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From:	Ryan, William T III [wtryan@tva.gov]
Sent:	Tuesday, June 02, 2009 3:42 PM
To:	Joshi, Ravindra
Cc:	Sebrosky, Joseph; Spink, Thomas E; Sterdis, Andrea Lynn; Eddie.Grant@excelservices.com
Subject:	Email Courtesty Copy of NRC BLN RAI Response to Letter 157 (06-02-09)
Attachments:	RAI157 Response 05 29 09 Rev0 1510 - OGCfinal.pdf

Attached is a courtesy copy of BLN 3&4 RAI response letter sent to NRC on June 02, 2009. As always, the official submittal has been submitted to the Document Control Desk via paper copy using Federal Express services. The paper copy should arrive on June 3, 2009.

If you have any questions, please do not hesitate to call me.

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

June 02, 2009

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 – CONTAINMENT LEAKAGE TESTING

Reference: Letter from Ravindra G. Joshi (NRC) to Andrea L. Sterdis (TVA), Request for Additional Information Letter No. 157 Related to SRP Section 06.02.06 for the Bellefonte Units 3 and 4 Combined License Application, dated May 7, 2009.

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 Tom Ryan at 1101 Market Street, LP5A, Chattanooga, Tennessee 37402-2801, by telephone at (423) 751-2596, or via email at wtryan@tva.gov.

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

Executed on this 2nd day of June, 2009.

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

Enclosure
cc: See Page 2

cc: (w/Enclosure)
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Enclosure
TVA letter dated June 02, 2009
RAI Responses

Responses to NRC Request for Additional Information letter No. 157 dated May 7, 2009
(8 pages, including this list)

Subject: Containment leakage testing in the Final Safety Analysis Report

RAI Number	Date of TVA Response
06.02.06-02	This letter – see following pages
06.02.06-03	This letter – see following pages

Associated Additional Attachments / Enclosures	Pages Included
None	

NRC Letter Dated: May 7, 2009

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 06.02.06-02

BLN has requested an exemption from the requirements of 10 CFR 52, Appendix D, Subsection III.B, from complying with the requirements of the Generic Technical Specifications (TS), specifically Generic TS 5.5.8.c (as provided in the AP1000 DCD, Chapter 16). The request for this change is in TVA letter dated 2 February 2009, Bellefonte Combined License Application – Response to Request for Additional Information - LOCA DBA Dose Analysis. (ML0903504430)

10 CFR 52, Appendix D, Design Certification Rule for the AP1000 Design, subsection III.B requires that an applicant or licensee referencing this appendix incorporate by reference the generic Technical Specifications. The generic TSs, section 5.5.8 (c), Containment Leakage Rate Testing Program, state: The maximum allowable primary containment leakage rate, La, at post accident pressure, Pa, shall be 0.10% of primary containment air weight per day.

BLN requests an exemption from complying with the containment leak rate in the generic TSs in order to reduce the containment maximum allowable leakage leak rate below the SRP minimum value of 0.10%/day to 0.09% primary containment air weight per day. This is intended to be a site specific departure from the AP1000 DCD.

Per 10 CFR 50.12(a)(2), BLN invokes the special circumstances that: applying the AP1000 standard containment leakage rate in the DCD is not necessary to achieve the underlying purpose of the rules; and, compliance with the rule would necessitate expanding the exclusion area boundary, resulting in undue hardship or other costs significantly in excess of those contemplated when the regulation was adopted.

1. BLN is requested to provide additional discussion in support of their statement "application of the AP1000 standard containment leakage rate in the DCD is not necessary to achieve the underlying purpose of the rules." Provide BLN's understanding of the purpose of the rule.
2. The Staff requires a basis for evaluating how any potentially necessary expansion of the exclusion area boundary would result in undue hardship or other costs to BLN. Therefore, provide a quantitative description of the expansion of the exclusion area. Identify and provide an explanation of any associated hardship or other costs in excess of those contemplated when the regulation was adopted.

BLN RAI ID: 3333

BLN RESPONSE:

As indicated in the above question, the requested exemption from the AP1000 Generic TS 5.5.8.c, Containment Leakage Rate Testing Program, indicates that special circumstances apply to BLN, i.e., that: applying the AP1000 standard containment leakage rate in the DCD is not necessary to achieve the underlying purpose of the rule; and, compliance with the rule would necessitate expanding the exclusion area boundary, resulting in undue hardship or other costs significantly in excess of those contemplated when the regulation was adopted.

Additional information to support these statements is provided herein.

Applying the AP1000 standard containment leakage rate in the DCD is not necessary to achieve the underlying purpose of the rule

The AP1000 Generic TS 5.5.8.c, Containment Leakage Rate Testing Program, is included in 10 CFR Part 52, Appendix D, as a requirement of any application referencing the certified AP1000 design (see Appendix D, Section III.B). This requirement supports the methods and analyses identified by the

AP1000 design for meeting the requirements of 10 CFR Part 52, specifically § 52.17(a)(1)(ix). The regulation requires the evaluation of the offsite radiological consequence of the postulated fission product release, using the expected demonstrable containment leak rate and any fission product cleanup systems intended to mitigate the consequences of the accidents, together with applicable site characteristics, including site meteorology. The regulation requires that the associated evaluation must determine that:

> "(A) An individual located at any point on the boundary of the exclusion area for any 2 hour period following the onset of the postulated fission product release, would not receive a radiation dose in excess of 25 rem total effective dose equivalent (TEDE).
>
> (B) An individual located at any point on the outer boundary of the low population zone, who is exposed to the radioactive cloud resulting from the postulated fission product release (during the entire period of its passage) would not receive a radiation dose in excess of 25 rem TEDE."

The AP1000 design demonstrated conformance with this regulation through analyses utilizing an assumed containment leakage rate of 0.10 percent of primary containment air weight per day and the offsite atmospheric dispersion site parameters. TVA has similarly demonstrated conformance with this regulation by performing site specific dose analyses utilizing the AP1000 design, an assumed containment leakage rate of 0.09 percent of primary containment air weight per day, and its site specific atmospheric dispersion characteristics for the exclusion area boundary (EAB). The site specific analysis using a containment leak rate of 0.09 percent of primary containment air weight per day meets the requirements of 10 CFR § 52.17(a)(1)(ix).

Thus, conformance with 10 CFR Part 52, § 52.17(a)(1)(ix), 10 CFR 52 Appendix D, Section III.B, and the associated AP1000 Generic TS 5.5.8.c, Containment Leakage Rate Testing Program, leakage rate of 0.10 percent of primary containment air weight per day and the AP1000 generic assumed atmospheric dispersion parameters is not necessary to achieve the underlying purpose of these rule, i.e., to meet items (A) and (B) of 10 CFR 52.17(a)(1)(ix) .

Compliance with the rule would necessitate expanding the exclusion area boundary, resulting in undue hardship or other costs significantly in excess of those contemplated when the regulation was adopted

Since the regulation for exemptions only requires one of the criteria of § 50.12(a)(2) and the above discussion supports the applicability of 10 CFR § 50.12(a)(2)(ii), the discussion of undue hardship will be removed as shown below in the Application Revisions section. This revision will be included in a future amendment.

This response is PLANT-SPECIFIC.

ASSOCIATED BLN COL APPLICATION REVISIONS:

1. COLA Part 7, Section B, Exemptions, will be revised (from the wording added per Change 27 of the February 2, 2009, supplemental response to BLN-RAI-LTR-129) to delete the following sentence in exemption request 3 and in exemption request 4 with reference to the hardship criteria:

   Additionally, special circumstance (iii) is present, since compliance would necessitate expanding the exclusion area boundary, which would result in undue hardship or other costs that are significantly in excess of those contemplated when the regulation was adopted.

ASSOCIATED ATTACHMENTS/ENCLOSURES:

None

NRC Letter Dated: May 7, 2009

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 06.02.06-03

BLN has requested an exemption from complying with the containment leak rate in the generic TSs containment maximum allowable leakage rate of 0.10%/day. BLN requests to reduce this maximum allowable to 0.09%/day. Standard Review Plan 6.2.6, Containment Leakage Testing, Acceptance Criterion establishes the minimum acceptable leak rate of 0.10% per day. This limit supports the 10 CFR 100.11, Determination of the Exclusion Area, which requires that an applicant assume the expected demonstrable leakage rate from the containment. Nuclear power plant leakage rate testing experience shows that a design leakage rate of 0.10% per day provides adequate margin above typically measured containment leakage rates and is compatible with current leakage rate test methods and test acceptance criteria.

For reactors currently operating in the U.S., the maximum allowable leak rate, La, at accident pressure, Pa, ranges from 0.10 to 1.0% per day for PWRs, and, from 1.0 to 3.0% per day for BWRs.

In order for the staff to evaluate this exemption request, we will need a thorough justification of why this new lower leakage rate is expected and, particularly, how this new lower leakage rate would be demonstrated. Specifically:

1. Identify any AP1000 design features which support the feasibility that this design could demonstrate this new, lower, leak rate. Compare the number of electrical and mechanical penetrations for AP1000 with the penetrations for the currently operating Westinghouse 4-loop plants. Provide the maximum allowable leak rates, La, for those plants.

2. Discuss in detail the pressure, temperature and flow rate test accuracies for the test instruments intended to be used for the BLN types A, B, and C tests. Include a description in the FSAR. Show that these test instrument accuracies, including uncertainties, allow discrimination between 0.09% and 0.10% primary containment air weight per day. Confirm that these instruments are currently available. Also compare the accuracies for these test instruments with those specified in ANSI/ANS-56.8-1994, Containment System Leakage Testing Requirements.

3. Is there operating plant leak rate testing experience for types A, B and C tests that demonstrates the stated accuracy can be achieved? Provide maximum allowable leak rates and measured leak rates for the operating experience. Identify whether these are for personnel hatches, type C, or cumulative tests.

BLN RAI ID: 3334

BLN RESPONSE:

Item 1: Feasibility of the postulated leak rate for the AP1000 design

A survey was performed on the current operating 4-Loop PWR plants in the US to determine that the current plants typically have on the order of 200 containment penetrations total. This compares with only 65 for the AP1000, which represents a 67% reduction in the total number of penetrations. Since, historically, containment leakage is almost always from the mechanical penetrations and their associated pathways, one would expect a significant reduction in total containment leakage rate from the AP1000 compared to the existing 4-Loop PWR plants.

Electrical penetrations typically have individual leakage limits. These limits are a tiny fraction of the total containment leakage limit and show that the electrical penetrations contribution to the total containment leakage is negligible.

With regards to the equipment hatch seals and leakage testing system:
The hatch cover flanges for the main equipment and maintenance hatches have testable seals as shown in Figure 3.8.2-2 of the AP1000 DCD. Figure 6.2.5-1 of the AP1000 DCD provides the piping and instrumentation diagram for the containment leak rate test system and illustrates examples of containment penetrations subject to Type B tests. The equipment hatch design configuration for the BLN Units 3&4 is similar to that currently installed at operating plants.

Subsection 3.8.2.1.3 of the DCD, "Equipment Hatches," states:
Two equipment hatches are provided. One is at the operating floor (elevation 135′-3″) with an inside diameter of 16 feet. The other is at floor elevation 107′-2″ to permit grade-level access into the containment, with an inside diameter of 16 feet. The hatches, shown in Figure 3.8.2-2, consist of a cylindrical sleeve with a pressure seated dished head bolted on the inside of the vessel. The containment internal pressure acts on the convex face of the dished head and the head is in compression. The flanged joint has double O-ring or gum-drop seals with an annular space that may be pressurized for leak testing the seals.

It is therefore concluded that the AP1000 equipment hatches should have comparable performance characteristics to current similar in-service configurations that have shown leakages are low during local and integrated leak rate testing.

The discussion of maximum allowable La values is provided in the reply to item #3 of the RAI.

<u>Item 2: Test instrument accuracy</u>

The incorporated by reference DCD Subsection 6.2.5.2.4 states "The instrument accuracy must meet the criteria of Reference 13." Reference 13 is ANSI/ANS-56.8-1994, "Containment System Leakage Testing Requirements." The following information is provided to show how the information CONTAINMENT LEAKAGE TESTING provided in the response to Item 1is used in the referenced standard to justify the BLN request.

The following provides the Instrumentation Selection Guide (ISG) applied to the AP1000. The formula used and its derivation are shown in ANSI/ANS-56.8-1987, Attachment G. The formula in ANSI/ANS-56.8-1987, Attachment G was dropped from the later 1994 and 2002 standards because it was realized that the reference criterion was always met if the instrument numbers and accuracies specified elsewhere in the standard were met. However, the formula remains a technically sound method to calculate the ability of an instrumentation system to measure containment leakage, even though it was deemed no longer needed in the standard.

The Instrumentation Selection Guide (ISG) formula is the method used to measure the ability of an instrumentation system to calculate the integrated leakage rate of a primary reactor containment system.

The ISG is given by:

$$ISG = \frac{2400}{t}\left[2\left(\frac{e_p}{P}\right)^2 + 2\left(\frac{e_T}{T}\right)^2 + 2\left(\frac{e_{pv}}{P}\right)^2\right]^{1/2}$$

Where,

ISG - instrumentation selection guide, %/day

t - Test duration, hours

e_p - Error associated with pressure measurement, psia

e_T - Error associated with temperature measurement, R

e_{pv} -Error associated with water vapor pressure measurement, psia

P - Containment atmosphere total absolute pressure, psia

T - Containment atmosphere volume weighted absolute dry bulb temp, R

The error associated with each parameter can be divided into two components:

1. Sensor sensitivity error (E)
2. Measurement system error (ε)

Where multiple independent measurements of a given parameter are taken with sensors of equal precision, the error associated with the average of the multiple measurements equals the error of the individual sensor divided by the square root of the number of sensors.

Thus, the error associated with pressure measurement is given by:

$$e_P = \pm\sqrt{\frac{(E_P)^2 + (\varepsilon_P)^2}{no.\ of\ sensors}}$$

The error associated with temperature measurement is given by:

$$e_T = \pm\sqrt{\frac{(E_T)^2 + (\varepsilon_T)^2}{no.\ of\ sensors}}$$

The error associated with vapor pressure measurement is given by:

$$e_{P_v} = \pm\sqrt{\frac{\left(E_{P_v}\right)^2 + \left(\varepsilon_{P_v}\right)^2}{no.\ of\ sensors}}$$

The instrumentation system envisioned for the AP1000 would use two pressure transmitters, 30 temperature sensors, and 10 humidity sensors.

The digital systems in use today are complete systems in themselves, so that there is essentially no system error; this value may be set to zero.

The actual sensor accuracies now exceed those minimum listed in the standards. Pressure is measured to 0.01 psi, temperature to 0.2 F and dew point to 1 F. Based upon these numbers and typical values such as a test pressure of 72.6 psia, an average containment temperature of 80 F, and a dew point of 50 F, a total measurement system ISG of 0.0518 %/day may be expected for an 8 hour test. Please note that the final value is a linearly decreasing function of test time. The ISG may be lowered to whatever value desired by simply increasing the test time.

Since the instrumentation accuracy requirement/description is already provided in the DCD and the instrumentation is confirmed to be currently available, and not atypical of instrumentation in use at operating plants (see item 3 below), no additional FSAR description is included.

Item 3: Accuracy Attainability

U.S. water cooled nuclear reactors are required to follow 10 CFR Part 50, Appendix J, for determining their primary containment testing requirements. Section III.A.4 of that regulation requires that a reduced pressure integrated leak rate test be performed as a part of the preoperational testing sequence. This test is required to be performed at a pressure Pt, not less than 0.50 Pa, where Pa is the calculated peak accident pressure listed in the plant's technical specifications. The stated acceptance criteria for this reduced pressure test is listed as either a value less than 70% of La or equal to $La*(Pt/Pa)^{0.5}$. Thus, Lt may be approximated as being equal to 70% of La.

In the case of a typical 4-loop PWRs with a La equal to 0.1 %/day, this is an acceptance criterion of 0.07 %/day. This test was required of plants that did not take an exception or exemption to this federal regulation. These measurements were made using the same instruments and methodology as those used to perform full pressure tests, which had acceptance criteria of 0.1 %/day. Actual measurements for these tests have been below 0.07 %/day as shown in the tabular information below.

Thus, ample precedents from decades of industry-wide preoperational testing exist to support the ability to successfully measure a containment leakage against an acceptance criterion of less than 0.09 %/day.

Airlock hatches, while often one of the largest of the containment penetrations, have historically been very small contributors to the total containment leakage. Airlocks have their own individual leakage limits which are typically less than 5% of the total limit. Also, they are spot checked for leakage in between Type B tests by the performance of low pressure leakage rate tests on the seals. Based upon this information, the number of airlock hatches would be expected to have a negligible effect on the total containment leakage rate.

The value of La is defined in plant technical specifications in units of percent per day. This is the percent of the mass of air contained in containment if it were pressurized with dry air at peak accident pressure defined in plant technical specifications (Pa), at a bulk containment temperature of Tc (Type A test air temperature). Based upon the information in ANS 56.8-2002, the relationship between La in units of %/day and actual engineering units may be given by the below equation.

$$scfm = \%/day * (4010.256 * Tc)/((Pa+14.6959)*Vc)$$

Where:

- %/day is the value of La listed in plant tech specs
- Tc is the average containment temperature during the Type A test in units R
- Pa is the plant's peak accident pressure listed in tech specs in units of psig
- Vc is the total containment free air volume, ft^3
- scfm is the maximum allowable leakage rate of La in units of scfm

Using this correlation, the below plants may be shown to have containment leakage limits in actual engineering units significantly less than the AP1000 with an La of 0.1 or 0.09 %/day.

Plant	La, %/day	La, scfm
AP1000 (DCD)	0.10	6.9
AP1000 (Exemption)	0.09	6.21
D.C. Cook 1 and 2	0.25	3.9
Sequoyah 1 and 2	0.25	3.8
Watts Bar 1	0.25	4.2

The leakage rate in engineering units is the basis for the limits that need to be met for the cumulative Type C testing limits. Thus, these three plants have been meeting both Type A and cumulative Type C limits lower than those proposed for the AP1000.

In addition, these plants have shown the ability to not only meet these limits but to show actual leakage rates less than half of the limits as shown in the below table.

PLANT	Pa, (psig)	Vc, (ft3)	La, (%/day)	La, (slm)	La, (scfm)	Typical Type A, %/day	Typical 0.6 La, %/day
DC Cook 1 and 2	12.0	1,235,000	0.250	110.4	3.9	0.090	0.040
Diablo 1 and 2	43.5	2,550,000	0.100	198.8	7.0	0.025	0.009
Indian Point 1 and 2	47.0	2,610,000	0.100	215.8	7.6	0.048	0.021
Sequoyah 1 and 2	12.0	1,192,220	0.250	106.6	3.8	0.090	
Watts Bar 1	15.0	1,200,000	0.250	119.4	4.2	0.125	0.063
AP1000	57.9	2,000,000	0.100	194.5	6.9	NA	NA
AP1000 BLN 3&4	57.9	2,000,000	0.09	175.8	6.21	NA	NA

This response is PLANT-SPECIFIC.

ASSOCIATED BLN COL APPLICATION REVISIONS:

No COLA revisions have been identified associated with this response.

ASSOCIATED ATTACHMENTS/ENCLOSURES:

None