Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402

CNL-18-097

July 27, 2018

10 CFR 50.4
10 CFR 50 90

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

Browns Ferry Nuclear Plant, Units 1, 2, and 3
Renewed Facility Operating License Nos. DPR-33, DPR-52, and DPR-68
NRC Docket Nos. 50-259, 50-260, 50-296, and 72-052

Subject: Tennessee Valley Authority Response to NRC Request for Additional Information (Round 2) Related to BFN Application to Revise Technical Specification 5.5.12 "Primary Containment Leakage Rate Testing Program" (BFN-TS-497)

References:

1. Letter from TVA to NRC, CNL-17-056, "Application to Revise Technical Specification 5.5.12 'Primary Containment Leakage Rate Testing Program' (BFN-TS-497)," dated August 15, 2017 (ML17228A490)
2. Letter from NRC to TVA, "Browns Ferry Nuclear Plant Units 1, 2, and 3 - Request for Additional Information related to License Amendment Request to Revise Technical Specification 5.5.12 'Primary Containment Leakage Rate Testing Program' (CAC Nos. MG0113, MG0114, and MG0115; EPID L-2017-LLA-0292)," dated January 25, 2018 (ML18010B055)
3. Letter from TVA to NRC, CNL-18-011, "Tennessee Valley Authority Response to NRC Request for Additional Information Related to BFN Application to Revise Technical Specification 5.5.12 'Primary Containment Leakage Rate Testing Program' (BFN-TS-497)," dated February 5, 2018 (ML18036A901)
4. Letter from TVA to NRC, CNL-18-032, "Tennessee Valley Authority Response to NRC Request for Additional Information (Set 2) Related to BFN Application to Revise Technical Specification 5.5.12 'Primary Containment Leakage Rate Testing Program' (BFN-TS-497)," dated March 27, 2018 (ML18087A426)
5. Electronic Mail from NRC to TVA, "Browns Ferry Nuclear Plant Units 1, 2, and 3 - 2nd Round RAI related to LAR to Revise Technical Specification 5.5.12 'Primary Containment Leakage Rate Testing Program' (CAC NOS. MG0113-5; EPID L-2017-LLA-0292)," dated June 15, 2018 (ML18169A012)

In Reference 1, Tennessee Valley Authority (TVA) submitted a License Amendment Request (LAR) to the Nuclear Regulatory Commission (NRC) to revise Browns Ferry Nuclear Plant Units 1, 2, and 3 (BFN) Technical Specification 5.5.12 "Primary Containment Leakage Rate Testing [ILRT] Program," to adopt Nuclear Energy Institute (NEI) 94-01, Revision 3-A, "Industry Guideline for Implementing Performance-Based Option of Title 10 of the Code of Federal Regulations (10 CFR) Part 50, Appendix J," as the implementation document for the performance-based Option B of 10 CFR Part 50, Appendix J.

In Reference 2, the NRC transmitted a Request for Additional Information (RAI) related to the Reference 1 LAR. In References 3 and 4, TVA provided the responses to the Reference 2 RAIs. In Reference 5, the NRC transmitted a second round of RAIs related to the Reference 1 LAR with a requested due date of July 31, 2018. The Enclosure to this letter contains TVA's response to the Reference 5 RAIs.

Consistent with the standards set forth in 10 CFR 50.92(c), TVA has determined that the additional information, as provided in this letter, does not affect the no significant hazards determination associated with the request provided in Reference 1.

There are no new regulatory commitments contained in this submittal. If you have any questions concerning this submittal, please contact Edward Schrull at (423) 751-3850.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 27th day of July 2018.

Sincerely,

Erin K. Henderson
Director, Nuclear Regulatory Affairs

Enclosure:

TVA Response to NRC Request for Additional Information

cc (Enclosures):
NRC Regional Administrator - Region II
NRC Senior Resident Inspector - Browns Ferry Nuclear Plant
NRC Project Manager - Browns Ferry Nuclear Plant
State Health Officer, Alabama State Department of Public Health

Enclosure
TVA Response to NRC Request for Additional Information

By letter dated August 15, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17228A490)), as supplemented by letters dated February 5 and March 27, 2018 (ADAMS Accession Nos. ML18036A901 and ML18087A426, respectively) Tennessee Valley Authority submitted a license amendment for Browns Ferry Nuclear Plant Units 1, 2, and 3. The proposed amendment would revise Browns Ferry's Technical Specification 5.5.12 "Primary Containment Leakage Rate Testing Program," by adopting Nuclear Energy Institute 94-01, Revision 3 A, "Industry Guideline for Implementing Performance-Based Option of 10 CFR [Title 10 of the Code of Federal Regulations] Part 50, Appendix J," as the implementation document for the performance-based Option B of 10 CFR Part 50, Appendix J. The proposed changes would allow the licensee to extend the Type A containment integrated leak rate testing interval from 10 to 15 years and the Type C local leakage rate testing intervals from 60 to 75 months.

The U.S. Nuclear Regulatory Commission (NRC) staff reviewed the licensee's submittals and determined that a second round of request for additional information (RAI), as described in the attached document, is needed to complete its review. On May 23, 2018, the NRC staff emailed you the draft RAIs. On May 24, 2018, the NRC staff discussed draft RAIs to confirm your understanding of the information that the NRC staff needs to complete the evaluation. Consequently, you informed the project manager for Browns Ferry you have decided to provide response to option "a" in APLA RAI 2-1. Therefore, you have proposed to submit your responses by July 31, 2018 (longer than usual 30 days for response time). The NRC staff agreed with your proposed response date of July 31, 2018.

APLA RAI 02-01

In review of the licensee's response to APLA RAI 02, dated March 27, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18087A426), the licensee updated the total large early release frequency (LERF) risk values across Units 1, 2, and 3 in Table 34 to incorporate the approved NRC methodology that provides guidance to address the credit taken for very early warning fire detection system (VEWFDS) in NUREG-2180, "Determining the Effectiveness, Limitations, and Operator Response for Very Early Warning Fire Detection Systems in Nuclear Facilities (DELORES-VEWFIRE), Final Report" (ADAMS Accession No. ML16343A058). The licensee stated that incorporation of NUREG-2180 identified three fire areas impacted in the fire probabilistic risk analysis (FPRA) model where the incipient fire detection failure rate was increased from 0.0199 using guidance in NUREG/CR-6850, Supplement 1, "Fire Probabilistic Risk Assessment Methods Enhancements" (ADAMS Accession No. ML103090242), to 0.53 using the guidance in NUREG-2180.

The licensee under Table 34 (NUREG-2180) in its response dated March 27, 2018, provided the total LERF values with NUREG-2180 considered. The total LERF results for internal events (IE) and external events (EE) combined were 1.20E-05/year, 1.31E-05/year, and 1.13E-05/year for Units 1, 2, and 3, respectively. The risk contribution from EE includes the effects of internal fires, seismic events, high winds, floods, and other external hazards. Table 33 in the response provides the risk metrics for increase in total LERF for IE and EE combined. The increase in total LERF, which included incorporation of NUREG-2180, was 3.05E-07, 3.38E-07, and 2.27E-07 for Units 1, 2, and 3, respectively. While the increase in total LERF remains within the acceptance criteria range of 1.0E-07 per reactor year to 1.0E-06 per reactor year, Regulatory Guide (RG) 1.174, Revision 3 (ADAMS Accession No. ML17317A256), Section 2.4, "Acceptance Guidelines," provides further guidance that states, in part,

- *When the calculated increase in LERF is in the range of 10^{-7} per reactor year to 10^{-6} per reactor year (i.e., the increase in LERF falls within Region II of Figure 5), applications are considered only if it can be reasonably shown that the total LERF is less than 10^{-5} per reactor year.*

These guidelines are intended to provide assurance that proposed increases in CDF [core damage frequency] and LERF are small and are consistent with the intent of the Commission's Safety Goal Policy Statement.

RG 1.174, Section 6.3.1, "Risk Assessment Methods," further states:

To generate confidence in the risk assessment used to support the proposed change, the licensee should submit a summary of the risk assessment methods used. Licensees should submit the following information to show that the engineering analyses conducted to justify the proposed licensing basis change are appropriate to the nature and scope of the change. [The RG provides such information to include:]

- *Information related to the assessment of the full-scope base LERF (the extent of the information needed depends on whether the analysis of the change in LERF is in Region II or Region III of Figure 5).*

- *Results of sensitivity analyses showing that the conclusions as to the impact of the licensing basis change on plant risk do not vary significantly under a different set of plausible assumptions; and*

- *Information related to issues identified in Section C.2.6 if the risk metrics approach the acceptance guidelines.*

a. The licensee in response to APLA RAI 02 discussed conservative treatment of the 3 fire compartments impacted, and potential modifications of the FPRA modeling practices that include: (1) refinements of the ignition sources of the fire compartments that are expected to produce significant risk reductions, and (2) additional walkdowns that could result in further refinement of cabinet grouping and decreased heat release rates. To address the exceedance of the total LERF for IE and EE combined, the licensee stated that "TVA expects that the current on-going refinements will reduce the CDF and LERF values to close to those originally submitted in the LAR." The total LERF values for IE and EE combined provided in the LAR submittal, dated August 15, 2017 (ADAMS Accession No. ML17228A490), were within the RG 1.174 acceptance criteria (i.e., less than 1.0E-05) for applications where the calculated increase in LERF for the change were in the small range.

Provide a summary and results (i.e., ΔLERF, conditional containment failure probability (CCFP), population dose rate (PDR), total LERF) of a sensitivity analysis as described in the RG 1.174 excerpt above that addresses the potential FPRA modeling refinements described in the response to APLA RAI 02 where it can be reasonably shown quantitatively that either the increase in LERF is in the very small range (less than 1.0E-07) or the increase in LERF is in the small range (10^{-7} per reactor year to 10^{-6} per reactor year) and the total LERF is below 1.0E-05. The sensitivity analysis should include incorporation of the NRC-accepted methodology *described in NUREG-2180 and all other applicable changes made in response to RAIs provided in the letters dated February 5, 2018 (ADAMS Accession No. ML18036A901), and March 27, 2018 (ADAMS Accession No. ML18087A426), to ensure use of the state-of-art methodology consistent with the 1995 Commission's PRA Policy Statement for the "Use of Probabilistic Risk Assessment Methods in Nuclear Regulatory Activities (60 FR 42622, August 16, 1995).*

Note, if the sensitivity analysis credits compensatory measures, such as deployment of FLEX equipment, discuss how these compensatory measures were credited in the sensitivity analysis consistent with RGs 1.174, 1.177 and 1.200, and NRC's assessment, dated May 30, 2017, of Nuclear Energy Institute (NEI) 16-06, "Crediting Mitigating Strategies in Risk-Informed Decision Making" (ADAMS Accession No. ML17031A269), including:

- *Discuss the conservatisms in the analysis.*
- *Discuss which accident scenarios were credited for the compensatory measures.*
- *Discuss the systems, structures, and components (SSCs) and operator actions associated with the credited compensatory measures, including whether the equipment needs to be relocated and installed before using.*
- *Discuss the procedures and guidance associated with employing the credited compensatory measures.*
- *Explain how the failure rates/probabilities of SSC failures (e.g., random failures, unavailability due to testing and maintenance) associated with the compensatory measures' setup and operation were estimated.*
- *Explain how the timelines for operator actions were established. Describe the cues or indications operators will use to initiate use of credited compensatory measures and how the time available and time required to complete operator actions were estimated.*

OR

b.1 Section V, "Guidelines for Regulatory Implementation," of the 1986 Commissioner's Safety Goal Policy Statement (51 FR 28044; August 4, 1986 as corrected and republished at 51 FR 30028; August 21, 1986) explicitly states, in part, "if pursuant to these guidelines, information is developed that is applicable to a particular licensing decision, it may be considered as one factor in the licensing decision." In addition, RG 1.174 states in part, "[w]hen the assessments of the risk implications from different hazard groups must be combined, it is important to understand the relative level of realism associated with the modeling of each of the hazard groups."

In review of the risk metrics provided by the licensee in Table 34 (NUREG-2180) in response to APLA RAI 02 for total LERF, the NRC staff has considered a holistic and complete approach of the Browns Ferry Nuclear Plant (BFNP) facility operating licensing changes for Units 1, 2, and 3 as a result of other regulatory initiatives to assure the PRA reflects the appropriate level of realism to support the ILRT extension.

Clarify whether the internal events PRA (IEPRA) and FPRA models used to perform the risk evaluation to support the ILRT extension credit FLEX equipment. For the FLEX equipment not credited in the IEPRA and FPRA models, discuss how the *equipment provides an additional layer of defense-in-depth relative to CDF/LERF. Include in this discussion whether the FLEX equipment is applicable to a specific unit or all three units and the modification to install the equipment has been completed. In addition, confirm whether the Emergency High Pressure Injection system has been credited in the IEPRA and FPRA models used for this evaluation.*

AND

b.2 It can be presumed that one of the postulated worst case scenario(s) for large early release with vessel failure occurrence is predominately driven by events that result in station blackout (SBO) sequences with an extended loss of offsite power.

Provide discussion of sequences resulting in SBO occurrences that lead to LERF and include the contribution to total LERF (percentage) for each PRA hazard as a result of those sequences modeled in the IEPRA and FPRA models. In the summary, include the model revision(s)/name used to determine the contribution to LERF percentage in the IEPRA and FPRA models.

AND

b.3 In response to APLA RAI 06.b in letter dated February 5, 2018, TVA proposed a license condition that stated,

> *Prior to extending the frequency for the Integral Leakage Rate Testing described in TS 5.5.12, the licensee shall implement the modifications, that are modeled in the Fire PRA and described in Table S-2, “Plant Modifications,” of Tennessee Valley Authority letter CNL-17-024, dated June 7, 2017.*

RG 1.174 states, in part,

> *However, licensees should not consider that the acceptance guidelines have been met if the risk metrics exceed the acceptance guidelines when implementing self-approval processes. If the risk associated with changes identified in self-approval processes exceeds the acceptance guidelines, licensees may submit additional information for NRC review and approval consistent with this guide.*

Supplement the above proposed license condition to include incorporation of the planned FPRA changes for (1) refinements of the ignition sources of the fire compartments that are expected to produce significant risk reductions, and (2) additional walkdowns that could result in further refinement of cabinet grouping and decreased heat release rates discussed in the licensee’s response to APLA RAI 02 (in letter dated March 27, 2018). Upon completion of Table S-2, “Plant Modifications” and incorporation of the FPRA modeling refinements and NUREG-2180, and prior to extending the frequency for the ILRT for each Unit, ensure that the risk metrics remain below the ILRT acceptance criteria for delta LERF, population dose rate (PDR), conditional containment failure probability (CCFP) and total LERF (i.e., only applicable if delta LERF is in the small range per RG 1.174). Also, propose a mechanism within the license condition consistent with RG 1.174, Revision 3 that if the updated risk associated with changes identified in the self-approval processes *exceeds the acceptance guidelines, TVA will submit additional information for NRC review and approval consistent with the EPRI Report 1009325, Revision 2-A and RG 1.174, Revision 3 guidance prior to extending the frequency for the ILRT.*

TVA RESPONSE TO APLA RAI 02-01 Option "a"

APLA RAI 02-01 provides two alternative pathways, "a" and "b" for response. As stated in the RAI, following a discussion with the NRC staff on May 24, 2018, TVA chose to provide the "a" pathway RAI response. No discussion of the "b" pathway is needed or provided.

In response to this RAI, TVA revised the fire PRA (FPRA) model to incorporate the approved NRC methodology in NUREG-2180, considered all other applicable changes in response to the noted RAIs, and included the FPRA modeling refinements as mentioned in the response to APLA RAI 02 (Reference 1). The results of the sensitivity analysis show that the increase in LERF continues to be in the small range (10^{-7} per reactor year to 10^{-6} per reactor year) and the total LERF became less than 1.0E-05 per reactor year (rx-yr), which is consistent with the guidance in RG 1.174, Revision 3, for extending the frequency for the ILRT.

The note contained in the "a" pathway RAI indicated that if the requested sensitivity analysis credits compensatory measures such as deployment of FLEX equipment, then certain additional information must be provided. Compensatory measures such as deployment of FLEX equipment were not credited, therefore it was not necessary to provide the information requested for that case.

As discussed in the Reference 1 APLA RAI 02 response, NUREG-2180 affects the BFN FPRA model via changes in incipient detection failure rates for fire compartments 16-K, 16-M, and 16-O, which are the only compartments that credited incipient detection. The RAI response also indicated that ongoing refinements were expected to offset much of the effect of the changes attributable to incorporation of NUREG-2180 information for fire compartments 16-K, 16-M and 16-O. This expectation has proven to be the case.

The BFN FPRA model was updated to incorporate NUREG-2180 and to perform detailed fire modeling refinements to create new scenarios based on actual locations of risk significant targets (or ignition of a combustible) and intermediate damage states that damage non-risk significant targets. In addition to the fire modeling refinements, the FPRA model was revised to remove conservatisms in the human failure events (HFE) timings and address HFE combinations that were conservatively not recognized in the model. The HFE combinations were refined for CDF but were not refined for LERF.

The FPRA model was quantified and the new results for compartments 16-K, 16-M and 16-O were substituted for the previous results for those areas in the information previously reported.

The inclusion of the results from the sensitivity study as proposed in option "a" resulted in all figures of merit (ΔLERF <1.0E-06/rx-yr and Total LERF <1.0E-05/rx-yr) being acceptable in accordance with the acceptance guidelines in RG 1.174, Revision 3 and the EPRI Guidance document (ΔPDR <1.0 person-rem/rx-yr and ΔCCFP <1.5%).

The following discussion provides the quantitative results of the sensitivity analysis in the same format as provided in the response to APLA RAI 02. However, the "base case" starting point is the "2180" tables. That is, Tables 31, 32, and 33 provide sequential information necessary to obtain the final results of total LERF/year, which are contained in Table 34.

In the response to APLA RAI 02, the NUREG-2180 values for incipient detection were used in the Browns Ferry FPRA evaluation. This evaluation started by incorporating the changes to include NUREG-2180 and a sensitivity study was performed that included refinements to the three fire compartments that credited incipient detection. The following table provides the FPRA results for CDF and LERF for both cases, i.e., the “2180” case (Reference 1) and the results of the current sensitivity analysis.

FPRA Refinement Results

	CDF/rx-yr			LERF/rx-yr		
	Unit 1	Unit 2	Unit 3	Unit 1	Unit 2	Unit 3
RAI 02 (“2180”)[1]	7.48E-05	7.81E-05	7.25E-05	8.95E-06	9.43E-06	7.57E-06
RAI 02-01	5.63E-05	6.16E-05	6.10E-05	6.84E-06	6.41E-06	5.62E-06

[1] Reference 1, Tables 1, 2 and 3.

In addition, a conservatism was removed with respect to the High Winds LERF contribution. In the response to APLA RAI 02, the Seismic CDF/LERF ratio was used, which is over conservative, because Seismic events can reasonably be assumed to cause common cause failures that would not be expected from a High Winds initiator. The weather related-LOOP event, compared to other LOOP events (e.g., plant centered, switchyard), includes relatively long recovery times due to the expected extensive repair work that would be required to restore power to the plant. The following values were taken from the quantified internal events weather-related Loss of Offsite Power (LOOP) event.

High Winds Contribution to LERF

	CDF/rx-yr			LERF/rx-yr		
	Unit 1	Unit 2	Unit 3	Unit 1	Unit 2	Unit 3
RAI 02 (“2180”)[1]	1.0E-06	1.0E-06	1.0E-06	2.98E-07	3.14E-07	3.08E-07
RAI 02-01	1.0E-06	1.0E-06	1.0E-06	9.46E-08	7.82E-08	1.49E-07

[1] Reference 1, Table 31 (2180)

<u>Table 31</u>

Table 31 provides the contribution to CDF and LERF from External Events (EE), Internal Events (IE), and the combined (EE+IE). The following tables provide the comparative results for CDF and LERF for the “2180” case and the results of the current sensitivity analysis.

Table 31 (“2180” from RAI 02 in Reference 1)

Hazard	CDF/rx-yr			LERF/rx-yr			Comment/Source
	Unit 1	Unit 2	Unit 3	Unit 1	Unit 2	Unit 3	
Seismic	3.70E-06	5.40E-06	5.40E-06	1.10E-06	1.70E-06	1.66E-06	Includes response to RAI 01b (Reference 2)
Fire	7.48E-05	7.81E-05	7.25E-05	8.95E-06	9.43E-06	7.57E-06	includes NUREG-2180 inputs
High Winds	1.00E-06	1.00E-06	1.00E-06	2.98E-07	3.14E-07	3.08E-07	Includes response to RAI 01b (Reference 2)
Other Hazards	Screened	Screened	Screened	Screened	Screened	Screened	IPEEE
External Events Total	7.95E-05	8.45E-05	7.89E-05	1.03E-05	1.14E-05	9.54E-06	
Internal Events	6.93E-06	6.29E-06	7.72E-06	1.26E-06	1.21E-06	1.45E-06	From Table 2 of the LAR (Reference 3)
Combined	8.64E-05	9.08E-05	8.66E-05	1.16E-05	1.27E-05	1.10E-05	

Table 31 RAI 02-01

Hazard	CDF/rx-yr			LERF/rx-yr			Comment/Source
	Unit 1	Unit 2	Unit 3	Unit 1	Unit 2	Unit 3	
Seismic	3.70E-06	5.40E-06	5.40E-06	1.07E-06	1.70E-06	1.65E-06	GI-199 App D (CDF) and Eq 33 (LERF)
Fire	5.63E-05	6.16E-05	6.10E-05	6.84E-06	6.41E-06	5.62E-06	includes NUREG-2180 inputs and fire compartment refinements
High Winds	1.00E-06	1.00E-06	1.00E-06	9.46E-08	7.82E-08	1.49E-07	CDF Assumed, LERF-Weather Related LOOP
Other Hazards	Screened	Screened	Screened	Screened	Screened	Screened	IPEEE
External Events Total	6.10E-05	6.80E-05	6.74E-05	8.00E-06	8.19E-06	7.43E-06	
Internal Events	6.93E-06	6.29E-06	7.72E-06	1.26E-06	1.21E-06	1.45E-06	From Table 2 of the LAR (Reference 3)
Combined	6.79E-05	7.43E-05	7.51E-05	9.26E-06	9.40E-06	8.87E-06	

The RAI 02-01 table includes the following changes:

- The Seismic contribution to LERF includes the data from the response to APLA RAI-01b in Reference 2
- Revised CDF and LERF inputs are from the NUREG-2180 impact sensitivity study
- The High Winds contribution is based on a weather-induced LOOP initiator
- Rounding has been removed

<u>Table 32</u>

Table 32 provides the data for EPRI Class 3b, which represents those sequences that could result in a Large Early Release for the Original Licensing Bases (3 tests / 10 years), the Current Licensing Basis (1 test / 10 years) and the Proposed Licensing Basis (1 test / 15 years). The delta from the Original Licensing Basis (OLB) to the Proposed Licensing Basis (PLB) represents the LERF increase for the proposed CILRT extension.

Table 32 ("2180" from RAI 02 in Reference 1)

Contributor	Original Licensing Basis			Current Licensing Basis			Proposed Licensing Basis			LERF Increase[1]		
	Unit 1	Unit 2	Unit 3	Unit 1	Unit 2	Unit 3	Unit 1	Unit 2	Unit 3	Unit 1	Unit 2	Unit 3
Internal (3b) from Tables 27 - 29	8.27E-09	8.07E-09	7.48E-09	2.76E-08	2.69E-08	2.49E-08	4.14E-08	4.04E-08	3.74E-08	3.31E-08	3.23E-08	2.99E-08
EE / IE Ratio	8.21	9.46	6.58	8.21	9.46	6.58	8.21	9.46	6.58	8.21	9.46	6.58
EE Contribution to 3b	6.79E-08	7.63E-08	4.92E-08	2.26E-07	2.54-07	1.64E-07	3.40E-07	3.82E-07	2.46E-07	2.72E-07	3.05E-07	1.97E-07
Combined	7.62E-08	8.44E-08	5.67E-08	2.54E-07	2.81E-07	1.89E-07	3.81E-07	4.22E-07	2.84E-07	3.05E-07	3.38E-07	2.27E-07

[1] Associated with the change from the baseline 3 tests / 10 years to the proposed 1 test / 15 years

The values for Internal Events (IE) are based on inputs from the quantified Model of Record used and documented in the original submittal (Reference 3, Tables 27 - 29). To determine the contribution of External Events (EE) hazards on the Class 3b frequencies, a ratio was calculated using the LERF (EE ÷ IE) data from Table 31, which was then multiplied by the Internal Events Class 3b frequencies.

The revised Table 32 for the response to RAI 02-01 represents the results of multiplying the Internal Events 3b frequencies by the ratios described above, resulting in the External

Events and External Events contributions to Class 3b are summed to provide the combined change in the LERF. The LERF increase (Class 3b) represents the delta from the 1 test / 15 years frequency and the 3 tests / 10 years frequency.

Table 32 RAI 02-01

Contributor	Original Licensing Basis			Current Licensing Basis			Proposed Licensing Basis			LERF Increase[1]		
	Unit 1	Unit 2	Unit 3	Unit 1	Unit 2	Unit 3	Unit 1	Unit 2	Unit 3	Unit 1	Unit 2	Unit 3
Internal (3b) from Tables 27 - 29	8.27E-09	8.07E-09	7.48E-09	2.76E-08	2.69E-08	2.49E-08	4.14E-08	4.04E-08	3.74E-08	3.31E-08	3.23E-08	2.99E-08
EE / IE Ratio	6.37	6.77	5.14	6.37	6.77	5.14	6.37	6.77	5.14	6.37	6.77	5.14
EE Contribution to 3b	5.27E-08	5.46E-08	3.84E-08	1.75E-07	1.82E-07	1.28E-07	2.63E-07	2.73E-07	1.92E-07	2.11E-07	2.19E-07	1.54E-07
Combined	6.10E-08	6.27E-08	4.59E-08	2.03E-07	2.09E-07	1.53E-07	3.05E-07	3.13E-07	2.30E-07	2.44E-07	2.51E-07	1.84E-07

1 Associated with the change from the baseline 3 tests / 10 years to the proposed 1 test / 15 years

Table 33

Table 33 summarizes the change in risk for LERF, PDR and CCFP. The following tables provide the comparative results for LERF, PDR, and CCFP for the "2180" case (Reference 1) and the results of the current sensitivity analysis.

Table 33 ("2180" from RAI 02 in Reference 1)

Contributor	ΔLERF/rx-yr[1]			PDR ΔPerson-REM/rx-yr (% Increase)[2, 3]						ΔCCFP[4, 5]		
	Unit 1	Unit 2	Unit 3	Unit 1		Unit 2		Unit 3		Unit 1	Unit 2	Unit 3
Internal Events	3.31E-08	3.23E-08	2.99E-08	4.71E-02	0.69%	4.84E-02	0.84%	4.26E-02	0.48%	1.08%	1.16%	0.87%
External Events	2.72E-07	3.05E-07	1.97E-07	3.87E-01	5.70%	4.58E-01	7.98%	2.80E-01	3.19%			
Combined	3.05E-07	3.38E-07	2.27E-07	4.34E-01	6.39%	5.06E-01	8.82%	3.23E-01	3.67%	1.08%	1.16%	0.87%
Acceptance Guideline	<1.0E-06/rx-yr (Small)			<1.0 person-rem/rx-yr or <1.0% (Whichever is Less Restrictive)						<1.5%		

1 Internal Events ΔLERF is a direct input from the Table 32 results (RAI-02 response in Reference 1)
2 ΔPDR (Internal Events) is carried over from Tables 27 - 29 for Units 1, 2 and 3, respectively
3 ΔPDR (External Events) is determined by multiplying the IE dose by the EE / IE ratio calculated in Table 32
4 Associated with the change from the baseline (3 tests / 10 years) to the proposed 1 test / 15 years
5 The probability of containment leakage due to the ILRT extension is assumed to be the same for both for internal and external events. Therefore, the percentage change remains constant with respect to initiator.

Table 33 RAI 02-01

Contributor	ΔLERF/rx-yr[1]			PDR ΔPerson-REM/rx-yr (% Increase)[2, 3]						ΔCCFP[4, 5]		
	Unit 1	Unit 2	Unit 3	Unit 1		Unit 2		Unit 3		Unit 1	Unit 2	Unit 3
Internal Events	3.31E-08	3.23E-08	2.99E-08	4.71E-02	0.69%	4.84E-02	0.84%	4.26E-02	0.48%	1.08%	1.16%	0.87%
External Events	2.11E-07	2.19E-07	1.54E-07	3.00E-01	4.42%	3.28E-01	5.71%	2.19E-01	2.49%			
Combined	2.44E-07	2.51E-07	1.84E-07	3.47E-01	5.11%	3.76E-01	6.55%	2.62E-01	2.97%	1.08%	1.16%	0.87%
Acceptance Guideline	<1.0E-06/rx-yr (Small)			<1.0 person-rem/rx-yr or <1.0% (Whichever is Less Restrictive)						<1.5%		

1 Internal Events ΔLERF is a direct input from the Table 32 results
2 ΔPDR (Internal Events) is carried over from Tables 27 - 29 for Units 1, 2 and 3, respectively
3 ΔPDR (External Events) is determined by multiplying the IE dose by the EE / IE ratio calculated in Table 32
4 Associated with the change from the baseline (3 tests / 10 years) to the proposed 1 test / 15 years
5 The probability of containment leakage due to the ILRT extension is assumed to be the same for both for internal and external events. Therefore, the percentage change remains constant with respect to initiator.

As shown by the revised Table 33 data for both sensitivity cases,

- ΔLERF - the results fall within the RG 1.174 R3 (Figure 5) acceptance guidelines of a small change (increase) risk band, hence, less than 1.0E-06/rx-yr.
- ΔPDR - the guidance states that the less restrictive of the increase in person-rem/rx-yr and the percent increase is to be used. Therefore, the increase in dose is least restrictive with all three units remaining below the acceptance guideline of <1.0 person-rem/rx-yr.
- ΔCCFP - the change in the CCFP is less than the 1.5% limit from the approved CILRT extension methodology. The changes reflected by NUREG-2180 and the requantification of the FPRA model do not cause a change to the CCFP

Table 34

Total LERF is provided in Table 34 based on a 1 test / 15 years frequency, and includes the calculated effect of liner corrosion.

Table 34 ("2180" from RAI 02 in Reference 1)

LERF Contributor	LERF/rx-yr		
	Unit 1	Unit 2	Unit 3
Internal Events	1.26E-06	1.21E-06	1.45E-06
External Events	1.03E-05	1.14E-05	9.54E-06
Internal Events Due to ILRT - 15-yr Frequency[1]	4.64E-08	4.53E-08	4.20E-08
External Events Due to ILRT - 15-yr Frequency[1]	3.81E-07	4.28E-07	2.76E-07
Total LERF/rx-yr	1.20E-05	1.31E-05	1.13E-05
Acceptance Criterion	<1.0E-05/rx-yr		

[1] Includes age adjusted steel liner corrosion likelihood

Table 34 RAI 02-01

LERF Contributor	LERF/rx-yr		
	Unit 1	Unit 2	Unit 3
Internal Events	1.26E-06	1.21E-06	1.45E-06
External Events	8.00E-06	8.19E-06	7.43E-06
Internal Events Due to ILRT - 15-yr Frequency[1]	4.64E-08	4.53E-08	4.20E-08
External Events Due to ILRT - 15-yr Frequency[1]	2.95E-07	3.06E-07	2.15E-07
Total LERF/rx-yr	9.60E-06	9.75E-06	9.13E-06
Acceptance Criterion	<1.0E-05/rx-yr		

[1] Includes age adjusted steel liner corrosion likelihood

As noted in the above Table 34 RAI 02-01, Total LERF values for all three BFN units are less than the RG 1.174, Revision 3 (Figure 5) acceptance criterion of less than 1.0E-05/rx-yr.

References:

1. Letter from TVA to NRC, CNL-18-032, "Tennessee Valley Authority Response to NRC Request for Additional Information (Set 2) Related to BFN Application to Revise Technical Specification 5.5.12 'Primary Containment Leakage Rate Testing Program' (BFN-TS-497)," dated March 27, 2018 (ML18087A426)
2. Letter from TVA to NRC, CNL-18-011, "Tennessee Valley Authority Response to NRC Request for Additional Information Related to BFN Application to Revise Technical Specification 5.5.12 'Primary Containment Leakage Rate Testing Program' (BFN-TS-497)," dated February 5, 2018 (ML18036A901)
3. Letter from TVA to NRC, CNL-17-056, "Application to Revise Technical Specification 5.5.12 'Primary Containment Leakage Rate Testing Program' (BFN-TS-497)," dated August 15, 2017 (ML17228A490)

APLA RAI 02-02

The licensee in response to APLA RAI 02, in its letter dated March 27, 2018, provided Tables 1, 2, and 3 to demonstrate the inclusion of NUREG-2180 for three fire compartments, 16-K, 16-M, and 16-O across the three units identified to be impacted by the approved NRC methodology. In review of the results provided across the three fire compartments, for all three Units there existed asymmetric percentage changes between CDF and LERF. In all cases the LERF change is at least twice that of the CDF change, except for one case that is roughly half. There is also asymmetry across the units, where the changes occur in 16-K and 16-O for Unit 1, but occurs only in 16-M for Unit 2. Fire compartment 16-O shows this asymmetry in Unit 3 as well. Provide justification to address the potential anomalies within the fire compartments across the three units. The justification should include discussion of any spatial differences within the fire areas and three units.

TVA RESPONSE TO APLA RAI 02-02

The referenced controlled fire PRA model and NUREG-2180 “sensitivity” evaluations were examined to explore the reasons for the identified differences between the fire compartments and between the three units as shown in Tables 1, 2, and 3.

Identified differences between the fire compartments:

“*In all cases the LERF change is at least twice that of the CDF change, except for one case that is roughly half.”*

The one case where the results of incorporating the NUREG-2180 guidance causes a roughly one-half change in LERF compared to the change in CDF is in Unit 1 fire compartment 16-O. This asymmetry was investigated by examining the associated sequences and it was found that CDF contribution from two scenarios, 16-O.015-CAB and 16-O.011-CAB, increased significantly when the non-suppression probability was increased from 1.99E-2 to 0.53, as a result of incorporation of information from NUREG-2180. Those scenarios went from being lower order to being top contributors. However, the fraction of core damage going to LERF for those scenarios is a smaller fraction than is assigned for some other sequences, due to the specifics of the sequences.

Therefore, the given CDF increase has a smaller effect on LERF than it might have for other type sequences. For instance, the increase in LERF would have been greater if the expected sequences had involved a high probability that core damage would result in LERF. This illustrates why incorporating NUREG-2180 guidance can cause a shift in the ratio between CDF and LERF. Not all scenarios for the areas incorporating incipient detection result in the same fractions of CDF going to LERF. Depending on which scenarios had increased non-suppression likelihoods, the ratio of CDF to LERF could increase or decrease.

<u>Identified differences between the three units:</u>

"*There is also asymmetry across the units, where the changes occur in 16-K and 16-O for Unit 1, but occurs only in 16-M for Unit 2. Fire compartment 16-O shows this asymmetry in Unit 3 as well.* "

The effect of fire on CDF is expected to vary from unit to unit, depending on the exact physical locations of equipment, instrumentation, power supplies and connective cabling. The same is true for LERF and for the ratio of LERF to CDF, when comparing the effects between units. The above discussion explains the reasons for the asymmetry in fire compartment 16-O for Unit 1. The following discussion explains the reasons for the asymmetry in fire compartment 16-K for Unit 1, 16-M for Unit 2, and 16-O for Unit 3.

In short, fire compartment 16-K is the BFN Unit 1 auxiliary (aux) instrument room, fire compartment 16-M is the Unit 2 aux instrument room, and fire compartment 16-O is the Unit 3 aux instrument room. Each unit's aux instrument room is physically closer to its respective control room than to the other control rooms and each unit's aux instrument room contains more instrumentation relevant to its respective control room. More cabling relevant to the respective control room may also be expected in the aux instrument room associated with that unit. It is reasonable then to expect, for example, that a fire in compartment 16-K will result in more impacts to Unit 1 and more risk to Unit 1 than to the other two units. As expected, each unit's aux instrument room shows greater risk significance to its associated unit than to the other two units, with respect to both CDF and LERF. However, it is also expected that each unit's aux instrument room does contribute to CDF and LERF for the other units. A major reason for this relates to impacts on the systems that are common/shared between the units. This illustrates why there can be differences in CDF or LERF impact from one unit to the next, given a fire in a particular aux instrument room compartment.

Finally, to address the question with respect to inter-unit differences in terms of percentage changes of CDF or LERF when going from the "controlled fire model" to the "2180" model, for example, LERF results for compartment 16-O for Unit 2 changed by a smaller percentage than results for compartment 16-O for Unit 1. This difference is at least in part because the base LERF value for compartment 16-O for Unit 2 is greater than the base LERF value for Unit 1. The actual numeric increase in LERF for Unit 2, going from the "controlled fire model" case to the "2180" case was fairly similar to the Unit 1 case. Unit 2 LERF results in the base "controlled fire PRA" model contain different results than base results for Unit 1. This difference is at least in part due to fire impacts on specific components and systems. This illustrates the fact that the exact composition of the scenario results in the base case will determine the amount of change as a percentage.

In summary, the discussion and examples provided illustrate how the effect of fire on CDF can be expected to vary from unit to unit, depending on the exact physical locations of equipment, instrumentation, power supplies and connective cabling. They also illustrate how the effect on LERF can vary, and also how the ratio of LERF to CDF can vary, when comparing the base case to the "2180" case or when comparing impacts between units.