Tennessee Valley Authority, 1101 Market Street, LP 5A, Chattanooga, Tennessee 37402-2801

August 1, 2008

10 CFR 52.79

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

In the Matter of) Docket No. 52-014 and 52-015
Tennessee Valley Authority)

BELLEFONTE COMBINED LICENSE APPLICATION – RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION – LIQUID WASTE MANAGEMENT SYSTEM

Reference: Letter from Ravindra G. Joshi, (NRC) to Andrea L. Sterdis (TVA), Request for Additional Information Letter No. 031 Related to SRP Section 11.02 for the Bellefonte Units 3 and 4 Combined License Application, dated June 6, 2008.

This letter provides the Tennessee Valley Authority's (TVA) response to the Nuclear Regulatory Commission's (NRC) request for additional information (RAI) items included in the reference letter.

A response to each NRC request in the subject letter is addressed in the enclosure which also identifies any associated changes that will be made in a future revision of the BLN application.

If you should have any questions, please contact Thomas Spink at 1101 Market Street, LP5A, Chattanooga, Tennessee 37402-2801, by telephone at (423) 751-7062, or via email at tespink@tva.gov.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on this 1ST day of Aug, 2008.

Jack A. Bailey

Jack A. Bailey
Vice President, Nuclear Generation Development

Enclosure
cc: See Page 2

D085
NRO

cc: (Enclosures)

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S. P. Frantz, Morgan Lewis
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Enclosure
TVA letter dated August 1, 2008
RAI Responses

Responses to NRC Request for Additional Information letter No. 031 dated June 6, 2008
(12 pages, including this list)

Subject: Liquid Waste Management System in the Final Safety Analysis

RAI Number	Date of TVA Response
11.02-01	This letter – see following pages
11.02-02	This letter – see following pages
11.02-03	This letter – see following pages
11.02-04	This letter – see following pages

Associated Additional Attachments / Enclosures	Pages Included
Attachment 11.02-02A	3 pages
Attachment 11.02-03A	7 pages
Attachment 11.02-03B	4 pages

Enclosure
TVA letter dated August 1, 2008
RAI Responses

NRC Letter Dated: June 6, 2008

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 11.02-01

FSAR Sections 11.2.3.5.2 and 11.2.5.2 (including BLN COL Item 11.2-2) reference draft NEI Template 07-11 as the basis of the cost-benefit analysis for justifying, in part, the design of the Liquid Waste Management System (LWMS). The NEI template proposed a bounding envelope of population doses associated with liquid effluent releases, which, if met, would demonstrate compliance with ALARA cost benefit requirements of Section II.D of Appendix I to Part 50. However, NEI Template 07-11 was withdrawn from further consideration by NEI. Accordingly, please explain how the applicant intends to develop a plant and site-specific cost-benefit analysis demonstrating compliance with Section II.D of Appendix I to Part 50 with respect to the LWMS, and provide sufficient information for the staff to evaluate the bases and assumptions used in the analysis against the applicable NRC regulations and guidance.

BLN RAI ID: 0420

BLN RESPONSE:

A plant-specific cost-benefit analysis has been developed demonstrating compliance with Section II.D of Appendix I to Part 50 with respect to the LWMS. This cost-benefit analysis replaces use of NEI 07-11; thus, reference to NEI 07-11 will be removed from the FSAR. The total annual costs of the liquid radwaste system augments listed in Regulatory Guide 1.110, Revision 0, were developed using the methodology and parameters provided in the regulatory guide. Conservative values were chosen for parameters not specified in the regulatory guide. The following variable parameters were used:

- Capital Recovery Factor (CRF) – This factor is taken from Table A-6 of Regulatory Guide 1.110 and reflects the cost of money for capital expenditures. A cost-of-money value of 7% per year is assumed in this analysis, consistent with the "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission" (NUREG/BR-0058). A CRF of 0.0806 was obtained from Table A-6.
- Indirect Cost Factor (ICF) – This factor takes into account whether the radwaste system is unitized or shared (in the case of a multi-unit site) and is taken from Table A-5 of Regulatory Guide 1.110. It is assumed that the radwaste system for this analysis is a unitized system at a 2-unit site, which equals an ICF of 1.625.
- Labor Cost Correction Factor (LCCF) – This factor takes into account the differences in relative labor costs between geographical regions and is taken from Table A-4 of Regulatory Guide 1.110. A LCCF of 1.0 (the lowest value) is assumed in this analysis.

The lowest-cost option for liquid radwaste treatment system augments is a 20 gpm Cartridge Filter at $11,140 per year, which yields a threshold value of 11.14 person-rem total body or thyroid dose from liquid effluents.

The population doses are given in revised Table 11.2-204 (Attachment 11.02-03B). As discussed above, the lowest cost liquid radwaste system augment is $11,140. Assuming 100% efficiency of

this augment, the minimum possible cost per person-rem is determined by dividing the cost of the augment by the population dose. This is $6,962 per person-rem total body ($11,140/1.60 person-rem) and $7,901 per person-rem thyroid ($11,140/1.41 person-rem). These costs per person-rem reductions exceed the $1,000 per person-rem criterion prescribed in Appendix I to 10 CFR Part 50 and are therefore not beneficial.

The associated application revisions include items that are both PLANT-SPECIFIC and items that are expected to be STANDARD for the S-COLAs as shown in the Application Revisions section below. The portion of this response which describes the methodology and parameters used to develop the total annual costs of the radwaste system augments is expected to be STANDARD for the S-COLAs. The remaining portions, including the content in the revised tables provided in Attachment 11.02-03B, are PLANT-SPECIFIC.

ASSOCIATED BLN COL APPLICATION REVISIONS:

1. COLA Part 2, FSAR, Chapter 11, Subsection 11.2.3.5.2, will be revised to delete the last paragraph that currently reads (note, this change is expected to be STANDARD for the S-COLAs):

This section adopts NEI 07-11 (Reference 201) which is currently under review by the NRC staff. The application of the methodology of NEI 07-11 satisfies the cost-benefit analysis requirements of 10 CFR Part 50, Appendix I, Section II.D. The augments provided in NEI 07-11 were reviewed and were found not to be cost beneficial due to the low BLN population doses.

2. COLA Part 2, FSAR, Chapter 11, Subsection 11.2.6, Reference 201, reference to NEI 07-11, will be deleted in its entirety (note, this change is expected to be STANDARD for the S-COLAs).

3. COLA Part 2, FSAR, Chapter 11, will be revised to add new Subsection 11.2.3.5.3, that reads (note, this change is expected to be STANDARD for the S-COLAs):

11.2.3.5.3 Liquid Radwaste Cost Benefit Analysis Methodology

STD COL 11.2-2 The application of the methodology of Regulatory Guide 1.110 was used to satisfy the cost benefit analysis requirements of 10 CFR Part 50, Appendix I, Section II.D. The parameters used in calculating the Total Annual Cost (TAC) are fixed and are given for each radwaste treatment system augment listed in Regulatory Guide 1.110, including the Annual Operating Cost (AOC) (Table A-2), Annual Maintenance Cost (AMC) (Table A-3), Direct Cost of Equipment and Materials (DCEM) (Table A-1), and Direct Labor Cost (DLC) (Table A-1). The following variable parameters were used:

- Capital Recovery Factor (CRF) – This factor is taken from Table A-6 of Regulatory Guide 1.110 and reflects the cost of money for capital expenditures. A cost-of-money value of 7% per year is assumed in this analysis, consistent with the "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission" (NUREG/BR-0058). A CRF of 0.0806 was obtained from Table A-6.
- Indirect Cost Factor (ICF) – This factor takes into account whether the radwaste system is unitized or shared (in the case of a multi-unit site) and is taken from Table A-5 of Regulatory Guide 1.110. It is assumed that the radwaste system for this analysis is a unitized system at a 2-unit site, which equals an ICF of 1.625.

- Labor Cost Correction Factor (LCCF) – This factor takes into account the differences in relative labor costs between geographical regions and is taken from Table A-4 of Regulatory Guide 1.110. A LCCF of 1.0 (the lowest value) is assumed in this analysis.

Appendix I to 10 CFR Part 50 prescribes a $1,000 per person-rem criterion for determining the cost benefit of actions to reduce radiation exposure.

The analysis used a conservative assumption that the respective radwaste treatment system augment is a "perfect" system that reduces the effluent and dose by 100%. The liquid radwaste treatment system augments annual costs were determined and the lowest annual cost considered a threshold value. The lowest-cost option for liquid radwaste treatment system augments is a 20 gpm Cartridge Filter at $11,140 per year, which yields a threshold value of 11.14 person-rem total body or thyroid dose from liquid effluents.

For AP1000 sites with population dose estimates less than 11.14 person-rem total body or thyroid dose from liquid effluents, no further cost-benefit analysis is needed to demonstrate compliance with 10 CFR 50, Appendix I Section II.D.

4. COLA Part 2, FSAR, Chapter 11, will be revised to add new Subsection 11.2.3.5.4, that reads (note, this change is PLANT-SPECIFIC):

11.2.3.5.4 Liquid Radwaste Cost Benefit Analysis

BLN COL 11.2-2 The population doses are given in Table 11.2-204. As discussed above, the lowest cost liquid radwaste system augment is $11,140. Assuming 100% efficiency of this augment, the minimum possible cost per person-rem is determined by dividing the cost of the augment by the population dose. This is $6,962 per person-rem total body ($11,140/1.60 person-rem) and $7,901 per person-rem thyroid ($11,140/1.41 person-rem). These costs per person-rem reduction exceed the $1,000 per person-rem criterion prescribed in Appendix I to 10 CFR Part 50 and are therefore not beneficial.

5. COLA Part 2, FSAR Tables 11.2-203 and 11.2-204 will be revised per response to RAI 11.02-03, this letter (note, this change is PLANT-SPECIFIC).

6. COLA Part 2, FSAR, Chapter 11, Subsection 11.2.5.2, will be revised from:

BLN COL 11.2-2 This COL Item is addressed in Subsections 11.2.3.3, 11.2.3.5, 11.2.3.5.1, and 11.2.3.5.2.

To read:

STD COL 11.2-2 This COL Item is addressed in Subsection 11.2.3.5.3.

BLN COL 11.2-2 This COL Item is addressed in Subsections 11.2.3.3, 11.2.3.5, 11.2.3.5.1, 11.2.3.5.2, and 11.2.3.5.4.

ATTACHMENTS/ENCLOSURES:

Attachment 11.02-03B; COLA Part 2, FSAR Tables 11.2-203 and 11.2-204

NRC Letter Dated: June 6, 2008

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 11.02-02

Please explain how the application demonstrates that the site can meet the general environmental radiation standard in 40 CFR Part 190 (per 10 CFR 20.1301(e)), and provide sufficient information for the staff to evaluate the bases and assumptions used in the applicant's analysis. Please incorporate this analysis into the FSAR or justify its exclusion.

BLN RAI ID: 0518

BLN RESPONSE:

Plant and site-specific offsite dose analyses have been developed for normal release of both liquid and gaseous effluents that demonstrate compliance with applicable federal regulations, including 40 CFR Part 190. 40 CFR Part 190 requires that the annual dose equivalent to any member of the public does not exceed 25 mrem to the total body, 75 mrem to the thyroid, and 25 mrem to any other organ as the result of exposures to planned discharges of radioactive materials to the general environment or operation of uranium fuel cycle facilities. There are no other uranium fuel cycle facilities in the vicinity of the site which would contribute to the dose received by the maximally exposed individual. Thus, only the dose from effluent released from the site and direct radiation from the site need be considered.

Offsite doses resulting from normal releases through the liquid pathway were calculated as described in FSAR Subsections 11.2.3.3 and 11.2.3.5 and presented in revised FSAR Table 11.2-203 (Attachment 11.02-03B). These are multiplied by two (2) to account for both units at the site. The maximum liquid-pathway doses calculated are: a total body dose of 0.412 mrem/yr., 0.0992 mrem/yr. to the thyroid, and 0.530 mrem/yr. (maximum organ). These annual doses are below 40 CFR Part 190 limits as presented in new FSAR Table 11.2-205 (Attachment 11.02-02A).

The liquid effluent doses per unit presented in Table 11.2-203 were added to the gaseous effluent doses per unit presented in Table 11.3-203. The resulting maximum doses to total body, thyroid, and to any organ are multiplied by two (2) to account for both units. These results are presented in new FSAR Table 11.2-206 (Attachment 11.02-02A). Direct radiation from containment and other plant buildings is negligible based on information presented in the AP1000 DCD, Tier 2, Chapter 12, Subsection 12.4.2.1. The maximum total doses calculated are: total body dose of 1.25 mrem/yr., thyroid dose of 18.6 mrem/yr., and maximum organ dose of 4.69 mrem/yr. These annual doses are below 40 CFR Part 190 limits.

This response is PLANT-SPECIFIC.

ASSOCIATED BLN COL APPLICATION REVISIONS:

1. COLA Part 2, FSAR Chapter 11, Subsection 11.2.3.5.1 will be revised to add the following new paragraphs after the last sentence.

The maximum doses to individuals resulting from routine liquid effluents per unit are given in Table 11.2-203. These doses are multiplied by two (2) to account for both units at the site. The total maximum doses for both units are summarized in Table 11.2-205 for comparison to the regulatory limits set forth in 40 CFR Part 190.

The annual doses to a maximally exposed individual from gaseous effluents are given in Table 11.3-207. The total site dose compared with the 40 CFR Part 190 criteria is provided in Table 11.2-206. The liquid effluent doses per unit presented in Table 11.2-203 are added to the gaseous effluent doses per unit presented in Table 11.3-203. The resulting maximum doses to total body, thyroid, and to any organ are multiplied by two (2) to account for both units. These results are presented in FSAR Table 11.2-206. The radiation exposure at the site boundary was considered in DCD Subsection 12.4.2. Direct radiation from containment and other plant buildings is negligible for the values in Table 11.2-206. Additionally, there is no contribution from refueling water because the refueling water is stored inside the containment instead of in an outside storage tank. In addition, there is no outside storage of solid radwaste. There are no radiation sources outside of the permanent plant structures. There are no other uranium fuel cycle facilities in the vicinity of the site that would contribute to the dose received by the maximally exposed individual. Thus, only the dose from effluent released from the site and direct radiation from the site need be considered.

2. COLA Part 2, FSAR Chapter 11, Section 11.2 will be revised to add FSAR Tables 11.2-205 and 11.2-206 as shown on Attachment 11.02-02A.

3. COLA Part 2, FSAR Tables 11.2-203 and 11.2-204 will be revised per response to RAI 11.02-03 (this letter).

4. COLA Part 2, FSAR, Chapter 11, Subsection 11.5.7, the last paragraph will be revised from:

STD COL 11.5-3 This COL Item is addressed in Subsections 11.2.3.5 and 11.3.3.4 for liquid and gaseous effluents respectively.

To read:

BLN COL 11.5-3 This COL Item is addressed in Subsections 11.2.3.5, 11.2.3.5.1 for liquid effluents and 11.3.3.4 for gaseous effluents

ATTACHMENTS/ENCLOSURES:

Attachment 11.02-02A, COLA Part 2, FSAR Chapter 11, Tables 11.2-205 and 11.2-206.

Attachment 11.02-03B, COLA Part 2, FSAR Chapter 11, Tables 11.2-203 and 11.2-204.

NRC Letter Dated: June 6, 2008

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 11.02-03

Please provide detailed information to enable the staff to validate and verify the estimated doses in FSAR section 11.2.3.5 with respect to the dose objectives of Appendix I to 10 CFR Part 50 and the dose limits in 10 CFR 20.1301(e); please revise the FSAR to include this information, or justify its exclusion. The information should include the following:

- A complete description of how the applicant derived all the values listed in Tables 11.2-201 and 11.2-202, including all assumptions made
- Citations to any reference material used (for documents not publicly available please provide a copy for staff's use)
- Detailed breakdown of individual doses by pathway and organ
- Detailed breakdown of population doses by pathway and organ

BLN RAI ID: 0519

BLN RESPONSE:

Regulatory Guide 1.206, Revision 0, and Standard Review Plan 11.2, Revision 3, require the parameters used to determine estimated doses from the liquid effluent system to be provided in the FSAR, but neither require the FSAR to provide a detailed basis for each parameter. The requested basis material is provided in the annotated Tables in Attachment 11.02-03A. The annotated tables included in this response provide additional information on how the values in FSAR Tables 11.2-201 and 11.2-202 were derived. These annotated Tables are not part of the FSAR and are not included in the revisions to the COLA. The tables provide the input parameters, the values used in the analysis, and the basis for each value. A reference is provided for each value with supporting discussion about how the value was determined if it is not found directly from the reference. FSAR Tables 11.2-201 and 11.2-202 have been expanded to list parameters that were not previously included.

While developing the attached annotated version of FSAR Table 11.2-202, it was determined that the shoreline usage, swimming exposure, and boating exposure values of 292,027,269 person-hrs/yr were incorrect. The annotated table shows the correct value of 22,814,630 person-hrs./yr. FSAR Table 11.2-202 will be corrected in a future amendment as shown in the Application Revisions section below.

FSAR Tables 11.2-203 and 11.2-204 will be revised in a future amendment to show a detailed breakdown of the calculated individual doses and population doses by pathway and organs shown in the Application Revisions section below. The revised tables are provided in Attachment 11.02-03B.

This response is PLANT-SPECIFIC.

ASSOCIATED BLN COL APPLICATION REVISIONS:

1. COLA Part 2, FSAR Chapter 11, Tables 11.2-201 will be revised to add the following parameter at the end of the input parameter listing:

Input Parameter	Average Annual Condition
Downstream Distance Used to Determine the Dilution Factor for Nearest Fish and Swimming Location (ft.).	300

2. COLA Part 2, FSAR Chapter 11, Table 11.2-202 will be revised from:

Shoreline Usage (person-hrs./yr.)	292,027,269
Swimming Exposure (person-hrs./yr.)	292,027,269
Boating Exposure (person-hrs./yr.)	292,027,269

To read:

Shoreline Usage (person-hrs./yr.)	22,814,630
Swimming Exposure (person-hrs./yr.)	22,814,630
Boating Exposure (person-hrs./yr.)	22,814,630

3. COLA Part 2, FSAR Chapter 11, Table 11.2-202 will be revised to add the following parameters:

Input Parameter	value
Discharge Depth (ft.)	27
Drinking water intakes downstream of BLN	
Scottsboro	
Distance (ft.)	30,096
Population	24,059
Guntersville	
Distance (ft.)	176,880
Population	7,647
Section &Dutton	
Distance (ft.)	50,160
Population	12,941
Fort Payne	
Distance (ft.)	23,760
Population	29,412
Albertville	
Distance (ft.)	161,040
Population	58,823
Arab	
Distance (ft.)	187,440
Population	25,294
Huntsville	
Population	168,132

4. COLA Part 2, FSAR Chapter 11, Table 11.2-202 will be revised to change the title from:

LADTAP II Input (a) For Individual Dose Rates

To Read:

LADTAP II Input (a)

5. COLA Part 2, FSAR Chapter 11, will be revised to replace Tables 11.2-203 and 11.2-204 with the Tables shown in Attachment 11.02-03B.

ATTACHMENTS/ENCLOSURES:

Attachment 11.02-03A, FSAR Table 11.2-201 (annotated) – Dilution Factor Parameters and Dilution Factors, and FSAR Table 11.2-202 (annotated) - LADTAP II Input; providing input parameter, value, assumptions and bases used to establish the value.

Attachment 11.02-03B, Revisions to COLA Part 2, FSAR Tables 11.2-203 and 11.2-204.

NRC Letter Dated: May 21, 2008

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 11.02-04

Section 11.2.3.5 states that the irrigation pathway was not evaluated because no irrigation of crops was identified downstream of the Bellefonte Units. Please discuss whether this approach to irrigation considers that individual users of public water that is withdrawn from downstream locations may use the water to irrigate their gardens. With respect to FSAR section 11.2.3.5, please explain whether the individual dose estimates should include this pathway and, if so, please include irrigation doses and provide calculations of sufficient detail for the staff to validate and verify the results.

BLN RAI ID: 421

BLN RESPONSE:

Calculation of the doses to man from routine release of liquid reactor effluents from the proposed Bellefonte Units 3 and 4 was done in accordance with Regulatory Guide 1.109 (Ref. 4). Regulatory Guide 1.109 characterizes the maximum individual as "maximum" with regard to food consumption, occupancy, and other usage of the region in the vicinity of the plant site, and as such represents individuals with habits representing reasonable deviations from the average for the population in general. In addition, Regulatory Guide 1.109 identifies exposure pathways for estimating radiation exposure for maximum individuals and the population within 50 miles. Other exposure pathways that may arise due to unique conditions at a specific site should be considered if they are likely to provide a significant contribution to the total dose. A pathway is considered significant if a conservative evaluation yields an additional dose increment equal to or more than 10 percent of the total from all pathways considered in Regulatory Guide 1.109. Similar discussion is found in NUREG 1555, Section 5.4.1 (Ref. 2).

Consumption of most of an individual's annual intake of vegetables from a vegetable garden irrigated with public water was not regarded as either a pathway that fell within a reasonable deviation from the average for the population, or a pathway unique to the Bellefonte site that was likely to contribute a dose increment equal to or greater than 10 percent of the total from all pathways considered in Regulatory Guide 1.109. Therefore, individual use of public water for garden irrigation was not considered in the determination of doses to the public from routine release of liquid reactor effluents from the proposed Bellefonte Units 3 and 4. The basis for this conclusion and further justification are provided below.

The computer code LADTAP II (Ref. 3) was used in the determination of liquid effluent doses. LADTAP II implements the guidance of Regulatory Guide 1.109. The primary exposure pathways for the maximum individual considered in LADTAP II are consumption of aquatic food, ingestion of drinking water and shoreline recreational use. Where commercial irrigation using water obtained downstream of the plant effluent discharge is identified, LADTAP II also determines conservative individual doses associated with input parameters for irrigation rates and commercial production rates for milk, meat and vegetables. When vegetables are commercially grown in the vicinity of the site using contaminated water, it is reasonable to conclude that a maximally exposed individual could consume a significant portion of his annual intake of vegetables from these local sources. LADTAP II default parameters for individual consumption of vegetables (520 kg./yr. for adult vegetable consumption and 64 kg./yr. for adult leafy vegetable consumption) and time delay between harvest and ingestion (14 days for vegetables and 1 day for leafy vegetables) indicate ready availability. However, as identified in Section 11.2.3.5 of the Final Safety Analysis Report, no irrigation of crops was identified downstream of the Bellefonte Units. Therefore, it is not considered a reasonable deviation from average habits of the general population to

assume that a maximally exposed individual could consume a significant portion of his annual intake of vegetables from local sources grown using contaminated irrigation. An individual with a garden irrigated with contaminated public water would not produce the variety of vegetables associated with LADTAP II default individual consumption rates. In addition, preservation of vegetables from an individual garden would result in holdup times between harvest and consumption greater than LADTAP II default individual holdup times.

To provide further justification for exclusion of the irrigated vegetable pathway, the dose to an individual using public drinking water to irrigate a vegetable garden was conservatively estimated using LADTAP II. Population dose was not considered since crop irrigation was not found to occur in the vicinity of Bellefonte.

The dose to the maximally exposed individual from this pathway was calculated assuming the use of public drinking water originating from the closest drinking water diversion location downstream of the Bellefonte plant discharge, Scottsboro. The transit time calculated for the drinking water diversion location is 20.7 hours. This value includes the time required for the river water to travel from the plant discharge to the closest public drinking water diversion plus 12 hours for transport through the water purification and distribution system. These values are consistent with the recommendations of Regulatory Guide 1.109 for evaluation of the maximally exposed individual. The dilution factor for the closest drinking water diversion location, calculated by LADTAP II, is 220.5.

A wide variety of vegetables are grown in the Southeast. Recommended water requirements for these vegetables when commercially grown are given in Alabama Cooperative Extension System, Basics of Vegetable Crop Irrigation (Ref. 1). Depending on the vegetable type, water requirements range from one inch in five days to one inch in 21 days. A rate of one inch in 12 days (64 L/m^2/month) represents a conservative, average water requirement for a wide range of vegetables grown in an individual garden. This value is also conservative given that the water requirements are recommended for commercial growers presumably using more economical, untreated water supplies.

Historical rainfall rates in the vicinity of Bellefonte were investigated to determine irrigation needs not typically met by normal rainfall (Ref. 5). The minimum rainfall occurring during the growing season in either Scottsboro, Guntersville or Huntsville, Alabama based on 29 years of data is 3.06 in./month (78 $L./m.^2$/month). This historical, minimum rainfall rate would meet the average water requirement for an individual garden given above; therefore, no irrigation would normally be required. This conclusion is supported by the fact that crop irrigation was not found to occur in the Bellefonte area. Regardless, an irrigation rate of one inch per month (25.4 $L./m.^2$/month was input to LADTAP II for consideration of this exposure pathway.

A vegetable production value of 1 kg./yr. was selected so that LADTAP II would calculate the individual doses due to the irrigated vegetable pathway. Values of 60 days and 2.0 $kg./m.^2$ were used for the growing period and crop yields, respectively, in accordance with the guidance of Table E-15 of Regulatory Guide 1.109.

Using the inputs described above, LADTAP II calculates a vegetable and leafy vegetable dose to the maximally exposed individual of 1.47E-02mrem/yr. to the total body of an adult. When summed with the total body doses due to the fish consumption, shoreline exposure, and drinking water pathways, an adult total body dose of 2.21E-01mrem/yr. is calculated. The adult age group results in the maximum total body dose due to liquid effluent releases. The total body dose due to the vegetable irrigation/consumption pathway contributes just 7.1% of the total body dose due to all liquid effluent pathways. When the irrigated vegetable pathway exposure is summed with the total body doses of all exposure pathways considered in Regulatory Guide 1.109, an adult total body dose of 5.54E-01mrem/yr. is calculated. The

total body dose due to the vegetable irrigation/consumption pathway contributes less than 3% of the total body dose due to all pathways considered in Regulatory Guide 1.109.

Since the conservatively calculated dose associated with the irrigated, individual garden pathway does not have the potential for contributing 10% or more to individual or population doses, this pathway is not considered significant. Therefore, the doses to the maximally exposed individual associated with consuming vegetables watered by public drinking water are not included in the dose analysis.

This response is PLANT-SPECIFIC

REFERENCES

1. Alabama Cooperative Extension System, ACES Publications: Basics of Vegetable Crop Irrigation, ANR-1169, April 2000
2. NUREG-1555, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants", October 1999
3. LADTAP II - Technical Reference and User Guide, NUREG/CR-4013, PNL-5270, April 1986
4. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.109, "Calculation of Annual Does 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
5. U. S Department of Commerce, National Oceanic & Atmospheric Administration, Climatography of the United States, No. 20, 1971 – 2000, COOP ID 013573, 014064, and 017304, Issue Date: February 2004.

ASSOCIATED BLN COL APPLICATION REVISIONS:

No COLA revisions have been identified associated with this response.

ATTACHMENTS:

None.

ATTACHMENT 11.02-02A
TVA letter dated xxx, 2008
RAI Responses

Attachment 11.02-02A
Tables 11.2-205 and 11.2-206

(These are new Tables to be added to the FSAR)

Table 11.2-205

LIQUID PATHWAY COMPARISON OF MAXIMUM INDIVIDUAL DOSE TO 40 CFR PART 190 LIMIT

Bellefonte Units 3 and 4

Type of Dose (Annual)	Design Limit [a] (mrem/yr.)	Calculated Dose [b] (mrem/yr.)
Total Body Dose Equivalent (adult)	25	4.12E-01
Thyroid Dose (child)	75	9.92E-02
Dose to Any Other Organ (teenager liver)	25	5.30E-01

[a] Source 40 CFR Part 190.
[b] Total for two units.

Table 11.2-206

COMPARISON OF MAXIMUM INDIVIDUAL TOTAL DOSE TO 40 CFR PART 190 LIMIT

Bellefonte Units 3 and 4

Type of Dose (Annual)	Design Limit [a] (mrem/yr.)	Calculated Dose [b] (mrem/yr.)
Total Body Dose Equivalent (child)	25	1.25
Thyroid Dose (infant)	75	18.6
Dose to Any Other Organ (child bone)	25	4.69

[a] Source 40 CFR Part 190.
[b] Total for two units. Includes effluent pathways and direct radiation sources for all units at the site. Direct radiation has been shown to be negligible per Subsection 11.2.3.5.1.

ATTACHMENT 11.02-03A

FSAR Table 11.2-201 (annotated) Dilution Factors Parameters and Dilution Factors, and

FSAR Table 11.2-202 (annotated) LADTAP II Input, providing input parameter, value, Assumptions and bases used to establish the values presented in the respective Tables.

(The annotated tables are provided for information only. They are not part of FSAR)

ATTACHMENT 11.02-03A
TVA letter dated August 1, 2008
RAI Responses

FSAR Table 11.2-201 (annotated)

Dilution Factor Parameters and Dilution Factors

Input Parameter	Average Annual Condition	Basis
Average Width of River (ft.)	3,400	FSAR Section 2.4
Average Depth of Guntersville Reservoir (ft.)	15	FSAR Section 2.4
Average Depth of River (ft.)	11	Note 1
Stream Velocity in Guntersville Reservoir (ft./sec.)	0.76	Note 2
Stream Velocity of Tennessee River Below Guntersville Reservoir (ft./sec.)	1.04	Note 3
Distance from Near Shore for Source (ft.)	0	Note 4
Distance to Drinking Water Extraction (mi.)	4.5	FSAR Table 2.4.1-202
Average Distance to Recreational Activities (mi.)	21.25	Note 5
Average Distance to Where Fish are Caught (mi.)	21.25	Note 5
Dilution Factor for Drinking Water Beyond Guntersville Reservoir	2,907	Note 6
Downstream Distance Used to Determine the Dilution Factor for Sport Fishing (mi.)	21.25	Note 5
Downstream Distance Used to Determine the Dilution Factor Nearest Fish and Swimming Location (ft.)	300	Note 7

Notes

1. For points beyond the Guntersville Dam, the minimum depth of the Tennessee River is 11 ft. [FSAR Section 2.4]. The minimum depth is conservatively used as the average depth.
2. The average flow rate of the Tennessee River is 38,850 $ft.^3$/sec. [FSAR Section 2.4]. With an average width of 3,400 ft. and an average depth of 15 ft. for the Guntersville Reservoir [FSAR Section 2.4], the average flow velocity is 0.76 ft./sec.

3. For points beyond the Guntersville Dam, the minimum depth of the Tennessee River, 11 ft. [FSAR Section 2.4], is used for calculating an average flow velocity of 1.04 ft./sec.

4. An offshore distance of zero is conservative because the closest water use is on the opposite side of the reservoir.

5. The Guntersville Reservoir stretches approximately 42.5 river miles downstream of the Bellefonte discharge point to the Guntersville Dam [FSAR Table 2.4.4-203]. The midpoint of the reservoir 21.25 miles downstream of the plant is used as a representative point for recreational activities and sport and commercial fishing.

   The dilution factor at this location is determined by LADTAP II using the methodology provided in Regulatory Guide 1.113 using the following parameters. A value of two is input for discharge into a lake because the discharge is into Guntersville Lake; the average flow velocity is 0.76 ft./sec. and the average depth of Guntersville Lake is 15 ft. [http://www.riversofalabama.org/Tennessee/TN_Hydrologic_Modifications.htm].

6. For drinking water intake locations beyond Guntersville Dam, the water is assumed to be fully mixed. The dilution factor is calculated using the following equation:

$$DF = \frac{Q_{river} + Q_{discharge}}{Q_{discharge}} = \frac{38{,}850 + 13.37}{13.37} = 2{,}907$$

   where:

   $Q_{discharge}$ = the plant discharge rate of 13.37 $ft.^3$/sec. [FSAR Table 11.2-202]

   Q_{river} = 38,850 $ft.^3$/sec. [FSAR Section 2.4.1.2.1]

7. Because the discharge is 27 ft. under water, time must be allowed for the discharge to reach the surface. A distance of 300 ft. is assumed for the maximum individual exposure case. A sensitivity study showed this is more conservative than a closer distance.

FSAR Table 11.2-202 (annotated)

LADTAP II Input[1]

(page 1 of 2)

Input Parameter	Value	Basis
Freshwater Site	Selected	LADTAP Job Control Option
Discharge Flowrate ($ft.^3/sec.$)	13.37	Note 2
50-mile Population	FSAR Tables 2.1-203 & 2.1-204	FSAR Tables 2.1-203 & 2.1-204
Source Term	DCD Table 11.2-7	DCD Table 11.2-7. The source term multiplier is set to the default value of 1.0.
Reconcentration Model	None	
Shore Width Factor	0.3	Note 3
Dilution Factors	Table 11.2-201	The basis for the parameters in this table are provided in annotated Table 11.2-201.
Transit Time – Nearest Drinking Water (hr)	8.7	Note 4
Transit Time – Midpoint of Guntersville Reservoir (hr.)	41	Note 5
Sport Fish Annual Harvest (kg./yr.)	309,134	Note 6
Commercial Fish Harvest (kg./yr.)	761,931	Note 7
Shoreline Usage (person-hrs./yr.)	22,814,630	Note 8
Swimming Exposure (person-hrs./yr.)	22,814,630	Note 8
Boating Exposure (person-hrs./yr.)	22,814,630	Note 8
Length of Guntersville Reservoir (mi.)	42.5	Note 9
Discharge Depth (ft.)	27	Tennessee Valley Authority, Design Drawings
Drinking water intakes downstream of BLN		
Scottsboro		Note 10, 11
Distance (ft.)	30,096	
Population	24,059	

FSAR Table 11.2-202 (annotated)

LADTAP II Input[1]

(page 2 of 2)

Guntersville		Note 10, 11
Distance (ft.)	176,880	
Population	7,647	
Section & Dutton		Note 10, 11
Distance (ft.)	50,160	
Population	12,941	
Fort Payne		Note 10, 11
Distance (ft.)	23,760	
Population	29,412	
Albertville		Note 10, 11
Distance (ft.)	161,040	
Population	58,823	
Arab		Note 10, 11
Distance (ft.)	187,440	
Population	25,294	
Huntsville		Note 10, 12
Population	168,132	

Notes

1. Input parameters not specified use default LADTAP II values.
2. The discharge flowrate is calculated from the 1,925 gal./d. effluent discharge and the cooling tower blowdown of 6,000 gpm [AP1000 DCD Revision 16].

$$\frac{1{,}925 gal./d.}{(7.48 gal./ ft.^3)(24 h./d.)(60 \text{ min.}/h.)(60 \text{ sec.}/\text{min})} + \frac{6{,}000 gal./\text{min.}}{(7.48 gal./ ft.^3)(60 \text{ sec.}/\text{min.})} = 13.37 ft.^3/\text{sec.}$$

3. The Tennessee River empties into the Guntersville Lake downstream of the plant. The shore width factor for a lake was selected for this reason.
4. The nearest drinking water intake downstream of the plant discharge point is 4.5 miles downstream [FSAR Table 2.4.1-202]. Using the average water velocity of 0.76 ft./sec. [FSAR Table 11.2-201], a transit time of 8.7 hours is calculated. A transit time of zero is assumed for the fish and shoreline pathways for the maximum individual exposure case.

5. The Guntersville Reservoir stretches approximately 42.5 river miles downstream of the Bellefonte discharge point to the Guntersville Dam [FSAR Table 2.4.4-203]. Using the average velocity of 0.76 ft./sec. [FSAR Table 11.2-201], a transit time of 41 hours is calculated to the midpoint of the Guntersville Reservoir.

6. FSAR Table 2.1-207 projects the annual number of visitors to the area surrounding the plant for the purpose of sport fishing to be 73,440. The average daily amount of bass caught by each angler in a bass tournament is 3.67 lbs/angler-day [Outdoor Alabama, "Table 1. Statewide summary of tournaments for bass clubs participating in Alabama's the 2004 B.A.I.T. Program", website: http://www.outdooralabama.com/fishing/freshwater/bait.cfm]. In order to account for the number of fish other than bass that are caught, the average daily amount of fish caught by each angler is increased to 8 lbs/angler-day. The amount of sport fishing is expected to increase 16% by 2030 [Section 4.24, Tennessee Valley Authority, Reservoir Operations Study – Final Programmatic EIS, February 19, 2004]; therefore, the amount of fish caught each year will be increased by 16%. Based on the above values, the total amount of fish caught each year is 681,532 lbs. (309,134 kg).

7. The estimated commercial fish harvest in 2000 was 8,021,129 lbs. (24.1 lbs./acre) for the TVA reservoir system [Tennessee Valley Authority, Reservoir Operations Study – Final Programmatic EIS, February 19, 2004]. The commercial fish harvest industry is not expected to change significantly in the future [Section 4.7, Tennessee Valley Authority, Reservoir Operations Study – Final Programmatic EIS, February 19, 2004]; therefore, it is acceptable to use this value to estimate the commercial fish harvest for a projected year. The Guntersville Reservoir is 69,700 acres of water surface area [Sponsored by Alabama Water Watch Association and funded by World Wildlife Fund, Rivers of Alabama, "Tennessee – Hydrologic Modifications", website: http://www.riversofalabama.org/ Tennessee/TN_Hydrologic_Modifications.htm]. Therefore, approximately 1,679,770 lbs. (761,931 kg.) of commercial fish will be harvested in the Guntersville Reservoir.

8. It is conservatively assumed that everyone within 50 miles of the plant will spend time in the Guntersville Reservoir downstream of the Bellefonte Nuclear Plant. From FSAR Section 2.1, the projected 50-mile permanent population for the year 2057 is 1,782,393 people.

   The average exposure times per person for each age group are taken from Table E-4 of Regulatory Guide 1.109. The exposure times for children, teenagers, and adults are 9.5 hrs./yr., 47 hrs./yr., and 8.3 hrs./yr., respectively. Multiplying these values by the fraction of the population represented by each age group, yields a shoreline exposure time of 12.8 hrs./person/yr. The default values for the fraction of the population represented by each age group are 18% children, 11% teenagers, and 71% adults [NUREG/CR-4013]. The percentage of infants is conservatively included in that of children. These values are in accordance with Regulatory Guide 1.109. Thus, the total usage is 22,814,630 person-hrs./yr. Total swimming exposure and boating exposure are each assumed to be the same as the shoreline usage.

9. The Guntersville Reservoir stretches approximately 42.5 river miles downstream of the Bellefonte discharge point to the Guntersville Dam [FSAR Table 2.4.4-203].

10. Several locations are input for drinking water intakes downstream of the Bellefonte Nuclear Plant discharge point. The distances and usages for each town's drinking water are from FSAR Table 2.4.1-202. For conservatism, it is assumed that for cities with two intakes, the entire population of that city uses water from the closest intake. This is conservative because it minimizes the transit time and dilution factor. The population using drinking water from each intake location is conservatively calculated based on the average annual intake for each site and the average water usage of a person living in the United States, which is 171.8 gpd [Aquacraft, Inc and American Water Works Association (AWWA) Research Foundation, "Residential Water Use Summary', 1999, website: httb://www.aquacraft.com/Publications/ resident.htm]. For conservatism in determining the affected population, a value of 170 gpd is used.
11. The dilution factor is determined by LADTAP based, in part, on the listed distance.
12. Huntsville is downstream of the Guntersville Dam. The dilution factor is provided in FSAR Table 11.2-201.

ATTACHMENT 11.02-03B
TVA letter dated August 1, 2008
RAI Responses

ATTACHMENT 11.02-03B

COLA Part 2, FSAR Tables 11.2-203 and 11.2-204

(The revised Tables replace existing FSAR Tables in their entirety.)

BLN COL 11.2-2

BLN COL 11.5-3

Table 11.2-203

ANNUAL DOSE TO A MAXIMALLY EXPOSED INDIVIDUAL

FROM LIQUID EFFLUENTS (page 1 of 2)

(PER UNIT)

Dose (mrem/yr.)

Adult

Pathway	Total body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Fish	1.88E-01	1.10E-02	1.27E-01	2.46E-01	8.24E-02	1.25E-02	2.81E-02	-
Drinking	1.75E-02	2.07E-02	7.65E-04	1.78E-02	1.71E-02	2.39E-02	1.67E-02	-
Shoreline	2.23E-04	2.23E-04	2.23E-04	2.23E-04	2.23E-04	2.23E-04	2.23E-04	2.61E-04
Total	2.06E-01	3.19E-02	1.28E-01	2.64E-01	9.97E-02	3.66E-02	4.50E-02	2.61E-04

Teenager

Pathway	Total body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Fish	1.08E-01	8.39E-03	1.33E-01	2.51E-01	8.30E-02	1.14E-02	3.23E-02	-
Drinking	1.22E-02	1.47E-02	7.34E-04	1.28E-02	1.22E-02	1.80E-02	1.18E-02	-
Shoreline	1.24E-03	1.24E-03	1.24E-03	1.24E-03	1.24E-03	1.24E-03	1.24E-03	1.45E-03
Total	1.21E-01	2.43E-02	1.35E-01	2.65E-01	9.64E-02	3.07E-02	4.53E-02	1.45E-03

BLN COL 11.2-2

BLN COL 11.5-3

Table 11.2-203

ANNUAL DOSE TO A MAXIMALLY EXPOSED INDIVIDUAL

FROM LIQUID EFFLUENTS (page 2 of 2)

(PER UNIT)

Dose (mrem/yr.)

Child

Pathway	Total body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Fish	4.21E-02	3.81E-03	1.64E-01	2.16E-01	6.94E-02	1.17E-02	2.53E-02	-
Drinking	2.29E-02	2.53E-02	2.10E-03	2.47E-02	2.34E-02	3.77E-02	2.27E-02	-
Shoreline	2.60E-04	2.60E-04	2.60E-04	2.60E-04	2.60E-04	2.60E-04	2.60E-04	3.04E-04
Total	6.53E-02	2.94E-02	1.66E-01	2.41E-01	9.31E-02	4.96E-02	4.82E-02	3.04E-04

Infant

Pathway	Total body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Fish	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-
Drinking	2.23E-02	2.39E-02	2.26E-03	2.48E-02	2.31E-02	4.60E-02	2.23E-02	-
Shoreline	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	2.23E-02	2.39E-02	2.26E-03	2.48E-02	2.31E-02	4.60E-02	2.23E-02	0.00E+00

BLN COL 11.2-2

BLN COL 11.5-3

Table 11.2-204

ANNUAL POPULATION DOSE FROM LIQUID EFFLUENTS

(PER UNIT)

Dose (person-rem per yr.)

Pathway	Total body	GI-LLI	Bone	Liver	Kidney	Thyroid	Lung	Skin
Fish- Sport Harvest	3.44E-01	1.99E-02	3.01E-01	5.40E-01	1.79E-01	1.51E-02	6.29E-02	-
Fish- Commercial	2.01E-01	1.16E-02	1.76E-01	3.15E-01	1.05E-01	7.24E-03	3.67E-02	-
Drinking Water	9.70E-01	1.13E+00	5.39E-02	1.00E+00	9.60E-01	1.32E+00	9.34E-01	-
Hydrosphere Tritium	7.63E-03	7.63E-03	0.00E+00	7.63E-03	7.63E-03	7.63E-03	7.63E-03	-
Shoreline	5.54E-02	-	-	-	-	5.54E-02	-	6.48E-02
Swimming	6.08E-04	-	-	-	-	6.08E-04	-	-
Boating	3.04E-04	-	-	-	-	3.04E-04	-	-
Total	1.58E+00	1.17E+00	5.31E-01	1.86E+00	1.25E+00	1.41E+00	1.04E+00	6.48E-02