



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

CNL-21-017

January 29, 2021

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, and 50-296

Subject: **Browns Ferry Nuclear Plant, Units 1, 2 and 3, Response to Request for Additional Information Regarding License Amendment Request to Incorporate Tornado Missile Risk Evaluator into the Licensing Basis, (L-2020-LLA-0099)**

- References:
1. TVA Letter to NRC, CNL-20-044, "License Amendment Request to Incorporate Tornado Missile Risk Evaluator into the Licensing Basis," dated May 6, 2020 (ML20127H904)
 2. TVA Letter to NRC, CNL-20-056, "Browns Ferry Nuclear Plant, Units 1, 2 and 3, Response to Request for Additional Information Regarding License Amendment Request to Incorporate Tornado Missile Risk Evaluator into the Licensing Basis, (L-2020-LLA-0099)," dated July 31, 2020 (ML20213C669)
 3. NRC Electronic Mail to TVA, "Browns Ferry Nuclear Plant, Units 1, 2, and 3 - Request for Additional Information Regarding Request to Incorporate TMRE (EPID L-2020-LLA-0099)," dated October 22, 2020 (ML20296A378)

In Reference 1, Tennessee Valley Authority (TVA) submitted a request for an amendment to Renewed Facility Operating License Nos. DPR-33, DPR-52, and DPR-68 for Browns Ferry Nuclear Plant, Units 1, 2, and 3, as supplemented in Reference 2. The proposed amendment would revise the Browns Ferry licensing basis to incorporate the Tornado Missile Risk Evaluator.

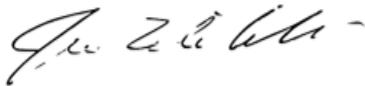
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In Reference 3, the Nuclear Regulatory Commission transmitted a request for additional information (RAI) and requested a response by January 29, 2021. The enclosure to this letter provides the TVA response to the RAI. The enclosure to this letter does not change the no significant hazards consideration or the environmental considerations contained in Reference 1.

There are no new regulatory commitments associated with this submittal. Please address any questions regarding this request to Kimberly D. Hulvey, Senior Manager, Fleet Licensing, at 423-751-3275.

I declare under penalty of perjury that the foregoing is true and correct. Executed on this 29th day of January 2021.

Respectfully,



James T. Polickoski
Director, Nuclear Regulatory Affairs

Enclosure:

Response to Request for Additional Information

cc: (Enclosure):

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

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Response to Request for Additional Information

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Response to Request for Additional Information

RAI 01 – TMRE Walkdown Training

Section 5 of RG 1.174 states that qualified personnel are necessary to meet the quality control standards for the PRA.

NEI 17-02 Section 3.4.1, “Tornado Missile Walkdown Personnel,” states that walkdown personnel should be trained in the methods provided in the NEI document and Section 4.3 of the Electric Power Research Institute (EPRI) Report, EPRI 3002008092, “Process for High Winds Walkdown and Vulnerability Assessments at Nuclear Power Plants.”

The LAR does not address the training of the personnel who conducted the tornado missile walkdown. Provide confirmation that the personnel who conducted the tornado missile walkdown were appropriately trained in accordance with the applicable guidance.

RAI 1 Response

TMRE Walkdowns followed the guidance from NEI 17-02 Revision 1B. Personnel who performed Tornado Missile Walkdowns were trained in the methods provided in NEI 17-02 as well as EPRI 3002008092.

RAI 02 – Tornado Missile Walkdown Area

Section C.2 of RG 1.174 states that the engineering analyses conducted to justify any proposed licensing basis change should be appropriate for the nature and scope of the proposed change. Section 3.4.2 of NEI 17-02 states that in the case of targets greater than 1500 feet from the plant reference point, a qualitative evaluation of the missile inventory within 2500 feet from the outlying target(s) should be done. The intent of this evaluation is to determine whether the missile inventory used for the TMRE is applicable to all the targets.

Section 3.3.3 of the enclosure to the LAR states that the missile walkdown area was defined by a 2500-foot radius around the center point of each reactor building but does not state if all targets satisfied the criterion of NEI 17-02.

Based on the information provided in the LAR, it is unclear to the NRC staff if the qualitative evaluation identified in NEI 17-02 was performed and whether such an evaluation resulted in changes to the missile inventory. Therefore, the NRC staff requests the following:

- a. Confirm that the Browns Ferry TMRE methodology includes a qualitative evaluation of the missile inventory within 2500 feet of targets that are further than 1500 feet from the plant reference point and changes the missile inventory, if necessary.*
- b. If such qualitative evaluation is not included in the Browns Ferry TMRE methodology, justify that exclusion for current and future applications of the Browns Ferry TMRE.*

RAI 2 Response

- a. BFN did not identify any targets greater than 1,500 feet from the reactor buildings (plant reference point). Therefore, no qualitative evaluation was necessary.*

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- b. BFN did not identify any targets greater than 1,500 feet from the reactor buildings (plant reference point). However as stated above, Section 3.3.3 of the enclosure to the LAR states that the missile walkdown area was a 2,500-foot radius around the reactor buildings. If in the future a target is identified farther than 1500 feet from the reactor buildings, a qualitative evaluation will be performed as discussed in Section 3.4.2 of NEI 17-02 Revision 1B.

RAI 03 – Turbine Building Assessment

Section C of RG 1.174 states a staff expectation that the engineering analyses conducted to justify the proposed licensing basis change should be appropriate for the nature and scope of the change.

Section 3.4.4 of NEI 17-02 states that missiles from turbine buildings should not be inventoried using the tables provided in that section but should be counted separately.

- a. *Confirm that the turbine building missile inventory walkdowns were performed using the guidance in NEI 17-02 Section 3.4.4 (that is, that the tables in that section were not used).*
- b. *If the turbine missile count was performed using the tables provided in Section 3.4.4 of NEI 17-02, provide justification that the use of this methodology does not impact the TMRE analyses results.*
- c. *Alternatively, to Parts a and b, provide an updated TMRE analysis that incorporates the appropriate turbine building walkdown missile inventory.*

RAI 3 Response

- a. The turbine building missile inventory walkdowns were performed using the guidance in NEI 17-02 Section 3.4.4, without using the tables in that section. Although turbine building missiles were not explicitly identified during the missiles inventory walkdowns, information from the walkdowns was used as input to the turbine building missile calculation described in the answer to (c) below.
- b. The tables in NEI 17-02, Section 3.4.4, were not used to calculate the turbine building missile inventory. See the answer to (c) below.
- c. The number of turbine building missiles was based on both calculations as well as plant walkdowns. The number of turbine building missiles was not included within the missile count in the original BFN TMRE submittal. The Turbine building is a reinforced concrete structure up to the 617 elevation. The Turbine building 617 elevation also has concrete on the outside walls. In addition, most components are also located within their own concrete rooms. At the 617 elevation the Turbine building is framed by traverse welded steel rigid frames.

The steel frames that start at the 617 elevation are 107 feet high and cover the entire perimeter of the turbine building where the length is 152.25 feet and the width is 153.75 feet. The number of missiles from the steel framing was calculated using the engineered

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building metal siding values from the NEI 17-02 Revision 1B. This gives an approximation of how many missiles would potentially be generated from a tornado.

In addition to the steel frames, there are also fans, electrical boards and tanks on the Turbine building roof and within the control bay fan rooms. Any of these components could potentially become tornado missiles. Based on previous walkdowns and general plant knowledge, it is estimated that there are less than 40 components between all three units that are located on the Turbine building roof and in the control bay fan rooms. This value was then multiplied by 5 to ensure that all components are captured. The number of components is estimated to be 200.

In order to ensure that the estimate of the number of missiles in the Turbine building (including siding) is conservatively calculated, the final number of missiles calculated was also multiplied by 10.

Turbine building siding – 1,637 missiles
Turbine building missiles – $40 \times 5 = 200$ missiles
Turbine building siding and missiles – $1637 + 200 = 1,837$ missiles
Final Total – $1,837 \times 10 = 18,370$ missiles

If the total number of estimated Turbine building missiles (18,370) is added to the number of BFN TMRE missiles (161,374) the new total number of BFN TMRE missiles is 179,744. This is still well below the generic value of 240,000 which was used in the BFN TMRE analysis.

RAI 04 – Compliant Case Conservatism Sensitivity Study

Section 2.5.1.2 of RG 1.174 states that in interpreting the results of a PRA, it is important to understand the impact of specific assumptions on those results.

Section 7.2.2 of NEI 17-02 states that the licensee should review the TMRE compliant results to identify conservatisms related to equipment failure only. The section provides some examples of possible sensitivity studies that focus on changes to the compliant case.

Section 3.3.9 of the LAR states that the ΔCDF and $\Delta LERF$ values for all three Browns Ferry units are below 1×10^{-7} /year and 1×10^{-8} /year, respectively, and that these are below the thresholds where sensitivity studies are required. The NRC staff notes that the NEI 17-02, Section 7.2.2 sensitivity study does not have any screening criteria. In light of these observations:

- a. Provide the results of the Section 7.2.2 sensitivity study.*
- b. Provide justification that the sensitivity study meets the requirements of NEI 17-02.*
- c. If the results of the study exceed the RG 1.174 threshold values, as stated in Section 7.3 of NEI 17-02, provide justification that the results do not impact the conclusions of the TMRE analysis.*

RAI 4 Response

- a. TVA concurs that NEI 17-02, Section 7.2.2 sensitivity study does not have any screening criteria and subsequently performed the sensitivity study documented below. The BFN TMRE Analysis results includes both the TMRE impacted results as well as the base model results. In order to perform the NEI 17-02 Compliant Case Conservatism sensitivity, the compliant case model will be set to zero. Because the BFN TMRE Compliant case TMRE model includes the base model results as well, only the TMRE impacts will be set to zero. In other words, the compliant case set to zero model is the same as the base PRA model results.

	Degraded	Compliant set to zero	Delta
U1 CDF	4.272E-06	4.07E-06	2.02E-07
U2 CDF	3.331E-06	3.28E-06	5.10E-08
U3 CDF	6.045E-06	5.99E-06	5.50E-08
U1 LERF	8.783E-07	8.64E-07	1.43E-08
U2 LERF	7.979E-07	7.95E-07	2.90E-09
U3 LERF	8.019E-07	7.98E-07	3.90E-09

This sensitivity shows that the impact from the TMRE analysis is less than 1E-06 for CDF and 1E-07 for LERF, which is below the RG 1.174 thresholds and is acceptable.

- b. The sensitivity study performed in (a) above followed the guidance in NEI 17-02, Revision 1B.
- c. As shown in the response to (a) above the sensitivity study results were below the RG 1.174 thresholds, and therefore, the results do not impact the conclusions of the TMRE analysis.

RAI 05 - TMRE Human Reliability and Dependency Analysis

Section 6.3 of RG 1.174 states that the licensee’s submittal should ensure the PRA used is acceptable to support the risk assessment of the licensing basis change being considered. Section 6.4 of NEI 17-02 states that operator actions performed outside of Category I structures or actions requiring transit outside of the Category I structures more than one hour after the tornado event should be assessed. Operator actions within one hour of the tornado strike and that take place in a non-Category I structure that has failed the tornado event are assumed to be failed.

With regards to impacting the dependency analysis, Section 6.4 of NEI 17-02 states that new operator action dependencies will be created as a result of the TMRE model change requirements or new cutsets associated with tornado initiators. Therefore, the analysis should appropriately account for these changes in the TMRE PRA models. Enclosure 3 of the LAR regarding supporting requirement HR-G7 states that no new combinations were created or credited. However, it does address modifications to existing combinations.

- a. *Provide justification that none of the original Browns Ferry human reliability analysis (HRA) combinations contain any of the human failure events (HFEs) assumed to be failed in the TMRE PRA cases. If the combinations did contain any of these HFEs, then provide justification that the dependency analysis used for Browns Ferry TMRE analyses*

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meets the requirements of NEI 17-02 or demonstrate that the exclusion of the updated dependency analysis does not impact the results of the TMRE analyses.

- b. If the above request cannot be justified, then provide an updated TMRE analysis, including sensitivities (if required), that incorporate the appropriate HFEs and dependency analysis.*

RAI 5 Response

- a. The BFN HRA does contain human failure events (HFEs) assumed to be failed in the TMRE PRA cases. Each of the HFEs that were failed based on being performed outside of the control room and requiring less than an hour to complete were renamed for the TMRE analysis. The fault tree was modified to have each of the new TMRE HFEs AND-ed with the TMRE Initiator and placed under an OR gate in the same locations as the existing internal events HFEs. When the TMRE analysis was performed, each of the TMRE HFEs were set to TRUE. This prevented the HFEs from showing up in any of the existing internal events combinations. The dependency analysis used for the BFN TMRE analysis meets the requirements of NEI 17-02 Rev. 1B.
- b. Part (a) was justified. Therefore, a response is not required.

RAI 06 – TMRE Compliant and Degraded PRA Models

Section 6.3 of RG 1.174 states that the licensee's submittal should ensure the PRA used is acceptable to support the risk assessment of the licensing basis change being considered. Section 6.3 of NEI 17-02 provides elements that make up the compliant and degraded cases. Some items (not an exhaustive list) are: (1) turbine buildings and exposed non-safety-related systems, structures, or components (SSCs) (e.g., tanks, pipes) should be evaluated to determine their capability to withstand wind pressures and associated failure probabilities, (2) non-Category I structures incapable of withstanding the forces for tornado winds > 103 mph, along with exposed non-safety-related SSCs (e.g., pumps, compressors) are assumed to fail (probability = 1.0), and (3) vulnerable but conforming components (those SSCs exposed to tornado-missiles and compliant with Browns Ferry's licensing basis) include tornado-missile induced failures based on exposed equipment failure probabilities (EEFP) calculations. Table 6-1 in Section 6.3 provides a succinct summary of elements for both cases.

Section 3.3.6 of the LAR does not appear to address these elements. It is not clear to the NRC staff that all the criteria of NEI 17-02 are met. In light of these observations:

- a. Provide clarification whether EEFPs were included in both the compliant and degraded PRA cases for exposed passive non-safety-related SSCs and other vulnerabilities as identified in Section 6.3 of NEI 17-02. Include in this discussion how this analysis was incorporated into both the compliant and degraded cases.*
- b. Provide details on the analysis related to non-Category I structures and turbine building related to tornado wind survivability. Include in this discussion how this analysis was incorporated into both the compliant and degraded cases.*

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- c. *If the compliant and degraded cases did not include the other failure modes required by NEI 17-02, provide justification that the exclusion of these items does not impact the TMRE analyses results.*
- d. *Alternatively to Part c, provide an updated TMRE analysis that incorporates all of the SSC failure modes required by NEI 17-02.*

RAI 6 Response

- a. EEFPs were included in both the compliant and degraded PRA cases for exposed passive non-safety-related SSCs and other vulnerabilities as identified in Section 6.3 of NEI 17-02 Rev. 1B. In the BFN TMRE analysis, it was determined that some buildings (such as the Residual Heat Removal Service Water pump rooms) were only 18 inches thick. Because of this, an EEFPP was calculated for all of the components located within these rooms that could be impacted by a tornado-missile. This EEFPP was then included in both the compliant and degraded case models.
- b. Each of the buildings that contain PRA components as well as those exposed components located outside of a building were assessed during the TMRE analysis. Any building that was determined to not be a Category 1 structure (such as the Turbine Building) had all PRA components located within it failed in both the compliant and degraded cases. All exposed components were reviewed to determine whether they could withstand a tornado-missile impact and any identified components that could not withstand a tornado-missile impact were failed in both the compliant and degraded cases.
- c. Because the compliant and degraded cases did include the other failure modes required by NEI 17-02, based on the response to parts (a) and (b), justification that the exclusion of these items does not impact the TMRE analyses is not required.
- d. Based on the response provided in part (c), an updated TMRE analysis is not required.

RAI 07 - Addition of FLEX to the PRA Model

The NEI published NEI 16-06 “Crediting Mitigating Strategies in Risk-Informed Decision Making” (ADAMS Accession No. ML16286A297), to address risk assessment of mitigating strategies used to support risk-informed applications. The NRC staff assessed this guidance and clarified the staff’s position in a memorandum dated May 30, 2017 (ADAMS Accession No. ML17031A269). The NRC staff identified challenges to incorporating Diverse and Flexible Coping Strategies (FLEX) equipment and strategies in support of risk-informed decision using a PRA model that meets the guidance in RG 1.200, Revision 2, “An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities,” (ADAMS Accession No. ML090410014).

Section 3.2 of the LAR refers to FLEX strategies but does not state whether or not TVA has incorporated FLEX mitigating strategies and associated equipment into the PRA models used to support this application. Therefore, it is unclear whether FLEX equipment and operator actions will be used to support this application and, if applicable, whether the incorporation of FLEX equipment and actions into the PRA models was performed in an acceptable manner.

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Provide the following information separately for internal events PRA, seismic PRA, and external hazard screening, as appropriate:

- a. *Clarify whether FLEX equipment and associated actions have been credited in the PRAs used to support this application, identifying the specific PRA(s) that include such credit. If not incorporated, no response to parts (b) and (c) is requested.*
- b. *If the FLEX equipment or operator actions have been credited, provide the following information separately for the internal events PRA (includes internal floods) and seismic PRA, as appropriate:*
 1. *Discuss the extent to which FLEX has been incorporated. That is, summarize the supplemental equipment and compensatory actions that have been quantitatively credited for each of the PRA models used to support this application.*
 2. *If any credited FLEX equipment is dissimilar to other plant equipment credited in the PRA (i.e., SSCs with sufficient plant-specific or generic industry data), discuss the data and failure probabilities used to support the modeling and provide the rationale for using the chosen data. Include discussion on whether the uncertainties associated with the parameter values are in accordance with the PRA Standard as endorsed by RG 1.200.*
 3. *If any operator actions related to FLEX equipment are evaluated using approaches that are not consistent with the endorsed PRA Standard (e.g., using surrogates), discuss the methodology used to assess human error probabilities for these operator actions. The discussion should include:*
 - i. *A summary of how the impact of the plant-specific human error probabilities and associated scenario-specific performance shaping factors listed in (a)-(j) of supporting requirement HR-G3 of the PRA Standard were evaluated.*
 - ii. *Whether maintenance procedures for the portable equipment were reviewed for possible preinitiator human failures that render the equipment unavailable during an event, and if the probabilities of the preinitiator human failure events were assessed as described in high level requirement HLR-HR-D of the PRA standard.*
 - iii. *If the procedures governing the initiation or entry into mitigating strategies are ambiguous, vague, or not explicit, a discussion detailing the technical bases for probability of failure to initiate mitigating strategies.*
- c. *The PRA Standard defines PRA upgrade as the incorporation into a PRA model of a new methodology or significant changes in scope or capability that impact the significant accident sequences or the significant accident progression sequences. The PRA Standard states that upgrades of a PRA shall receive a peer review in accordance with the requirements specified in the peer review section of the relevant part of the Standard (Part 1, Sections 1 5). Either:*
 1. *Provide an evaluation of the model changes associated with incorporating non-safety-related SSCs (whether permanently installed or portable) that were included following the FLEX mitigation strategies but are not similar to safety related SSCs. This evaluation should demonstrate that none of the following criteria are satisfied: (1) use of new methodology, (2) change in scope that impacts the significant accident sequences or the*

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significant accident progression sequences, and (3) change in capability that impacts the significant accident sequences or the significant accident progression sequences; or

2. *Confirm that a focused-scope peer review has been performed on the model changes associated with incorporating mitigating strategies, and associated F&Os are resolved to Capability Category II.*

RAI 7 Response

- a. The TMRE Analysis does not use the seismic PRA or external hazard screening. Additionally, the internal events model utilized in this LAR does not credit any FLEX equipment or any associated actions.
- b. Based on the response to part (a), this response is not required.
- c. Based on the response to part (a), this response is not required.