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

November 17, 2008

10 CFR 52.79

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

In the Matter of)
Tennessee Valley Authority)

Docket No. 52-014 and 52-015

BELLEFONTE COMBINED LICENSE APPLICATION – RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION – LIQUID EFFLUENT

Reference: Letter from Joseph M. Sebrosky (NRC) to Andrea L. Sterdis (TVA), Request for Additional Information Letter No. 130 Related to SRP Section 2.4.13 for the Bellefonte Units 3 and 4 Combined License Application, dated October 16, 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 does not identify any associated changes to be made in a future revision of the BLN application.

If you should have any questions, please contact Phillip Ray at 1101 Market Street, LP5A, Chattanooga, Tennessee 37402-2801, by telephone at (423) 751-7030, or via email at pmray@tva.gov.

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

Executed on this 17th day of Nov, 2008.

Andrea L. Sterdis
Manager, New Nuclear Licensing and Industry Affairs
Nuclear Generation Development & Construction

Enclosure
cc: See Page 2

D085
NRO

cc: (w/ Enclosures)
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Enclosure
TVA letter dated November 17, 2008
RAI Responses

Responses to NRC Request for Additional Information letter No. 130 dated October 16, 2008
(8 pages, including this list)

Subject: Liquid Effluent in the Final Safety Analysis Report

RAI Number	Date of TVA Response
02.04.13-06	This letter – see following pages
02.04.13-07	This letter – see following pages

Associated Additional Attachments / Enclosures	Pages Included
None	

NRC Letter Dated: October 16, 2008

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 02.04.13-06

SRP 2.4.13, under SRP Acceptance Criteria #5, references Branch Technical Position BTP 11-6, which provides guidance in assessing potential release of radioactive liquids at the nearest potable water supply located in an unrestricted area for direct human consumption or indirectly through animals, crops, and food processing. BTP 11-6 further states the evaluation of the release considers the use of water for direct human consumption or indirectly through animals (livestock watering), crops (agricultural irrigation), and food processing (water as an ingredient). The analysis does not include a discussion of pathways other than drinking water.

The analysis should discuss these other pathways, especially the pathways such as fish and crop irrigation that may result in concentration of the source term. Either discuss other pathways, or justify why they need not be included.

BLN RAI ID: 2163

BLN RESPONSE:

As discussed in the response to previous RAI 11.02-04 (BLN RAI LTR 031), there is sufficient annual precipitation such that irrigation is typically not necessary. Additionally, no crop irrigation has been identified in the site area; therefore no dose consequence would result from crop irrigation.

Likewise, no commercial fishing is performed in the area. Any recreational fishing performed would not provide enough of an aquatic food supply to provide significant dose as a result of ingestion.

Regardless, a basic evaluation of the dose consequence for these two pathways has been performed to demonstrate that in the unlikely event of a liquid effluent tank failure, there would be no significant dose due to these pathways.

According to Regulatory Guide 1.109, with similar discussion in NUREG-1555, Section 5.4.1, a pathway is considered significant if a conservative evaluation yields an additional dose increment equal to or greater than 10 percent of the total from all pathways.

Values for the infiltration factor for irrigation, contamination fraction, transfer factors, ingestion rates, and dose conversion factors are from the RESRAD-OFFSITE default values (Ver. 2.0 – Reference 1), which in turn use Federal Guidance Report 11 (FGR 11). Site-specific values (see FSAR Tables 2.4.13-203 and 2.4.13-204) are used for hydraulic conductivity (1325.5 m/yr), soil density (1.44 g/cm^3), and the source water Tritium (H^3) concentration (3.77E+04 pCi/L).

Making some basic assumptions, the annual dose for these two pathways is calculated below for H^3. Tritium is evaluated since it accounts for greater than 99% of the detectable concentration in the receptor body, and is therefore the primary dose contributor that appears in the water body receptor.

Fish Ingestion

The formula for calculating the dose due to the fish ingestion pathway is presented in Equation 1 from Reference 2.

Equation 1 – Fish Ingestion Dose Consequence

$$T_d = I * C_f * R_c * T_f * D_f$$

Where:

T_d = Total annual dose consequence
I = Food consumption in kg per year
C_f = Contaminated food fraction
R_c = Radionuclide concentration in picocuries per liter
T_f = Radionuclide transfer factor
D_f = Dose conversion factor in millirem per picocurie

Table 1 – Fish Ingestion Parameter Values

Parameter	Fish Ingestion	Reference
Food consumption per year (I)	20.6 kg	Reference 1
Contamination Fraction (C_f)	0.5	Reference 1
Transfer Factor for H^3 (T_f)	1 pCi/kg/pCi/L	Reference 1
H^3 concentration in water (R_c)	3.77E+04 pCi/L	Table 2.4.13-204
Dose Conversion Factor for H^3 (D_f)	6.4E-08 mrem/pCi	Reference 1
Annual Dose	**0.025 mrem/yr**	Calculated

Plant Ingestion

Calculating the dose due to plant ingestion is slightly more complex. The first step is calculating the concentration of H^3 in the soil following irrigation. Using the monthly average precipitation rate (3.06 inches per month) from the response to RAI 11.02-04 and conservatively assuming one additional inch per month of irrigation water from the receptor water body gives a total plant water availability of 4.06 inches per month (1.24 meters per year). Thus, the irrigation fraction, which is the inverse of the availability, is calculated to be 2.46E-01.

In order to calculate the soil water concentration, a saturation ratio must be determined. This is found using Equation 2 below, which is equation E.7 in the RESRAD Version 6 User manual (Reference 2).

Equation 2 – Saturation Ratio

$$R_s = \left(\frac{I}{K_{sat}} \right)^{\frac{1}{2b+3}}$$

Where:

R_s = Saturation ratio
I = Infiltration rate in meters per year
K_{sat} = Saturated zone hydraulic conductivity in meters per year
b = Soil specific exponential factor for sandy loam

Table 2 – Saturation Ratio Parameter Values

Parameter	Value	Reference
Infiltration rate (I) in m/yr (1.24*0.8)	0.992	Reference 1
Saturated zone hydraulic conductivity in m/yr (K_{sat})	1325.5	Table 2.4.13-203
Soil specific exponential factor for sandy loam (b)	4.90[1]	Reference 5

The evaluation continued by assuming a soil makeup similar to the contaminated zone. As such, the soil density is 1.44 g/cm^3 and the total porosity is 0.018, which are site-specific values used in the accident evaluation.

The concentration of H^3 in the soil water following irrigation is calculated using Equation 3 from Reference 5, equation L.5, adjusted for the irrigation fraction.

Equation 3 – Soil Water Concentration

$$W_{H3} = \frac{P_b * S_{H3}}{P_t * R_s} * I_f$$

Where:

[1] RESRAD Version 6.0 user manual Table E.2

W_{H3} = Concentration of H^3 in the soil water in pCi/cm^3
P_b = Bulk density of the soil in g/cm^3
S_{H3} = Concentration of H^3 in soil in pCi/g
P_t = Total porosity of the soil
R_s = Saturation ratio from Equation 2 above
I_f = Irrigation fraction

Table 3 – Soil Water Concentration Parameter Values

Parameter	Value	Reference
Bulk density of soil (P_b)	1.44 g/cm^3	Reference 2
Concentration of H^3 in soil (S_{H3})	3.77E+04 pCi/L	Reference 3
Total porosity of soil (P_t)	0.018	Reference 2
Saturation ratio (R_s)	0.57[2]	Calculated
Irrigation fraction (I_f)	2.46E-01	Calculated

For simplicity, the concentration of H^3 in soil is conservatively assumed to be equal to the receptor water body concentration resulting from the postulated release. In reality, the concentration would be much lower because of factors such as dilution in the soil, soil pore space, and runoff.

The dose due to plant ingestion is calculated by Equation 4 assuming the plant water content has a density of 1 g/cm^3.

Equation 4 – Plant Ingestion Dose Consequence

$$T_d = W_{H3} * P_c * (R * C_f) * D_f$$

Where:

T_d = Total dose from plant ingestion in mrem
W_{H3} = Concentration of H^3 in the soil water, from Equation 3 above in pCi/cm^3
P_c = Plant water ratio in Kg (wet plant) vs. Kg (dry soil)
R = Plant ingestion rate in Kg per year
C_f = Plant contamination fraction
D_f = Dose conversion factor for H^3 (6.4E-08 mrem per year per pCi)

Table 4 – Plant Ingestion Parameter Values

Parameter	Value	Reference
H^3 soil water concentration (W_{H3})	1.3E+03 pCi/cm^3	Calculated
Plant water ratio (P_c)	0.8[3]	Reference 5

[2] From Equation 2

Parameter	Value	Reference
Plant ingestion per year (R)	14,000 g	Reference 1
Plant Contamination Fraction (C_f)	0.5	Reference 1
Dose Conversion Factor for H^3 (D_f)	6.4E-08 mrem/pCi	Reference 1
Annual Dose	**0.466 mrem/yr**	Calculated

The total dose consequence from the fish and plant ingestion pathways is:

Table 5 – Total Dose Consequence

Pathway	Annual Dose (mrem/yr)	Reference
Fish Ingestion	0.025	Calculated
Plant Ingestion	0.466	Calculated
Total Dose Consequence	**0.491**	Calculated

As is evident in Table 5, the dose consequence for H^3 is well below 1 millirem per year. By comparison, 10 CFR 20 Appendix B Table 2 Column 2 values are based on an annual exposure of 50 millirem per year. The purpose of the accident evaluation was not to calculate the dose consequence, but rather the concentration in the receptor water body; therefore, the direct comparison of the dose consequence is difficult. However, comparing the total of the fish and plant irrigation dose consequence to the basis for 10 CFR 20 Appendix B Table 2 Column 2, the dose consequence is approximately 0.98 percent of the 10 CFR 20 Appendix B Table 2 Column 2 basis value. Therefore, these are considered insignificant pathways and do not require further evaluation.

Because of the depth of the postulated release, other potential pathways, such as inhalation and direct gamma exposure, are eliminated from consideration in the model of record.

References

1. RESRAD-OFFSITE Version 2.0 Default Values
2. RESRAD Version 6 User Manual

This response is PLANT SPECIFIC.

ASSOCIATED BLN COL APPLICATION REVISIONS:

No COLA revisions have been identified associated with this response.

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[3] RESRAD Version 6.0 user manual Table L.1

Enclosure
TVA letter dated November 17, 2008
RAI Responses

ASSOCIATED ATTACHMENTS/ENCLOSURES:

None

NRC Letter Dated: October 16, 2008

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 02.04.13-07

BTP 11-6, B.4. "Specifications on Tank Waste Radioactivity Concentration Levels," specifies an evaluation of the proposed technical specification limiting the radioactivity content of the tank to ensure that the technical specification is consistent with the safety evaluation. No technical specification limits were proposed in FSAR section 2.4.13 on the radioactivity content of the effluent holdup tanks. The applicant should provide the technical specification limits in the FSAR or justify why no limits are needed.

BLN RAI ID: 2162

BLN RESPONSE:

NRC Branch Technical Position 11-6, "Postulated Radioactive Releases Due To Liquid-Containing Tank Failures" Section B.4, states "The reviewer will evaluate the proposed technical specification limiting the radioactivity content (becquerel, curie) of liquid-containing tanks to ensure that the technical specification is consistent with the safety evaluation. Chapter 16 of the SRP identifies the requirements for this technical specification. The radioactivity content (becquerel, curie) is based on that quantity which would not exceed the concentration limits of 10 CFR Part 20, Appendix B, Table 2, Column 2, at the nearest potable water supply, located in an unrestricted area, in the event of an uncontrolled release of the tank's contents." The referenced Chapter 16 of the SRP indicates that the Technical Specification should be based on the improved Standard Technical Specifications (STS) identified for Westinghouse plants in NUREG-1431. The pertinent liquid storage tank radioactivity requirements are found in STS 5.5.12, "Explosive Gas and Storage Tank Radioactivity Monitoring Program."

The STS for this monitoring program provides controls for the quantity of radioactivity contained in unprotected outdoor liquid storage tanks. The STS requires that the monitoring program include a "surveillance program to ensure that the quantity of radioactivity contained in all outdoor liquid radwaste tanks that are not surrounded by liners, dikes, or walls, capable of holding the tanks' contents and that do not have tank overflows and surrounding area drains connected to the [Liquid Radwaste Treatment System] is less than the amount that would result in concentrations less than the limits of 10 CFR 20, Appendix B, Table 2, Column 2, at the nearest potable water supply and the nearest surface water supply in an unrestricted area, in the event of an uncontrolled release of the tanks' contents."

For the AP1000 design, the liquid storage tanks do not meet the above identified criteria for inclusion in the Technical Specifications, i.e., the design does not include any outdoor liquid radwaste tanks that are not surrounded by liners, dikes, or walls, capable of holding the tanks' contents and that do not have tank overflows and surrounding area drains connected to the liquid radwaste treatment system. Thus, there was no such specification included in the AP1000 Generic Technical Specifications or in the site specific Technical Specifications included in the COL application.

This response is expected to be STANDARD for the S-COLAs.

ASSOCIATED BLN COL APPLICATION REVISIONS:
No COLA revisions have been identified associated with this response.

ASSOCIATED ATTACHMENTS/ENCLOSURES:

None