unrestricted Area Boundary	NE	1580	1.05e-05	1.10e-08	2.10	
Unrestricted Area Boundary	ENE	1370	1.23e-05	8.77e-09	1.70	
Unrestricted Area Boundary	E	1280	1.37e-05	9.66e-09	1.60	
Unrestricted Area Boundary	ESE	1250	1.43e-05	1.16e-08	1.80	
Unrestricted Area Boundary	SE	1250	1.11e-05	9.49e-09	1.50	
Unrestricted Area Boundary	SSE	1250	6.04e-06	8.21e-09	1.50	
Unrestricted Area Boundary	S	1340	5.33e-06	1.17e-08	1.90	
Unrestricted Area Boundary	SSW	1550	4.14e-06	1.05e-08	2.00	
Unrestricted Area Boundary	SW	1670	4.46e-06	7.34e-09	2.10	
Unrestricted Area Boundary	WSW	1430	5.47e-06	6.37e-09	1.80	
Unrestricted Area Boundary	W	1460	2.11e-06	2.07e-09	1.20	
Unrestricted Area Boundary	WNW	1400	2.49e-06	2.38e-09	2.50	
Unrestricted Area Boundary	NW	1400	2.05e-06	2.13e-09	1.70	
Unrestricted Area Boundary	NNW	1460	2.68e-06	3.08e-09	1.60	
Nearest Resident	N	2134	2.84e-06	4.21e-09	1.50	
Nearest Resident	NNE	3600	2.69e-06	4.41e-09	1.80	
Nearest Resident	NE	3353	3.84e-06	3.22e-09	2.20	
Nearest Resident	ENE	2414	6.26e-06	3.83e-09	1.90	
Nearest Resident	E	3268	3.97e-06	2.14e-09	1.70	
Nearest Resident	ESE	4416	2.64e-06	1.46e-09	1.90	
Nearest Resident	SE	1372	9.66e-06	8.16e-09	1.50	
Nearest Resident	SSE	1524	4.18e-06	5.56e-09	1.40	
Nearest Resident	S	1585	3.91e-06	8.42e-09	1.80	
Nearest Resident	SSW	1979	2.76e-06	6.64e-09	1.90	
Nearest Resident	SW	4230	1.15e-06	1.43e-09	2.00	
Nearest Resident	WSW	1829	3.61e-06	4.03e-09	1.70	
Nearest Resident	W	2896	7.30e-07	6.01e-10	1.10	
Nearest Resident	WNW	1646	2.26e-06	2.12e-09	2.90	
Nearest Resident	NW	2061	1.03e-06	9.95e-10	1.50	
Nearest Resident	NNW	4389	3.50e-07	2.97e-10	1.00	
Nearest Garden	N	7664	3.13e-07	3.00e-10	1.00	
Nearest Garden	NNE	6173	1.06e-06	1.42e-09	1.50	
Nearest Garden	NE	3353	3.84e-06	3.22e-09	2.20	
Nearest Garden	ENE	4927	2.01e-06	9.39e-10	1.60	
Nearest Garden	E	6372	1.35e-06	5.42e-10	1.40	
Nearest Garden	ESE	4758	2.26e-06	1.21e-09	1.80	
Nearest Garden	SE	4633	1.58e-06	8.97e-10	1.30	
Nearest Garden	SSE	7454	3.73e-07	2.80e-10	1.10	
Nearest Garden	S	2254	2.50e-06	4.94e-09	1.90	

Table 11.3-8 Data On Points Of Interest Near Watts Bar Nuclear Plant (Page 2 of 2)

	Sector	Distance (Meters)	Chi-over-Q (s/m^3)	D-over-Q (1/m^2)	Terrain Adjustment Factor	Milk Feeding Factor
Nearest Garden	SSW	1979	2.76e-06	6.64e-09	1.90	
Nearest Garden	SW	8100	4.28e-07	4.03e-10	1.80	
Nearest Garden	WSW	4667	8.70e-07	7.11e-10	1.50	
Nearest Garden	W	5120	3.03e-07	2.03e-10	1.00	
Nearest Garden	WNW	5909	1.72e-07	1.05e-10	1.30	
Nearest Garden	NW	3170	4.13e-06	3.50e-10	1.10	
Nearest Garden	NNW	4602	3.28e-07	2.74e-10	1.00	
Milk Cow	ESE	6706	1.35e-06	6.18e-10	1.70	0.65
Milk Cow	SSW	2286	2.24e-06	5.20e-09	1.90	0.65
Milk Cow	SSW	3353	1.36e-06	2.84e-09	2.00	0.65

Table 11.3-9 Projected 2040 Population Distribution Within 50 Miles Of Watts Bar Nuclear Plant Population Within Each Sector Element Distance From Site (Miles)

Direction	0-10	1-20	20-30	30-40	40-50	Total
N	2,619	1,885	2,778	4,768	6,172	18,222
NNW	2,150	11,762	18,766	14,502	2,547	49,727
NE	1,441	3,783	16,734	29,838	78,334	130,130
ENE	1,110	3,553	29,539	63,798	253,831	351,832
E	1,915	11,352	18,647	3,063	44,013	105,990
ESE	135	6,230	2,120	5,068	3,280	34,833
SE	203	19,852	1,185	3,950	4,822	44,012
SSE	782	8,951	1,907	2,918	48,593	74,151
S	5,823	4,586	42,883	56,430	17,985	127,707
SSW	567	5,725	42,517	46,281	106,392	201,482
SW	1,051	12,978	14,449	62,307	111,795	202,630
WSW	938	12,791	2,837	2,840	3,372	22,778
W	937	3,406	5,555	2,944	5,474	18,316
WNW	717	2,091	4,372	5,654	20,511	33,345
NW	3,998	2,889	18,634	10,462	15,956	51,940
NNW	3,413	1,536	33,843	11,609	5,890	56,290
Total	27,799	113,368	299,818	353,432	728,968	1,523,385

Table 11.3-10 Watts Bar Nuclear Plant- Individual Doses From Gaseous Effluents (For 1 Unit without TPC)

Effluent	Pathway	Guideline*	Location	Dose
Noble Gases	γ Air dose	10 mrad	Maximum Exposed Individual[1]	0.801 mrad/yr
	β Air dose	20 mrad	Maximum Exposed Individual[1]	2.710 mrad/yr
	Total body	5 mrem	Maximum Residence[2,3]	0.571 mrem/yr
	Skin	15 mrem	Maximum Residence[2,3]	1.540 mrem/yr
Iodines/ Particulates	Bone (critical organ)	15 mrem	Maximum Real Pathway[4]	9.15 mrem/yr

Breakdown of Iodine/Particulate Doses (mrem/yr)

Total Vegetable Ingestion	6.57
Inhalation	0.0704
Ground Contamination	0.0947
Submersion	0.130
Beef Ingestion[5]	2.28
Total	9.145 mrem/yr

*Guidelines are defined in Appendix I to 10 CFR Part 50.

[1]Maximum exposure point is at 1250 meters in the ESE sector.

[2]Dose from air submersion.

[3]Maximum exposed residence is at 1372 meters in the SE sector.

[4]Maximum exposed individual is a child at 1979 meters in the SSW sector.

[5]Maximum dose location for all receptors is 1250 meters in the ESE sector.

Table 11.3-11 Summary Of Population Doses

THYROID

	Infant	Child	Teen	Adult	Total
Submersion	1.26e-02	1.41e-01	1.28e-01	5.57e-01	8.38e-01
Ground	2.31e-03	2.59e-02	2.36e-02	1.03e-01	1.54e-01
Inhalation	6.62e-02	1.24e+00	6.64e-01	2.36e+00	4.33e-00
Cow Milk Ingestion	3.22e-01	1.57e+00	6.63e-01	1.25e+00	3.81e+00
Beef Ingestion	0.00e+00	3.17e-01	1.59e-01	8.04e-01	1.28e+00
Vegetable Ingestion	0.00e+00	1.04e+00	4.16e-01	1.09e-01	2.55e+00
Total man-rem	4.04e-01	4.34e+00	2.05e+00	6.17e+00	1.30e+01

TOTAL BODY

	Infant	Child	Teen	Adult	Total
Submersion	1.26e-02	1.41e-01	1.28e-01	5.57e-01	8.38e-01
Ground	2.31e-03	2.59e-02	2.36e-02	1.03e-01	1.54e-01
Inhalation	3.93e-03	1.05e-01	6.65e-02	2.76e-01	4.52e-01
Cow Milk Ingestion	1.04e-01	5.73e-01	2.17e-01	3.85e-01	1.28e+00
Beef Ingestion	0.00e+00	3.06e-01	1.53e-01	7.74e-01	1.23e+00
Vegetable Ingestion	0.00e+00	1.06e-00	4.40e-01	1.21e+00	2.70e+00
Total man-rem	1.23e-01	2.20e+00	1.03e+00	3.31e+00	6.66e+00

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Enclosure 2, Attachment 4
Response to FSAR Chapter 11 and FSEIS, Chapter 3
Request For Additional Information

Proposed Markups for FSEIS, Chapter 3

Table 3-19. Receptors from Actual Land Use Survey Results Used for Potential Gaseous Releases From WBN Unit 2

Receptor Number	Receptor Type	Sector	Distance (meters)
1	Nearest Residence	N	2134
2	Nearest Residence	NNE	3600
3	Nearest Residence	NE	3353
4	Nearest Residence	ENE	2414
5	Nearest Residence	E	3139
6	Nearest Residence	ESE	4416
7	Nearest Residence	SE	1372
8	Nearest Residence	SSE	1524
9	Nearest Residence	S	1585
10	Nearest Residence	SSW	1979
11	Nearest Residence	SW	4230
12	Nearest Residence	WSW	1829
13	Nearest Residence	W	2896
14	Nearest Residence	WNW	1646
15	Nearest Residence	NW	3048
16	Nearest Residence	NNW	4389
17	Nearest Garden	N	7644
18	Nearest Garden	NNE	6173
19	Nearest Garden	NE	3829
20	Nearest Garden	ENE	4831
21	Nearest Garden	E	8005
22	Nearest Garden	ESE	4758
23	Nearest Garden	SE	4633
24	Nearest Garden	SSE	2043
25	Nearest Garden	S	4973
26	Nearest Garden	SSW	2286
27	Nearest Garden	SW	8100
28	Nearest Garden	WSW	4667
29	Nearest Garden	W	5150
30	Nearest Garden	WNW	5793
31	Nearest Garden	NW	3170
32	Nearest Garden	NNW	4698
33	Milk Cow	ESE	6096
34	Milk Cow	ESE	6706
35	Milk Cow	SSW	2286
36	Milk Cow	SSW	3353
37	Milk Cow	NW	8100

Replace this table with information provided on the next page.

Place the information provided in this table into the table on the preceding page.

Table 3-19 Receptors from Actual Land Use Survey Results Used for Potential Gaseous Releases From WBN Unit 2

Receptor Number	Receptor Type	Sector	Distance (meters)
1.	Nearest Resident	N	2134
2.	Nearest Resident	NNE	3600
3.	Nearest Resident	NE	3353
4.	Nearest Resident	ENE	2414
5.	Nearest Resident	E	3268
6.	Nearest Resident	ESE	4416
7.	Nearest Resident	SE	1372
8.	Nearest Resident	SSE	1524
9.	Nearest Resident	S	1585
10.	Nearest Resident	SSW	1979
11.	Nearest Resident	SW	4230
12.	Nearest Resident	WSW	1829
13.	Nearest Resident	W	2896
14.	Nearest Resident	WNW	1646
15.	Nearest Resident	NW	2061
16.	Nearest Resident	NNW	4389
17.	Nearest Garden	N	7664
18.	Nearest Garden	NNE	6173
19.	Nearest Garden	NE	3353
20.	Nearest Garden	ENE	4927
21.	Nearest Garden	E	6372
22.	Nearest Garden	ESE	4758
23.	Nearest Garden	SE	4633
24.	Nearest Garden	SSE	7454
25.	Nearest Garden	S	2254
26.	Nearest Garden	SSW	1979
27.	Nearest Garden	SW	8100
28.	Nearest Garden	WSW	4667
29.	Nearest Garden	W	5120
30.	Nearest Garden	WNW	5909
31.	Nearest Garden	NW	3170
32.	Nearest Garden	NNW	4602
33.	Milk Cow	ESE	6706
34.	Milk Cow	SSW	2286
35.	Milk Cow	SSW	3353

Replace this table with information provided in the table on the next page.

Table 3-20. WBN Total Annual Gaseous Discharge Per Operating Unit (curies/year/reactor)

Nuclide	Containment Building	Auxiliary Building	Turbine Building	Total per Unit
Kr-85m	1.99E+01	4.53E+00	1.23E+00	2.57E+01
Kr-85	6.90E+02	7.05E+00	1.86E+00	6.99E+02
Kr-87	1.09E+01	4.27E+00	1.09E+00	1.63E+01
Kr-88	2.83E+01	7.95E+00	2.13E+00	3.84E+01
Xe-131m	1.17E+03	1.73E+01	4.53E+00	1.19E+03
Xe-133m	4.63E+01	1.90E+00	5.21E-01	4.87E+01
Xe-133	3.12E+03	6.70E+01	1.77E+01	3.20E+03
Xe-135m	3.85E+00	3.68E+00	9.80E-01	8.51E+00
xXe-135	1.55E+02	2.40E+01	6.46E+00	1.85E+02
Xe-137	3.18E-01	9.67E-01	2.58E-01	1.54E+00
Xe-138	3.32E+00	3.42E+00	9.06E-01	7.65E+00
Ar-41	3.40E+01	0.00E+00	0.00E+00	3.40E+01
Br-84	6.00E-05	5.01E-02	4.81E-04	5.06E-02
I-131	7.29E-03	1.39E-01	7.08E-03	1.53E-01
I-132	1.60E-03	6.56E-01	1.70E-02	6.75E-01
I-133	3.55E-03	4.35E-01	2.03E-02	4.59E-01
I-134	1.66E-03	1.06E+00	1.47E-02	1.08E+00
I-135	3.16E-03	8.10E-01	3.13E-02	8.44E-01
H-3	1.37E+02	0.00E+00	0.00E+00	1.37E+02
H-3 (TPC)	3.70E+02	0.00E+00	0.00E+00	3.70E+02
Cr-51	9.21E-05	5.00E-04	0.00E+00	5.92E-04
Mn-54	5.30E-05	3.78E-04	0.00E+00	4.31E-04
Co-57	8.20E-06	0.00E+00	0.00E+00	8.20E-06
Co-58	2.50E-04	2.29E-02	0.00E+00	2.32E-02
Co-60	2.61E-05	8.71E-03	0.00E+00	8.74E-03
Fe-59	2.70E-05	5.00E-05	0.00E+00	7.70E-05
Sr-89	1.30E-04	2.85E-03	0.00E+00	2.98E-03
Sr-90	5.22E-05	1.09E-03	0.00E+00	1.14E-03
Zr-95	4.80E-08	1.00E-03	0.00E+00	1.00E-03
Nb-95	1.80E-05	2.43E-03	0.00E+00	2.45E-03
Ru103	1.60E-05	6.10E-05	0.00E+00	7.70E-05
Ru-106	2.70E-08	7.50E-05	0.00E+00	7.50E-05
Sb-125	0.00E+00	6.09E-05	0.00E+00	6.09E-05
Cs-134	2.53E-05	2.24E-03	0.00E+00	2.27E-03
Cs-136	3.21E-05	4.80E-05	0.00E+00	8.01E-05
Cs-137	5.58E-05	3.42E-03	0.00E+00	3.48E-03
Ba-140	2.30E-07	4.00E-04	0.00E+00	4.00E-04
Ce-141	1.30E-05	2.64E-05	0.00E+00	3.94E-05
C-14	2.80E+00	4.50E+00	0.00E+00	7.30E+00

A companion figure, illustrating the release points for radioactive gaseous effluents from WBN is presented in Figure 3-9.

Place the information provided in this table into the table on the preceding page.

Table 3-20 WBN Total annual Gaseous discharge Per Operating Unit (curies/year/reactor)

Nuclide	Containment Building	Auxiliary Building	Turbine Building	Total
Kr-85m	3.72E+00	4.53E+00	1.23E+00	9.48E+00
Kr-85	6.69E+02	7.05E+00	1.86E+00	6.78E+02
Kr-87	4.48E-01	4.27E+00	1.09E+00	5.81E+00
Kr-88	3.10E+00	7.95E+00	2.13E+00	1.32E+01
Xe-131m	1.07E+03	1.73E+01	4.53E+00	1.09E+03
Xe-133m	4.07E+01	1.90E+00	5.21E-01	4.31E+01
Xe-133	2.82E+03	6.70E+01	1.77E+01	2.90E+03
Xe-135m	2.26E-02	3.68E+00	9.80E-01	4.68E+00
Xe-135	5.83E+01	2.40E+01	6.46E+01	8.88E+01
Xe-137	3.76E-04	9.67E-01	2.58E-01	1.23E+00
Xe-138	1.69E-02	3.42E+00	9.06E-01	4.34E+00
Ar-41	3.40E+01	0.00E+00	0.00E+00	3.40E+01
Br-84	8.16E-07	5.02E-02	4.81E-04	5.07E-02
I-131	6.74E-03	1.39E-01	7.08E-03	1.53E-01
I-132	1.36E-04	6.56E-01	1.70E-02	6.73E-01
I-133	2.36E-03	4.35E-01	2.03E-02	4.57E-01
I-134	4.26E-05	1.06E+00	1.47E-02	1.07E+00
I-135	8.80E-04	8.10E-01	3.13E-02	8.42E-01
H-3	1.39E+02	0.00E+00	0.00E+00	1.39E+02
H-3 (TPC)	3.70E+02	0.00E+00	0.00E+00	3.70E+02
Cr-51	9.21E-05	5.00E-04	0.00E+00	5.92E-04
Mn-54	5.30E-05	3.78E-04	0.00E+00	4.31E-04
Co-57	8.20E-06	0.00E+00	0.00E+00	8.20E-06
Co-58	2.50E-04	2.29E-02	0.00E+00	2.32E-02
Co-60	2.61E-05	8.71E-03	0.00E+00	8.74E-03
Fe-59	2.70E-05	5.00E-05	0.00E+00	7.70E-05
Sr-89	1.30E-04	2.85E-03	0.00E+00	2.98E-03
Sr-90	5.22E-05	1.09E-03	0.00E+00	1.14E-03
Zr-95	4.80E-08	1.00E-03	0.00E+00	1.00E-03
Nb-95	1.80E-05	2.43E-03	0.00E+00	2.45E-03
Ru-103	1.60E-05	6.10E-05	0.00E+00	7.70E-05
Ru-106	2.70E-08	7.50E-05	0.00E+00	7.50E-05
Sb-125	0.00E+00	6.09E-05	0.00E+00	6.09E-05
Cs-134	2.53E-05	2.24E-03	0.00E+00	2.27E-03
Cs-136	3.21E-05	4.80E-05	0.00E+00	8.01E-05
Cs-137	5.58E-05	3.42E-03	0.00E+00	3.48E-03
Ba-140	2.30E-07	4.00E-04	0.00E+00	4.00E-04
Ce-141	1.30E-05	2.64E-05	0.00E+00	3.95E-05
C-14	2.80E+00	4.50E+00	0.00E+00	7.30E+00

A companion figure illustrating the release points for radioactive gaseous effluents from WBN is presented in Figure 3-9.

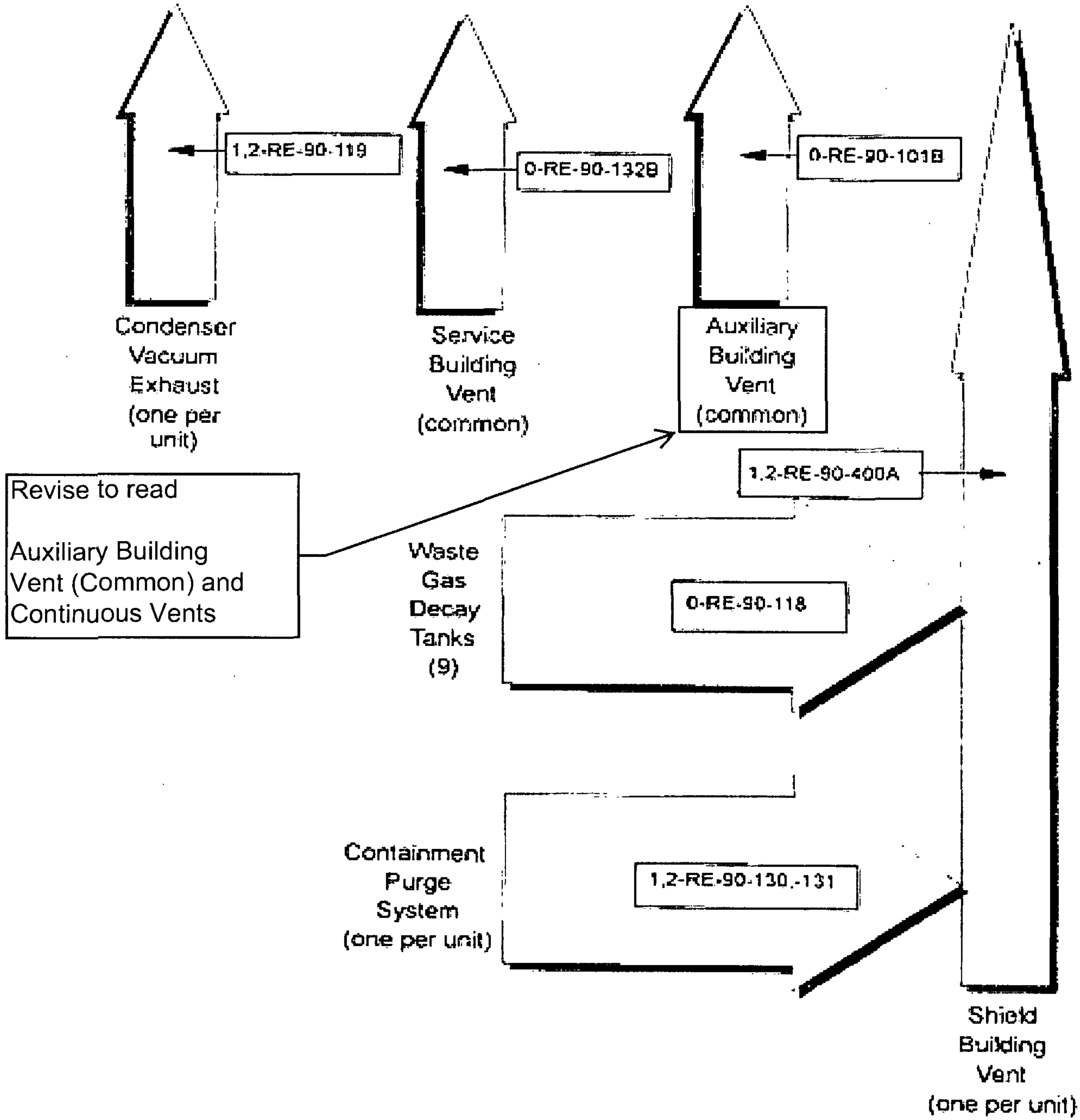

Figure 3-9. Watts Bar Nuclear Plant Gaseous Effluent Release Points

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A tabulation of the resulting calculated gaseous doses to individuals per operational unit is given in Table 3-21.

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Table 3-21. WBN Doses From Gaseous Effluent For Unit 2 W… …uction for Year 2040

Effluent	Pathway	Guideline[1]	Location	Dose
Noble Gases	γ Air dose	10 mrad	Maximum Exposed Individual[2]	0.801 mrad/year
	β Air dose	20 mrad	Maximum Exposed Individual[2]	2.710 mrad/year
	Total body	5 mrem	Maximum Residence[3,4]	0.571 mrem/year
Iodines/ Particulate	Skin	10 mrem	Maximum Residence[3,4]	1.540 mrem/year
	Thyroid (critical organ)	15 mrem	Maximum Real Pathway[5]	2.715 mrem/year

Replace with

4

Breakdown of Iodine/Particulate Doses (mrem/yr)

Cow Milk with Feeding Factor of 0.65	2.44
Inhalation	0.174
Ground Contamination	0.0405
Submersion	0.0603
Beef Ingestion[2]	0.00
Total	2.7148

Replace with

Total Vegetable Ingestion

Replace with

5

Replace with

6.57

0.0704

0.0947

0.130

2.28

9.145

[1] Guidelines are defined in Appendix I to 10 CFR Part 50.
[2] Maximum exposure point is at 1250 meters in the ESE sector.
[3] Dose from air submersion.
[4] Maximum exposed residence is at 1372 meters in the SE sector.
[5] Maximum exposed individual is an infant at 3353 meters in the SSW sector.

The estimated annual airborne releases and resulting doses as presented by the 1972 FES, the WBN Unit 1 FSAR, Unit 2, Unit 1 and 2 totals, and recent historical data from WBN Unit 1 (as submitted in the Annual Radioactive Effluent Reports to the NRC) with NRC guidelines given in 10 CFR 50 Appendix I are compared in Table 3-22. These guidelines are designed to assure that releases of radioactive material from nuclear power reactors to unrestricted areas during normal conditions, including expected occurrences, are kept as low as practicable.

Replace with

*
1
2
3
4

Insert

[5] Maximum dose location for all receptors is 1250 meters in the ESE sector.

Replace with

1979

Replace with

child

Table 3-22. Comparison of Estimated Annual Airborne Releases and Resulting Doses

	1972 FES (Table 2.4-2)	Unit 1 FSAR	Unit 2 Evaluation	Units 1 & 2 Combined	Unit 1 10-year Operational Average	10 CFR 50 Appendix I Guidelines per Unit
Particulate Activity (Ci[1])	3.0E-01	7.6E+00	4.70E-02	7.6E+00	9.29E-05	10
Noble Gas Activity (Ci[1])	7.0E+03	1.4E+04	4.84E+03	4.84E+03	2.7E-03	N/A[2]
External Dose (mrad[3])	6.6E+00	6.2E+00	3.5E+00	9.7E+00	3.69E-01	10
Organ Dose (mrem[4])	3.5E+00 (inhalation and milk only)	1.1E+01 (all pathways)	2.82E+00 (all pathways)	1.38E+01 (all pathways)	8.3E-02 (all pathways)	15

[1] Ci = Curies
[2] N/A = Not Applicable
[3] mrad = millirad
[4] mrem = millirem

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[illegible]sions can be drawn from the data in Table 3-20:

- The Unit 2 FSAR estimates, even though based on very conservative (worst-case) assumptions, indicate that estimated doses continue to meet the per unit dose guidelines given in 10 CFR Part 50, Appendix I.
- Historical WBN operational data for airborne effluents indicate that actual releases and resulting dose estimates (external and organ) to the public are a small fraction of the Appendix I guideline (averaging about 1 percent or less).

Based on these conclusions, the analyses of radiological impact from airborne release in the 1972 FES continue to be valid, and operation of WBN Unit 2 would not materially change the results.

Population Doses

TVA has estimated the radiological impact from the normal operation of WBN Unit 2 using a 50-mile regional population projection for the year 2040 of 1,523,385. The estimated population doses as presented by the 1972 FES, the WBN Unit 1 FSAR, Unit 2, Unit 1 and Unit 2 totals, and recent historical data from WBN (as submitted in the Annual Radioactive Effluent Reports to the NRC) are presented in Table 3-23.

Table 3-23. Estimated Population Doses From Operation of Watts Bar Nuclear Plant

1972 FES (Table 2.4-4)	Unit 1 FSAR	Unit 2 Evaluation	Units 1 & 2 Combined	Unit 1 10-year Operational Average	10 CFR 50 Appendix I Guidelines
3.1E+01	12.8E+00	2.362E+01	3.64E+01	3.38E-01	N/A

	1972 FES (Table 2.4-2)	Unit 1 FSAR	Unit 2 Evaluation	Units 1 & 2 Combined	Unit 1 10-year Operational Average	10 CFR 50 Appendix I Guidelines per Unit
Particulate Activity (Ci[1])	3.00E-01	4.71E-01	4.71E-01	9.42E-01	9.29E-05	10
Noble Gas Activity (Ci[1])	7.00E+03	4.84E+03	4.84E+03	9.68E+03	2.70E-03	N/A[2]
External Dose (mrad[3])	6.60E+00	2.71E+00	3.50E+00	6.21E+00	3.69E-01	10
Organ Dose (mrem[4])	3.50E+00 (inhalation and milk only)	9.41E+00 (all pathways)	9.15E+00 (all pathways)	1.86E+01 (all pathways)	8.30E-02 (all pathways)	15

1972 FES (Table 2.4-4)	Unit 1 FSAR	Unit 2 Evaluation	Units 1 & 2 Combined	Unit 1 10-year Operational Average	10 CFR 50 Appendix I Guidelines
3.10E+01	4.35E+00	6.66E+00	1.10E+01	3.38E-01	N/A

For FSEIS Table 3-23

For FSEIS Table 3-22

Enclosure 2, Attachment 5
Response to FSAR Chapter 11 and FSEIS, Chapter 3
Request For Additional Information

Proposed Clean Copy of FSEIS, Chapter 3

CHAPTER 3

3.0 CHANGES IN THE AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

The environmental consequences of constructing and operating WBN were addressed comprehensively in the 1972 FES for WBN Units 1 and 2. Subsequent environmental reviews updated that analysis, as described in Section 1.3 of this FSEIS. By 1996, when the construction of WBN Unit 1 was complete, most of the construction effects had already occurred. As described in Section 2.1, WBN Unit 2 would use structures that already exist and most of the work required to complete Unit 2 would occur inside those buildings. As shown in Figure 1-2, any disturbance proposed for the construction of new support facilities would be within the current plant footprint. Although the facility locations in this tentative site plan are not firm, any relocation would occur within the marked area to be disturbed. TVA would use standard construction BMPs to control minor construction impacts to air and water from dust, sedimentation, and noise.

The reviews by TVA and NRC in 1993 and 1995 focused primarily on the completion of WBN Unit 1. Some modifications to plant design and operations have occurred since that time. Chapter 3 summarizes the environmental effects assessed in past WBN-related environmental reviews, identifies any new or additional effects that could result from the completion and operation of WBN Unit 2, and assesses the potential for impacts. The current review focused on the entire proposed area to be disturbed.

Cumulative Effects

cumulative effects of constructing and operating WBN Units 1 and 2 were considered in the 1972 FES and the 1995 NRC FES, which TVA adopted, The potential for cumulative effects to surface water and aquatic resources are addressed by the plant's NPDES permit and its monitoring requirements. Concerns over potential cumulative effects to air were tied to emissions from WBF plant, which had not operated since 1983 and has since been retired.

Cumulative effects are also considered in many of the documents incorporated by reference and/or tiered from for this supplement. Most notably, cumulative effects of spent fuel storage and transportation were addressed in the CLWR FEIS; cumulative effects of transportation of radioactive materials were addressed in NUREG-75/038 (NRC 1975); and cumulative effects of hydrothermal and water supply were addressed in the ROS FEIS. In this review, TVA has found that no new or additional cumulative effects beyond those identified in earlier NEPA documents are expected to result from completing the construction of WBN Unit 2. As summarized in Table 2-1, for the most part, only minor, temporary, or insignificant effects are expected for most of the resources considered. As such, these effects are not expected to contribute to cumulative impacts on affected resources. The potential for additional operational cumulative effects are considered in the following assessments.

3.1. Water Quality

3.1.1. Surface Water – Hydrothermal Effects

Hydrothermal effects primarily consist of the impact of the heated effluent from WBN on the Tennessee River. Here, hydrothermal effects are divided into two categories, near-field effects and far-field effects. Near-field effects consist of the impact of the heated effluent on the river water temperature in the immediate vicinity of the plant, as defined by the assigned mixing zones for the outfalls in the NPDES permit. Limits for river water temperature are specified by the State of Tennessee in the NPDES permit for the plant. Far-field effects consist of the impact on the receiving stream on a larger scale, in this case all of Chickamauga Reservoir.

Waste heat created by the operation of WBN is dissipated both in the atmosphere and in the Tennessee River. A description of the heat dissipation system is given in Section 2.2.2. The current configuration of the system includes three outfalls to the river. Outfall 101 includes regulated releases through two multiport diffusers located on the bottom of the river at TRM 527.9. Outfall 102 includes emergency overflow from the plant yard holding pond and consists of a surface discharge from a local stream channel at TRM 527.2. Historically, releases from Outfall 102 have been made only when maintenance is required for Outfall 101. Outfall 113 includes releases from the WBN SCCW system through a discharge structure at TRM 529.2. Outfall 113, originally the outfall for the retired WBF, consists of a shoreline release slightly below the water surface of the river. The current configuration of the SCCW system provides water solely for WBN Unit 1. For the combined operation of Unit 1 and Unit 2, the control structures that regulate the amount SCCW flow between and out of the cooling tower basins would need to be modified to preserve the original design bases for all three outfalls.

An extensive number of previous studies on the hydrothermal characteristics of releases from WBN have been conducted over the years. These studies are described and their results summarized in Appendix A. In general, these studies have basically evaluated and documented:

1. That WBN can be effectively operated without causing violations of water temperature limits in the Tennessee River (near-field effect).
2. The validity of operating assumptions made in previous analyses.
3. The validity of the assigned mixing zones and modeling results for river temperature.
4. Evaluations for changes such as the addition of the SCCW system or the Reservoir Operations Study (ROS).
5. That operation of WBN is not expected to have any noticeable impact on Chickamauga Reservoir (far-field effect).

NPDES River Temperature Limits

The current NPDES permit limits for managing the near-field impact of the thermal effluent from WBN outfalls are summarized in Table 3-1. Those for Outfall 101 and Outfall 102 apply to the temperature of the effluent before it enters the river (i.e., "end-of-pipe" limitations). Those for Outfall 113 are instream limitations and apply relative to the assigned mixing zones. Releases from Outfall 101 can be made only when the flow in the river from WBH is at or above 3500 cfs.

Releases from Outfall 113 do not require a minimum flow in the river, except in events where there is a planned, sudden change in the thermal loading from the SCCW system.

Table 3-1. NPDES Temperature Limits for WBN Outfalls to the Tennessee River

Outfall	Effluent Parameter	Daily Report	Limit
101	Effluent Temperature	Daily Avg	35.0°C (95°F)
102	Effluent Temperature	Grab	35.0°C (95°F)
113	Instream Temperature[1]	Max Hourly Avg	30.5°C (86.9°F)
	Instream Temperature Rise[2]	Max Hourly Avg	3.0 C° (5.4°F)
	Instream Temperature Rate-of-Change[1]	Max Hourly Avg	±2 C°/hr (±3.6 F°/hour)
	Instream Temperature Receiving Stream Bottom[3]	Max Hourly Avg	33.5°C (92.3°F)

Notes: [1] Downstream edge of mixing zone
[2] Upstream ambient to downstream edge of mixing zone
[3] Mussel relocation zone at SCCW outlet

Mixing Zones

The mixing zone for Outfall 101 is shown in Figure 3-1. The recommended dimensions of the mixing zone are based on a physical hydrothermal model test of the diffusers (TVA 1977b, 1977c). Measurements from the model indicated that sufficient mixing would be achieved at a distance equivalent to roughly the length of the outflow section of the diffuser ports. The blowdown system includes two diffuser legs, one containing an outflow section 80 feet long (upstream) and one containing an outflow section 160 feet long (downstream). Hence, the assigned mixing zone for Outfall 101 is 240 feet wide and 240 feet downstream. The width of the river at Outfall 101 is about 1100 feet, thus about 80 percent of the river is available for safe passage of fish. The design of the diffusers and mixing zone are based on the operation of both units at WBN, and the extreme river conditions used for the design of the diffuser are still applicable (i.e., minimum river flow of 3500 cfs). For the operation of one unit, the performance of the diffuser was confirmed by field studies after the startup of Unit 1 (TVA 1998b). Similar studies would be performed to confirm the performance of the diffusers with the operation of two units at WBN.

Since releases resulting from the emergency overflow of the yard holding pond are so infrequent, a mixing zone currently is not defined in the NPDES permit for Outfall 102.

For Outfall 113, standards for water temperature are enforced by means of two mixing zones, active and passive, as shown in Figure 3-2. Two mixing zones are used to better align monitoring of Outfall 113 with the behavior of the effluent in the river. Computations and measurements show that spreading of the effluent from Outfall 113 varies substantially between conditions *with* and *without* flow in the river from Watts Bar Dam (TVA 1997b, 2001, 2004b). For conditions *with* flow, the effluent tends to reside in the right-hand-side of the river (facing downstream) and is monitored by the active mixing zone, which includes instream temperature monitors at its downstream edge. For conditions *without* flow, the effluent can spread across the river and is monitored by the passive mixing zone. Since the passive mixing zone encompasses regions of the river that must remain clear for navigation, the adequacy of the passive mixing zone is checked biannually (winter and summer) by special water termperature surveys (i.e., rather than instream monitors). Outfall 113 is a near-surface discharge, and computations and measurements confirm that the heated effluent from Outfall 113 disperses in the surface region of the water column (TVA, 1997b, 2001, 2004b, 2005c, 2006a, 2007b, 2007c), providing ample room beneath for the safe passage of fish, particularly in the deep navigation channel on the right-hand-side of the river. TVA would not change the dimensions of the Outfall 113 mixing zones with the completion and startup of Unit 2.

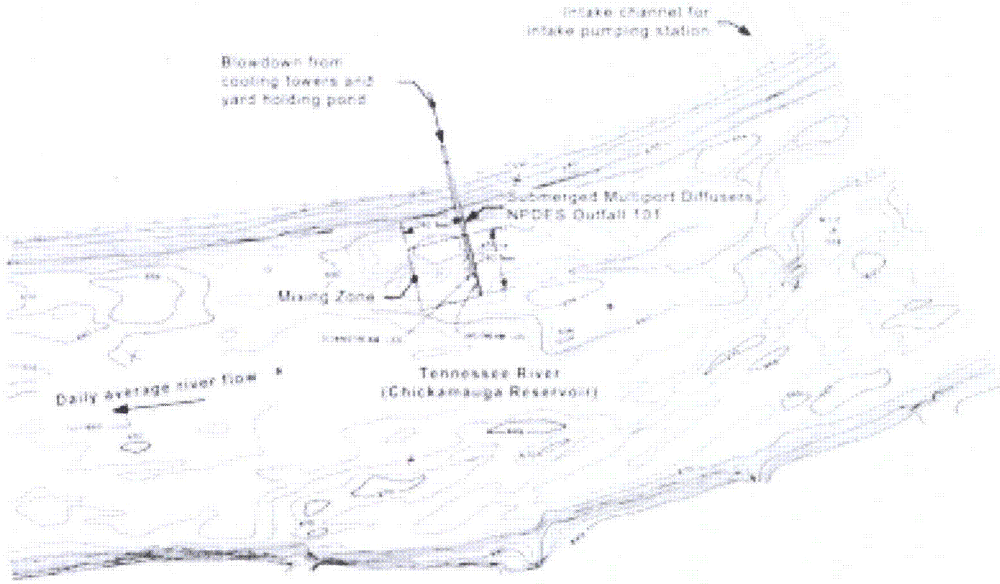

Figure 3-1. Mixing Zone for Outfall 101

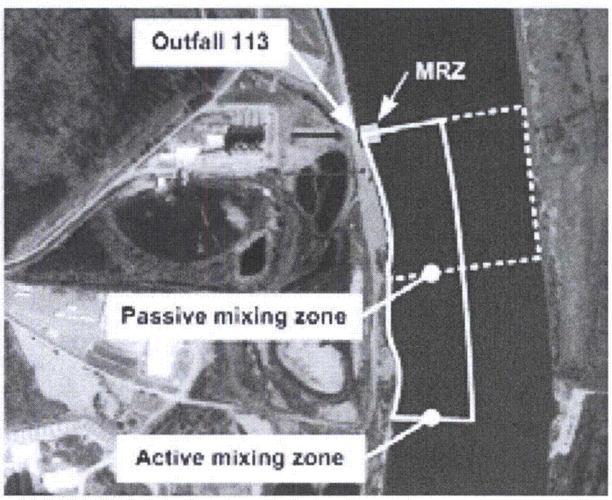

Figure 3-2. Mixing Zones for Outfall 113

It is important to note that since the startup of WBN Unit 1, the plant has operated successfully through a wide range of river flow conditions, without any exceedences of the NPDES limits for the near-field impact of thermal effluent on the Tennessee River. Concurrently, no significant adverse impacts have been reported on the ecological health of the river as a result of releases from any of the WBN discharge structures—Outfall 101, Outfall 102, or Outfall 113.

Updated Hydrothermal Analyses
In depth near-field hydrothermal analyses of the heat dissipation system have been updated for the proposed completion and operation of WBN Unit 2 (Dynamic Solutions 2007). This was necessary for several reasons. First, although the SCCW system has proven to be an effective method to boost generation of the plant, the combined operation of Unit 1 and Unit 2 with the SCCW system had not been examined. Second, detailed multiyear simulations with the dual mixing zone for Outfall 113, as depicted in Figure 3-2, had not been performed. Third, previous model evaluations had not considered the combined operation of Unit 1 and Unit 2 coupled with the river operating policy of the ROS FEIS or the characteristics of new steam generators recently installed for WBN Unit 1. Appendix A includes more detail about previous model evaluations and the modifications to the Outfall 113 mixing zone.

The updated analyses began with the model used for the 1998 EA of the SCCW system (TVA 1998a). For the updated analyses, modifications were made in the model for: (1) combined operation of Unit 1 and Unit 2, (2) discharges from Outfall 113 with dual mixing zones, (3) ambient river conditions based on the river operations policies of the ROS, and (4) performance characteristics of the new steam generators for WBN Unit 1. In this process, the following modeling assumptions are emphasized:

The cooling tower for WBN Unit 2 would be upgraded to provide the same level of performance as that of the cooling tower for Unit 1.

WBN Unit 2 would operate with the original steam generators.

The SCCW system currently serves Unit 1. With the combined operation of Unit 1 and Unit 2, the SCCW system would serve both units. While some modifications to the SCCW system would be required for combined operation (see above), these modifications would be limited to installed plant systems and would not change the volume of water delivered and removed by the SCCW system. The following analysis assumes that the SCCW system would be changed to provide service solely to Unit 2. This assumption provides a suitable bounding estimate of the potential order of magnitude of the hydrothermal impact on the Tennessee River from the operation of Unit 2 while both Units are in operation. Although other options are possible, none would result in a substantial change in volume and/or temperature of flow released to the river through Outfalls 101, 102, and 113.

Mixing of thermal effluent from Outfall 101 is adequately described by the observed behaviour in the physical model study of the discharge diffusers (TVA 1977b; TVA 1997c), and in a field study conducted after the startup of Unit 1 (TVA 1998c).

Mixing of thermal effluent from Outfall 113 is adequately described by an analysis tool recommended by the U.S. EPA known as CORMIX (Jirka, et al. 1996).

Model simulations were performed for a 30-year period based on observed hydrology and meteorology in the upper Tennessee River watershed for years 1976 through 2005. The model input requires the flow and ambient temperature of the river at WBN. To incorporate the impact of the ROS operating policy, a reservoir scheduling model was used to help estimate the hourly river flow at WBN. Hourly values of the ambient water temperature were estimated using SysTemp, a collection of linked water quality models of the key water bodies in the Tennessee River reservoir system. The reservoir scheduling model and SysTemp were both previously calibrated as a part of the ROS FEIS (TVA 2004a).

An important aspect common to all the above assumptions is that with the addition of Unit 2, the blowdown and SCCW systems would be adapted, if needed, to ensure no substantial change in the design bases for Outfalls 101, 102, and 113. That is, the maximum volume of flow and heat from the outfalls would not change substantially from their original design. For Outfalls 101 and 102, this includes the operation of both WBN units, and for Outfall 113, this includes a maximum flow of about 365 cfs, whether from Unit 1, Unit 2, or both Unit 1 and Unit 2. In this manner, the updated hydrothermal analyses would primarily ascertain the expected impact of recent changes in river operations, and provide assurance that with both WBN units, the current mixing zones and methods of operating the plant and river would effectively satisfy state standards for instream water temperature and provide safe passage for aquatic species in Chickamauga Reservoir.

Two operating cases for WBN were considered as part of the updated hydrothermal analyses—Unit 1 only (i.e., current, base case conditions) and combined operation of Unit 1 and Unit 2, with the SCCW system serving only Unit 2. For both cases, the key statistical properties of flow and temperature of water released from Watts Bar Dam are summarized in Table 3-2. As shown, daily average releases ranged from a minimum of 3300 cfs in May to a maximum of over 150,000 cfs in both March and April. Flows over about 45,000 cfs would be due to spill operations in support of flood control. On an hourly basis, releases can be 0 cfs, due to peaking operations of the hydro units. The overall average release for the entire 30-year period was about 27,000 cfs. The hourly release temperature varied between a minimum of 36.3°F in February and a maximum of 84.6°F in August. Thus, based on historical hydrology and meteorology, the ambient river temperature is not expected to exceed the state standard of 86.9°F.

Table 3-2. Estimated Hydrothermal Conditions for Release From Watts Bar Dam

Month	Daily Average Release (cfs)			Hourly Release (cfs)			Hourly Release Temperature (°F)		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Jan	5,600	36,900	122,400	0	36,900	122,400	36.6	44.0	52.0
Feb	6,300	43,000	115,300	0	43,000	115,300	36.3	43.8	52.2
Mar	5,000	36,600	156,600	0	36,600	156,600	38.9	48.9	60.0
Apr	3,600	21,000	156,600	0	21,000	156,600	47.8	56.3	65.4
May	3,300	17,300	119,300	0	17,300	119,300	54.4	63.9	73.2
Jun	5,200	21,600	81,300	0	21,600	81,300	61.6	71.3	79.1
Jul	5,900	19,300	60,200	0	19,300	60,200	68.7	76.4	83.9
Aug	5,600	22,600	41,200	0	22,600	49,100	72.4	78.0	84.6
Sep	4,300	22,400	81,300	0	22,400	81,300	69.6	76.2	82.7
Oct	4,000	21,000	70,600	0	21,000	70,600	57.5	68.3	79.2
Nov	6,500	29,700	85,000	0	29,700	85,000	47.1	58.5	68.1
Dec	4,400	32,300	102,300	0	32,300	102,300	37.7	49.3	59.5

Notes:
1. Results per SysTemp hydrothermal model simulation
2. Reservoir operating policy per the ROS FEIS
3. Historical hydrology and meteorology for 1976 through 2005

The following summaries are provided for the results of the updated hydrothermal analyses.

Outfall 101

The estimated hydrothermal conditions for the thermal effluent from Outfall 101 are given in Table 3-3 for sole operation of Unit 1 (base case) and Table 3-4 for the combined operation of both Unit 1 and Unit 2. For the sole operation of Unit 1, the hourly discharge through Outfall 101 varied between 0 cfs and about 108 cfs. Discharges of 0 cfs occur for periods when the release from WBH is less than 3500 cfs. With both WBN units in service, the hourly discharge from Outfall 101 can be as large as 175 cfs, as shown in Table 3-4. This is about 3 percent larger than the maximum value cited in previous design studies (TVA 1977b), but is not considered significant with respect to the as-built size of the blowdown system. For both cases, the estimated maximum daily average effluent temperature was 89.8°F, well below the NPDES limit of 95°F. For the purpose of judging the impact on instream river temperatures, the statistical properties of the resulting hourly river temperature and river temperature rise also are given in Tables 3-3 and 3-4. As shown, the maximum values are well below the state standards of 86.9°F for maximum river temperature and 5.4 F° for maximum river temperature rise. For the latter, the estimated maximum temperature rise is 1.3 F° for the sole operation of Unit 1 and 1.6 F° for the combined operation of both Unit 1 and Unit 2. At these levels, the maximum instream temperature rate-of-change would be well below the state standard of ±3.6 F° per hour.

Table 3-3. Estimated Hydrothermal Conditions for Thermal Effluent From Outfall 101 With Unit 1 Operation

Month	Hourly Discharge (cfs)			Daily Average Effluent Temperature (°F)			Hourly Temperature at Downstream Edge of Mixing Zone (°F)			Hourly Temperature Rise at Downstream Edge of Mixing Zone (F°)		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Jan	0	44	102	49.0	64.0	79.4	38.2	45.8	53.8	0.0	0.1	1.1
Feb	0	44	102	49.2	65.9	78.4	37.9	45.6	55.7	0.0	0.1	1.1
Mar	0	43	102	53.2	69.6	82.1	40.3	50.5	61.0	0.0	0.1	1.1
Apr	0	43	108	62.5	74.2	84.6	48.9	58.2	66.9	0.0	0.2	1.3
May	0	43	108	70.7	78.9	85.8	57.3	66.1	73.8	0.0	0.2	0.9
Jun	0	43	108	75.3	83.6	89.0	62.7	72.8	79.6	0.0	0.1	0.8
Jul	0	43	108	80.2	85.6	89.1	70.2	77.5	84.6	-0.2	0.1	0.5
Aug	0	43	108	77.4	85.6	89.8	73.8	78.8	84.7	-0.1	0.0	0.5
Sep	0	43	108	71.6	81.8	88.2	69.9	76.8	83.0	-0.3	0.0	0.5
Oct	0	43	102	63.7	75.3	83.9	58.3	68.8	79.3	-0.3	0.0	0.6
Nov	0	43	102	56.2	69.5	83.3	47.9	59.3	69.7	-0.1	0.0	1.0
Dec	0	43	102	49.4	65.2	81.2	38.2	50.7	61.7	-0.1	0.1	1.2

Notes:

1. Results per WBN hydrothermal model simulation
2. WBN Unit 1 with new steam generators of 2006
3. WBN Unit 2 idle
4. SCCW serving Unit 1
5. Reservoir operating policy per the ROS FEIS
6. Historical hydrology and meteorology for 1976 through 2005

Table 3-4. Estimated Hydrothermal Conditions for Thermal Effluent From Outfall 101 With Unit 1 and Unit 2 Operation

Month	Hourly Discharge (cfs)			Daily Average Effluent Temperature (°F)			Hourly Temperature at Downstream Edge of Mixing Zone (°F)			Hourly Temperature Rise at Downstream Edge of Mixing Zone (F°)		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Jan	0	80	165	48.9	64.0	79.3	38.3	45.9	53.9	0.0	0.2	1.4
Feb	0	80	165	49.1	65.9	78.3	38.0	45.7	56.0	0.0	0.2	1.6
Mar	0	79	166	53.1	69.6	82.1	40.3	50.6	61.2	0.0	0.2	1.5
Apr	0	79	171	62.5	74.2	84.5	48.9	58.3	67.3	0.0	0.3	1.6
May	0	80	170	70.6	78.9	85.8	57.4	66.2	73.9	0.0	0.3	1.0
Jun	0	80	171	75.3	83.6	88.9	62.7	72.8	79.6	0.0	0.2	0.9
Jul	0	81	175	80.1	85.5	89.0	70.2	77.6	84.6	-0.2	0.2	0.6
Aug	0	81	172	77.3	85.5	89.8	73.9	78.8	84.7	-0.2	0.1	0.6
Sep	0	80	170	71.6	81.7	88.2	69.9	76.8	83.1	-0.4	0.1	0.6
Oct	0	80	166	63.6	75.2	83.8	58.4	68.9	79.3	-0.4	0.1	0.9
Nov	0	80	166	56.1	69.4	83.2	47.9	59.4	69.8	-0.2	0.1	1.1
Dec	0	79	166	49.3	65.1	81.1	38.4	50.8	61.8	-0.2	0.2	1.5

Notes:
1. Results per WBN hydrothermal model simulation
2. WBN Unit 1 with new steam generators of 2006
3. WBN Unit 2 with original steam generators
4. SCCW serving Unit 2
5. Unit 2 cooling tower performance the same as Unit 1 cooling tower performance
6. Reservoir operating policy per the ROS FEIS
7. Historical hydrology and meteorology for 1976 through 2005

Outfall 102
For both the sole operation of Unit 1 (base case) and the combined operation of both Unit 1 and Unit 2, there were no events with overflow from the plant yard holding pond. As a result, under normal operating conditions, releases from Outfall 102 are not expected.

Outfall 113
The estimated hydrothermal conditions for the thermal effluent from Outfall 113 are given in Table 3-5 for sole operation of Unit 1 (base case) and Table 3-6 for the combined operation of both Unit 1 and Unit 2. For both cases, the hourly discharge through Outfall 113 varied between about 222 cfs and about 294 cfs. This demonstrates that the flow from the SCCW system is independent of the unit served by the system (i.e., Unit 1 for the base case and Unit 2 for the case with both units in operation). In a similar fashion, for both cases, the hourly effluent temperature through Outfall 113 varied between about 39.5°F and 97.3°F. Since the flow and temperature of the SCCW effluent are essentially the same for both cases, similar conditions are found for instream temperature conditions. The estimated maximum hourly instream river temperature for both cases is 84.7°F, well below the NPDES limit of 86.9°F. The estimated maximum hourly instream river temperature rise for both cases is 5.4 F°, which is the same as the current NPDES limit. The estimated largest hourly instream river temperature rate-of-change (up/+ or down/-) for both cases is -3.6 F° per hour, which is the same as the current NPDES limit. The extreme values for the temperature rise and temperature rate-of-change occur in the cooler "winter months" of the year, when the buoyancy-related mixing of the thermal effluent is reduced. In practice, TVA would not risk operation of the SCCW system with the effluent parameters so close to the NPDES limits. In extreme temperature events, the SCCW system would be operated in a more conservative manner than what has been assumed in the hydrothermal model. In particular, the temperature of the Outfall 113 effluent would be reduced

Table 3-5. Estimated Hydrothermal Conditions for Thermal Effluent From Outfall 113 With Unit 1 Operation

Month	Hourly Discharge (cfs)			Hourly Effluent Temperature (°F)			Hourly Temperature at Downstream Edge of Mixing Zone (°F)			Hourly Temperature Rise at Downstream Edge of Mixing Zone (°F)			Hourly Temperature Rate-of-Change at Downstream Edge of Mixing Zone (°F/hr)[1]		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Jan	222	222	223	39.5	62.7	82.7	38.1	45.8	53.7	0.0	1.8	5.4	-3.4	0.0	2.7
Feb	222	222	223	40.7	64.8	82.8	37.8	45.6	55.3	0.3	1.8	5.4	-3.6	0.0	2.4
Mar	222	223	227	45.9	68.3	86.1	40.2	50.9	62.0	0.0	1.9	5.4	-3.6	0.0	2.5
Apr	226	256	277	57.5	72.7	90.2	48.9	58.6	68.5	0.0	2.3	5.4	-3.6	0.0	2.4
May	240	286	292	63.6	79.3	90.9	56.8	66.3	74.6	0.0	2.4	5.4	-3.0	0.0	1.8
Jun	257	291	292	68.6	83.8	94.2	62.7	73.1	79.8	0.0	1.8	5.2	-2.8	0.0	1.7
Jul	275	292	293	71.6	86.1	97.3	70.2	77.8	84.5	0.0	1.4	4.3	-2.2	0.0	1.7
Aug	284	292	293	73.2	85.5	94.9	73.6	78.9	84.7	0.0	0.9	3.5	-2.0	0.0	1.5
	291	292	293	65.7	81.7	92.6	69.6	76.9	83.0	0.0	0.7	2.9	-1.7	0.0	1.3
Oct	287	291	292	57.7	75.0	89.7	58.3	69.3	80.4	0.0	1.0	4.8	-2.8	0.0	2.0
Nov	226	258	288	52.7	69.7	85.7	47.9	59.8	70.9	0.0	1.3	5.4	-3.4	0.0	2.1
Dec	222	222	226	44.5	64.7	84.4	39.1	51.0	63.2	0.0	1.7	5.4	-3.5	0.0	2.1

[1]Amount of change in reiver temperature, up or down, in one hour.

Additional Notes:

1. Results per WBN hydrothermal model simulation
2. WBN Unit 1 with new steam generators of 2006
3. WBN Unit 2 idle
4. SCCW serving Unit 1
5. Reservoir operating policy per the ROS FEIS
6. Historical hydrology and meteorology for 1976 through 2005

Table 3-6. Estimated Hydrothermal Conditions for Thermal Effluent From Outfall 113 With Unit 1 and Unit 2 Operation

Month	Hourly Discharge (cfs)			Hourly Effluent Temperature (°F)			Hourly Temperature at Downstream Edge of Mixing Zone (°F)			Hourly Temperature Rise at Downstream Edge of Mixing Zone (F°)			Hourly Temperature Rate-Of-Change at Downstream Edge of Mixing Zone (F°/hr)		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Jan	222	222	222	39.5	62.6	82.6	38.1	45.8	53.7	0.0	1.8	5.4	-3.6	0.0	2.7
Feb	222	222	222	40.7	64.7	82.7	37.8	45.6	55.3	0.3	1.8	5.4	-3.5	0.0	2.4
Mar	222	222	227	45.9	68.2	86.0	40.2	50.9	62.0	0.0	1.9	5.4	-3.5	0.0	2.5
Apr	226	256	277	57.3	72.6	90.2	48.9	58.6	68.4	0.0	2.3	5.4	-3.5	0.0	2.6
May	240	285	292	63.5	79.2	90.8	56.7	66.2	74.6	0.0	2.3	5.3	-3.0	0.0	1.8
Jun	257	291	292	68.5	83.7	94.1	62.7	73.0	79.8	0.0	1.7	5.2	-2.8	0.0	1.7
Jul	275	291	294	71.5	86.0	97.2	70.2	77.8	84.5	0.0	1.4	4.3	-2.2	0.0	1.7
Aug	284	292	292	73.1	85.4	94.8	73.6	78.9	84.7	0.0	0.9	3.4	-2.0	0.0	1.5
Sep	291	292	292	65.5	81.6	92.5	69.6	76.8	83.0	0.0	0.7	2.9	-1.7	0.0	1.3
Oct	287	291	292	57.5	74.8	89.6	58.3	69.3	80.4	0.0	0.9	4.8	-2.7	0.0	2.0
Nov	226	258	288	52.6	69.6	85.7	47.9	59.8	70.9	0.0	1.3	5.4	-3.4	0.0	2.1
Dec	222	222	226	44.3	64.6	84.3	39.1	51.0	63.3	0.0	1.7	5.4	-3.5	0.0	2.1

Notes:

1. Results per WBN hydrothermal model simulation
2. WBN Unit 1 with new steam generators of 2006
3. WBN Unit 2 with original steam generators
4. SCCW serving Unit 2
5. Unit 2 cooling tower performance the same as Unit 1 cooling tower performance
6. Reservoir operating policy per the ROS FEIS
7. Historical hydrology and meteorology for 1976 through 2005

by passing additional water through the SCCW bypass conduit or perhaps by removing the SCCW system from operation.

For Outfall 113 the NPDES permit also includes a limitation on the maximum temperature of the receiving stream bottom (mussel relocation zone). This temperature is not estimated by the WBN hydrothermal model. However, historical data can be examined to demonstrate that the Outfall 113 effluent would not create a significant impact on river bottom temperature. Measured temperatures for the Outfall 113 effluent and river bottom in the mussel relocation zone (MRZ) are shown in Figure 3-3. Data are shown for 1999, when the SCCW system first began operation, through mid-2004. In this span, 2002 was among the warmest years since TVA began monitoring water temperature below Watts Bar Dam. As shown, even in a warm year, the maximum MRZ bottom temperature is only about 84°F, well below the NPDES limit of 92.3°F. It is important to note that the maximum allowable temperature of essential raw cooling water (ERCW) for continued operation of WBN Unit 1 currently is 85°F, which is needed to guarantee a safe shutdown of the reactor in the event of an emergency. Efforts currently are underway to increase this limit to 88°F (TVA, 2004c, 2006b). The completion of Unit 2 is expected to include an ERCW limit of 88°F. If the water temperature at the plant pumping station located 1.3 miles downstream of Outfall 113 approaches 88°F, the operation of WBN would be suspended, and thus the heat load from the SCCW system would be dramatically reduced. Therefore, in terms of protecting bottom-dwelling species and fish passage, the impact to the river from Outfall 113 would by necessity be reduced by WBN suspension of operations should the ambient bottom temperature ever reach 88°F, still well below the MRZ temperature limit of 92.3°F.

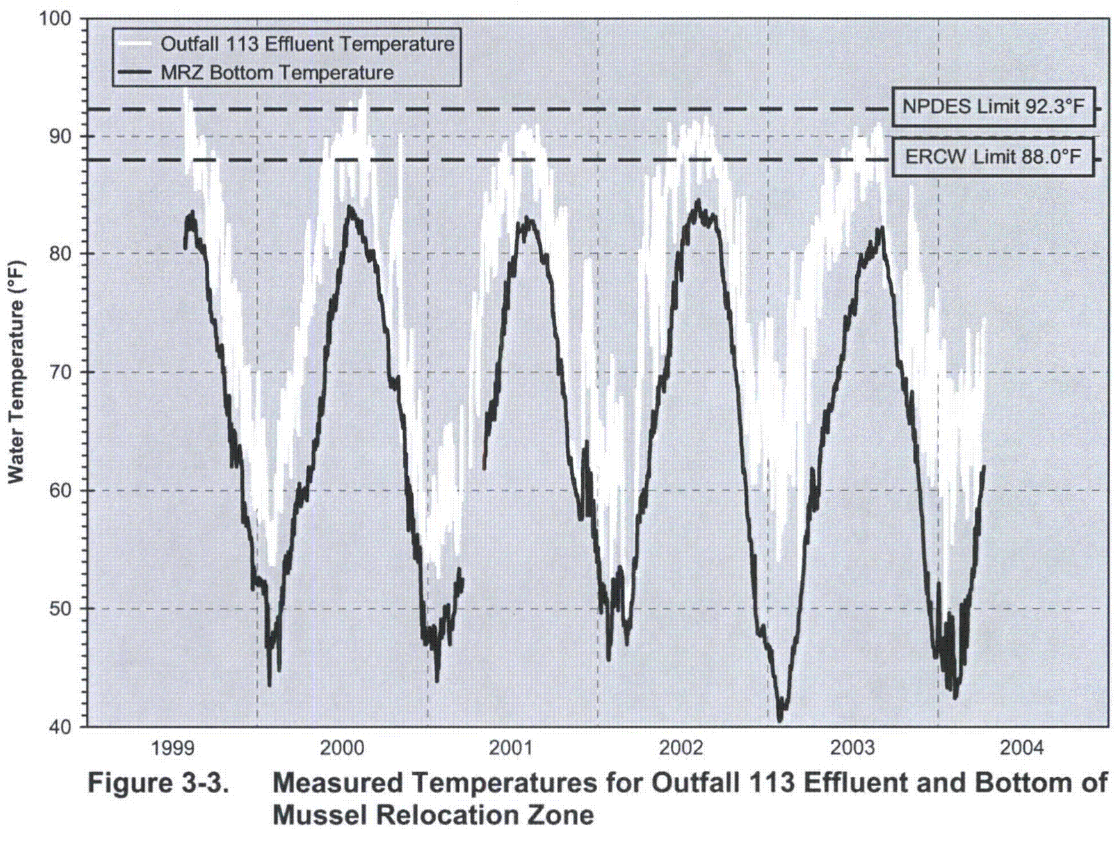

Figure 3-3. Measured Temperatures for Outfall 113 Effluent and Bottom of Mussel Relocation Zone

Impact on WBN Operation

As emphasized in Section 2.2.1, the purpose of the WBN SCCW is to enhance the performance of the unit(s) that it serves. When TVA anticipates that one or more of the NPDES temperature limits are threatened for Outfall 113, part of the SCCW inflow is diverted via the bypass to the discharge conduit to reduce the temperature of the SCCW effluent (e.g., see Figure 2-2). If the temperature of the Outfall 113 effluent cannot be sufficiently reduced by this process, the SCCW system is removed from service. In this manner, the impact of the SCCW system on WBN operation can be evaluated based on the length of time the SCCW system is placed in bypass and the length of time the SCCW system is removed from service. Provided in Table 3-7 is a summary of these impacts for the two cases examined herein. As noted, compared to current conditions with the SCCW system supporting Unit 1, combined operation of both units with the SCCW system supporting Unit 2 provides a slight reduction in the hours of required bypass operation, and no change in the number of hours the system must be removed from service. For all practical purposes, given modeling uncertainties, the results in Table 3-7 suggest that the completion and operation of Unit 2 as assumed herein would not create a substantive change in the operation of the SCCW system. The average annual generation for base-case conditions with Unit 1 obtained by the updated analyses was about 10,602,000 megawatt hours per year (MWh/year). For the combined operation of Unit 1 and Unit 2, the average annual generation obtained by the analyses was about 21,182,000 MWh/year, which is less than 0.01 percent less than twice the amount of generation for the base-case (Unit 1) conditions. This slight difference is due to the minor change in performance characteristics of the new steam generators for Unit 1 verses the original steam generators for Unit 2.

Table 3-7. Predicted SCCW Impact on WBN Operation

Case	Average Hours per Year SCCW in Bypass	Average Hours per Year SCCW Removed From Service
Unit 1 only with SCCW serving Unit 1 (base case)	525	10
Unit 1 and Unit 2 with SCCW serving Unit 2	515	10

Low River Flow

It is important to note that the simulation period from 1976 through 2005 contains four of the five driest years ever recorded in East Tennessee, 1988, 1986, 2000, and 2005 (1st, 3rd, 4th, and 5th driest for period of record from 1875 to present). Thus, the simulations summarized herein encompass perhaps near the most extreme conditions expected for the impact of WBN thermal effluent on the river. For Outfall 101, the extent of dry conditions is of little significance because the thermal effluent can be released from Outfall 101 only when the discharge from Watts Bar Dam is at least 3500 cfs. That is, even in the driest years, there will be at least 3500 cfs of flow in the river for the assimilation of waste heat from WBN. The minimum daily average release in Table 3-2, 3300 cfs, would allow a release of 3500 cfs for at least 22 hours in a single day. In practice, hydro releases from Watts Bar Dam are usually made at levels above 3500 cfs (e.g., 6000 cfs). Under these conditions, the impact of a dry year is to reduce the number of hours per day that a flow of 3500 cfs can be provided for Outfall 101, thereby forcing a greater volume of water to be stored in the WBN yard holding pond. This would increase the probability of an overflow from the yard holding pond and unwanted releases from Outfall 102. But as presented earlier, in the 30-year simulations, there were no events where it was found necessary to provide releases from the yard holding pond via the emergency overflow (i.e., including years such as 1988).

For Outfall 113, the impact of a low flow year would be to increase the duration of events where hourly releases from the SCCW system are made in the absence of hourly releases from Watts Bar Dam. In general, for such events, if there is a threat to one or more of the hourly instream water temperature limits, the amount of heat released from Outfall 113 would be reduced by passing water through the SCCW bypass conduit or perhaps by removing the SCCW system from operation. Since the plant can be operated without the SCCW system in service, such action poses no threat to the overall integrity of WBN generation. Overall, because WBN in closed mode uses such a small amount of flow compared to the potential minimum daily average flow in the river, the plant thermal effluent under extreme low flow conditions would not have an adverse impact on water temperature in the Tennessee River.

Overall Near-Field Effects

Overall, with the recent changes that have been made at the plant (e.g., SCCW system and new steam generators for Unit 1) and for the operation of the Tennessee River (i.e., ROS), the updated hydrothermal analyses reconfirm, as concluded in the 1972 FES, that the operation of two units at WBN will not have a significant impact on near-field hydrothermal conditions in the Tennessee River. Effects on water temperatures in the river can be effectively maintained within the current NPDES limits for all the plant discharge outfalls without significant adverse effects on plant generation. Additionally, data from recent field studies (Appendix A) support the methods of modeling the dissipation of waste heat in the river, and the patterns of mixing from the outfalls provide ample space for fish passage and protection of bottom habitat.

Far-Field Effects

By virtue of the fact that the heated effluent is expected to have an insignificant impact on near-field conditions in river, far-field impacts on Chickamauga Reservoir also are expected to be insignificant, for both the operation of one or two units at WBN. This is supported by the WBN discharge temperature limit evaluation conducted in 1993 (TVA 1993b), by water quality modeling performed as part of the ROS FEIS (TVA 2004a), and by operating experience since the startup of Unit 1 in 1996. Ongoing activities under the TVA Reservoir Releases Improvement Program and the TVA Vital Signs Monitoring Program would continue to provide close scrutiny of any potential far-field impacts from the heated effluent from WBN.

The near-field and far-field effects summarized above are based on the hydrothermal analyses described herein, and are judged to have no significant impact on temperatures in Chickamauga Reservoir. That conclusion, however, is limited to the impacts of discharge to the Tennessee River from Outfalls 101, 102, and 113 associated with the presumed simultaneous operation of Watts Bar Units 1 and 2. The potential for cumulative effects of the completion of WBN Unit 2 in conjunction with other factors that could impact Tennessee River temperatures was also considered.

In June 2004, following completion of a detailed ROS, TVA implemented a new reservoir operating policy (TVA 2004a). This policy specified changes in the operating guide curves at Chickamauga and other reservoirs. Potential changes in reservoir and water quality characteristics were studied in detail as a part of the ROS FEIS. These characteristics included turbine discharges and associated temperatures, residence times, thermal stratification, both cold and warm water volumes, dissolved oxygen, and algae. The impacts of the adoption of the ROS preferred operating policy for all of these characteristics, relative to the previous operating policy, were determined to be insignificant in Chickamauga Reservoir. There is no evidence to suggest that the adoption of the new operating policy has had or will have any contribution to cumulative effects in Chickamauga Reservoir. Whereas the ROS studies included only the operation of WBN Unit 1, the updated hydrothermal analyses summarized above show that the impact to the near-field river temperature of adding WBN Unit 2 would be insignificant. As such, the startup of WBN Unit 2 would not change this conclusion regarding the potential for cumulative effects.

3.1.2. Surface Water – Chemical Additives to Raw Water

The referenced earlier environmental reviews analyzed potential impacts to surface water and water quality. A primary area of concern for surface water and water quality relates to the chemicals added to treat raw water. These earlier analyses continue to adequately depict the kinds of chemicals used at the plant and associated environmental impacts.

Proposed chemical additives and their respective toxicological data are presented to the state for approval prior to plant use in the facility's Biocide and Corrosion Treatment Plan (B/CTP) required by the WBN Unit NPDES permit. To ensure the water quality criteria in the receiving stream is maintained, the state reviews the chemical usage request and evaluates the reasonable potential environmental impacts of a specific chemical discharge to determine the plant NPDES permit monitoring requirements and discharge limits. Upon start of operation in May 1996, WBN was issued NPDES permit number TN0020168 (TVA 2005d). WBN is authorized to discharge process and non-process wastewater, cooling water and storm water runoff from Outfall 101 and Outfall 102 turbine building sump water, alum sludge supernate, reverse osmosis reject water, drum dewatering water, water purification plant water, and storm water runoff from internal monitoring point (IMP) 103; metal cleaning wastewater, turbine building station sump water, diesel generator coolant, and storm water through IMP 107; treated sanitary wastewater through IMP 111; HVAC cooling water, storm water, and fire protection wastewater through Outfall 112; and SCCW from Outfall 113 to the Tennessee River (refer to Figure 1-2, Unit 2 Site Plan and Appendix B, NPDES Flow Diagram). In addition to revisions to the B/CTP, the potential sources of chemicals and chemical quantities are reviewed and updated in connection with the application for NPDES Permit renewal. Compliance with the State Water Quality criteria is also confirmed by routine semi-annual Whole Effluent Toxicity (WET) testing at Outfall 101, Outfall 112, and Outfall 113.

TVA applied to renew the WBN permit in May 2006. To support the application for this permit reissuance, a detailed walkdown of the plant was conducted to ensure that previously identified discharge point sources remain valid. A comprehensive sampling and analysis event was also conducted to characterize waste water discharges from the authorized discharge points.

As a component of the NPDES Permit, Part III, Section G, B/CTP, WBN is authorized to conduct treatments of intake or process waters with biocides, dispersants, surfactants, corrosion inhibiting chemicals, and detoxification chemicals. To ensure protection of the receiving stream, water treatment processes are controlled to comply with State Water Quality criteria and applicable NPDES permit conditions. WBN monitors effluent discharges and reports to the state the specific chemicals injected along with the respective active ingredient discharged on the monthly Discharge Monitoring Report (DMR) and the Annual B/CTP Report. In addition, WBN performs semi-annual WET testing at Outfall 101, Outfall 112, and Outfall 113. Most of the chemicals used in these treatment programs are added at the IPS to ensure all raw water systems are protected. Several of these systems, the High Pressure Fire Protection and the ERCW systems in particular, are essential for the safe operation of the plant.

While WBN has requested modifications to the B/CTP over the years, the approach and active ingredients for the various water treatment programs at WBN have not fundamentally changed. Proposed chemicals undergo an extensive toxicological review and comparison with maximum instream wastewater concentrations to ensure water quality standards are met. The products used have changed over the years to slightly different formulations of the same active ingredients or constituents and the processes or frequencies of applying those products occasionally have been changed. These B/CTP modifications continue to provide the same high level of protection for aquatic life in the Tennessee River while increasing the flexibility of plant equipment treatment options. Most recently, WBN submitted a B/CTP modification request to the state in December 2006. TVA sought approval (1) to replace the dispersant PCL-401 with 73200, (2) for continuous use of oxidizing biocides, and (3) to chlorinate using sodium hypochlorite. In addition, TVA requested to add the non-oxidizing biocide H150M to the B/CTP approval list. This request was approved by the state on April 30, 2007. The history of the use of chemicals for treatment during the same time period is shown in Table 3-8 and Table 3-9.

Table 3-8. History of Betz Chemical Treatment of Raw Water at WBN 1996-Present Chemicals

Chemical	Start Year	End Year	System
Clamtrol CT1300*	1996	1998	ERCW/RCW
Spectrus NX1104*	1998	Present	ERCW/RCW
CopperTrol CU-1	1996	1998	ERCW/RCW
Biotrol 88P	1996	1998	ERCW/RCW

*Vendor global chemical name change from Clamtrol CT1300 to Spectrus NX1104 in 1998
**ERCW = Essential Raw Cooling Water; RCW = Raw Cooling Water

Table 3-9. History of Nalco Chemical Treatment of Raw Water at WBN 1996-Present[1]

Chemical	Start Year	End Year	System
H-901G	1996	Present	ERCW[3]/RCW[4]
Coppertrol	1996	1999	ERCW/RCW
PCL-10Z	1996	2002	ERCW/RCW
PCL-60K	1996	2002	ERCW/RCW
PCL-401	1996	2006	ERCW/RCW
Towerbrom 960	1999	Present	Cooling Tower
H-130M[2]	2002	2002	ERCW/RCW
MSW-109	2003	Present	ERCW/RCW
H-130M	2004	2004	ERCW/RCW
Coagulant Aid-35	2004	Present	ERCW/RCW
H150M	2005	Present	ERCW/RCW

[1] Known as Calgon Corporation, 1996-2001; Ondeo-Nalco, 2001-2003; Nalco, 2003-present
[2] H-130M used with no detoxification in 2002
[3] ERCW = Essential Raw Cooling Water
[4] RCW = Raw Cooling Water

Raw Water Chemical Treatment Summary for the WBN Unit 1 B/CTP
The following summarizes chemical treatment programs currently in use or available for future use at WBN Unit 1 and/or Unit 2 for corrosion, deposit, microbiological, and macrofouling control in the raw water systems in accordance with the current B/CTP. Protection of the raw water cooling water pipe systems requires oxidizing biocide (chlorination) and non-oxidizing biocide treatments to control macro invertebrates and microbiologically induced corrosion (MIC). WBN currently uses products from Nalco, a major industrial water treatment company.

Raw Water Corrosion and Deposit Treatment
Mild Steel Corrosion and Deposit Control. WBN uses a zinc/orthophosphate-based program (MSW-109) for mild steel corrosion control of the ERCW and raw cooling water (RCW) systems. MSW-109 contains 12.6 percent zinc chloride and 36 percent orthophosphate. A seasonal feed program is used where MSW-109 is fed to the raw water system when river water temperature is above 60° F. The concentration of zinc and phosphorous is not to exceed 0.2 parts per million (ppm) at effluent discharges Outfall 101 and Outfall 113.

WBN has the option to feed a dispersant (73200) to the ERCW and RCW systems that controls deposits of calcium phosphate, zinc, iron, manganese, and suspended solids. Dispersant 73200 contains 36 percent high stress polymer (HSP). The active HSP level will not exceed 0.2 ppm at effluent discharges Outfall 101 and Outfall 113.

Copper Corrosion Control. WBN has the option to feed tolytriazole (Nalco 1336) on a continuous basis to small portions of the ERCW and RCW systems for copper corrosion control. Nalco 1336 contains 42.8 percent tolytriazole. Tolytriazole level will not exceed 0.25 ppm at effluent discharges Outfall 101 and Outfall 113.

Raw Water Microbiological/Macrofouling Treatment
Microbiological Control. Microbiological and macrofouling refers to the undesirable accumulation of microorganisms, plants, algae, and aquatic animals on submerged structures and piping systems. WBN currently injects on a continuous basis the oxidizing biocide BCDMH (H-901G) for microbiological and macrofouling control in the ERCW and RCW systems. Continuous oxidation is necessary to ensure plant safety as TVA has recently observed year-round veliger (mussel larvae) infestations. H-901G puts 57 percent of its active halogen ingredient into solution as bromine and chlorine. Chlorine, or Total Residual Oxidant (TRO) is monitored five (5) days per week at Outfall 101 and Outfall 113 in accordance with permit requirements to ensure discharge limits of 0.10 ppm or 0.158 mg/l daily maximum (respectively) are met.

As an alternative to H-901G, WBN has the option to feed liquid bleach in the form of sodium hypochlorite. Liquid bleach, containing 10.2 percent available chlorine, can also be fed on a continuous basis. Monitoring for chlorine levels in the effluent would remain the same as for H-901G.

An option to feed a biodetergent (73551) to increase the efficacy of either H-901G or liquid bleach with microbiological control has been retained by WBN. The 73551 biodetergent consists of a 20 percent blend of non-ionic surfactants and is fed for 30 minutes one to three times per week to the ERCW and RCW systems. The active surfactant level will not exceed 2.0 ppm to the effluent discharges Outfall 101 and Outfall 113.

WBN de-chlorinates as required using sodium bisulfite (Nalco 7408) to ensure the current discharge limit of 0.1 ppm TRO is not exceeded at effluent discharges Outfall 101 or 0.158 mg/l daily maximum at Outfall 113. Nalco 7408 consists of 45 percent sodium bisulfite and is fed at a ratio of approximately 4 ppm product for every 1.0 ppm of TRO. The sodium bisulfite level will not exceed 10 ppm at effluent discharges Outfall 101 and Outfall 113.

Macrofouling Control.
When river temperatures are greater than or equal to 60°F, WBN terminates oxidizing biocides treatment and performs a periodic (minimum of 4 times per train per year) non-oxidizing biocide treatment of the raw water systems. A train is the cluster of equipment which must be operational to perform a certain function.

WBN uses a non-oxidizing biocide (H150M, Clamtrol) to limit Asiatic clam and zebra mussel populations in the raw water system, the presence of which can significantly affect ERCW and RCW system performance. H150M is a quaternary amine (quat) which consists of 25 percent dimethyl benzyl ammonium chloride and 25 percent dimethyl ethylbenzyl ammonium chloride. H150M is used to treat the A and B trains of ERCW and the RCW systems a minimum of four times per year. Spectrus NX1104 (quat), and Clamtrol are used for short-term (4-6 hour), low concentration applications for cross-tie (piping which joins the A train to the B train) treatments.

In order to limit the active H150M residual to no more than 0.05 ppm at effluent discharges Outfall 101 and Outfall 113, bentonite clay (Coagulant Aid-35) is fed into the Unit 1 cooling tower basin prior to effluent discharge to the river via NPDES outfalls Outfall 101 or Outfall 113. Coagulant Aid-35 is fed at a ratio of 5 parts to 1 part H150M during each mollusk treatment. Total clay level is not to exceed 10 ppm at effluent discharges Outfall 101 and Outfall 113. The effectiveness of detoxification is confirmed with twice daily sampling for the active ingredient in the discharge during the treatment period.

Cooling Tower Treatments
WBN currently adds Towerbrom 960 to the cooling tower basin on a periodic basis for microbiological control for CCW. Towerbrom 960 is an oxidizing biocide, containing 57 percent available halogen, and generates bromine and chlorine solutions when dissolved in water. WBN also has the option to feed liquid bleach in place of Towerbrom 960. This treatment is performed with the diffusers and the SCCW system isolated (closed). To ensure the current discharge limit of 0.1 ppm TRO is not exceeded at effluent discharges Outfall 101 or 0.158 mg/l daily maximum at Outfall 113, the chemically treated water is not released to the river until the discharge concentration of chlorine is below the NPDES permit limit. To enhance the effectiveness of this program, WBN has requested the option to feed Biodetergent 73551 with Towerbrom 960. WBN de-chlorinates as needed using sodium bisulfite (Nalco 7408) to ensure the current discharge limit of 0.1 ppm TRO is not exceeded at effluent discharges Outfall 101 or 0.158 mg/l daily maximum at Outfall 113. Nalco 7408 is ratio-fed at a rate of 4 ppm product for every 1.0 ppm of chlorine.

Additional Chemicals Used in WBN Processes
In addition to the raw water additives for biocide and corrosion treatment chemicals discussed above, other chemical additives are used in plant processes. These chemicals may be found in trace quantities at the various NPDES discharge points (Outfall 101, Outfall 102, IMP 103, IMP 107, Outfall 112) due to cooling tower blowdown (CTBD) to the Yard Holding Pond (YHP) or Outfall 101, leakage, and system maintenance activities (see Figure 2.1). Since the potential discharge of these chemicals is through the CTBD line,

Outfall 113 does not receive these discharges. The summary of potential chemicals discharged by NPDES outfall number is shown in Table 3-10.

Table 3-10. Potential Chemical Discharge to NPDES Outfalls at WBN

Outfall Number	Outfall Description	Chemical
101	Diffuser Discharge	Ammonium Hydroxide, Ammonium Chloride, Alpha Cellulose, Boric Acid, Sodium Tetraborate, Bromine, Chlorine, Copolymer Dispersant, Ethylene Glycol, Hydrazine, Laboratory Chemical Wastes, Lithium, Molybdate, Monoethanolamine, Molluscicide H150M, Oil and Grease, Phosphates, Phosphate Cleaning Agents, Paint Compounds, Sodium Hydroxide, Surfactant - Dimethylamide and Alcohol, Tolyltriazole, Zinc Sulfate, Zinc Acetate Dihydrate, LCS-60
102	YHP Overflow Weir	Alternate discharge path for Outfall 101
103	LVWTP	Ammonium Hydroxide, Ammonium Chloride, Boric Acid, Sodium Tetraborate, Bromine, Chlorine, Copolymer Dispersant, Ethylene Glycol, Hydrazine, Laboratory Chemical Wastes, Molybdate, Monoethanolamine, Molluscicide H150M, Oil and Grease, Phosphates, Phosphate Cleaning Agents, Paint Compounds, Sodium Hydroxide, Surfactant - Dimethylamide and Alcohol, Tolyltriazole, Zinc Sulfate
107	LP and ULP	Metals - Iron and Copper, Acids and Caustics, Ammonium Hydroxide, Ammonium Chloride, Boric Acid, Sodium Tetraborate, Bromine, Chlorine, Copolymer Dispersant,Hydrazine, Laboratory Chemical Wastes, Molybdate, Monoethanolamine, Molluscicide H150M, Oil and Grease, Phosphates, Phosphate Cleaning Agents, Sodium, Sodium Hydroxide, Surfactant - Dimethylamide and Alcohol, Tolyltriazole, Zinc Sulfate
111	Sewage Treatment Plant	Chlorine, Organic Matter, Laboratory Chemical Wastes, Paint Compounds
112	Runoff Holding Pond	Chlorine, Organic Matter, Paint Compounds, Potable Water (Cooling Tower at Training Center), High Pressure Fire Protection flushes, Superior SWS 4550

<u>Primary System Chemical Additions</u>

The Primary Systems are generally located in the radiologically controlled areas of the plant and support the Reactor Cooling System (RCS). These systems include the Component Cooling Water System (CCS) and the Ice Condenser.

RCS Corrosion and pH Control. At plant startup lithium hydroxide is added to the RCS via components in the Auxiliary Building to establish the initial pH and corrosion control. After the reactor becomes critical, lithium is a byproduct of a neutron-boron reaction and no further lithium hydroxide additions are required. A boric acid concentration is established in the RCS at startup to control neutron flux and is limited based upon core design. This concentration is reduced for approximately one month after restart from a refueling outage. For approximately the next month the concentration is increased and then over the course of the operating cycle the concentration steadily decreases. Hydrogen peroxide is added during a refueling outage to enhance primary system cleanup to reduce radiation exposure to maintenance personnel and ensure water clarity. Hydrazine is added stoichiometrically prior to heat-up from a refueling outage to scavenge oxygen and minimize system corrosion. The RCS is a closed system, therefore any leakage or letdown from the RCS system would be processed through the liquid radiological waste system.

RCS Corrosion Control and Radioactive Dose Reduction. WBN received state approval in October 2006 to add low concentrations of Zinc Acetate Dihydrate to the RCS. Industry experience has shown zinc additions yield a 20 to 30 percent reduction in plant dose rates and reduce primary water stress corrosion cracking in plant materials. Zinc would also reduce the corrosion rate and release of corrosion products to the coolant from the metal surfaces of replacement or new steam generators. WBN initiated injection at 20 grams per day via components in the Auxiliary Building and maintained this feed rate until a zinc residual was observed in RCS samples. As the residual built in and the crud layer absorption of zinc slowed, WBN lowered the feed rate to maintain 5 ppb zinc in the RCS. Since the RCS is a closed system, any leakage or letdown from the RCS system would be processed through the liquid radiological waste system. A history of Zinc Acetate Dihydrate and other chemical treatment are shown in Table 3-11.

Table 3-11. History of Other Chemical Treatment of Raw Water at WBN 2006-Present

Chemical	Start Year	End Year	System
Zinc Acetate Dihydrate	2006	Present	RCS[1]
Superior SWS 4550	2006	Present	Training Center Cooling Tower

[1] RCS = Reactor Coolant System

Component Cooling Water Corrosion and pH control. Sodium molybdate, tolyltriazole, sodium hydroxide are added to this system in the Auxiliary Building to control pH and corrosion. Leakage from this system would be processed through the radwaste system while complete system draining is routed to the Turbine Building Station Sump (TBSS). The TBSS is normally routed to the discharge to the Low Volume Waste Treatment Pond (LVWTP), but can be routed to the Lined Pond (LP), the Unlined Pond (ULP), or the YHP.

Ice Condenser. Sodium tetraborate is used in the Ice Condenser for emergency boration. The Ice Condenser is located in the Reactor Building and the components to mix and initially freeze the tetraborate solution are located in the Additional Equipment Building. Ice melt bypasses the radwaste demineralizer beds, is routed to a radwaste discharge tank, and is discharged through the radwaste system. Ethylene glycol is used in the ice condenser chiller packages. Leakage with concentrations less than10 percent is discharged to the ULP for degradation, while greater than or equal to 10 percent is collected in drums and shipped to a vendor to be recycled.

Secondary System Chemical Additions

The main Secondary Systems are the Condensate System, the Main Feedwater System and the Main Steam System. The purpose of the Secondary Systems is to heat and pressurize cooler water to produce feed water for the steam generators. The Main Steam System then routes steam from the steam generators to the plant turbines for power generation. The Condensate System receives exhausted steam from the turbine discharge to repeat the cycle.

Corrosion and Deposit Treatment. Hydrazine, ammonia, ammonia chloride, boric acid, and monoethanolamine (ETA) are injected into the Condensate System at the turbine building for secondary chemistry control. Hydrazine functions as a dissolved oxygen scavenger while ammonia and ETA are added for pH control and corrosion control. Ammonia chloride is injected as necessary for molar ratio control to aid in reduction of stress corrosion cracking in the steam generators. Boric acid is also injected at the turbine building for reduction or prevention of stress corrosion cracking in the steam generators. The reduction of stress corrosion cracking assists in the maintenance of steam generator integrity thereby realizing their design lifespan. Up to 300 pounds of modified alpha cellulose may be added to the condenser intake channel to temporarily plug pinhole tube leaks in the condenser.

Other Plant Systems

Chemicals are also added to other plant systems and include Chilled Water Systems, Turbine Building Heating System, Auxiliary Boilers, and Diesel Jacket Cooling Systems.

- Hydrazine and ammonia are added to the Chilled Water Systems, Turbine Building Heating System, and Auxiliary Boilers for pH and corrosion control:
- LCS-60 is added to the diesel jacket cooling water for corrosion control and consists of sodium nitrite, sodium tetraborate and tolytriazole.

These chemicals are incidental discharges that are are controlled via BMPs. Discharges occur via leakage or maintenance activities and are discharged to the LP, ULP, LVWTP, or YHP.

Superior SWS 4550 is added to the Training Center Cooling Tower Water System to neutralize the chemical deposits in the Training Center Cooling Tower and inhibit corrosion. Any blowdown discharge is routed to the Runoff Holding Pond (RHP) and Outfall 112.

Environmental Consequences of Chemical Additions to Raw Water

Under the preferred alternative, TVA would complete the construction of WBN Unit 2 and the plant would operate at its full capacity as originally designed. Prior to construction activity, WBN would develop an erosion and sedimentation control plan as part of an application for a General NPDES Permit for Storm Water Discharges Associated with Construction Activity although it is expected that most of the construction work would occur inside constructed buildings, and all of the work is expected to occur within the existing plant site footprint. Operation of Unit 2 along with Unit 1 would result in an increase of raw water intake usage at the IPS by an estimated 33 percent compared to sole operation of Unit 1, with a corresponding increase of ERCW and RCW raw water chemical additives by an estimated 33 percent. This increase is within original design basis for operation of Units 1 and 2. Since an additional existing cooling tower would be placed in service, Towerbrom 960 treatment for CCW treatment would increase by an estimated 100 percent.

The current NPDES permit contains provisions requiring authorization of the B/CTP and the use of the water treatment chemicals described above are expected to continue in use if and when WBN Unit 2 starts up. TVA would use the same protocols for Unit 2 as used with Unit 1 to show permit compliance with the treatment plans using mass balance calculations where possible. In addition, detoxification of non-oxidizing biocides would be confirmed with twice-daily sampling for the active ingredient in the effluent during the treatment period.

The state retains the authority to require WBN to conduct additional monitoring to ensure that Unit 2 operation does not have an adverse affect on NPDES effluent limitations or other permit conditions. In the event the state determines that additional monitoring should be conducted, the results would need to be evaluated and submitted to the state per the conditions set forth. Potential changes in plant discharges are not expected to be significant as compliance with applicable regulatory safeguards and internal assessments would ensure that resulting effects to water quality are insignificant.

3.1.3. Groundwater

The 1995 FSER updated the groundwater information in the 1972 FES, and the descriptive information about groundwater systems in the vicinity of WBN provided in that update is still accurate. In August 2002, tritium was detected in one of the on-site environmental monitoring locations at levels that were just at the detectable level. At that time, TVA notified the NRC and State of Tennessee environmental and radiological representatives. To address this issue, in December 2002, TVA installed four new environmental monitoring locations on the plant site as a modification to the Radiological Environmental Monitoring Program. Since that time TVA has been closely monitoring in-ground tritium and reporting these results in the WBN Annual Radiological Environmental Operating Reports to NRC and the state of Tennessee.

Samples taken January 2003 through December 2004 indicated the presence of low levels of tritium in three of the four monitoring locations, which are maintained for environmental monitoring purposes only. The sources of this tritium were leakage from an underground radioactive effluent piping and leakage from a bellows for the Unit 2 fuel transfer tube. In order to stop the tritium ingress into the groundwater, the radioactive effluent piping was replaced with a new 4-inch pipe. In addition, the Unit 2 fuel transfer tube was sealed, and the fuel transfer canal was coated. These activities were completed by November 2005.

Results from two of the new individual sample locations, taken in February 2005 and June 2005, were greater than the NRC 30-day reporting level of 30,000 picocuries per liter (pCi/L). Further inspections revealed no leakage in underground radioactive effluent piping. TVA's investigation determined that the source of the increased tritium levels was a result of the previous effluent piping leak, which had been repaired. The highest amount of tritium detected was approximately 550,000 pCi/L.

Some residual tritium will remain in the groundwater until the tritium either decays or is diluted. Eventually, this groundwater will migrate into the river where these degraded tritium levels will be even further reduced and therefore pose no public health hazard. TVA continues to monitor wells monthly to verify past repairs and detect any new sources of contaminated groundwater. Routine reports are made to the NRC and the state.

Completion of WBN Unit 2 would not impact groundwater resources in the vicinity of WBN.

3.2. Aquatic Ecology

The characteristics of the WBN site's aquatic environment and biota were described in the 1972 FES (TVA 1972) with updated information described in the NRC 1995 FES (NRC 1995a) and the TVA 1998 FEA for the WBN SCCW Project (TVA 1998a). This information was based on site-specific data combined with general knowledge of Tennessee River tailwater habitats and associated aquatic biota. Extensive supplemental information specific to WBN is available from reports detailing results of the TVA Vital Signs Monitoring Program (TVA, unpublished data). These cited reports and data were examined and determined to continue to represent current environmental conditions adequately in the Watts Bar Dam tailwaters and upper Chickamauga Reservoir. They were used for the present FSEIS as a basis for a review of the aquatic ecology in the vicinity of the WBN site.

Plankton

Recent studies indicate that the majority of planktonic organisms (including fish eggs, larval fish, microinvertebrates, algae, etc.) in the vicinity of WBN originate in the Watts Bar Reservoir and pass through the turbines at Watts Bar Dam. Plankton density varies greatly from day to day. Sampling surveys (1973-1985) indicate that plankton populations decreased rapidly as distance from Watts Bar Dam increased due to the swift-flowing, riverine nature of the upper portions of Chickamauga Reservoir. As water enters the reservoir pool of Chickamauga Reservoir (25-30 miles downstream of WBN), velocities decrease and plankton densities gradually increase to levels comparable to those in the Watts Bar Dam forebay (TVA 1986).

Though there are no data on phytoplankton densities in the vicinity of the WBN site, comparisons between preoperational (1976-1985) and operational (1996-1997) densities of fish eggs and larval fish show similar patterns (Appendix C, Table C-1) (TVA 1998d). An entrainment study conducted during the spring and summer of 1975 estimated the average loss of fish larvae in the vicinity of WBF as a result of water diversion to the plant was 0.24 percent of the total population (TVA 1976b).

In the TVA FEA for the SSCW, TVA evaluated one-unit operation and concluded that the proposed project would result in loss of fish eggs and larvae through entrainment at approximately the same rate as previously studied in 1976 (TVA 1998a). Similar results were reported in the 2001 fish monitoring program for the SCCW and it was concluded that no significant impact to ichthyoplankton populations from WBN SCCW operation would occur (Baxter et al. 2001). These entrainment rates indicate the operation of both WBN Unit 1 and Unit 2 would have little or no effect on larval fish and egg populations in Chickamauga Reservoir because the WBN condenser cooling water system (CCW) is commensurate with a closed cycle cooling system.

Invasive and Noninvasive Aquatic Plants

Aquatic plants present in Chickamauga Reservoir include the invasive species Eurasian water milfoil (*Myriophyllum spicatum*), spinyleaf naiad (*Najas minor*), and the native southern naiad (*Najas guadalupensis*) (TVA 1994a). Excessive aquatic plant coverage can cause reservoir–use conflicts in areas around industrial water intakes, public access and recreation sites, and lakeshore developments. These effects have not been seen in the vicinity of WBN because the WBN site is located in the riverine tailwater area of the reservoir downstream of Watts Bar Dam. Aquatic plants have difficulty establishing dense growths in this area even during years of peak coverage due to current velocity. As a result, aquatic plant densities in the reservoir near WBN have not reached nuisance levels, and no control measures have been taken in the vicinity of the plant. Peak aquatic plant coverage in Chickamauga Reservoir occurs in shallow, overbank lakelike habitat far downstream of WBN. Combined operation of WBN Units 1 and 2 would not have effects on the occurrence of invasive or noninvasive aquatic plants.

Aquatic Communities
Before 1978, fisheries biologists thought the tailwaters of Watts Bar Dam contained favorable spawning habitat for several species including sauger (*Stizostedion canadense*), smallmouth bass (*Micropterus dolomieui*), white bass (*Morone chrysops*) and possibly yellow perch (*Perca flavescens*). However, the evaluation of information in the 1978 NRC FES discounted this theory. Since 1978, additional studies have confirmed that the reach between the Watts Bar Dam and the WBN site is a staging area, not an area of significant spawning activity for these species (NRC 1995a).

TVA began a program to systematically monitor the ecological conditions of its reservoirs in 1990, though no samples were taken on the Watts Bar or Chickamauga Reservoirs until 1993. Previously, reservoir studies had been confined to assessments to meet specific needs as they arose. Reservoir (and stream) monitoring programs were combined with TVA's fish tissue and bacteriological studies to form an integrated Vital Signs Monitoring Program. Part of the monitoring consisted of the reservoir fish assemblage index (RFAI), a method of assessing the quality of the fish community. Since the institution of the Vital Signs Monitoring Program, the quality of the fish community in the vicinity of the WBN site has remained relatively constant with an average rating of "good" (see Appendix C, Tables C-2 and C-3).

Another aspect of the Vital Signs Monitoring Program is the benthic index, which assesses the quality of benthic communities in the reservoirs (including upstream inflow areas such as that around WBN). The tailwaters of Watts Bar Dam support a variety of benthic organisms including several large mussel beds. One of these beds has been documented along the right-descending shoreline immediately downstream from the mouth of Yellow Creek. To protect these beds, the state has established a mussel sanctuary extending 10 miles from TRM 520 to TRM 529.9. Since the institution of the Vital Signs Monitoring Program, the quality of the benthic community in the vicinity of the WBN site has remained relatively constant. The riverine tailwater reach downstream of Watts Bar Dam and WBN rated "good" in 2001 and the rating has increased to "excellent" in 2003-2005 (Appendix C, Tables C-4 and C-5).

Under the proposed action, no construction activities would occur within 500 feet of the reservoir, and all construction activities would be subject to appropriate BMPs to ensure that there are no impacts to surface water quality. NPDES discharge limits as outlined in the 1995 NRC FES and in this document would not be revised. No discharges exceeding current NPDES limits would occur during operation of WBN Units 1 and 2. The amount of cooling water required for operation of both WBN Unit 1 and WBN Unit 2 would result in increases in cooling water intake and discharge volumes, but thermal discharge rates would remain below maximum allowed levels outlined in the 1978 NRC FES (see section 3.1).

Because all construction work would be conducted using appropriate BMPs, and no additional discharge-related impacts would occur, there would be no effect on aquatic animals or their habitats in the vicinity of WBN. Because intake flows would not be increased above levels outlined in the 1978 NRC FES, fish entrainment rates would not exceed maximum levels previously evaluated in that FES for operation of both WBN Units 1 and 2.

Invasive and Exotic Aquatic Animals
At the time the 1972 FES was issued, the Asiatic clam (*Corbicula fluminea*) was the only benthic nuisance species known to occur in Chickamauga Reservoir. Subsequently, the zebra mussel (*Dreissena polymorpha*) has become established in the Watts Bar Dam tailwater area. The planktonic larvae of zebra mussels can be drawn into raw-water piping systems, and attach to pipe surfaces. Multiple layers of adult zebra mussels can accumulate resulting in partial to total blockage of pipes and grates. This can cause damage to pipes and facilities requiring facility outage time to remove the blockage. Currently, WBN has implemented the use of Clamtrol (WBN uses H150M), a nonoxidizing molluscide, within the facility to inhibit biofouling by Asiatic clams and zebra mussels. However, this control method is restricted to the facility itself and concentrations of molluscide released into the reservoir are too low to have any effect on native mussel beds (NRC 1995a).

3.3. Terrestrial Ecology

3.3.1. Plants

The terrestrial plant communities were assessed during the initial environmental review for the construction of WBN Units 1 and 2 (TVA 1972). Major plant community types are described and statistical values were calculated from data obtained from vegetation plot analyses from each terrestrial community. In addition, importance values along with frequency, density, basal area and volume for all tree species occurring on the Watts Bar reservation are presented. In the 1976 Environmental Information Report for WBN Units 1 and 2, the major community types are listed as oak-hickory forest, oak-gum forest, yellow pine-hardwood forest, Virginia pine forest, sumac shrub community, early old-field community, horseweed-type community, fescue meadow community, and a marsh community (TVA 1976a). Of the 967 acres acres identified for building WBN, 210 wooded acres were to remain undisturbed (approximately 80 percent of the existing woodlands). More than 70 percent of the plant area was already disturbed in the form of cultivated or old fields.

The terrestrial plant communities of the WBN site have changed very little over the past 34 years. The majority of the project area (over 70 percent) is composed of herbaceous vegetation types found in old fields, gravel parking areas, roadside rights-of-way and various other disturbed sites. Approximately 30 percent of the site is still forested with the following forested vegetation classes: deciduous forest and evergreen-deciduous forest. The deciduous forest can be characterized as two separate community types, oak-hickory forest and bottomland hardwood forest. Invasive species including Japanese stilt grass, Japanese honeysuckle, multiflora rose, and Russian olive occur on WBN Reservation.

Some disturbance of existing plant communities may occur if construction of WBN Unit 2 recommences although most construction activities are expected to occur in already constructed buildings or within the previously disturbed plant footprint. Because no uncommon terrestrial communities or otherwise unusual vegetation occurs on the lands to be disturbed under the proposed action, impacts to the terrestrial ecology of the region are expected to be insignificant as a result of the proposed actions. No new infestations of exotic invasive plant species are expected as a result of the Action Alternative.

3.3.2. Wildlife

The terrestrial ecology at the WBN facility has changed little from those described in earlier environmental reviews. Habitats surrounding the facilities consist of mowed grass, fields of short vegetation, and ditches that are intermittently wet. The project site, which is highly developed, includes parking areas and ball fields in addition to these habitats.

Wildlife using these areas, primarily adjacent to the disturbed area footprint, include locally abundant species that are tolerant of human activity and highly modified habitats. Species such as eastern meadowlark, American goldfinch, eastern bluebird, and song sparrow were observed at or adjacent to the proposed project site. Spotted sandpiper and killdeer were observed in or near the settling ponds at the facility; most of these ponds are lined with riprap and provide poor habitat for shorebirds. However, species including double-crested cormorants, mallards, Canada geese, black vultures, rock pigeons, and white-tailed deer were noted near the ponds. An osprey nest was also observed on a nearby structure.

Due to the overall lack of wildlife habitat at the project site and the limited amount of additional habitat disturbance anticipated, the proposed project is not expected to result in adverse impacts to terrestrial animal resources within the disturbed area footprint (Figure 1-2) or in the adjacent areas. Wildlife in the project area is locally abundant and no rare or uncommon habitats exist at the site.

3.4. Threatened and Endangered Species

As discussed in Sections 3.2 and 3.3, most of the aquatic and site disturbance required for completion of WBN Unit 2 has already occurred. The following sections provide an update of the federally listed and state-listed species found in the vicinity of the WBN site and the potential for impacts from the proposed action.

3.4.1. Aquatic Animals

Four mussel species federally listed as endangered, dromedary pearlymussel, pink mucket, rough pigtoe, and fanshell, are known to occur in mussel beds in the vicinity of WBN (Appendix C, Table C-6). To protect these beds, the state has established a mussel sanctuary extending 10 miles from TRM 520 to TRM 529.9 (Appendix C, Table C-7) (TVA 1998b). Figure 3-4 shows the location of the mussel sanctuary relative to WBN.

The snail darter, federally listed as threatened, is also known to occur occasionally in this reach of the Tennessee River. The majority of the snail darter population in the area is confined to Sewee Creek, a tributary to the Tennessee River, which enters the river at TRM 524.6.

The larvae of snail darters are pelagic and can drift substantial distances (miles) during early life stages. Spawning of snail darters has not been documented in the main stem of the Tennessee River downstream of Watts Bar Dam, and no snail darter larvae have been collected during entrainment sampling.

Two mussel species considered sensitive by the State of Tennessee; pyramid pigtoe and Tennessee clubshell, and one state-listed threatened fish species; blue sucker, are also known from this reach of the Tennessee River (Appendix C, Table C-6).

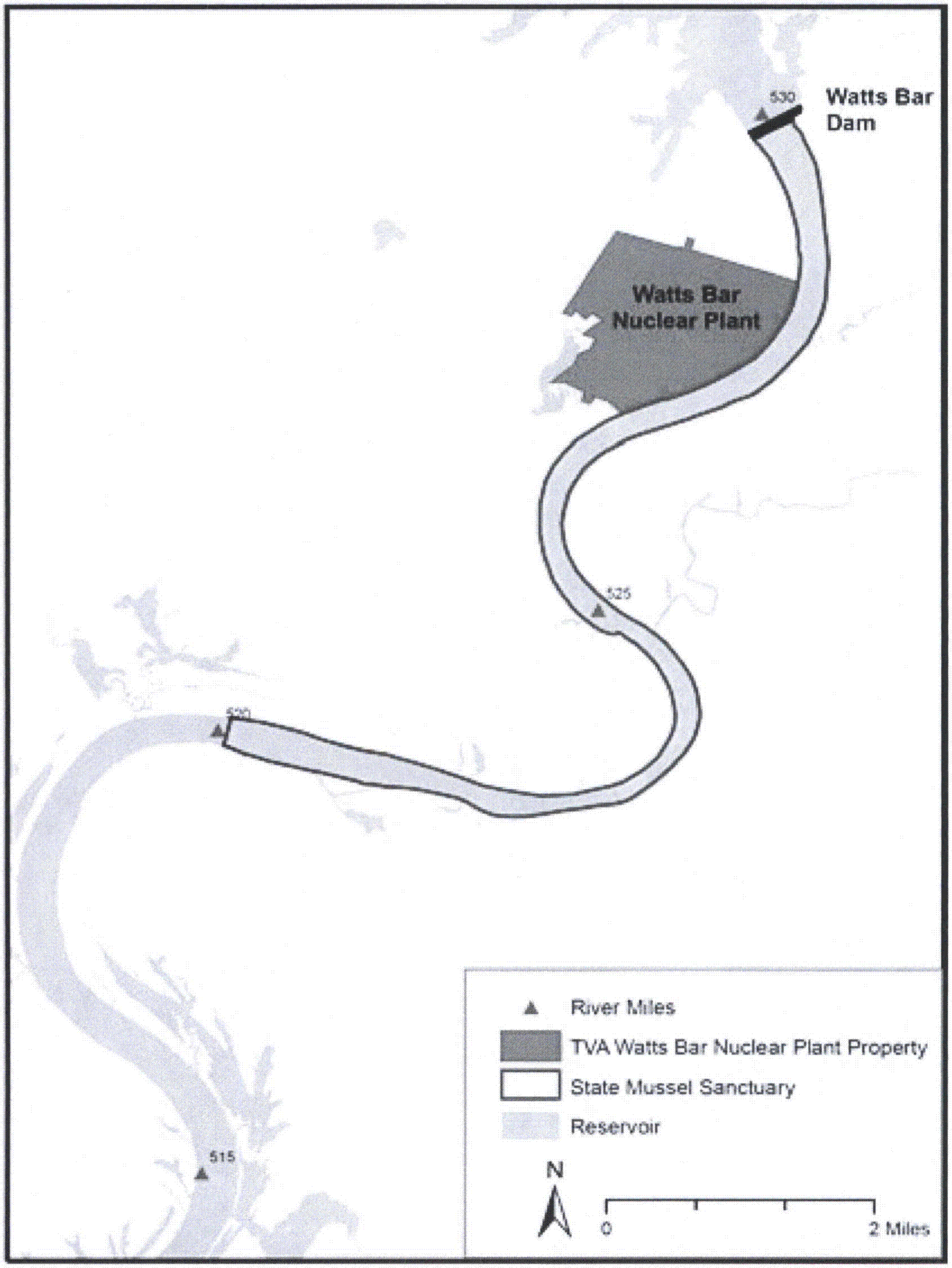

Figure 3-4. Location of Mussel Sanctuary in Chickamauga Reservoir Below Watts Bar Dam

Under the proposed action, work would be conducted on WBN Unit 2 in order to bring it to full operational capacity. No construction activities would occur within 500 feet of the reservoir, and all construction activities would be subject to appropriate BMPs to ensure that there are no impacts to surface water quality. NPDES discharge limits as outlined in the 1995 NRC FES would not be revised. No discharges exceeding current NPDES limits would occur during operation of WBN Units 1 and 2. The amount of cooling water required for operation of both WBN Unit 1 and WBN Unit 2 would result in increases in cooling water intake and discharge volumes up to the original two-unit design. Thermal discharge rates would remain below maximum allowed levels outlined in the 1978 NRC FES.

The steam generator blowdown (SGDB) contains low levels of ammonia, which is injected in the turbine building to control corrosion. The highest concentration of ammonia measured in the SGDB during the past four years was 4.2 mg/l (or 4.2 ppm). The maximum SGBD discharge for Units 1 and 2 would be 524 gallons per minute (gpm) through the diffusers at outfall 101 and would require 3500 cfs of minimum riverflow. Based on the hydrothermal analysis in Section 3.1 and previous diffuser studies (Hadjerioua, et.al. 2003), in the worst case conditions, ammonia concentrations would be fully mixed prior to reaching the stream bottom in the 240-feet wide by 240-feet-long assigned mixing zone. SGDB is diverted to the yard holding pond with cooling tower blowdown when the minimum river flow of 3500 cfs is not available, unless it has already been diverted to the condensate system. When the minimum riverflow of 3500 cfs is available, the YHP discharges through outfall 101. The YHP has an emergency overflow that discharges through outfall 102. In general, the operation of Watts Bar Dam and the WBN blowdown system are very carefully coordinated so that there are no unexpected overflows from the yard holding pond. (see Section 2.2.2). No events with overflow from the YHP occurred during the hydrothermal analysis described in Section 3.1, therefore under operating conditions, releases from Outfall 102 are not expected. Therefore, there would be no effect to any federally listed as endangered or threatened mussels.

Because all construction work would be conducted using appropriate BMPs, and no additional discharge-related impacts would occur, there would be no effect on state-listed or federally listed aquatic animals or their habitats in the vicinity of WBN. Because intake flows would not be increased above levels outlined in the 1978 NRC FES, fish entrainment rates would not exceed maximum levels previously evaluated in that FES for operation of both WBN Units 1 and 2. Because snail darter larvae have not been encountered in entrainment sampling at WBN, there is no potential for snail darter larvae to be entrained at the cooling water intake for WBN even under the increased withdrawal rates required to support operation of both WBN Units 1 and 2.

3.4.2. Plants

Historically, one plant species, spider lily, *Hymenocallis occidentalis* (now *H. carolinensis*), was identified as being a proposed rare and endangered species by the USFWS in the original FES (TVA 1972). This designation was made prior to the Endangered Species Act of 1973, and the species was not listed as threatened or endangered under this act nor is it given any special status within the state of Tennessee. In addition, field surveys in 1994 failed to find any populations of spider lilies in the vicinity of WBN (TVA 1995a; 1995b). The FEA for the WBN Unit 1 Replacement of Steam Generators documents six Tennessee state-listed plant species known from within 5 miles of WBN, and no sensitive plant species or habitat to support these species were found during field reviews (TVA 2005a).

The six Tennessee state-listed plant species known from within 5 miles of WBN are shown in Table 3-12. There are no known federally listed as threatened or endangered plant species within Rhea County, Tennessee. No designated critical habitat for plant species are known from within 5 miles of WBN or Rhea County.

Table 3-12. State-Listed Plant Species Reported From Within 5 Miles of the Proposed Project in Rhea County, Tennessee

Common Name	Scientific Name	State Status/Rank
Appalachian bugbane	*Cimicifuga rubrifolia*	THR (S3)
Heavy sedge	*Carex gravida*	SPCO (S1)
Northern bush honeysuckle	*Diervilla lonicera*	THR (S2)
Prairie goldenrod	*Solidago ptarmicoides*	END (S1S2)
Slender blazing star	*Liatris cylindracea*	THR (S2)
Spreading false foxglove	*Aureolaria patula*	THR (S3)

Status abbreviations: END=Endangered, SPCO=Species of special concern, THR = Threatened, S1 = critically imperiled with 5 or fewer occurrences; S2 = imperiled with 6 to 20 occurrences, S3 = Rare or uncommon with 21 to 100 occurrences

No occurrences of state-listed or federally listed plant species are known on or immediately adjacent to the area to be disturbed under the proposed Action Alternative. Therefore, no impacts to sensitive plant species are expected.

3.4.3. Wildlife

Earlier reviews indicated that federally listed as threatened or endangered gray bats (*Myotis grisescens*) and bald eagles (*Haliaeetus leucocephalus*) were reported within 5 miles of the project. Small numbers (less than 500) of gray bats continue to roost in a cave approximately 3.3 miles from the project. Bald eagles nest on Chickamauga and Watts Bar Reservoirs approximately 1.8 and 4.7 miles, respectively, from the project site. Gray bats and bald eagles forage over the Tennessee River in the vicinity.

Several heron colonies have been reported from the vicinity since the late 1980s. Many of these colonies were destroyed during recent pine beetle infestations. The closest active colony is located 4 miles north of WBN.

Hellbenders (*Cryptobranchus alleganiensis*), listed as in need of management by the State of Tennessee, have been reported from the upper reaches of Sewee Creek, approximately 2.5 miles from the project site. The species may continue to inhabit streams in the vicinity.

Completion of WBN Unit 2 is not expected to result in impacts to any federally listed or state–listed as threatened or endangered species of terrestrial animals or their habitats. No suitable habitat for gray bats or bald eagles exists on or adjacent to the project site. Construction and operation of WBN Unit 2 would not result in impacts to bald eagles and gray bats in the region.

3.5. Wetlands

Wetland communities were assessed during the initial environmental review for the construction of WBN Units 1 and 2 (TVA 1972), and were also assessed for the construction of various other operational components of the site (TVA 1995a; TVA 1995b; TVA 2005a). Forested wetlands are present on the southwest portion of the site, and emergent wetlands have developed within ash disposal sites and in containment ponds located in the southwest portion of the site. Scattered areas of fringe emergent wetlands are present along the shoreline of the WBN site, and there are small areas of forested, scrub-shrub, emergent wetlands associated with streams on the plant site.

A field survey for wetlands conducted on October 30, 2006, indicated a forested wetland is present adjacent to the project footprint. This wetland is associated with an unnamed stream between the road and the rail line just outside of the northeast corner of the project footprint. The area is approximately 1 acre in size; dominant vegetation includes tag alder, sycamore, and black willow. The remainder of the site is composed of upland plant communities, gravel parking areas, and developed areas.

Since there are no plans to disturb the above-mentioned forested wetland, no impacts to wetlands would occur as the result of construction activities related to the completion of WBN Unit 2. If project plans are modified and impacts to this wetland are unavoidable, mitigation may be required as a condition of state and/or federal wetland protection regulations (Section 404, Clean Water Act, and Aquatic Resources Alterations Permit). Mitigation may consist of off-site mitigation in the form of wetland creation or purchase of credits in a wetland mitigation bank. Overall impacts to wetlands in the project area would be insignificant due to the small size and limited ecological function of the wetland.

3.6. Natural Areas

Changes (since the 1978 NRC FES; NRC 1995b; and TVA 1998a) in natural areas and the environmental impact on natural areas within 3 miles of WBN are assessed below for the purpose of updating previous documentation to current conditions.

Three of five natural areas currently listed in the Natural Heritage database and within 3 miles of WBN were reviewed in previous documents. These areas are Yellow Creek unit of the Chickamauga State Wildlife Management Area (WMA), the Chickamauga Reservoir State Mussel Sanctuary, and the Chickamauga Shoreline TVA Habitat Protection Area (HPA). TVA 1998a found no direct or indirect effects to Yellow Creek WMA or the TVA HPA. NRC 1995b, which reviewed the 1978 NRC FES, noted no significant changes in, and therefore no significant impacts to, the aquatic environment in the vicinity of WBN. Additionally, no impacts to the mussel sanctuary (an area designated by the State of Tennessee to be a biological preserve for mussel species) are anticipated from the proposed action (Stephanie Chance, TVA, personal communication, November 14, 2006). No significant changes in area or management objectives of the WMA and TVA HPA have occurred since they were last reviewed, and therefore, no direct or indirect impacts to these areas are anticipated from the proposed action.

Two additional natural areas within 3 miles of WBN include Meigs County Park, a 240-acre public recreation area approximately 1.5 miles north of the site, and Yuchi Wildlife Refuge at Smith Bend, a 2600-acre haven for migratory waterfowl and shorebirds. This refuge, managed by the Tennessee Wildlife Resources Agency, is approximately 2.2 miles south of the site. The distance from the site to these two areas is sufficient such that no direct or indirect impacts are anticipated.

3.7. Cultural Resources

As part of the extensive history of environmental review of constructing and operating WBN, TVA has considered the potential impact on historic and archaeological resources associated with each undertaking. It was determined during the initial environmental review that two archaeological sites (40RH6 and 40RH7) would be adversely affected by construction of the plant. Based on this finding, TVA proceeded with data recovery of these sites (Calabrese 1976; Schroedl 1978). One historic cemetery (Leuty Cemetery) was located on the property prior to plant construction. Two graves were removed in 1974 and placed in Ewing Cemetery. Subsequent environmental reviews conducted resulted in a "no-effect finding" for archaeological resources. In the 1998 review of the WBN SCCW project (TVA 1998a), TVA determined that WBF was eligible for listing on the National Register of Historic Places (NRHP). However, it was determined that this property would not be adversely affected.

Four archaeological sites are located within the WBN property (40RH6, 40RH7, 40RH8, and 40RH64). The first three sites were recorded as part of the Watts Bar Basin survey in 1936. The latter was recorded later during a post-inundation Chickamauga Reservoir shoreline survey. While a portion of these sites was excavated, the sites remain eligible for listing on the NRHP with a potential for significant archaeological deposits and features to be present. Sites 40RH8 and 40RH64 are both considered potentially eligible for listing on the NRHP. While a reconnaissance survey was conducted on the plant property prior to its construction, archaeological survey techniques have significantly improved since that time. Based on what we already know, undisturbed areas outside the current project's area of potential effect (APE) have a high potential for archaeological resources to be present. Any future ground-disturbing activity in these areas would have to be reviewed.

A majority of the APE for this project has been extensively disturbed. Completing WBN Unit 2 would result in some additional ground-disturbing activities but largely would be restricted to the existing disturbed portion of the plant property. A field visit conducted confirmed the prior disturbance in these areas. Project plans submitted include a larger footprint surrounding the plant that has been identified as the "disturbance area." A portion of this footprint east of the cooling towers (the avoidance area shown on Figure 3-5) includes parts of archaeological site 40RH6 and it is unknown if this site contains significant archaeological deposits. Although this site is within the area identified as potentially to be disturbed, current plans actually would not disturb it. If those plans change and this area would be disturbed, an archaeological survey of the affected area would be conducted to determine the significance of the site and if determined to be archaeologically significant, appropriate measures would be taken to avoid adversely impacting identified resources. This would include coordination with the SHPO.

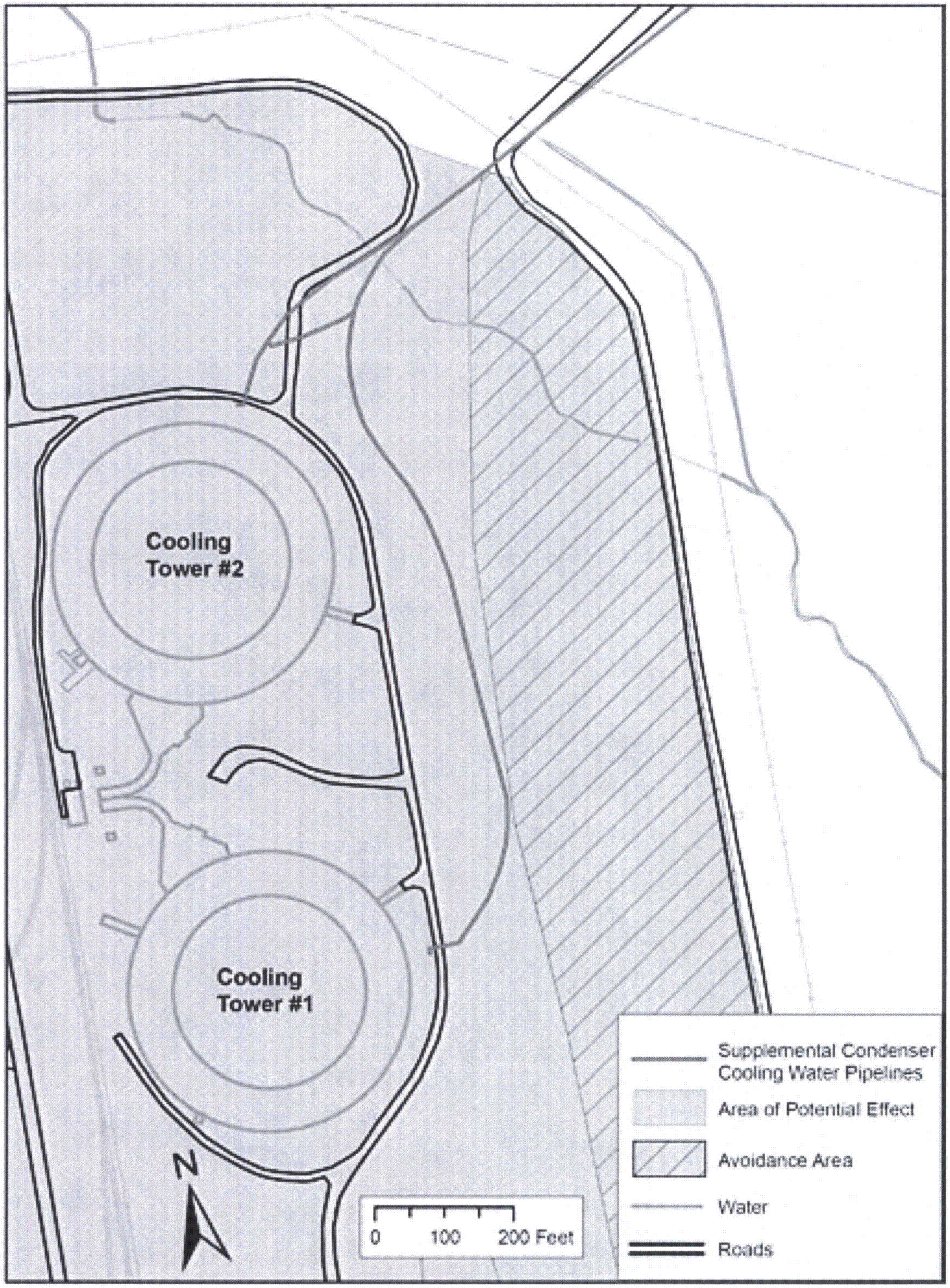

Figure 3-5. Archaeological Avoidance Area Within the Area of Potential Effect

As planned, archaeological resources within the APE at WBN should not be adversely affected by this action. TVA is coordinating with the SHPO for concurrence with this finding.

3.8. Socioeconomic, Environmental Justice, and Land Use

3.8.1. Population

The 1972 FES on WBN Units 1 and 2 estimated the 1970 population within 10 miles of the site to be 10,515. Rhea County, in which the plant is located, and Meigs County which is located just east of the site across the river, were both slow growing, with a total net population growth of 400 between 1960 and 1970. This information was updated and expanded for the 1978 NRC FES. While the 1972 FES projected population by the year 2000 to be 11,995 within 10 miles of the site and 1,028,345 within 50 miles, the 1978 NRC FES had slightly lower projections of 10,770 within 10 miles and 950,461 within 50 miles. In 1995, NRC and TVA provided estimates for 1990 and projections for 2040 (1995 NRC FES, and 1995 FSER). For 1990, population within 10 miles was estimated to be 15,842, and within 50 miles, 862,465. Projections for 2040 were a total population of 17,854 within 10 miles and 1,066,580 within 50 miles.

Based on the 2000 Census of Population, the population for 2000 is estimated to be 16,392 within 10 miles and 1,064,513 within 50 miles, indicating that the area around the site has been growing faster than projected. Based on these trends, the population in 2040 is projected to be about 29,300 within 10 miles and 1,519,000 within 50 miles, a much higher growth rate than in earlier projections.

Since the earlier reports were prepared both Rhea and Meigs Counties, as well as most of the surrounding counties, have seen a substantial increase in population growth rates. Rhea County increased by only about 0.4 percent from 1980 to 1990, but by 16.7 percent from 1990 to 2000. Meigs County experienced a similar increase in growth rate, from 8.1 percent between 1980 and 1990 to 38.0 percent between 1990 and 2000. Fast-growing areas in Meigs and Rhea Counties include much of the area near the Tennessee River, on both sides, and the area to the east toward Athens, Tennessee. Increases from 1990 to 2000 in surrounding counties within the 50-mile range varied from 4.5 percent in Anderson County to 34.7 percent in Cumberland County. Population estimates for 2005 show continuing growth in the area and specifically in Rhea and Meigs Counties, but at a somewhat slower rate than during the 1990s.

During construction, population would increase due to the influx of workers. At peak construction employment, the total construction and design employment could be as high as 3000; however, many of these are engineers, nonmanual craft, and other workers who likely would not relocate to the site. TVA is conducting a more detailed study of construction requirements, which will provide a more precise estimate. For this analysis, a conservative estimate is made by assuming that the peak on-site workforce would be 2200. Based on previous experience at the site, it is assumed that 40 percent of these would move into the area. Given this assumption, the total number of movers would be 880. The remaining 60 percent or more of the workers would either be local residents or would commute from the surrounding area, including the Chattanooga and Knoxville areas. Impacts of this increase in population should be similar to those described in the earlier documents referenced above.

Based on experience during construction at Unit 1 from 1982 to 1986, about two-thirds of the in-moving workers would move into Rhea and Meigs Counties due to their proximity to the site. Most of the others would locate in readily accessible locations such as McMinn and Roane Counties, and a small number to Knox or Hamilton Counties and other nearby areas. Actual locations would, of course, depend on the availability of housing or of sites for recreational vehicles (RVs) and trailers. The widespread distribution of the residential location of workers, including those who move into the area, would lessen the impacts. Overall, this influx should be similar to what occurred during the mid-1980s with earlier construction at the site, except that the number of workers is expected to be slightly lower than during much of the earlier construction.

3.8.2. Employment and Income

The earlier studies noted that the immediate vicinity of the plant, Rhea and Meigs Counties, had been experiencing employment growth, in particular industrialization. The latest employment data suggest that these counties have been able to retain their industrial competitive edge. While the nation, the state, and almost all of the counties within the 50 mile area around the plant experienced substantial decreases in manufacturing employment between 1995 and 2005, Meigs County had a small increase (from 697 to 741) and Rhea County a very small increase (from 4701 to 4711). The average decrease for all the counties within the 50-mile area was 20.7 percent, while the state decreased by 23.3 percent and the nation by 22.5 percent. Private employment other than farm and manufacturing generally had significant increases throughout the area, as in the state and in the nation.

The 1995 NRC FES noted that real income in Meigs and Rhea Counties continued to grow. This trend has continued since that time, with per capita personal income in 2005 in Meigs County, 51.3 percent higher than in 1995, and in Rhea County, 40.2 percent higher. In contrast, the Consumer Price Index increased by 28.1 percent during this time. The growth rate of income in the 50-mile area was 44.4 percent. Most of these rates, however, are lower than the state and national averages of 46.3 and 49.4 percent, respectively.

Much of the income received by these workers on the WBN Unit 2 project would be spent in the area, especially by those who move families into the area and those who are already residents. This would increase income of businesses in the area, especially those oriented directly to consumers, and could lead to a small temporary increase in employment. After construction is completed, there would still be some increase in income and employment in the area from operation of Unit 2, although the size of the increase would be much smaller.

3.8.3. Low-Income and Minority Populations

In Rhea and Meigs Counties in 2000, the minority population was 5.4 and 2.7 percent, respectively, of the total population. Within 10 miles of the site, the average was 3.5 percent and within 50 miles, 11.5 percent. Minority population in the area of Rhea County immediately around the site in 2000 was 2.7 percent of total population (Census Tract 9751, Block Group 2) and was 4.5 percent in the area of Meigs County immediately across the Tennessee River (Census Tract 9601, Block Group 2). In both block groups, the minority population is somewhat geographically distributed, not highly concentrated in one location. All of these averages are well below the state average of 20.8 percent and the national average of 30.9 percent.

According to the 2000 Census of Population, the poverty level in Rhea County is 14.7 percent and in Meigs County, 18.3 percent. These rates are higher than both the statewide rate of 13.5 and the national rate of 12.4 percent. The county rates show decreases from rates 10 years earlier of 19.0 and 22.3 percent; the total of persons below the poverty level decreased from 4476 to 4042 in Rhea County and increased from 1761 to 2000 in Meigs County. The most recent estimates, for the year 2004, show a poverty level in Rhea County of 16.2 percent and in Meigs County, 17.5 percent; given the confidence levels of the estimates, little or no change seems to be indicated since the 2000 Census. Poverty levels within the 10-mile area around the plant are slightly higher than both the state and national levels, with a poverty rate estimated to be about 15.1 percent among those who live within 10 miles of the site and 11.8 percent within 50 miles. Based on the 2000 Census of Population, the poverty level in the area immediately around the site (Rhea County, Census Tract 9751, Block Group 2) is 18.1. This was a decrease from 19.0 percent 10 years earlier, although the number of persons below the poverty level increased from 237 to 282. In the area immediately across the river (Meigs County, Census Tract 9601, Block Group 2) the poverty level is 21.7 percent. This was an increase from 19.2 percent 10 years earlier and an increase in the number of persons below poverty from 184 to 333. Within the 10-mile area around the site, the poverty level decreased from 16.2 percent in 1989 to 15.1 percent in 1999, increasing from about 3300 persons to about 3800. This decrease (1.1 percentage points) was greater than the national decrease of 0.7 percentage points, but less than the statewide decrease of 2.2 percentage points. Thus, the poverty levels in the area around the site have been declining, as have the rates statewide and nationally, while the number of persons in poverty has continued to increase in some of the areas around the site as it has statewide and nationally. However, the overall poverty level in the area is still above the state and national averages and also above the level for the 50-mile area around the site.

The low minority population share, along with the diffused nature of potential negative impacts, makes it unlikely that there would be disproportionate impacts to minority or low-income populations. However, such impacts are possible, particularly impacts arising from housing needs and increased traffic during the construction period. TVA would work with local representatives and officials to help reduce impacts from these sources by providing more detailed information about the anticipated workforce. A mitigating action could be identification of the area as an impact area under the existing state tax code (see Section 3.8.7). This would allow more of the tax equivalent payments that TVA annually makes to Tennessee to be allocated to these counties.

3.8.4. Housing and Community Services

Both Rhea and Meigs Counties have experienced notable increases in the number of housing units in recent years. This increase from 1990 to 2000 was 2204 housing units, 21.3 percent, in Rhea County and 1499 units, 40.6 percent, in Meigs County. Both counties experienced a higher rate of increase than the state as a whole, which increased by 20.4 percent. This growth may result in more difficulty in finding sites for temporary housing, such as RVs and trailers. However, the temporary influx of workers during construction would be spread out among not only Rhea and Meigs Counties, but nearby counties also, especially those within 30 to 35 miles away. In addition, many of the workers would be commuting from their existing homes in this area or slightly farther away, especially the Chattanooga and Knoxville areas. The result would be some increase in temporary housing needs, including apartments and facilities for trailers and RVs. To the extent that the pattern from construction in the 1980s is followed, Rhea and Meigs likely would see close to 600 temporary workers locating in those two counties; of these, about three-fourths would bring families with them. At that time, families on the average had about 1.3 children, making an average family size of 3.3. Families, especially those with children, would be more likely to look for houses or apartments while workers moving alone may be more likely to bring trailers or RVs with them or to rent trailers or small apartments. Many, especially those whose work is likely to continue through most of the construction period, are likely to look for houses to purchase. The result of this increased demand for temporary housing and for locations for RVs and trailers would be noticeable, especially in Rhea and Meigs Counties. TVA would work with local representatives and officials to help reduce impacts by providing more detailed information about the anticipated workforce. A mitigating action could be identification of the area as an impact area under the existing state tax code (see Section 3.8.7).

Community services such as health services, water and sewer, and fire and police protection would also be impacted. While Rhea and Meigs Counties likely would feel the greatest impact, nearby counties would also be impacted. These impacts should be similar to those that occurred earlier with construction of Unit 1 at the site, which were projected to have no adverse effects. After construction is completed, there would be an increase of approximately 150 in permanent employment at the site; this increase would be small enough that the community could accommodate it with no noticeable impacts.

3.8.5. Schools

As noted above, Rhea and Meigs Counties most likely would be the residential location of roughly two-thirds of the workers who move into the general area to work at the site. If the location patterns and mover characteristics of workers during construction of Unit 1 in the 1980s is followed, there would be an increase of approximately 660 school-age children in the broader area around the site, of which an estimated 434 likely would reside in Rhea and Meigs Counties. Total public school enrollment in these two counties is approximately 6800. There is some capacity for certain grade levels in some of the schools. However, the systems overall are at or near capacity, and in some cases over capacity, such as at Rhea County High School and in some lower grade levels in Rhea County. The schools in these counties have been experiencing a steady growth in enrollment for several years, and this growth is expected to continue. Additional growth due to an influx of construction workers would increase the overcrowding already being experienced. TVA would work with local representatives and officials to help reduce impacts by providing more detailed information about the anticipated workforce. A mitigating action could be identification of the area as an impact area under the existing state tax code (see Section 3.8.7).

3.8.6. Land Use

Land use in the area around the site was discussed in earlier studies, particularly in the TVA 1972 FES. Since that time, the same general pattern of land use and land use change has continued, with significant increases in land used for housing and for commercial purposes, along with ongoing decreases in open space and land used for farming. Completion and operation of Unit 2 are not likely to have a major impact on this trend, although it might accelerate it slightly. As discussed above, the number of construction workers and their families that would locate in the area during the construction period is expected to be less than 2000.

3.8.7. *Local Government Revenues*

Under Section 13 of the TVA Act, TVA makes tax equivalent payments to the State of Tennessee, with the amount determined 50 percent by the book value of TVA property in the state and 50 percent by the value of TVA power sales in the state. In turn, the state redistributes 48.5 percent of the increase in payments to local governments. Payments to counties are based on relative population (30 percent of the total), total acreage in the county (30 percent), and TVA-owned acreage in the county (10 percent). The remaining 30 percent is paid to cities, distributed on the basis of population. In 2006, tax equivalent payments to Rhea County were $724,050 and to Meigs County, $484,465. Completion of WBN Unit 2 would increase book value of TVA property in the state and would, therefore, increase tax equivalent payments to the state. This increase would be distributed in part to local governments as described above, resulting in a small increase in payments to Rhea and Meigs Counties.

During construction, Tennessee law (Tennessee Code Annotated [TCA], §67-9-101) provides for allocation of additional payments to impacted local governments from the TVA tax equivalent payments. These additional payments would be made to the local governments, upon designation by TVA of these areas as impacted areas, and would continue throughout the construction period. Payments would continue to be made in decreasing amounts for three years afterward. The actual amount paid would be determined by the state comptroller of the treasury, based on the provisions of TCA §67-9-102(b). The additional payments from state allocation of TVA tax equivalent payments to these local governments during construction could be used to address some of the impacts on public services discussed above.

In addition, there would be additional tax revenue associated with expenditures made in the area for materials associated with the proposed plant completion as well as sales tax revenue associated with purchases by individuals employed during construction and subsequently during operation. The magnitude of these increases could vary greatly, depending on the amount of local purchases for construction and on the relocation and buying decisions of workers employed at the site.

3.8.8. *Cumulative Effects*

No cumulative socioeconomic effects were identified in earlier WBN-related environmental reviews. The major change in the area's socioeconomic environment since those earlier documents were prepared is the more rapid population growth the area has seen and is expected to continue to experience, especially in the areas along the Tennessee River in Rhea and Meigs Counties (Section 3.8.1). Much of this area is sparsely populated and capable of supporting additional growth. Along with this population growth, the area economy is diverse and growing; however, this growth has resulted in some impact to community services, most notably in increased overcrowding in certain public schools. The increase from the influx of workers during construction of WBN Unit 2 would temporarily add to these impacts, especially to the school systems in Rhea and Meigs Counties.

TVA is currently updating the draft land plan and draft environmental impact statement (TVA 2005d) for Watts Bar Reservoir. TVA plans to issue an amended DEIS for the Watts Bar Reservoir Land Management Plan in the summer of 2007. In the event that nearby TVA land is allocated for industrial or recreational development in the revised land plan, potential cumulative effects from subsequent development in conjunction with construction or operation of WBN Unit 2 would be addressed when proposals for development are reviewed.

The extent of the impact overall and on individual school systems and schools is largely dependent on where in-moving workers locate their residences. The recent growth that has occurred, along with the expected continuation of this growth, could result in location patterns different in some ways from the patterns associated with earlier construction at the site. For example, some of the in-coming workers might locate farther away from the site than they would prefer. This could have the effect of decreasing the number locating in Rhea and Meigs Counties, or parts of these counties, and increasing the number in some nearby counties. Improved roadways in the area, as contrasted to earlier construction periods, may also make location at greater distances relatively more attractive, increasing the tendency to locate farther from the site. In addition to schools, other community services could be impacted by the temporary influx of construction workers in conjunction with the current growth pattern. These impacts are likely to be less noticeable than the school impacts. Additional road traffic at peak times, given the combination of construction workers and the growth of permanent population, could cause a noticeable impact at some locations. There could also be noticeable impacts to other community services such as medical facilities and public safety. The extent of all these cumulative impacts would depend greatly on the residential locations of the in-moving workers. As noted above, TVA is conducting a labor study, the results of which will be provided to officials in the impacted counties to help with local planning to accommodate the anticipated impacts In addition, TVA would work with the local communities to facilitate planning for these potential impacts.

3.9. Floodplains and Flood Risk

In the TVA 1972 FES for WBN Units 1 and 2, a letter was included to Mr. Gartrell, with the U.S. Department of the Interior, regarding siting of these units. The letter states: "Plant Siting--The Geological Survey is reviewing geologic and hydrologic data relevant to WBN Units 1 and 2, as supplied by TVA in a preliminary safety analysis report (PSAR) to the AEC. This review pertains to geologic and hydrologic aspects of the site such as earthquake effects, foundation conditions, and flooding potential." The PSAR became the FSAR on June 30, 1976, with the submittal of amendment 23 (TVA 1976c). The FSAR contains information related to potential flooding of the Watts Bar site from the Tennessee River and local probable maximum precipitation[4] (PMP) site drainage and is still current. Section 3.7 Floodplains and Flood Risk of the FEA for the WBN Unit 1 Replacement of the Steam Generators describes the current conditions at WBN (TVA 2005a).

WBN is located on the right bank of Chickamauga Reservoir between TRM 528.0 and 528.6 in Rhea County, Tennessee. The area potentially impacted by this project would extend from about TRM 528.4 to 529.0. The proposed project area could possibly be flooded from the Tennessee River and local PMP site drainage.

[4] The Probable Maximum Precipitation is defined as the theoretically greatest depth of precipitation for a given duration that is physically possible over a particular drainage area at a certain time of year (American Meteorological Society, 1959). In consideration of the limited knowledge of the complicated processes and interrelationships in storms, PMP values are identified as estimates.

The 100-year floodplain for the Tennessee River would be the area below elevation 697.3 feet above mean sea level (msl) at TRM 528.4 and elevation 697.6-feet msl at TRM 529.0. The Tennessee River TVA flood risk profile (FRP) elevation would be elevation 701.1-feet msl at TRM 528.4 and 701.4 at TRM 529.0. The FRP is used to control residential and commercial development on TVA lands and flood damageable development for TVA projects. In this area, the FRP elevations are equal to the 500-year flood elevations.

Under current conditions, the estimated Tennessee River Probable Maximum Flood[5] (PMF) level would be elevation 734.9-feet msl at WBN. Consequent wave run-up above the flood level would be 2.0 feet, which would produce a maximum flood level of elevation 736.9-feet msl (TVA 2004d). Based on site topography, much of the proposed project area would be inundated at this elevation. It has previously been determined that the critical elevation for PMP site drainage should be no higher than elevation 729.0-feet msl.

The floodplains and flood risk assessment involves ensuring that facilities would be sited to provide a reasonable level of protection from flooding. In doing this, the requirements of Executive Order 11988 (Floodplain Management) would be fulfilled. Due to the fact that the proposed project could potentially impact flood elevations at several buildings at a nuclear generating facility, the NRC requires a flood risk evaluation of possible impacts from the PMF and PMP site drainage for all alternatives.

The following proposed activities could be impacted by flood conditions: material handling buildings, materials storage building, a multipurpose building, a new construction access facility, temporary outage building, and an in-processing center would be constructed; temporary craft trailers would be added; and temporary parking and laydown areas would be developed. All proposed facilities would be located outside the limits of the Tennessee River 100- and 500-year floodplains, but many of the proposed structures would be located on ground below the Tennessee River PMF elevation of 734.9-feet msl. For those structures located below the Tennessee River PMF, an acceptable level of flood risk would be provided because the probability of flooding would be extremely low, and flooding of these structures would not impact the safe operation of the plant. None of the proposed activities would result in changes to the Tennessee River PMF elevation.

All existing safety-related facilities, systems, and equipment are housed in structures that would provide protection from flooding for all flood conditions up to plant grade at elevation 728-feet msl. Other rainfall floods would exceed plant grade elevation 728-feet msl and require plant shutdown. However, flood warning criteria and forecasting techniques have been developed to assure that there will always be adequate time to shut the plant down and be ready for floodwaters above plant grade (TVA 2004d).

The placement of temporary and permanent structures both inside and outside the security fence would be required to complete Unit 2. The tentative locations of the proposed new structures are shown on the site plan (Figure 1-2). The building numbers in the following analysis correspond to the legend of Figure 1-2. The material handling buildings (2), materials storage building (4), and in-processing center (32) would be located outside of the

[5] The Probable Maximum Flood is defined as the most severe flood that can reasonably be predicted to occur at a site as result of hydrometeorological conditions. It assumes an occurrence of PMP critically centered on the watershed and a sequence of related meteorologic and hydrologic factors typical of extreme storms.

security fence. These structures would not be located within critical areas for PMP site drainage and would not adversely impact PMP site drainage elevations.

The new multipurpose building (28) and temporary craft trailers (29) are both within the area defined as "Area East of Main Plant" in the site drainage calculation that were developed for the Watts Bar FSAR (TVA 2004d). The original site analysis determined the elevation resulting from the site PMP would be less than the critical elevation of 729.0. This was based on a flow path from north to south along the east side the turbines and turbine building and through the switchyard. The new multipurpose building (28) and temporary craft trailers (29) are being designed not to exceed the footprint of the buildings that have been removed from this area (Richard King, TVA, personal communication, December 2006). Therefore, the new structures would not impact previously determined PMP elevations. The proposed new construction access facility (31) would be located adjacent to the existing control building and auxiliary (reactor) building and would not impact flood elevations. The temporary outage building (33) would not be an obstruction as shown on the current site plan.

Construction of the temporary parking areas (3) could result in minor changes to the existing topography, but PMP drainage from these areas does not flow toward the plant and, therefore, no adverse impacts would be expected. An area on the west side of the plant south of the Unit 2 material handling building that has in the past been used for temporary parking should be designated as a no parking area. This area is located within the PMP drainage "ditch" and any cars parked in the area could adversely impact PMP drainage elevations. Although there is no indication that development would take place in the switchyard area (30), this area has been identified as critical for PMP drainage. Therefore, any structural modifications that are proposed in the switchyard should be reviewed prior to construction to ensure they would not adversely impact PMP drainage elevations.

Based on the current design and site plan, the proposed project would be consistent with Executive Order 11988, and there would be no anticipated adverse flood-related impacts. Any changes to the tentative site plan would be reviewed to determine the potential for flood related impacts.

3.10. Seismic Effects

The 1972 FES described the maximum historical Modified Mercalli Intensity (a scale of earthquake effects that ranges from Roman numeral I through XII) experienced at WBN from local quakes and the origins of this ground motion. The 1995 FSER described the safe shutdown earthquake for WBN and its basis and discussed seismic analyses of WBN using a site-specific earthquake model and a review level earthquake (TVA 1995b). The WBN FSAR (TVA 2004d) provides a thorough description of the geology and seismicity in the vicinity of WBN in Section 2.5. The basic conclusions of the 1995 FSER and the 1972 FES with respect to the regional seismology of WBN and its seismic design remain valid. There are two items that require updating. First, the largest earthquake in the southern Appalachians since the 1972 FES is now the April 29, 2003, Fort Payne, Alabama, earthquake, which had a moment magnitude of 4.6 and Nuttli body wave magnitude of 4.9. The Fort Payne earthquake's magnitude is still lower than the design basis earthquake, which has a body wave magnitude of 5.8; therefore, the occurrence of the 2003 Fort Payne earthquake has no significant impact on previous findings.

Second, preliminary results of the Individual Plant Examination for External Events (IPEEE) for WBN were discussed in the 1995 FSER. The final results of this study were completed and transmitted to NRC in February 1998 (TVA 1998e). The study included an examination of seismic effects and concluded that the seismic capacity of WBN for a Review Level Earthquake exceeds 0.3g[6], the minimum level required by NRC. Therefore, no seismic design change recommendations resulted from the IPEEE seismic evaluation.

3.11. Climatology and Meteorology

The 1972 FES contains a discussion of the climatology and meteorology for the Watts Bar site. The 1995 FSER provides a description of the Watts Bar on-site meteorological program and a review of the previous discussion. The conclusion was that the regional climate description in the 1972 FES remained valid. Some of the information was updated based on more recent data. It also concluded that the 20-year data period update (1974-1993) in local meteorology was more representative than the one year of data used previously. The severe weather information in the 1972 FES was judged to be valid except for an update to the tornado data.

Regional Climatology

The regional climate description in the 1972 FES remains accurate as discussed in this section. This conclusion is based on information contained in the *Local Climatological Data Annual Summary Comparative Data for Chattanooga, Tennessee*, for 2005 (U.S. Department of Commerce 2005) and in the *Climatography of the United States No. 81* (U.S. Department of Commerce 2003).

Temperature data for the 1971-2000 period of record for Chattanooga, Tennessee, indicate an average annual temperature of 60.0°F, with monthly averages ranging from 39.4°F in January to 79.6°F in July. These temperatures are slightly warmer than data for the 1961-1990 period of record used in the 1995 FSER. The extreme temperatures, maximum rainfall in 24 hours, and maximum snowfall in 24 hours at Chattanooga are the same for the 1971-2000 period as for the 1961-1990 period. Wind speed data from Chattanooga for the 1971-2000 period of record indicate an average wind speed of 5.9 miles per hour. This is slightly lower than data for the 1961-1990 period of record.

Local Meteorology

The one year of data collected from the temporary WBN meteorological facility is supplemented with more representative data from the 20-year period from 1986-2005. These data were collected from the permanent meteorological facility. On an annual basis, the most frequent wind directions at 10 meters are south-southwest and southwest at 16.0 percent and 8.4 percent, respectively. This reflects a small shift from easterly to westerly directions from the on-site data from 1974-1993 used in the 1995 FSER. The annual average wind speed decreased from 4.1 miles per hour to 3.7 miles per hour at the 10-meter level in the more recent 20-year data period. In addition, the annual frequency of calms, defined as wind speeds less than 0.6 mi/h, increased from 3.0 percent to 3.4 percent. The impact of these changes on dispersion values is discussed below under the heading dispersion.

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[6] Percent "g" is the force of gravity (an acceleration of 9.78 meters/second^2). When there is an earthquake, the forces caused by the shaking can be measured as a percentage of the force of gravity, or percent g.

Severe Weather
Based on Section 2.3.1.3 of the WBN FSAR (TVA 2004d), the severe weather information in the 1972 FES remains accurate, except for the following update. During the period from 1916-2005, only one tornado has been reported in Rhea County. The FSAR estimate of the probability of a tornado striking the site is 1.48E-4 with a recurrence interval of 6755 years. This is based on tornado data from 1950 through 1986. Extension of the tornado database end date from 1986 to 2005 increases the estimate of the probability of a tornado striking the site to 2.7 E-4 with a recurrence interval of 3703 years. During the period from 1950-2005, 44 tornadoes were identified within a 30-nautical-mile radius of Watts Bar (approximately 2827 square miles). The mean tornado path was 0.96 square miles, and the annual tornado frequency was 0.80.

Dispersion
Section 5.10 of the 1995 FSER presents the estimated annual airborne doses as calculated by the *Watts Bar Off-Site Dose Calculation Manual* (TVA 1994b). It uses the 20-year period of meteorological data from 1974-1993. Use of the later 20-year data period discussed in under local meteorology, above, results in an increase of the maximum dispersion value from 1.09E-5 to 1.43E-5 second/cubic meters and shifts the critical downwind sector from southeast to east-southeast. The impact of this increase is discussed in Section 3.13.

Air Quality
Two oil-fired boilers used for building heat and startup steam emit small amounts of air pollutants as addressed in the 1972 FES. These emissions are controlled to meet applicable regulatory requirements, and resulting impacts are insignificant.

3.12. Nuclear Plant Safety and Security

3.12.1. Severe Accident Analysis

TVA maintains a probabilistic safety assessment model to use in evaluating the most significant risks of radiological release from WBN fuel into the reactor and from the reactor into the containment structure. In 1995, both TVA and NRC concluded that, except for a few procedural changes implemented as part of the WBN operation, none of the severe accident mitigation design alternatives were beneficial to mitigating the risk of severe accidents further. The term "accident" refers to any unintentional event (i.e., outside the normal or expected plant operation envelope) that results in a release or a potential for a release of radioactive material to the environment. The NRC categorizes accidents as either design basis or severe. Design basis accidents are those for which the risk is great enough that NRC requires plant design and construction to prevent unacceptable accident consequences. Severe accidents are those that NRC considers too unlikely to warrant normal design controls.

Since 1995, TVA has implemented the industry-required design and corresponding design and corresponding mitigating action changes as required by NRC for continued operation of WBN Unit 1 and would implement them for operation of Unit 2. The design changes have already been implemented in the WBN Unit 1 probabilistic safety assessment model. The analysis is based on the WBN Unit 1 probabilistic safety assessment model, which is considered applicable for Unit 2 operations because of its similarity to Unit 1.

An analysis was performed for this FSEIS to estimate the human health impacts from potential accidents at WBN in the event that Unit 2 became operational (Karimi 2007). Only severe reactor accident scenarios leading to core damage and containment bypass or containment failure are presented here. Accident scenarios that do not lead to containment bypass or containment failure are not presented because the public and environmental consequences would be significantly less.

The MACCS2 computer code (Version 1.13.1) was used to perform probabilistic analyses of radiological impacts. The generic input parameters given with the MACCS2 computer code that were used in NRC's severe accident analysis (NUREG-1150) formed the basis for the analysis. These generic data values were supplemented with parameters specific to WBN and the surrounding area. Site-specific data included population distribution, economic parameters, and agricultural product. Plant-specific release data included nuclide release, release duration, release energy (thermal content), release frequency, and release category (i.e., early release, late release). The behavior of the population during a release (evacuation parameters) was based on declaration of a general emergency and the emergency planning zone (EPZ) evacuation time. These data in combination with site-specific meteorology were used to simulate the probability distribution of impact risks (exposure and fatalities) to the surrounding 80-kilometer (within 50 miles) population.

The consequences of a beyond-design-basis accident, with mean meteorological conditions, to the maximally exposed off-site individual, an average individual, and the population residing within an 80-kilometer (50-mile) radius of the reactor site are summarized in Table 3-13. The analysis assumed that a site emergency would have been declared early in the accident sequence and that all nonessential site personnel would have evacuated the site in accordance with site emergency procedures before any radiological releases to the environment occurred. In addition, emergency action guidelines would have been implemented to initiate evacuation of 99.5 percent of the public within 16 kilometers (10 miles) of the plant. The location of the maximally exposed off-site individual may or may not be at the site boundary for these accident sequences because emergency action guidelines would have been implemented and the population would be evacuating from the path of the radiological plume released by the accident.

Table 3-13. Severe Accident Annual Risks

Release Category (frequency per reactor year)	Maximally Exposed Off-Site Individual		Average Individual Member of Population Within 80 Kilometers (50 miles)	
	Dose Risk [a] (rem/year)	Cancer Fatality [b]	Dose Risk [a] (rem/year)	Cancer Fatality [b]
I - Early Containment failure (3.4×10^{-7})	2.2×10^{-5}	2.6×10^{-8}	1.8×10^{-7}	1.1×10^{-10}
II - Containment Bypass (1.4×10^{-6})	2.2×10^{-5}	1.3×10^{-8}	8.2×10^{-7}	4.9×10^{-10}
III - Late Containment Failure (3.0×10^{-6})	4.6×10^{-7}	2.8×10^{-10}	1.3×10^{-7}	7.8×10^{-11}

[a] Includes the likelihood of occurrence of each release category
[b] Increased likelihood of cancer fatality per year

The results presented in this table indicate that the highest risk to the maximally exposed off-site individual is one fatality every 38 million years (or 2.6×10^{-8} per year) and the highest risk to an average individual member of the public is one fatality every 2 billion years (or 4.9×10^{-10} per year). Overall, the risk results presented above are small. Completion and operation of WBN Unit 2 would not change the risks evaluated here because the likelihood of an accident that could affect both units and lead to radioactive releases beyond those analyzed here would be extremely low. This is consistent with the conclusions of NRC's Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS) (NRC 1996a). Accidents that could affect multi-unit sites are initiated by external events. Severe accidents initiated by external events as tornadoes, floods, earthquakes, and fires traditionally have not been discussed in quantitative terms in final environmental statements and were not considered in the GEIS. In the GEIS, however, NRC staff did evaluate existing impact assessments performed by NRC and the industry at 44 nuclear plants in the United States and concluded that the risk from beyond-design-basis earthquakes at existing nuclear power plants is small. Additionally, the staff concluded that the risks from other external events are adequately addressed by a generic consideration of internally initiated severe accidents.

3.12.2. Terrorism

Some nongovernmental entities and members of the public have expressed concern about the risks posed by nuclear generating facilities in light of the threat of terrorism. Because WBN is already an active nuclear generating facility, the risks posed by adding a second generating unit are not the same as the risks that may be associated with locating a nuclear generating facility at a new location. The risk posed by a terrorist attack already exists at this site. Regardless, TVA believes that the possibility of a terrorist attack affecting operation of WBN Unit 2 or the combined operation of both WBN units is very remote and that postulating potential health and environmental impacts from a terrorist attack involves substantial speculation.

TVA has in place detailed, sophisticated security measures to prevent physical intrusion into its nuclear plant sites, including WBN, by hostile forces seeking to gain access to plant nuclear reactors or other sensitive facilities or materials. TVA contract security personnel are trained and retrained to react to and repel hostile forces threatening TVA nuclear facilities. TVA's security measures and personnel are inspected and tested by the NRC. It is highly unlikely that a hostile force could successfully overcome these security measures and gain entry into sensitive facilities, and even less likely that they could do this quickly enough to prevent operators from putting plant reactors into safe shutdown mode. However, the security threat that is more frequently identified by members of the public or in the media are not hostile forces invading nuclear plant sites but attacks using hijacked jet airliners, the method used on September 11, 2001, against the World Trade Center and the Pentagon. The likelihood of this now occurring is equally remote in light of today's heightened security awareness, but this threat has been carefully studied.

The Nuclear Energy Institute (NEI) commissioned the Electric Power Research Institute (EPRI) to conduct an impact analysis of a large jet airline being purposefully crashed into sensitive nuclear facilities or containers including nuclear reactor containment buildings, used fuel storage ponds, used fuel dry storage facilities, and used fuel transportation containers. The EPRI analysis was peer reviewed when it was finished. Using conservative analyses, EPRI concluded that there would be no release of radionuclides from any of these facilities or containers. They are already designed to withstand potentially destructive events. Nuclear reactor containment buildings, for example, have thick concrete walls with heavy reinforcing steel and are designed to withstand large earthquakes, extreme overpressures, and hurricane force winds. Using computer models, a Boeing 767-400 was crashed into containment structures that were representative of all U.S. nuclear power containment types. The containment structures suffered some crushing and chipping at the maximum impact point but were not breached. The results of this analysis are summarized in an NEI paper titled "Aircraft Crash Impact Analyses Demonstrate Nuclear Power Plant's Structural Strength" (NEI 2002). (For security reasons, the EPRI analysis has not been publicly released.)

The EPRI analysis is fully consistent with research conducted by NRC. When NRC recently considered such threats, NRC Commissioner McGaffigan observed:

> *Today the NRC has in place measures to prevent public health and safety impacts of a terrorist attack using aircraft that go beyond any other area of our critical infrastructure. In addition to all the measures the Department of Homeland Security and other agencies have put in place to make such attacks extremely improbable (air marshals, hardened cockpit doors, passenger searches, etc.), NRC has entered into a Memorandum of Understanding with NORAD/NORTHCOM to provide real-time information to potentially impacted sites by any aircraft diversion.*
>
> *As NRC has said repeatedly, our research showed that in most (the vast majority of) cases an aircraft attack would not result in anything more than a very expensive industrial accident in which no radiation release would occur. In those few cases where a radiation release might occur, there would be no challenge to the emergency planning basis currently in effect to deal with <u>all</u> beyond-design-basis events, whether generated by mother nature, or equipment failure, or terrorists (NRC 2007).*

Notwithstanding the very remote risk of a terrorist attack affecting WBN operations, TVA increased the level of security readiness, improved physical security measures, and increased its security arrangements with local and federal law enforcement agencies at all of its nuclear generating facilities after the events of September 11, 2001. These additional security measures were taken in response to advisories issued by NRC. TVA continues to enhance security at its plants in response to NRC guidance. The security measures TVA has taken at WBN are complemented by the measures taken throughout the United States to improve security and reduce the risk of successful terrorist attacks. This includes measures designed to respond to and reduce the threats posed by hijacking large jet airliners.

In the very remote likelihood that a terrorist attack did successfully breach the physical and other safeguards at WBN resulting in the release of radionuclides, the consequences of such a release are reasonably captured by the discussion of the impacts of severe accidents discussed above in this section.

3.13. Radiological Effects

This section discusses the potential expected radiological dose exposure of the public during normal operations of WBN Units 1 and 2. Based on operational data from WBN Unit 1, TVA expects WBN Unit 2 dose data to be of the same magnitude as those projected in its 1972 FES for a single unit. TVA has determined that the doses to the public resulting from the discharge of radioactive effluents from WBN would likely be less than two percent of the NRC guidelines given in 10 CFR 50 Appendix I, and that there would be no new or different effects on the surrounding environment due to these releases than from those discussed in the FES. NRC addressed potential radiological effects in detail in its SEIS, at pp. 5-11 to 5-21 (NRC 1995b). TVA's assessment of potential impact agrees with NRCs. The dose values used in the Draft SEIS assessment were based on calculations that used meteorological data from January 1974 to December 1993. TVA has recalculated the dose values using meteorological data from January 1986 to December 2005 for the FSEIS. The revised values do not differ materially from those presented in the DSEIS.

Radiological Impacts on Humans

Radionuclides in Liquid Effluents

The exposure pathways to humans that were used in the 1972 FES analysis remain valid. The pathways considered are illustrated in Figure 3-6. Several of the pathways included in the 1972 FES analysis are not considered in the current analysis of the impact of the release of radioactivity in liquid effluents in the area around WBN site. These pathways are doses received from swimming in and boating on the Tennessee River. These pathways are no longer considered because they have been found to be several orders of magnitude lower than the dose received from shoreline recreation. The exclusion of these external dose pathways for the analysis does not significantly change the calculated dose commitments to individuals or populations since essentially all of the total body dose due to the release of radioactive material is accounted for by fish and water ingestion. Doses to terrestrial vertebrates from the consumption of aquatic plants, and doses to aquatic plants, aquatic invertebrates, and fish have not been reassessed in the current analysis of the impact of radioactivity in liquid effluents because doses to these organisms are less than or equal to the doses to humans (TVA 1972).

Current analyses of potential doses to members of the public due to releases of radioactivity in liquid effluents are calculated using the models presented in NUREG-0133 (NRC 1996b) and *Regulatory Guide 1.109, Revision 1* (NRC 1977). These models are essentially those used in the 1972 FES, and are based on the *International Commission of Radiological Protection Publication 2*. Changes in the model assumptions since the release of the 1972 FES include:

The calculation of doses to additional organs (kidney and lung).

River water use (ingestion, fish harvest), and recreational use data have been updated using more recent information (Tables 3-14 and 3-15).

Decay time between the source and consumption is handled as describe in *Regulatory Guide 1.109* (NRC 1977).

Only those doses within a 50-mile radius of WBN are considered in the population dose.

The population data are updated and projected through the year 2040.

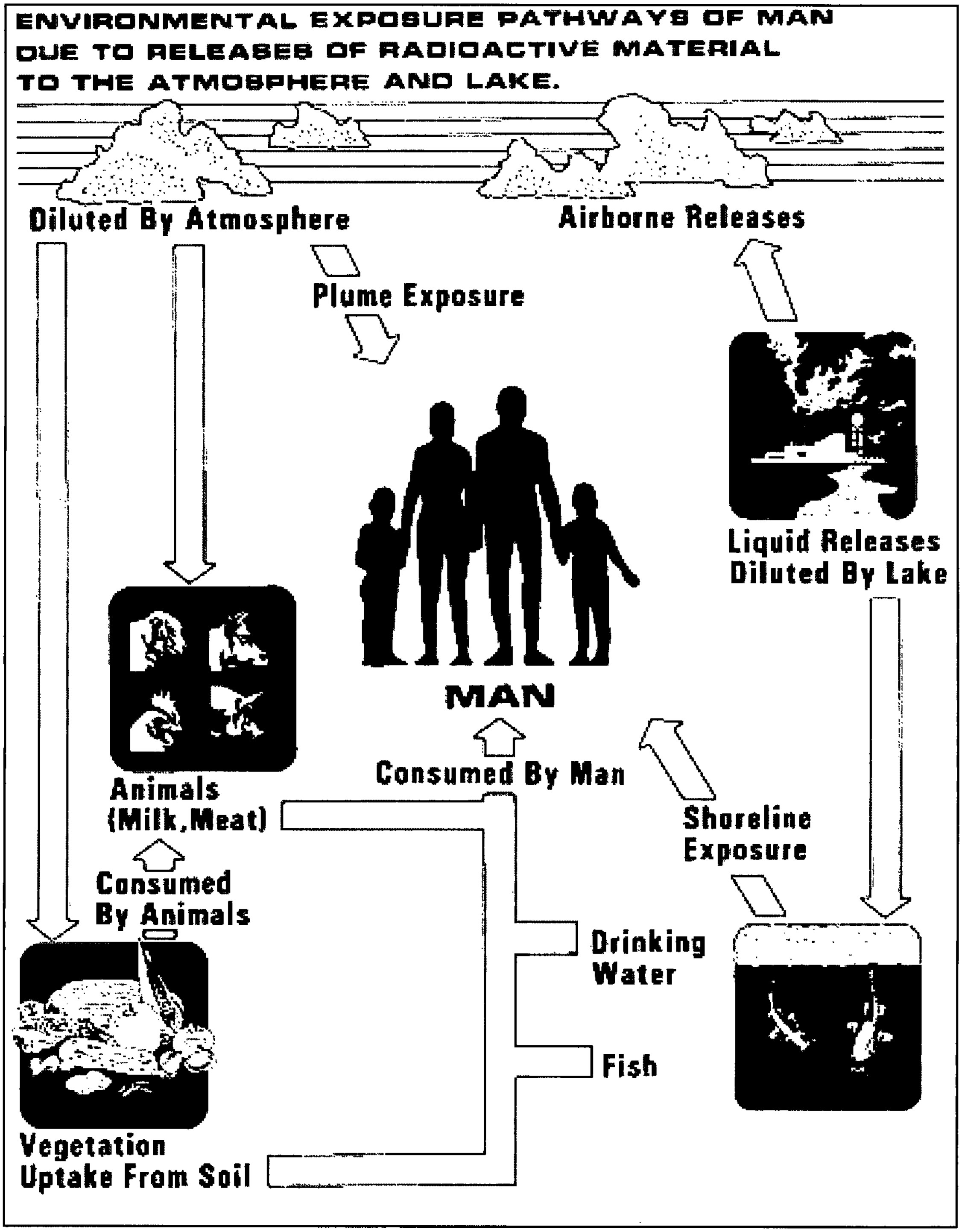


Figure 3-6. Pathways to Man Due to Releases of Radioactive Material

Table 3-14. Public Water Supplies Within a 50-Mile Radius Downstream of WBN

Name	Tennessee River Mile	Estimated 2040 Population
Dayton, Tennessee	504	19,170
Soddy-Daisy/Falling Water Utility District	487	11,452
East Side Utility, Tennessee	473	49,700
Chattanooga, Tennessee	465	237,048

Table 3-15. Estimated Recreational Use of Tennessee River Within a 50-Mile Radius Downstream of WBN

Name	Beginning TRM[1]	Ending TRM	Size (acres)	Estimated 2040 Recreational visits/year
Chickamauga Reservoir (from WBN to 100 percent mixing point)	528	510	4,799	120,986
Chickamauga Reservoir (from 100 percent mixing point to SQN)	510	484	22,101	1,297,880
Chickamauga Reservoir (from SQN to Chickamauga Dam)	484	471	9,889	7,421,905
Nickajack Reservoir (from Chickamauga Dam to WBN 50-mile radius)	471	460	1,799	284,000

[1]Tennessee River Mile

Transfer coefficients, consumption rates, and bioaccumulation factors used are those presented in the documents listed above, or more recent data, if available. The models and input variable used are those presented in the *Watts Bar Off-Site Dose Calculation Manual* (TVA 1994b), which was approved by the NRC on July 26, 1994. The estimated liquid radioactive releases used in the analysis are given in Table 3-16.

Table 3-16. WBN Total Annual Discharge-Liquid Waste Processing System for Two-Unit Operation

Nuclide	1 Unit LRW[1]	1 Unit SGB[2]	1 Unit Totals	2 Unit Totals
Br-84	1.65E-04	5.23E-04	6.88E-04	1.38E-03
I-131	2.63E-02	1.14E+00	1.16E+00	2.33E+00
I-132	1.32E-02	1.08E-01	1.21E-01	2.43E-01
I-133	5.29E-02	8.57E-01	9.10E-01	1.82E+00
I-134	6.26E-03	2.65E-02	3.28E-02	6.55E-02
I-135	4.75E-02	4.22E-01	4.70E-01	9.39E-01
Rb-88	6.89E-03	7.84E-04	7.68E-03	1.54E-02
Cs-134	2.93E-02	1.68E-01	1.98E-01	3.95E-01
Cs-136	2.55E-03	1.72E-02	1.98E-02	3.96E-02
Cs-137	4.03E-02	2.21E-01	2.61E-01	5.23E-01
Na-24	1.86E-02	0.0E+00	1.86E-02	3.72E-02
Cr-51	7.03E-03	9.27E-02	9.98E-02	2.00E-01
Mn-54	4.99E-03	5.10E-02	5.59E-02	1.12E-01
Fe-55	8.09E-03	0.0E+00	8.09E-03	1.62E-02
Fe-59	2.42E-03	9.05E-03	1.15E-02	2.29E-02
Co-58	2.20E-02	1.44E-01	1.66E-01	3.31E-01
Co-60	1.44E-02	1.72E-02	3.16E-02	6.32E-02
Zn-65	3.82E-04	0.0E+00	3.82E-04	7.65E-04
Sr-89	1.92E-04	4.33E-03	4.52E-03	9.03E-03
Sr-90	2.20E-05	3.88E-04	4.10E-04	8.19E-04
Sr-91	2.84E-04	2.18E-03	2.47E-03	4.94E-03
Y-91m	1.68E-04	0.0E+00	1.68E-04	3.37E-04
Y-91	9.00E-05	3.00E-04	3.90E-04	7.80E-04
Y-93	1.27E-03	0.0E+00	1.27E-03	2.54E-03
Zr-95	1.39E-03	1.20E-02	1.34E-02	2.68E-02
Nb-95	2.10E-03	8.98E-03	1.11E-02	2.22E-02
Mo-99	4.20E-03	9.95E-02	1.04E-01	2.07E-01
Tc-99m	3.35E-03	0.0E+00	3.35E-03	6.70E-03
Ru-103	5.88E-03	0.0E+00	5.88E-03	1.18E-02
Ru-106	7.63E-02	0.0E+00	7.63E-02	1.53E-01
Te-129m	1.41E-04	0.0E+00	1.41E-04	2.82E-04
Te-129	7.30E-04	0.0E+00	7.30E-04	1.46E-03
Te-131m	8.05E-04	0.0E+00	8.05E-04	1.61E-03
Te-131	2.03E-04	0.0E+00	2.03E-04	4.06E-04
Te-132	1.11E-03	2.93E-02	3.05E-02	6.09E-02
Ba-140	1.02E-02	3.48E-01	3.58E-01	7.16E-01
La-140	1.62E-02	4.98E-01	5.14E-01	1.03E+00
Ce-141	3.41E-04	0.0E+00	3.41E-04	6.81E-04
Ce-143	1.53E-03	0.0E+00	1.53E-03	3.05E-03

Table 3-16 (continued)

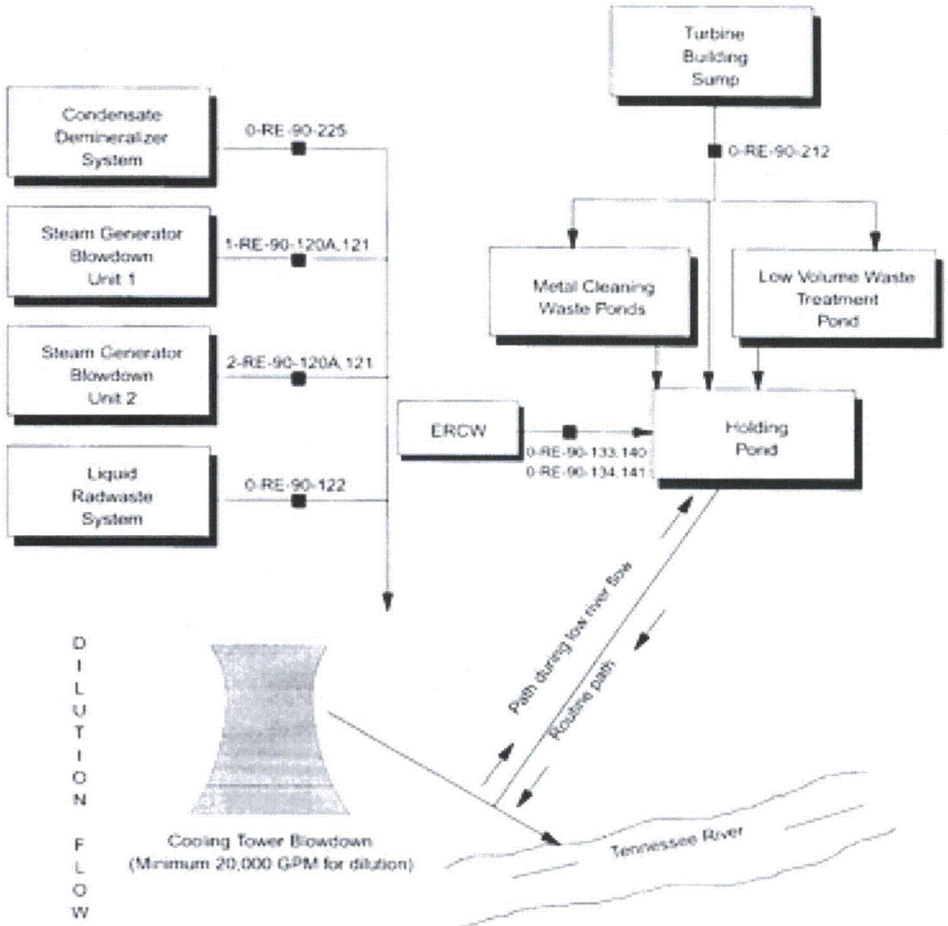
Nuclide	1 Unit LRW[1]	1 Unit SGB[2]	1 Unit Totals	2 Unit Totals
Ce-144	6.84E-03	1.26E-01	1.33E-01	2.66E-01
Np-239	1.37E-03	0.0E+00	1.37E-03	2.75E-03
H-3	1.25E+03	0.0E+00	1.25E+03	2.51E+03
H-3 (TPC)	3.33E+03	0.0E+00	3.33E+03	4.58E+03
Totals w/o H-3	**4.38E-01**		**4.84E+00**	**9.68E+00**
Totals w H-3	**1.25E+03**		**1.26E+03**	**2.52E+03**
Total w H-3 (TPC[3])	**3.33E+03**		**3.33E+03**	**4.59E+03**

[1] Liquid Radwaste
[2] Steam Generator Blowdown
[3] Tritium Production Core (single unit)

A companion figure, illustrating the release points for radioactive plant liquid effluents from WBN is presented in Figure 3-7. A simplified diagram of the WBN radioactive liquid waste (radwaste) system is shown in Figure 3-8. The liquid radwaste system is designed to control and minimize release of the subject radionuclides.

A tabulation of the resulting calculated doses for Unit 2 without TPC is given in Table 3-17. Doses for adults, teens, children, and infants are in millirem (mrem). Population doses are in man-rem.

The estimated annual liquid releases and resulting doses as presented by the TVA 1972 FES, the WBN Unit 1 FSAR, Unit 2, Unit 1 and 2 totals, and recent historical data from WBN Unit 1 (as submitted in the Annual Radioactive Effluent Reports to the NRC) with the guidelines given by NRC in 10 CFR 50, Appendix I are compared in Table 3-18. These guidelines are designed to assure that releases of radioactive material from nuclear power reactors to unrestricted areas during normal conditions, including expected occurrences, are kept as low as practicable.



GPM = Gallons per Minute

Figure 3-7. Plant Liquid Effluent Pathways and Release Points

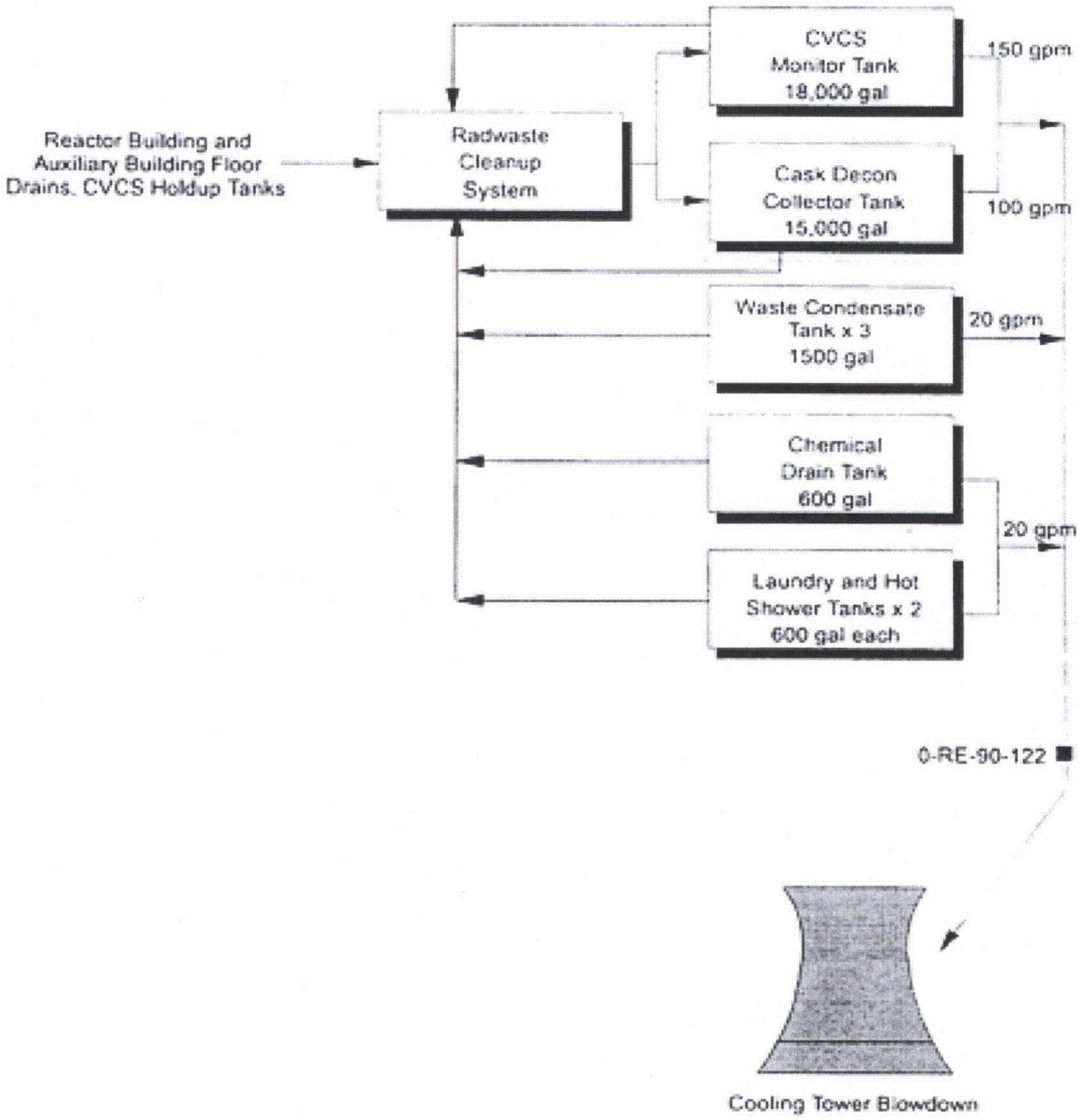


Figure 3-8. Watts Bar Nuclear Plant Liquid Radwaste System

Table 3-17. Watts Bar Nuclear Plant Doses From Liquid Effluents per Unit for Year 2040

				(mrem)				
ADULT	TB[1]	Bone	GIT[2]	Thyroid	Liver	Kidney	Lung	Skin
	0.72	0.56	0.132	0.88	0.96	0.352	0.136	0.031
TEEN	TB	Bone	GIT	Thyroid	Liver	Kidney	Lung	Skin
	0.44	0.6	0.104	0.8	1	0.356	0.152	0.031
CHILD	TB	Bone	GIT	Thyroid	Liver	Kidney	Lung	Skin
	0.188	0.76	0.06	0.92	0.88	0.312	0.128	0.031
INFANT	TB	Bone	GIT	Thyroid	Liver	Kidney	Lung	Skin
	0.032	0.036	0.033	0.264	0.036	0.034	0.032	0.031
				(man-rem)				
POP[3] DOSE	TB	Bone	GIT	Thyroid	Liver	Kidney	Lung	Skin
	1.14	1.24	1	10.8	1.5	0.98	0.73	0.222
	TB	Bone	GIT	Thyroid	Liver	Kidney	Lung	Skin
POP DOSE 2040	1.619	1.761	1.420	15.336	2.130	1.392	1.037	0.315

[1] Total body
[2] Gastro intestinal tract
[3] Population

Table 3-18. Comparison of Estimated Annual Liquid Releases and Resulting Doses per Unit at WBN

	1972 FES (Table 2.4-2)	Unit 1 FSAR	Unit 2 Evaluation	Units 1 & 2 Combined	Unit 1 10 year Operational Average	10 CFR 50 Appendix I Guidelines per Unit
Tritium Released (Ci)[1]	1.46E+02	3.33E+03	1.25E+03	4.58E+03	707	N/A[2]
Activity Released (Ci)[1]	3.2E-01	4.84	4.84	9.68	2.2E-01	10
Total Body Dose (mrem)[3]	1.7E-02	7.2E-01	7.2E-01	1.44E+00	3.1E-02	3
Maximum Organ Dose (mrem)[3]	5.5E-02	1.0 E+00	1.0E+00	2.0E+00	4.25E-02	10

[1] Ci = Curies
[2] N/A = Not Applicable
[3] mrem = millirem

Several conclusions can be drawn from the data in Table 3-18:

- The Unit 2 estimates, even though based on very conservative (worst-case) assumptions, indicate that estimated doses would continue to meet the per unit dose guideline given in 10 CFR Part 50, Appendix I.

- Recent WBN operational data for liquid effluents indicated that actual releases and resulting dose estimates to the public are a small fraction of the Appendix I guidelines (averaging about two percent or less). Based on these conclusions, the analyses of radiological impact to humans from liquid releases in the TVA FES continue to be valid, and operation of WBN Unit 2 would not materially change the result.

Radionuclides in Gaseous Effluents
The exposure pathways used in the current analyses of the impact of radioactive material released in gaseous effluents are expanded from those used in the 1972 FES. The pathways considered are illustrated in Figure 3-6. These pathways include external doses due to noble gases, and internal doses from particulates due to inhalation, and the ingestion of milk, meat, and vegetables from the area around WBN. Changes in the model assumptions since the publication of the TVA FES include: the calculation of internal doses to additional organs (bone, liver, total body, gastrointestinal tract, kidney, and lung); actual land use survey results are used (shown in Table 3-19); and the population data are projected through the year 2040. Current analyses of potential doses to members of the public due to releases of radioactivity in gaseous effluents are calculated using the models presented in NUREG-0133 (NRC 1996b) and *Regulatory Guide 1.109, Revision 1* (NRC 1977). These models are those used in the TVA FES, and are based on the *International Commission of Radiological Protection Publication 2.* Transfer coefficients, consumption rates, and bioaccumulation factors used are those presented in the documents listed above, or more recent data, if available. The models and input variable used are those presented in the *WBN Off-Site Dose Calculation Manual,* which was approved by the NRC on July 26, 1994. The estimated gaseous radioactive releases used in the analysis are given in Table 3-20.

Table 3-19 - Receptors from Actual Land Use Survey Results Used for Potential Gaseous Releases From WBN Unit 2

Receptor Number	Receptor Type	Sector	Distance (meters)
1.	Nearest Resident	N	2134
2.	Nearest Resident	NNE	3600
3.	Nearest Resident	NE	3353
4.	Nearest Resident	ENE	2414
5.	Nearest Resident	E	3268
6.	Nearest Resident	ESE	4416
7.	Nearest Resident	SE	1372
8.	Nearest Resident	SSE	1524
9.	Nearest Resident	S	1585
10.	Nearest Resident	SSW	1979
11.	Nearest Resident	SW	4230
12.	Nearest Resident	WSW	1829
13.	Nearest Resident	W	2896
14.	Nearest Resident	WNW	1646
15.	Nearest Resident	NW	2061
16.	Nearest Resident	NNW	4389
17.	Nearest Garden	N	7664
18.	Nearest Garden	NNE	6173
19.	Nearest Garden	NE	3353
20.	Nearest Garden	ENE	4927
21.	Nearest Garden	E	6372
22.	Nearest Garden	ESE	4758
23.	Nearest Garden	SE	4633
24.	Nearest Garden	SSE	7454
25.	Nearest Garden	S	2254
26.	Nearest Garden	SSW	1979
27.	Nearest Garden	SW	8100
28.	Nearest Garden	WSW	4667
29.	Nearest Garden	W	5120
30.	Nearest Garden	WNW	5909
31.	Nearest Garden	NW	3170
32.	Nearest Garden	NNW	4602
33.	Milk Cow	ESE	6706
34.	Milk Cow	SSW	2286
35.	Milk Cow	SSW	3353

Table 3-20 - WBN Total annual Gaseous discharge Per Operating Unit (curies/year/reactor)

Nuclide	Containment Building	Auxiliary Building	Turbine Building	Total
Kr-85m	3.72E+00	4.53E+00	1.23E+00	9.48E+00
Kr-85	6.69E+02	7.05E+00	1.86E+00	6.78E+02
Kr-87	4.48E-01	4.27E+00	1.09E+00	5.81E+00
Kr-88	3.10E+00	7.95E+00	2.13E+00	1.32E+01
Xe-131m	1.07E+03	1.73E+01	4.53E+00	1.09E+03
Xe-133m	4.07E+01	1.90E+00	5.21E-01	4.31E+01
Xe-133	2.82E+03	6.70E+01	1.77E+01	2.90E+03
Xe-135m	2.26E-02	3.68E+00	9.80E-01	4.68E+00
Xe-135	5.83E+01	2.40E+01	6.46E+01	8.88E+01
Xe-137	3.76E-04	9.67E-01	2.58E-01	1.23E+00
Xe-138	1.69E-02	3.42E+00	9.06E-01	4.34E+00
Ar-41	3.40E+01	0.00E+00	0.00E+00	3.40E+01
Br-84	8.16E-07	5.02E-02	4.81E-04	5.07E-02
I-131	6.74E-03	1.39E-01	7.08E-03	1.53E-01
I-132	1.36E-04	6.56E-01	1.70E-02	6.73E-01
I-133	2.36E-03	4.35E-01	2.03E-02	4.57E-01
I-134	4.26E-05	1.06E+00	1.47E-02	1.07E+00
I-135	8.80E-04	8.10E-01	3.13E-02	8.42E-01
H-3	1.39E+02	0.00E+00	0.00E+00	1.39E+02
H-3 (TPC)	3.70E+02	0.00E+00	0.00E+00	3.70E+02
Cr-51	9.21E-05	5.00E-04	0.00E+00	5.92E-04
Mn-54	5.30E-05	3.78E-04	0.00E+00	4.31E-04
Co-57	8.20E-06	0.00E+00	0.00E+00	8.20E-06
Co-58	2.50E-04	2.29E-02	0.00E+00	2.32E-02
Co-60	2.61E-05	8.71E-03	0.00E+00	8.74E-03
Fe-59	2.70E-05	5.00E-05	0.00E+00	7.70E-05
Sr-89	1.30E-04	2.85E-03	0.00E+00	2.98E-03
Sr-90	5.22E-05	1.09E-03	0.00E+00	1.14E-03
Zr-95	4.80E-08	1.00E-03	0.00E+00	1.00E-03
Nb-95	1.80E-05	2.43E-03	0.00E+00	2.45E-03
Ru-103	1.60E-05	6.10E-05	0.00E+00	7.70E-05
Ru-106	2.70E-08	7.50E-05	0.00E+00	7.50E-05
Sb-125	0.00E+00	6.09E-05	0.00E+00	6.09E-05
Cs-134	2.53E-05	2.24E-03	0.00E+00	2.27E-03
Cs-136	3.21E-05	4.80E-05	0.00E+00	8.01E-05
Cs-137	5.58E-05	3.42E-03	0.00E+00	3.48E-03
Ba-140	2.30E-07	4.00E-04	0.00E+00	4.00E-04
Ce-141	1.30E-05	2.64E-05	0.00E+00	3.95E-05
C-14	2.80E+00	4.50E+00	0.00E+00	7.30E+00

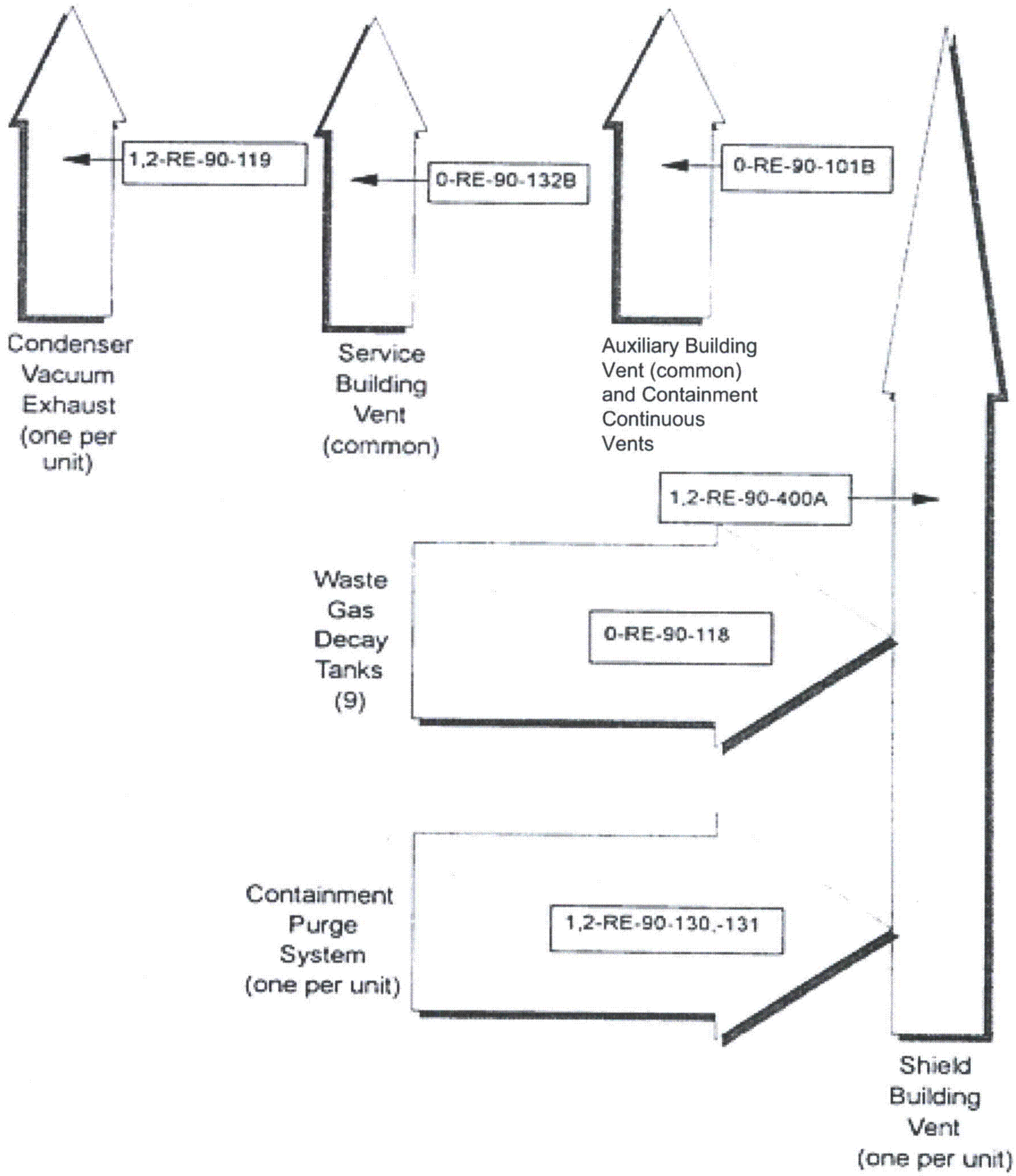


Figure 3-9. Watts Bar Nuclear Plant Gaseous Effluent Release Points

A tabulation of the resulting calculated gaseous doses to individuals per operational unit is given in Table 3-21.

Table 3-21 WBN Doses From Gaseous Effluent for Unit 2 Without Tritium Production for Year 2040

Effluent	Pathway	Guideline*	Location	Dose
Noble Gases	γ Air dose	10 mrad	Maximum Exposed Individual[1]	0.801 mrad/year
	β Air dose	20 mrad	Maximum Exposed Individual[1]	2.710 mrad/year
	Total body	5 mrem	Maximum Residence[2,3]	0.571 mrem/year
Iodines/ Particulate	Skin	15 mrem	Maximum Residence[2,3]	1.540 mrem/year
	Bone (critical organ)	15 mrem	Maximum Real Pathway[4]	9.15 mrem/year

Breakdown of Iodine/Particulate Doses (mrem/yr)

Total Vegetable Ingestion	6.57
Inhalation	0.0704
Ground Contamination	0.0947
Submersion	0.130
Beef Ingestion[5]	2.28
Total	9.145

*Guidelines are defined in Appendix I to 10 CFR Part 50.
[1]Maximum exposure point is at 1250 meters in the ESE sector.
[2]Dose from air submersion.
[3]Maximum exposed residence is at 1372 meters in the SE sector.
[4]Maximum exposed individual is a child at 1979 meters in the SSW sector.
[5]Maximum dose location for all receptors is 1250 meters in the ESE Sector.

The estimated annual airborne releases and resulting doses as presented by the 1972 FES, the WBN Unit 1 FSAR, Unit 2, Unit 1 and 2 totals, and recent historical data from WBN Unit 1 (as submitted in the Annual Radioactive Effluent Reports to the NRC) with NRC guidelines given in 10 CFR 50 Appendix I are compared in Table 3-22. These guidelines are designed to assure that releases of radioactive material from nuclear power reactors to unrestricted areas during normal conditions, including expected occurrences, are kept as low as practicable.

Table 3-22 - Comparison of Estimated Annual Airborne Releases and Resulting Doses

	1972 (Table 2.4-2)	Unit 1 FSAR	Unit 2 Evaluation	Units 1 & 2 Combined	Unit 1 10-year Operational Average	10CFR50 Appendix I Guidelines per Unit
Particulate Activity (Ci[1])	3.00E-01	4.71E-01	4.71E-01	9.42E-01	9.29E-05	10
Noble Gas Activity (Ci[1])	7.00E+03	4.84E+03	4.84E+03	9.68E+03	2.70E-03	N/A[2]
External Dose (mrad[3])	6.60E+00	2.71E+00	3.50E+00	6.21E+00	3.69E-01	10
Organ Dose (mrem[4])	3.50E+00 (inhalation and milk only)	9.41E+00 (all pathways)	9.15E+00 (all pathways)	1.86E+01 (all pathways)	8.30E-02 (all pathways)	15

[1] Ci = Curies
[2] N/A = Not Applicable
[3] mrad = millirad
[4] mrem = millirem

Two conclusions can be drawn from the data in Table 3-20:

- The Unit 2 FSAR estimates, even though based on very conservative (worst-case) assumptions, indicate that estimated doses continue to meet the per unit dose guidelines given in 10 CFR Part 50, Appendix I.

- Historical WBN operational data for airborne effluents indicate that actual releases and resulting dose estimates (external and organ) to the public are a small fraction of the Appendix I guideline (averaging about 1 percent or less).

Based on these conclusions, the analyses of radiological impact from airborne release in the 1972 FES continue to be valid, and operation of WBN Unit 2 would not materially change the results.

Population Doses
TVA has estimated the radiological impact from the normal operation of WBN Unit 2 using a 50-mile regional population projection for the year 2040 of 1,523,385. The estimated population doses are presented by the 1972 FES, the WBN Unit 1 FSAR, Unit 2, Unit 1 and Unit 2 totals, and recent historical data from WBN (as submitted in the annual radioactive Effluent Reports to the NRC) are presented in Table 3-23.

Table 3-23 - Estimated Population Doses From Operation of Watts Bar Nuclear Plant

1972 (Table 2.4-4)	Unit 1 FSAR	Unit 2 Evaluation	Units 1 & 2 Combined	Unit 1 10-year Operational Average	10 CFR 50 Appendix I Guidelines
3.10E+01	4.35E+00	6.66E+01	1.10E+01	3.38E-01	N/A

Releases to Sanitary Sewers

Releases to sanitary sewage systems from WBN would continue to be sampled for radioactivity. Any identified radioactivity will be evaluated for its source. If the source of the radioactivity is determined to be from plant operation, the sewage would not be released to the sewer system, but will be treated as radioactive waste.

3.14. Radioactive Waste

The 1995 FSER described changes in plans for the radioactive water treatment systems, which had occurred since the 1970s (TVA 1995b). Many of the systems described in that document were based on TVA's experience from SQN, which are comparable to the systems in use at WBN Unit 1. The updates in this section are based on TVA's operating experience at WBN Unit 1. Since hazardous waste handling equipment is either shared between units or would be similar, the processing of radioactive waste produced by the operation of Unit 2 would be performed in the same manner as Unit 1. Only minor changes have been made to the radioactive waste treatment system at WBN Unit 1 since 1995, and these changes do not alter the conclusions previously reached.

Liquid Radioactive Waste Treatment Systems

The 1995 FSER discussed attributes such as separation and processing of tritiated and nontritiated liquids, laboratory sample processing, and processing of waste from regeneration of condensate polishing demineralizer and spent resin. Since 1995, the boric acid evaporators and condensate demineralizer waste evaporator (CDWE) system have been deactivated and the functions have been replaced with the mobile waste demineralizer system described in the 1995 FSER. These changes are shown in Figure 3-10 for tritiated water and Figure 3-11 for nontritiated water (revised from Figure 4-1, TVA 1995b). The conclusion in the FSER that any releases from these systems would meet the requirements of the NPDES permit, 10 CFR 20, Appendix B; 10 CFR 50, Appendix I; and 40 CFR 190, as applicable, remain valid, and operation of WBN Unit 2 would not change this conclusion.

Gaseous Radioactive Waste Treatment Systems

The gaseous waste processing system is designed to remove fission product gases from the nuclear steam supply system and to permit operation with periodic discharges of small quantities of fission gasses through the monitored plant vent. No changes to equipment or operation have occurred and, therefore, the conclusions remain valid.

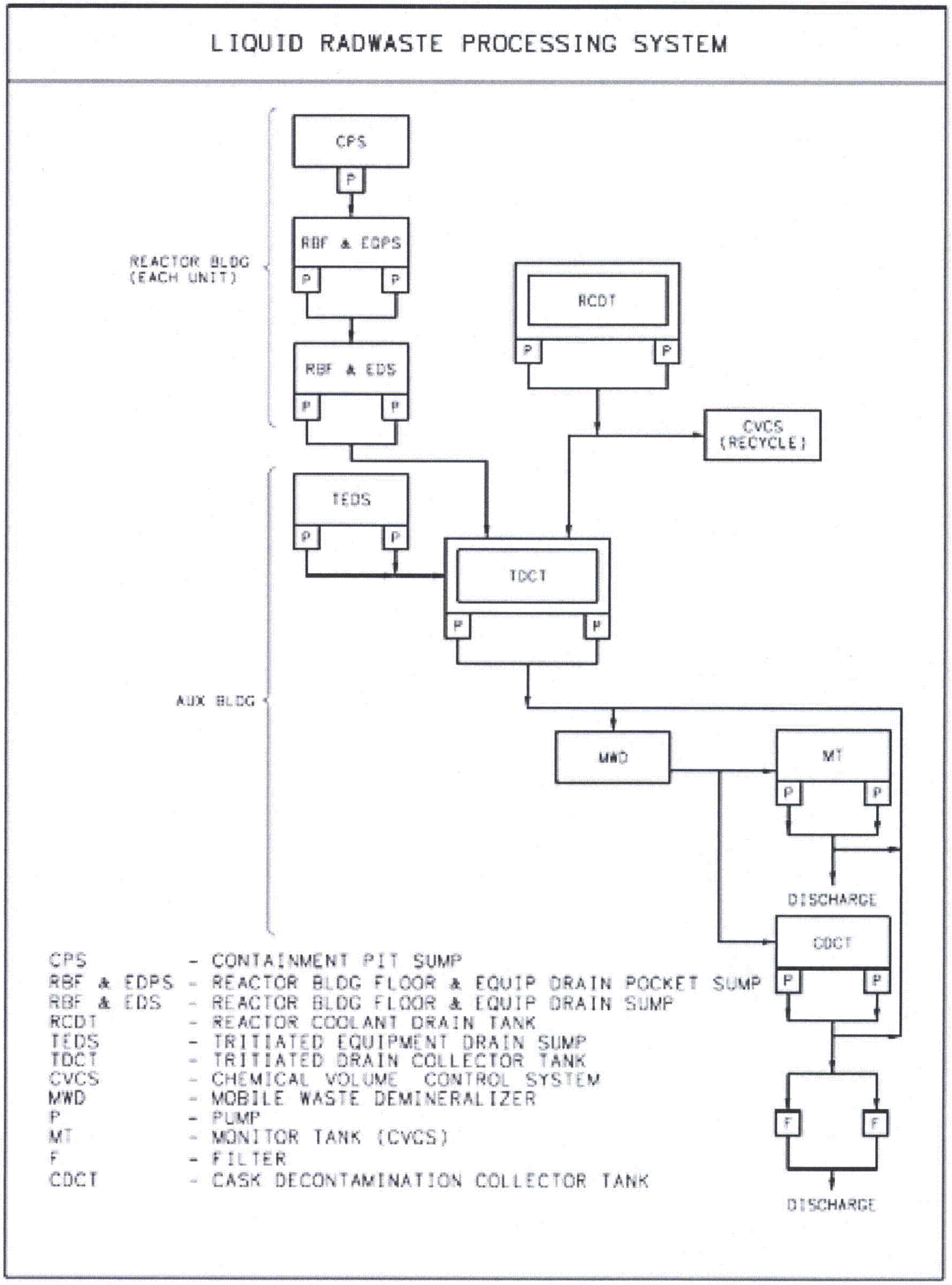


Figure 3-10. Liquid Radwaste Processing System – Simplified Flow Diagram for Tritiated Water

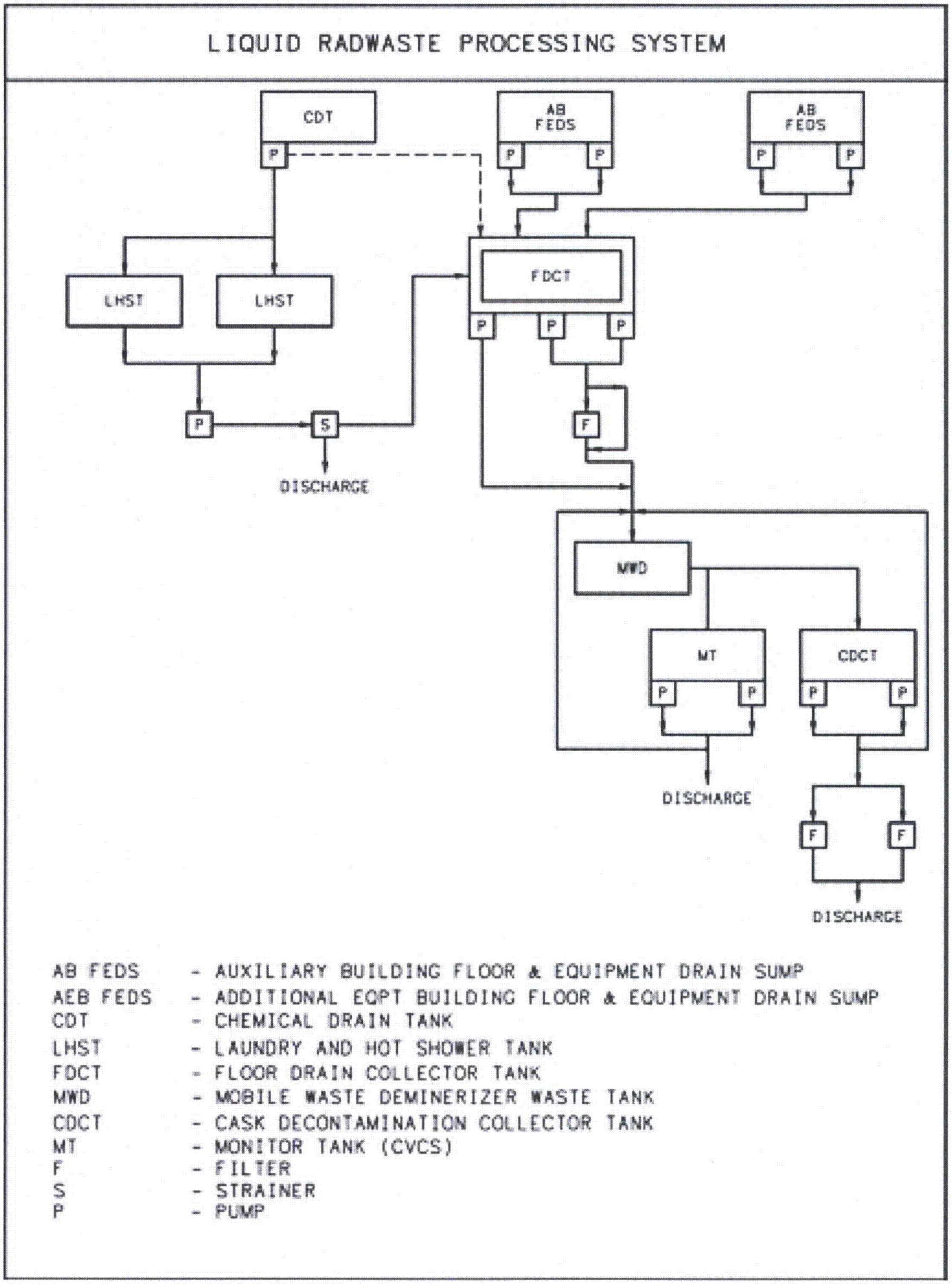


Figure 3-11. Liquid Radwaste Processing System – Simplified Flow Diagram for Nontritiated Water

Solid Radioactive Wastes
Radioactive waste (radwaste) generated from the operation of WBN Unit 2 would be handled in the same manner as radwaste from Unit 1. The solid radwaste disposal system (SRDS) processes and packages the dry and wet solid radioactive waste produced through power generation for off site shipment and disposal. The dry active waste (DAW) consists of compactable and noncompactable material. Compactable material includes paper, rags, plastic, mop heads, discarded clothing, and rubber boots. Noncompactable wastes include tools, pumps, motors, valves, piping, and other large radioactive components. The wet active wastes (WAW) consist of spent resins and filters. Radwaste is classified as either A, B, or C, with Class A being the least hazardous and Class C being the most hazardous. Class A includes both DAW and WAW. Classes B and C are normally WAW. The SRDS is a shared system between Units 1 and 2. The sharing does not inhibit the safe shutdown of one unit while the other unit is experiencing an accident. Some minor changes to the SRDS have occurred since 1995.

The 1995 FSER discusses solidification of resins and evaporator concentrates using cement and vermiculite. Evaporator concentrates are no longer generated at WBN due to the deactivation of the CDWE (see Liquid Radioactive Waste Treatment Systems, above). Handling of resins has not changed.

In 1995, TVA planned to send low-level radwaste to Barnwell, South Carolina, until a new disposal facility at Wake County, North Carolina, opened in mid-1998. This facility was not constructed. TVA has continued to ship all WAW (Classes A, B, and C) to the Barnwell facility and will do so through 2008 when that facility is scheduled to close. All DAW is currently shipped to a processor in Oak Ridge, Tennessee, for compaction and then by the processor to Clive, Utah, for disposal. Following 2008, Class A WAW will also be shipped to Clive, Utah. Class B and C waste will be shipped either to SQN, which is licensed to receive and store low–level radwaste from WBN, or to another licensed Class B and C radwaste disposal facility. WBN also has the option of compacting DAW on site. The shipping distances to these facilities are comparable or shorter than those analyzed in previous environmental reviews.

Transportation of Solid Waste
In the 1995 FSER, TVA used records documenting radioactive effluents and the results of off-site radiological monitoring at SQN to confirm the 1972 FES conclusion that insignificant environmental risk would result from the transportation of low-level waste to off-site disposal grounds is still valid. The exposures in Table 4-1 of the 1972 FSER were calculated from an estimated 43 shipments and 15,119 cubic feet of waste from SQN. WBN now has over 10 years of radwaste shipment records. During a one-year period ranging from May 2005-May 2006, there were eight shipments from WBN, for a total of 5120 cubic feet of waste. The addition of a second unit at WBN would result in a total of 16 shipments per year and 11,060 cubic feet of waste (Table 3-24). These figures represent 37.2 percent and 73.1 percent of the values presented in the 1995 FSER, and therefore, it can be expected that exposures to the truck driver and to the public would also range from 37.2 percent and 73.1 percent of the exposure estimated in the 1995 FSER. The 1995 FSER confirmed the conclusion in the 1972 FES that the environmental risk from transportation of low-level waste to off-site disposal grounds would be insignificant. Given that the number and size of shipments per year are less than previously projected, this conclusion is not changed.

Table 3-24. Maximum Anticipated Two-Unit Annual Solid Radwaste to be Processed

Waste Type	Volume (cubic feet)
Spent Resins and Filter Sludges	720
Filter Cartridges	240
Compactable and Noncompactable Trash	10,000
Contaminated Oil	100
Total	**11,060**

3.15. Spent Fuel Storage

The 1972 FES assumed that spent fuel would be shipped to the reprocessing plant in Barnwell, South Carolina. The 1993 review of the FES noted that reprocessing was no longer likely, and that TVA then "expected to store spent fuel on-site until the DOE completed the construction of storage or permanent disposal facilities in accordance with the Nuclear Waste Policy Act of 1982" (TVA 1993a). The revised plan was for TVA to provide additional storage capacity on site, if needed, until a licensed DOE facility became available. On-site storage of spent fuel was mentioned in the 1995 FES, but not in the 1995 FSER.

The need to expand on-site spent fuel storage at TVA nuclear plants was addressed when DOE prepared the CLWR FEIS (DOE 1999). This FEIS analyzed spent fuel storage needs at BFN Units 1, 2, and 3, SQN Units 1 and 2, and WBN Unit 1 and included a thorough review of the environmental effects of constructing and operating an on-site independent spent fuels storage installation (ISFSI). The present FSEIS incorporates by reference the spent fuel storage impact analysis in the CLWR FEIS and updates the analysis to include operation of WBN Unit 2.

Operation of a second unit at Watts Bar would increase the number of spent fuel assemblies generated at the site. For the purpose of this FSEIS, it is assumed that the additional spent fuel generated by the operation of a second unit would be accommodated at the site in a dry cask ISFSI. This generic ISFSI would be designed to store the number of additional spent nuclear fuel assemblies required for 40-year, two-unit operation at the reactor site. The additional fuel generated by the operation of Unit 2 would accelerate the schedule for on-site dry cask spent fuel storage expansion at WBN. To date, no ISFSI has been constructed at WBN. Under the current schedule for Unit 1, an ISFSI would be needed by 2018. Assuming WBN Unit 2 would begin operation in 2012, the ISFSI would be needed by 2015.

The CLWR FEIS assessed the number of dry storage casks needed to accommodate tritium production at WBN Unit 1 based on 24-pressurized water reactor spent nuclear fuel assembly capacity of four of the ISFSI cask designs in the United States at the time. Table 3-25 below updates Table 5-48 in the CLWR FEIS for WBN Unit 1 and adds data for Unit 2 to provide an estimated total number of casks that would be needed for 40 years of operation if WBN Unit 2 were completed. Although SQN has received licensing approval to use casks that can contain 32 spent fuel assemblies, this evaluation uses the more conservative 24-fuel assembly cask design capacity. Note that the data for WBN Unit 2 reflects the difference between a unit producing tritium (Unit 1) and one that would not produce tritium (Unit 2).

Table 3-25. Data for Number of ISFSI Casks Determination

Data Parameter	WBN Unit 1	WBN Unit 2
Operating cycle length	18 months	18 months
Fresh fuel assemblies per cycle – no tritium	80	80
Fresh fuel assemblies per cycle – maximum tritium	136	N/A
Increase in fresh fuel assemblies due to tritium	56	N/A
Number of operating cycles in 40 years[1]	27	27
Number of additional fuel assemblies for tritium	1512	N/A
Number of ISFSI dry casks needed to store fuel assemblies due to tritium production activities	63	0
Number of fuel assemblies for 40 year operation	2160	2160
Number of ISFSI dry casks needed to store fuel assemblies for spent fuel pool (SFP) capacity shortfall, [2 3]	27	90
Number of ISFSI dry casks needed to store fuel for each unit. [b]	90	90
Total number of ISFSI dry casks required for WBN site, two-unit operation	**180**	

[1] Forty years of operation covers 26 refueling outages and 27 operating cycles. Spent fuel is discharged 27 times from each unit.
[2] Number is based on 24 fuel assembly cask designs.
[3] SFP capacity shortfall is based on existing SFP usable capacity of 1363 storage cells. The number of casks tabulated above for Unit 1 SFP capacity shortfall has been reduced from level projected in the CLWR FEIS to reflect actual tritium generation rates of fuel assemblies being less than originally estimated (56).

A number of ISFSI dry storage designs have been licensed by the NRC and are in operation in the United States, including facilities at TVA's SQN and BFN. Licensed designs include the metal casks and concrete casks. The majority of these operating ISFSIs use concrete casks. Concrete casks consist of either a vertical or a horizontal concrete structure housing a basket and metal cask that confines the spent nuclear fuel. Currently, there are three vendors with concrete pressurized water reactor spent nuclear fuel dry cask designs licensed in the United States, Holtec International, NAC International, and Transnuclear Inc. The Holtec International and NAC International designs are vertical concrete cylinders; whereas, the Transnuclear design is a rectangular concrete block. These designs store varying numbers of spent nuclear fuel assemblies, ranging from 24 to 37. However, since the Holtec design is currently being used at TVA's SQN and is representative of all other designs, the environmental impact of using the Holtec concrete dry storage ISFSI design has been addressed. As stated above, although the multipurpose canister (MPC)-32 is being used at SQN, this update has taken a more conservative approach using the MPC-24, since it would require more casks and correspondingly more concrete and steel.

The environmental analysis of spent fuel storage in the CLWR FEIS, which focused on dry storage casks, is still valid. The following sections update information about the equipment vendors and processes currently used at WBN and provide analysis of the effects of completing WBN Unit 2 on spent fuel storage construction and operation.

3.15.1. Construction Impacts

The CLWR FEIS describes a NUHOMS-24P horizontal spent fuel storage module. Currently, HI-STORM vertical storage modules are used at SQN. For the purposes of this analysis, it is assumed that the same type of storage modules would be used at WBN. The modules used at SQN consist of cylindrical structure with inner and outer steel shells filled with concrete. The stainless steel MPC that contains the spent fuel assemblies is placed inside the vertical storage module. The MPC is fabricated off site.

The spent fuel storage site described for WBN Unit 1 in the CLWR FEIS was proposed to contain 63 spent nuclear fuel casks (see Table 3-25). Using the SQN ISFSI as a basis for calculating an appropriately sized pad, an area of approximately 55,800 square feet would be needed to store the 180 casks required to support a two-unit operation at WBN for 40 years. Assuming a proportionate ratio of area required for construction disturbance, nuisance fencing, and transport activities, a projected net disturbed area of approximately 2.2 acres would be required. The differences between constructions of an ISFSI for Unit 1 alone as compared to an ISFSI that would serve two units are shown in Table 3-26. Construction and installation of the HI-STORM modules would be similar to that described in the CLWR FEIS for the NUHOMS-24P, as would be the environmental effects. There is ample room at the WBN site to locate a storage facility.

Table 3-26. ISFSI Construction for Watts Bar Nuclear Plant Unit 1 as Compared to Construction of Both Units 1 and 2

Environmental Parameter	Unit 1 (from 1999 CLWR FEIS)	Units 1& 2
External appearance	63 Horizontal storage modules Rectangular cubes 19 x 9.7 feet constructed on three concrete cask foundation pads approximately 116.4 x 38 feet	180 Vertical cylindrical storage modules (casks) placed on a concrete cask foundation pad of an approximate area of 55,800 square feet and 2 feet thick. Each cask would be a nominal 12 feet in diameter and 21 feet tall.
Health and safety (only construction work performed subsequent to the loading of any storage modules with spent fuel may result in worker exposures from direct and skyshine radiation in the vicinity of the loaded horizontal storage modules)	Dose rate: 0.5 mrem per hour[1] Total dose during construction: 47.25 person-rem	Dose Rate: 0.5 mrem per hour[1] Total dose during construction: 135 person-rem
Size of disturbed area	ISFSI footprint: 1.3 acres Disturbed: 5.3 acres	ISFSI footprint: 1.3 acres Disturbed: 2.2 acres
Materials (approximate)	Concrete: 10,618 tons Steel: 1,208 tons	Concrete: 27,675 tons Steel: 3150 tons

[1]DOE 1999

3.15.2. Operational Impacts

The NUHOMS horizontal storage module dry cask system described in the CLWR FEIS was designed and licensed to remove up to 24 kilowatts (kW) of decay heat safely from spent fuel by natural air convection. The Holtec HI-STORM dry cask storage system currently in use at SQN is licensed to remove up to 28 kW of decay heat safely. Conservative calculations have shown that, for 24 kW of decay heat, air entering the cask at a temperature of 70°F would be heated to a temperature of 161°F. For a 28-kW maximum heat load, and assuming similar air mass flow rate through the cooling vents, the resulting temperature would be approximately 176°F. The environmental impact of the discharge of this amount of heat can be compared to the heat (336 kW) emitted to the atmosphere by an automobile with a 150–brake horsepower engine (Bosch 1976). The heat released by an average automobile is the equivalent of as few as 12 ISFSI casks at their design maximum heat load of 28 kW. Therefore, the decay heat released to the atmosphere from the spent nuclear fuel ISFSI is equivalent to the heat released to the atmosphere from approximately 15 average cars.

SQN has proposed and the NRC is reviewing the use of storage casks with a licensed maximum heat load of up to 40 kW. The use of this higher allowable maximum heat load cask would result in an increase from the values reported in the paragraph above. For example, for a 40 kW maximum heat load, and assuming similar air mass flow rate through the cooling vents results in a projected temperature of approximately 221°F. The heat released by an average automobile is the equivalent of as few as nine ISFSI casks at their proposed higher design maximum heat load of 40 kW. The decay heat released to the atmosphere from the spent nuclear fuel ISFSI would be equivalent to the heat released to the atmosphere from approximately 20 average cars. If approved, this type of cask could be used at WBN.

The CLWR FEIS concluded that the heat emitted from the WBN ISFSI would have no effect on the environment or climate because of its small magnitude. Although an ISFSI large enough to accommodate two-unit spent fuel storage would emit somewhat more heat, the amount is still negligible. The heat emitted by the fully loaded, largest projected ISFSI, even at the maximum design-licensed decay heat level for each cask of 28 kW, would be approximately 5000 kW (i.e., 180 casks × 28 kW = 5040 kW or 5.04 MW), as compared to 2000 kW for the system analyzed in 1999. This increase of 3000 kW of heat added to the atmosphere is not large enough to change the conclusion that this amount of heat is about 0.1 percent the heat released to the environment from any of the proposed nuclear power plants—on the order of 2,400,000 kW for each operating nuclear reactor. The actual decay heat from spent nuclear fuel in the ISFSI should be lower than 5000 kW and would decay with time due to the natural decay of fission products in the spent nuclear fuel. As stated in the CLWR FEIS, the incremental loading of the ISFSI over a 40-year period would not generate the full ISFSI heat until 40 years after the initial operation.

The proposed use of casks with higher allowable maximum heat load (40 kW) would result in an increase from the values reported above. For example, for a 40-kW maximum heat load, a site total of 7200 kW would represent about 0.15 percent of the heat released to the environment from any of the proposed nuclear power plants. Therefore, for the proposed 40-kW cask design, no noticeable effects on the environment or climate would be expected.

The differences between the operation of an ISFSI for Unit 1 alone as compared to an ISFSI that would serve two units are shown in Table 3-27. TVA has concluded that due to the small magnitude of the total potential dose, the radiation dose to workers from ISFSI operation would be minor. In general, the operational effects of the HI-STORM modules would be similar to that described in the CLWR FEIS for the NUHOMS-24P, as would be the environmental effects.

Table 3-27. ISFSI Operation for Watts Bar Nuclear Plant Unit 1 as Compared to Operation of Both Units 1 and 2

Environmental Parameter	Unit 1 (from CLWR FEIS)	Units 1 and 2
Effects of operation of the heat dissipation system	Equivalent to heat emitted into the atmosphere by approximately 2-6 averaged-sized cars.	Equivalent to heat emitted into the atmosphere by approximately 15 average size cars, or 20 cars if the higher maximum heat load cask proposed at SQN is used.
Facility water use	Transfer cask decontamination water consumption of less than 946 cubic feet.	Transfer cask decontamination water consumption of less than 2703 cubic feet.
Radiological impact from routine operation	Worker exposure: As the result of daily inspection of casks, during a 40-year life cycle, workers would be exposed to 58.8 person-rem. Public exposure: The regulatory limit for public exposure is 25 mrem per year. Doses received by a member of the public living in the vicinity of the ISFSI would be well below the regulatory requirements.	Worker exposure: As the result of daily inspection of casks, during a 40-year life cycle, workers would be exposed to 168 person-rem. Public exposure: The regulatory limit for public exposure is 25 mrem per year. Doses received by a member of the public living in the vicinity of the ISFSI would be well below the regulatory requirements.
Radwaste and source terms	Cask loading and decontamination operation generates less than 126 cubic feet of low-level radioactive waste.	Cask loading and decontamination operation generates less than 360 cubic feet of low-level radioactive waste.
Climatological impact	Small (less than 0.1 percent of the nuclear power plant's heat emission to the atmosphere)	Small (approximately 0.1 percent of the nuclear power plant's heat emission to the atmosphere, or approximately .15 percent if 40 kW cask are used)
Impact of runoff from operation	The horizontal storage module surface is not contaminated. No contaminated runoff is expected.	The storage cask surface is not contaminated. No contaminated runoff is expected.

3.15.3. Postulated Accidents

The CLWR FEIS analyzed the postulated accidents that could occur at an ISFSI and concluded that the potential radiological releases would all be well within regulatory limits. The impact of the calculated doses, which were approximately 50 mrem or less for different scenarios, were compared with the natural radiation dose of about 300 mrem annually received by each person in the United States (DOE 1999). The storage casks proposed for use at WBN for a two-unit operation would be of similar or better design than those analyzed in the mid-1990s, and any accident doses resulting from such a postulated event would be consistent with doses previously determined.

3.16. Transportation of Radioactive Materials

The effects of transporting nuclear fuels and radioactive wastes are addressed in the 1972 FES. The 1995 FSER addressed the transportation of spent fuels and radioactive waste. The transportation of radioactive waste and spent fuel are addressed briefly in Section 3.14 and 3.15 of this document. The 1972 FES analysis was based on the annual shipment of about 100 tons of natural uranium. Analysis was based on 30 years of plant operation with annual refueling. As the FES explained, relatively low levels of radiation are emitted from unirradiated new fuel assemblies. Therefore, the only exposure to people from the routine shipment of new fuel would be in direct view and to the individual truck drivers assigned. The exposure in the cab of the fuel transport truck was estimated to be 0.1 mrem per hour, and exposure to transportation personnel was estimated to be less than 1 mrem per shipment. This level would not cause any adverse effects. The FES also discussed accident potential, concluding that there would be no significant environmental risks from radiation resulting from an accident involving a shipment of new fuel (TVA 1972).

In the review of the FES, TVA concluded that the analysis of new fuel shipments in the 1972 FES was still valid at that time (TVA 1993a). When TVA applied for an operating license for WBN Unit 1, plans were for 40 years of operations, with refueling to occur every 18 months. The 1995 NRC FES stated that the proposed changes would result in a slight reduction in fuel usage as compared to the original application and that the changes would not alter the conclusion that the dose and potential health effects would be small compared to the effects of natural radiation doses (NRC 1995a).

Currently, 54 tons of new fuel is shipped annually to WBN Unit 1. If WBN Unit 2 were completed, for two-unit operation, there would be four reloads in three years, which would work out to 107 tons shipped annually. The 1972 FES indicated that fuel would most likely be shipped by truck, although transport by barge or rail was also considered. An estimated 10 shipments per year were expected, with up to seven shipping containers per load, each containing two fuel assemblies or a maximum of 14 assemblies per truck shipment. The FES discussed six shipping routes. Currently, TVA receives seven shipments per reload with a maximum number of assemblies per truck of 12, packed in six shipping containers. Westinghouse is developing new shipping containers and will only be able to ship 10 assemblies per truck in 10 shipping containers. They expect to be required to start using the new containers in 2009.

The *Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Plants* (AEC 1972) and *Supplement 1* (NRC 1975) evaluated the environmental effects of transportation of fuel and waste for light water reactors and found the impacts to be small. These analyses provided the basis for Table S-4 in 10 CFR 51.52, which summarizes the environmental impacts of transportation of fuel and radioactive wastes to and from a reference reactor. Both normal conditions of transport and accidents are addressed in the table.

Subparagraph 10 CFR 51.52(a)(5) requires that unirradiated fuel be shipped to the reactor site by truck. A condition that the truck shipments not exceed 73,000 pounds as governed by federal or state gross vehicle weight restrictions is included in Table S-4. New fuel assemblies would be transported to WBN Units 1 and 2 by truck from a fuel fabrication facility, in accordance with U.S. Department of Transportation and NRC regulations. The initial fuel loading for Unit 2 would consist of 193 fuel assemblies. Every 18 months, refueling would require an average of 80 fuel assemblies. The fuel assemblies, which are fabricated at a fuel fabrication plant, would be shipped by truck to WBN shortly before they are required. Truck shipments would not exceed the applicable federal or state gross vehicle weight.

If WBN Unit 2 were completed, TVA would comply with all NRC, state, and federal requirements for transport of unirradiated fuel, as it does with fuel deliveries for Unit 1. The impacts of such deliveries on human health and the environment are expected to be minimal.

3.17. Decommissioning

Post-operational impact considerations were addressed in the 1972 FES (TVA 1972) under short-term versus long-term productivity and irreversible and irretrievable commitment of resources. Decommissioning is also addressed in the 1995 NRC FES (NRC 1995a) and TVA's 1995 FSER (TVA 1995b). As these documents explain, at the end of the operating life of the WBN units, TVA would seek the termination of its operating license from NRC. Termination requires that the units be decommissioned, a process that ensures the units are safely removed from service and the site made safe for unrestricted use. Consistent with the 1995 FSER, TVA is not proposing a decommissioning plan now. A decommissioning plan would be developed for approval by NRC, with appropriate environmental reviews, when TVA applies for decommissioning of these units in the future.

Methods

The three NRC-approved methods of decommissioning nuclear power facilities described in the 1995 FSER are still viable alternatives. These are:

1. **DECON**. The DECON option calls for the prompt removal of radioactive material at the end of the plant life. Under DECON, all fuel assemblies, nuclear source material, radioactive fission and corrosion products, and all other radioactive and contaminated materials above NRC-restricted release levels are removed from the plant. The reactor pressure vessel and internals would be removed along with removal and demolition of the remaining systems, structures, and components with contamination control employed as required. This is the most expensive of the three options.

2. **SAFSTOR**. SAFSTOR is a deferred decontamination strategy that takes advantage of the natural dissipation of almost all of the radiation. After all fuel assemblies, nuclear source material, radioactive liquid, and solid wastes are removed from the plant, the remaining physical structure would then be secured and mothballed. Monitoring systems would be used throughout the dormancy period and a full-time security force would be maintained. The facility would be decontaminated to NRC-unrestricted release levels after a period of up to 60 years, and the site would be released for unrestricted use. Although this option makes the site unavailable for alternate uses for an extended period, worker and public doses would be much smaller than under DECON, as would the need for radioactive waste disposal.

3. **ENTOMB.** As the name implies, this method involves encasing all radioactive materials on site rather than removing them. Under ENTOMB, radioactive structures, systems, and components are encased in a structurally long-lived substance, such as concrete. The entombed structure is appropriately maintained and monitored until radioactivity decays to a level that permits termination of the license. This option reduces worker and public doses, but because most power reactors will have radionuclides in concentrations exceeding the limits for unrestricted use even after 100 years, this option may not be feasible under current regulation.

It is expected that by the time WBN is decommissioned, new, improved technologies, including use of robotics, will have been developed and approved by NRC.

Cost

In 1995, NRC estimated that it would cost up to $200 million to decommission a pressurized water reactor like WBN Units 1 and 2. NRC currently estimates that decommissioning would cost up to $366 million in today's dollars. TVA maintains a nuclear decommissioning trust to provide money for the ultimate decommissioning of its nuclear power plants. The fund is invested in securities generally designed to achieve a return in line with overall equity market performance. In June 1994, this fund had accumulated $50 million. Since then, funds have been accumulated to cover the cost of decommissioning TVA's operating nuclear units. The assets of the decommissioning trust fund as of December 31, 2006, totaled $1004 million. This balance is greater than the present value of the estimated future nuclear decommissioning costs for TVA's operating nuclear units. The present value is calculated by escalating the decommissioning cost in today's dollars by 4 percent per year through decommissioning. This liability is then discounted at a 5 percent real rate of return. This equates into an estimated decommissioning liability present value of $699 million at calendar year end 2006. TVA monitors the assets of its nuclear decommissioning trust versus the present value of its liabilities and believes that, over the long term and before cessation of nuclear plant operations and commencement of decommissioning activities, adequate funds from investments will be available to support decommissioning.

At the time WBN Unit 2 commences operation, TVA would create a separate trust account for the unit within the decommissioning trust fund and would make any necessary contributions to the fund to cover the costs of future decommissioning.

Potential Impacts to the Environment

Environmental issues associated with decommissioning were analyzed in the *Generic Environmental Impact Statement for Licensing of Nuclear Power Plants*, NUREG–1437 (NRC 1996a; 1999). The generic environmental impact statement included a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues were sorted into two categories. For those issues meeting Category 1 criteria, no additional plant-specific analysis is required by NRC, unless new and significant information is identified. Category 2 issues are those that do not meet one or more of the criteria of Category 1 and therefore require additional plant-specific review. Environmental analysis of the future decommissioning plan for WBN would tier from this or the appropriate NRC document in effect at the time.

TVA has not identified any significant new information during this environmental review that would indicate the potential for decommissioning impacts not previously reviewed. Therefore, TVA does not at this time anticipate any adverse effects from the decommissioning process. As stated earlier, further environmental reviews would be conducted at the time a decommissioning plan for WBN is proposed.

Enclosure 3
Response to FSAR Chapter 11 and FSEIS, Chapter 3
Request For Additional Information

List of Commitments

1. Because TVA will not meet all 10 CFR 50, Appendix I addendum RM 50-2 dose limits for the site, TVA will complete a Cost Benefit Analysis per Regulatory Guide 1.110 by July 29, 2011.

2. TVA also received additional request for information at a public meeting on May 11, 2011, regarding inputs for the dose calculations. This additional information will be provided by May 27, 2011.

3. The proposed FSAR revision (Enclosure 2, Attachment 3) will be included in FSAR Amendment A104.

4. The proposed FSEIS revisions will be issued by June 10, 2011.