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10 CFR 50.90

GNRO-2019/0007

January 23, 2019

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

SUBJECT: Response to Request for Additional Information Regarding License Amendment Request to Incorporate Tornado Missile Risk Evaluator into Licensing Basis - Supplement

Grand Gulf Nuclear Station, Unit 1
NRC Docket No. 50-416
Renewed Facility Operating License No. NPF-29

Dear Sir or Madam:

In Reference 1, the U.S. Nuclear Regulatory Commission (NRC) transmitted requests for additional information (RAIs) to Entergy Operations Inc. (Entergy) in order to complete its review of an Entergy license amendment request (LAR). This LAR proposed incorporation of the Tornado Missile Risk Evaluator (TMRE) into the Grand Gulf Nuclear Station, Unit 1 (GGNS) licensing basis. The LAR and additional supplements were provided in Reference 2, Reference 3, and Reference 4. In Reference 5, Entergy requested an extension to October 24, 2018 to complete responses to the RAIs, due to changes in the Missile Impact Parameters. In Reference 6, Entergy provided a response to a subset of the RAIs and indicated that a response to the remaining RAIs would be provided early in the first quarter of 2019. This delay in responding to a subset of the Reference 1 RAIs was based on the need to update the GGNS Probabilistic Risk Assessment (PRA) model used to analyze the TMRE.

The enclosure to this letter provides the responses to the remaining RAI questions. These responses are based on the GGNS updated PRA model.

No new regulatory commitments are made in this submittal. The information provided in this submittal does not impact the No Significant Hazards Consideration analysis that was documented in the Reference 2 LAR.

In accordance with 10 CFR 50.91, "Notice for Public Comment; State Consultation," paragraph (b), a copy of this application, with attachments, is being provided to the designated State Officials.

There are no regulatory commitments contained within this letter.

If you have any questions concerning the content of this letter, please contact Mr. Douglas A. Neve, Manager Regulatory Assurance, at 601-437-2103.

I declare under penalty of perjury that the foregoing is true and correct. Executed on January 23, 2019.

Sincerely,

Eric A. Larson

EAL/rws

Enclosure: Supplemental Response to RAI Regarding License Amendment Request to Incorporate the Tornado Missile Risk Evaluator into Licensing Basis

References:

1. NRC Letter EPID L-2017-LLA-0371, "Grand Gulf Nuclear Station Request for Additional Information, Request to Revise Updated Final Safety Analysis Report to Incorporate Tornado Missile Risk Evaluator Methodology into Licensing Basis," dated July 20, 2018 (ADAMS Accession No. ML18187A329)

2. Entergy Operations, Inc. (Entergy) letter to U.S. Nuclear Regulatory Commission (NRC), "License Amendment Request to Incorporate Tornado Missile Risk Evaluator into Licensing Basis," dated November 3, 2017 (ADAMS Accession No. ML17307A440)

3. Entergy letter to NRC, "Supplemental Letter to License Amendment Request to Incorporate Tornado Missile Risk Evaluator into Licensing Basis," dated December 6, 2017 (ADAMS Accession No. ML17340B025)

4. Entergy letter to NRC, "Supplemental Letter to License Amendment Request to Incorporate Tornado Missile Risk Evaluator into Licensing Basis," dated January 22, 2018 (ADAMS Accession No. ML18022A598)

References (cont.):

5. Entergy letter to NRC, "License Amendment Request to Incorporate Tornado Missile Risk Evaluator into Licensing Basis - Extension of Response to Request for Additional Information," dated September 22, 2018 (ADAMS Accession No. ML18267A078)

6. Entergy letter to NRC, "License Amendment Request to Incorporate Tornado Missile Risk Evaluator into Licensing Basis – Partial Response to Request for Additional Information and Extension of Response to Request for Additional Information for Remaining Questions," dated October 24, 2018

cc: NRC Region IV - Regional Administrator
NRC Senior Resident Inspector, Grand Gulf Nuclear Station
State Health Officer, Mississippi Department of Health
NRC Project Manager, Grand Gulf Nuclear Station

ENCLOSURE

GNRO-2019/0007

Supplemental Response to RAIs Concerning License Amendment Request to Incorporate the Tornado Missile Risk Evaluator into Licensing Basis

(31 Pages)

# 1. BACKGROUND

By letter dated November 3, 2017 (Reference 1), as supplemented by letters dated December 6, 2017 and January 22, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML17307A440, ML17340B025, and ML18022A598, respectively), Entergy Operations, Inc. (Entergy) submitted a pilot license amendment request (LAR) regarding Grand Gulf Nuclear Station, Unit 1 (GGNS). The submittal incorporated, by reference, Nuclear Energy Institute (NEI) technical report NEI 17-02, Revision 1, "Tornado Missile Risk Evaluator (TMRE) Industry Guidance Document, "September 2017, which contains the TMRE methodology (ADAMS Accession No. ML17268A023) (hereafter referred to as NEI 17-02, Revision 1). The proposed amendment would modify the GGNS licensing bases as described in the Updated Final Safety Analysis Report to include a new methodology for determining whether physical protection from tornado-generated missiles is warranted. The methodology can only be applied to discovered conditions where tornado missile protection is not currently provided, and cannot be used to revise the design basis to avoid providing tornado missile protection in the plant modification process.

By letter dated July 20, 2018, (ADAMS Accession No. ML18187A329), the U.S. Nuclear Regulatory Commission (NRC) informed Entergy that additional information was needed to support their review. Many of the request for additional information (RAI) questions were either identical or similar to questions asked of Southern Nuclear Operating Company (SNC) and Duke Energy Progress LLC (Duke Energy) regarding similar LARs submitted for Vogtle Electric Generating Plant and Shearon Harris Power Plant. The responses to these RAIs were submitted by SNC in a letter dated July 26, 2018 (ADAMS Accession No. ML18207A876, Reference 2) and by Duke Energy in a letter dated September 19, 2018 (ADAMS Accession No. ML18262A328, Reference 3). Following receipt of the SNC response, NRC staff provided comments in a public meeting on August 2, 2018, some of which were discussed in a letter from the NRC to SNC dated August 30, 2018 (ADAMS Accession No. ML18236A445). NRC staff perspectives shared in those public forums have informed the GGNS response.

By letter dated October 24, 2018, Entergy provided an initial response to a subset of the RAIs, and indicated that a response to the remaining RAIs would be provided early in the first quarter of 2019. This delay in responding to the remaining RAIs was based on the need to perform an interim update to the GGNS Probabilistic Risk Assessment (PRA) model that was used to analyze the TMRE.

In the fourth quarter of 2018, Entergy completed an interim update to the GGNS PRA Model of Record (MOR). As a result, the GGNS PRA MOR changed from Revision 4A to Revision 4B. The Revision 4B update was performed to recover MSPI margin and to address modeling inconsistencies and improve the accuracy of assumptions resulting in improved TMRE PRA risk outcomes. The RAI responses provided herein reflect TMRE analysis results using the updated GGNS Revision 4B PRA MOR.

The PRA MOR changes associated with Revision 4B included the following:

- The GGNS internal events and internal flooding models were updated to correct modeling issues associated with duplicate cutsets, mutually exclusive events, and circular logic gates.
- The event trees associated with the Small LOCA, the Stuck Open Relief Valve (SORV) LOCA, and transients were revised to be consistent in how the continued operation of the ECCS pumps is modeled post containment venting failure.
- The split fraction for containment failure locations that prevent scrubbing of releases for low-pressure sequences was changed to be consistent with the split fraction for high-pressure sequences since the underlying calculation applied to containment failure location regardless of reactor vessel pressures.
- The time delay assumed in the operator action associated with early depressurization was revised based on interviews with operations personnel. This is consistent with how similar operator actions were modeled.
- To ensure consistency with plant procedures and the as-operated plant, an event was added to represent the rescheduling of planned equipment maintenance activities for Division 3 equipment that would result in an EOOS Orange condition should they be scheduled simultaneous to corrective maintenance of the RHR A or B trains or the SSW B train.
- Several PRA Model Change Requests (MCRs) were addressed and closed.

This following information provides Entergy's responses to those RAIs that were not answered in the October 24, 2018 RAI response letter (i.e., RAI Nos. 1, 5, 11, 16, 17, 19e, 20b, 20c, and 23 through 28). Some of the Entergy responses reference docketed SNC and Duke Energy correspondence (i.e., References 2 and 3), including SNC and Duke Energy proposed changes to the TMRE methodology, to avoid redundancy.

## 2. SUPPLEMENTAL RAI RESPONSES

### NRC RAI 1

Section B.2, "Using EPRI NP 768 Data to Determine Missile Impact Parameter (MIP)," of Nuclear Energy Institute (NEI) 17-02, Revision 1, "Tornado Missile Risk Evaluator (TMRE) Industry Guidance Document," September 2017 (ADAMS Accession No. ML17268A036), states, in part:

> Choosing the most conservative target MIP from NP 768 (Target 4) would lead to overly conservative results for many targets at a NPP [nuclear power plant]. Therefore, the normalized tornado missile impact probability from "All Targets" in NP 768 (from Table 3 15) is proposed for use in the TMRE. This results in a MIP that is based on the combined hits on all modeled surfaces in NP 768, Plant A.

The derivation of the MIP includes the containment building (Target 1). As stated in NEI17-02, Revision 1, Section B.2, in part:

> [t]he containment building is surrounded by other buildings ...so only the upper part of the containment is exposed to tornado missiles.

Additionally, the elevation of the exposed upper part of the containment is different from the elevation of other targets included in the calculation of near ground missiles.

Due to the overall height and the large surface area of the containment building, many missiles may be unable to reach upper portions of the containment building, which reduces the overall density of missile strikes and could become unrepresentative of other shorter plant buildings.

Section 3.2.3.2, "Missile Impact and Damage Probability Estimates," of the Electric Power Research Institute (EPRI) topical report NP 768, "Tornado Missile Risk Analysis," May 1978, states, in part:

> [t]he individual target contributions to the total hit probability is generally greater for the larger targets but least for the containment structure (7.65 x 10 10, Table 3 8) which is shielded from impact for the first 60 feet [(ft.)] above ground elevation.

Justify including Target 1 (containment building) of Plant A in EPRI NP 768 in computing the average MIP for targets less than 30 ft. above grade, given that the containment building is shielded by other buildings and is not impacted by near ground missiles. Discuss how inclusion of Plant A containment building in computation of the average MIP for targets less than 30 ft above grade impacts this application.

**Entergy Response to RAI 1**

The Missile Impact Parameter (MIP) is only one variable in the calculation of the Exposed Equipment Failure Probability (EEFP). Tables A-3, A-6, and A-7 show the EEFP is conservative when compared with TORMIS failure probabilities for the same targets at two sites; a total of 35 separate targets at 5 tornado intensities (175 EEFPs) were compared. The EEFPs calculated include near ground and elevated targets, using the MIP values from NEI 17-02 Revision 1, Table 5-1.

As noted in this RAI, choosing the most conservative target MIP from Target 4 would result in overly conservative results for many targets at a NPP. Therefore, the TMRE MIP was derived from hits on all NP-768 Plant A targets.

The initial industry proposal was to derive average MIPs using the total hit probability for all targets and the total area for all targets. However, there were NRC concerns that including the roof area in the MIP derivation would result in MIP values that were too low – the derived MIP values would be lower due to the assumed relatively low probability of missile hits on the roof and the relatively large area of some of the roofs. Note: MIP is proportional to [target hit probability] ÷ [target area].

The industry re-evaluated the derivation of MIP; however, the NP-768 data does not have the granularity to perform refined calculations. The only data provided is the hit frequency for each target (including all walls and the roof) and the dimensions of the target. Although the areas can be parsed to separate the roof and wall areas, the target hits could not be subdivided. Therefore, a simplified approach was taken to develop two sets of MIPs:

*Elevated MIP = [Total Hit Probability for Target (all walls and roof)] ÷ [Wall + Roof Area]*

Note: The Elevated MIP is the same as the original average MIP, it includes all target hits and all target areas

*Near Ground MIP = [Total Hit Probability for Target (all walls and roof)] ÷ [Wall Area]*

Since the target hit data is not subdivided for different target surfaces or portions of surfaces, the only way to distinguish between near ground and elevated MIPs is to use different areas in the derivation of MIP. It was decided to not subdivide the wall surface area to account for the demarcation elevation, because the target hit probability could not be similarly subdivided, which would tend to bias the MIP values higher.

The increase in near ground MIP is approximately 30% if the Building 1 hits and area are not included in the MIP calculation. This increase in MIP is relatively small and is considered to be bounded by the increase in MIP for the sensitivity described in Section 7.2.1 (275%).

However, given the concerns expressed with this potential non-conservatism in the MIP estimation, the near ground MIP has been increased by approximately 30%. The new near ground MIPs are listed below along with the previous MIPs from NEI 07-02, Revision 1. This is documented in Section B.3.4 of Enclosure 2 of Reference 3.

| Tornado Category | Old MIPs | New MIPs |
|---|---|---|
| F'2 | 1.10E-10 | 1.40E-10 |
| F'3 | 3.60E-10 | 4.60E-10 |
| F'4 | 6.30E-10 | 7.90E-10 |
| F'5 | 1.60E-09 | 2.00E-09 |
| F'6 | 2.40E-09 | 3.10E-09 |

GGNS has assumed all non-conforming targets are near ground, therefore, the impact of the increase in near ground MIPs impacts all targets.

The new MIPs were incorporated in the TMRE analysis and the delta risk for GGNS was recalculated. The new total ΔCDF and ΔLERF for non-conformances at GGNS were calculated to be 1.35E-07/yr. and 1.25E-09/yr., respectively. These new results are well within the acceptance criteria of RG 1.174.

**NRC RAI 5**

Section 3.2.3, "SSC [Structures, Systems, and Components] Failure Modes," of NEI 17-02, Revision 1, references consequential failures and describes treatment of identified and documented cases to be addressed in Section 6, "Develop TMRE PRA Model," of NEI 17-02, Revision 1. Specifically, the first bullet in Section 3.2.3 characterizes tanks and piping as "passive" components.

Section 3.2.3 does not appear to include guidance on consideration of secondary effects. Such effects include consideration for fluid filled tanks and pipes, combustion motor intake effects (loss of oxygen from inert gas tank rupture or exhaust re direction scenarios), and other potential secondary effects to the SSCs' function.

Describe how secondary effects that may result from failure of non-conforming conditions were considered for identification of the initiating events and failure modes in the licensee's TMRE development.

**Entergy Response to RAI 5**

Section 3.2.3 of the Enclosure 2 to ML18207A876 was updated to describe secondary effects that should be noted during the discovery walkdown. Section 6.1 was revised and Section 6.5.2 was added to the enclosure to require evaluation of these secondary effects of tornado missile impacts on nonconforming SSCs.

A review of the non-conformances was performed in relation to the guidance provided in Enclosure 2 of Reference 2 and one potential secondary effect was identified.

Standby Service Water (SSW) piping routed to the HPCS room cooling passes through a breezeway that is partially exposed to a limited variety of missiles. If this piping is struck by a missile, the flow of water from the break into the breezeway could potentially cause an internal flooding event that could allow water to enter the diesel generator rooms, ultimately failing the diesels. This condition was analyzed in a revised TMRE analysis that included the update of the new MIPs (See response to RAI #1).

The impact of including this secondary effect along with the new MIPs has been analyzed in a revised TMRE analysis to calculate new results for GGNS. Those results are shown in the table below. These new results are well within the acceptance criteria of RG 1.174.

| | **CDF / year** | **LERF / year** |
|---|---|---|
| Compliant | 5.67E-07 | 7.54E-09 |
| Degraded | 7.02E-07 | 8.79E-09 |
| Delta | 1.35E-07 | 1.25E-09 |

**NRC RAI 11**

Regulatory Position 2.1.1 in RG 1.174, Revision 2, discusses defense-in-depth as one of the key principles of risk-informed integrated decision-making. This regulatory position states that one of the considerations in the assessment of whether the proposed change meets the defense-in-depth philosophy is to determine whether over-reliance on programmatic activities as compensatory measures associated with the proposed change is avoided.

Diverse and Flexible Coping Strategies (FLEX) equipment is cited as a defense-in-depth feature in Section 3.2 of the Enclosure to the submittal. It is stated that "critical equipment is stored in structures that would prevent it from being impacted by a tornado or tornado missile."

For each non-conforming condition, describe how the FLEX equipment will provide additional defense-in-depth in the context of the assumptions used for the TMRE PRA including the lack of credit for operator actions outside protected structures and the potential for staged equipment becoming missiles.

**Entergy Response to RAI 11**

FLEX equipment is not credited in the TMRE PRA. Although logic for FLEX capabilities were incorporated into the internal events model, FLEX is not credited in the TMRE analysis during quantification though the use a flag file to set the recovery actions to "TRUE". Setting the recovery to "TRUE" during quantification fails the FLEX equipment ensuring that the strategies do not contribute to the results. Any credit for FLEX in relation to defense-in-depth would be qualitative since no quantitative credit is used in the TMRE analysis.

As noted in Entergy's response to RAI 6.c in the initial October 24, 2018 RAI response letter, non-structural missiles (items stored in the building) are added to the missile count for the building. The FLEX storage building is in Zone 5 of the TMRE missile count walkdown area. Equipment (vehicle, backhoe, air conditioner, storage boxes, and miscellaneous equipment) stored in FLEX storage building are included in total missile count for Zone 5. Therefore, potential for staged and pre-staged equipment becoming missiles was considered.

**NRC RAI 16**

Regulatory Position 2.3.2, "Level of Detail Required to Support an Application," in RG 1.174, Revision 2, states that the level of detail required of the PRA is that which is sufficient to model the impact of the proposed change. This Regulatory Position further states that the characterization of the problem should include establishing a cause effect relationship to identify portions of the PRA affected by the issue being evaluated.

Section 6.5, "Target Impact Probability Basic Events," of NEI 17-02, Revision 1, states, in part, that:

> SSC failures from tornado missiles may need to be considered for failure modes not previously included in the internal events system models.

Section 6.5 then provides four relevant examples (i.e., flow diversion and/or leaks, tank vent failures, valve position transfer - spurious actuations, and ventilation damper failures). The section does not appear to provide guidance about when and to what extent such failure modes should be considered.

Describe how the potential failure modes stated in Section 6.5 of NEI 17-02, Revision 1, were considered by the licensee during the TMRE walkdown, identified, and included in the licensee's TMRE PRA model used to support this application.

**Entergy Response to RAI 16**

Based upon the new information relating to secondary effects identified in Enclosure 2 of Reference 2, a review of the non-conformances was performed for GGNS relating to potential failure modes discussed in Section 6.5. The results of this review identified an additional failure mode not previously considered in the TMRE analysis. This new failure mode is discussed below:

Standby Service Water (SSW) piping routed to the HPCS room cooling passes through a breezeway that is partially exposed to a limited variety of missiles. If this piping is struck by a missile, the flow of water from the break into the breezeway could cause an internal flooding event that allows water to enter the diesel generator rooms, ultimately failing the diesels. This condition was analyzed in the TMRE analysis that included in the update of the new MIPs (See response to RAI #1).

The impact of including this secondary effect along with the new MIPs has been analyzed in a revised TMRE analysis to calculate new results for GGNS. Those results are shown in the table below. These new results are well within the acceptance criteria of RG 1.174.

| | CDF / year | LERF / year |
|---|---|---|
| Compliant | 5.67E-07 | 7.54E-09 |
| Degraded | 7.02E-07 | 8.79E-09 |
| Delta | 1.35E-07 | 1.25E-09 |

Additionally, each system modeled in the GGNS PRA model includes an evaluation of potential flow diversions associated with the system and with the specific functions of the system. When potential flow diversions were identified that would preclude the system from performing its PRA function, those flow diversions were explicitly modeled in the GGNS PRA. The GGNS System Notebooks each include a discussion of the system level flow diversions evaluated, including both those modeled and those determined to not fail the system function. A review of each of the "screened out" flow diversions did not identify any that should have been added into the model specifically for the TMRE. The bases for screening were determined to be applicable to the TMRE PRA as well.

Both the GGNS PRA Model of Record and the TMRE PRA include spurious actuations and ventilation damper failures. Spurious actuations are modeled for motor-operated valves (MOV CO, MOV OC), air-operated valves (AOV OC, AOV CO), combined stop and control bypass valves (CSC OC), hydraulic-operated valves (HDV OC), MSIVs (MSV OC, MSV CO), pressure control valves (PCV OC), main steam safety valves (SFV CO), solenoid-operated valves (SOV OC), safety relief valves (SRV CO), manual valves (XVM CO, XVM OC), air-operated dampers (AOD OC), and motor-operated dampers (MOD OC). In addition to the spurious ventilation damper failures, ventilation dampers failure modes modeled also include: air-operated dampers fail to open (AOD CC), check damper fails to open (CKD CC), and motor-operated damper fails to open (MOD CC).

Vent valves on tanks are not explicitly modeled in the internal events PRA since none were identified that would cause a failure of the tank to perform its intended PRA function. For the TMRE, potentially impacted tanks were re-evaluated and only the EDG fuel oil tanks vents were identified as potential vulnerabilities. The failure mode and potential susceptibility of these vent valves is water intrusion, if the piping is sheared off. This water intrusion would eventually affect the ability of the EDG to perform its function. The bottom of the fuel transfer pump's suction is at is 8 inches. Approximately 2,659 gallons of water would have to enter each tank before the level reaches 8 inches. The vent and fill connections are considered robust targets with failure modes of crushing/crimping, penetration, or global failure. NEI 17-02 describes global failure as referring to the overall flexural response (of bending) of pipes, tanks and concreted panels. Therefore, the actual failure of the vents and fill connections which results in water intrusion would be penetration of the pipes instead of shearing of the pipe. Penetration of pipe would result in a slower flow rate into the tank compared to shearing, which would allow more time to respond to the failure.

**NRC RAI 17**

Section 3.3, "Ex-Control Room Action Feasibility," of NEI 17-02, Revision 1, states that no credit for operator action should be taken for actions performed within 1 hour of a tornado event outside a Category I structure (in a location for which the operator must travel outside a Category I structure), but can be considered in the PRA after 1 hour. Guidance in this section states that operator actions after 1 hour could be impacted by such environmental conditions as debris that blocks access paths and should be considered by taking into account whether equipment will be accessible and whether the time required to perform the action will be impacted.

Discuss, with justification, the assessments performed to ensure that environmental conditions will not affect operator actions that are credited after 1 hour in the licensee's TMRE PRA model used to support this application.

**Entergy Response to RAI 17**

There are no operator actions outside of a Category I structure that are credited after 1 hour in the GGNS TMRE PRA Model. As shown in the table below, only one operator action in the TMRE PRA model cut set results is performed outside of a Category I structure. That operator action, P64-XHE-FO-PT98H, "FAILURE TO ALIGN FIREWATER INJECTION PATHWAY #9 THROUGH FW TRAIN A OR B (+8H)", is performed in the yard and turbine building and is assumed failed in the TMRE analysis. All of the other operator actions that affect the TMRE analysis are either performed in the Main Control Room (MCR) or in the Control Building; both of which are Category I structures.

## Operator Actions That Affect TMRE Results

| Event Name | Description | Failed | Basis |
|---|---|---|---|
| B21-XHE-FO-DEP2I | FAILURE TO MANUALLY DEPRESSURIZE WITH ADS/SRVS | No | Action performed in Main Control Room (MCR) |
| CIS-XHE-FO-ISOLL | FAILURE TO MANUALLY ISOLATE CONTAINMENT ON LOCA SIGNAL | No | Action performed in MCR |
| E12-XHE-FO-CSACT | OPERATOR FAILS TO ACTUATE CONTAINMENT SPRAY | No | Action performed in MCR |
| E12-XHE-FO-ECCSL | OPERATOR FAILS TO INITIATE LP ECCS | No | Action performed in MCR |
| E12-XHE-FO-ISLLP | FAILURE TO CLOSE LPCI INJECTION MOVS (E12-MOVF042A, B, C) FOR CIS | No | Action performed in MCR |
| E12-XHE-FO-SPCAL | OPERATOR FAILS TO MANUALLY ALIGN FOR SUPPRESSION POOL COOLING | No | Action performed in MCR |
| E12-XHE-FO-SSWXTIE | OPERATOR FAILS TO ALIGN SSW B TO RHR B FOR RPV INJECTION | No | Action performed in MCR |
| E22-XHE-FO-F015 | OPERATOR FAILS TO OPEN SP SUCTION VALVE | No | Action performed in MCR |
| E22-XHE-FO-HPCS | OPERATOR FAILS TO MANUALLY ACTUATE HPCS | No | Action performed in MCR |
| E51-XHE-FO-F031A | FAILURE TO TRANSFER RCIC SUCTION TO SP ON LOW CST LEVEL | No | Action performed in MCR |
| E51-XHE-FO-GRP9 | FAILURE TO REOPEN F068 AFTER GROUP 9 ISOLATION | No | Action performed in MCR |
| E51-XHE-FO-ISOL8 | OPERATOR FAILS TO MANUALLY ISOLATE RCIC SYSTEM | No | Action performed in MCR |
| E51-XHE-FO-SYACT | OPERATOR FAILS TO MANUALLY INITIATE RCIC | No | Action performed in MCR |
| E51-XHE-FO-TRPBY | HUMAN ERROR FAIL TO BYPASS RCIC TEMPERATURE TRIPS (EOP ATTACHMENT 3) | No | Action performed in Control Building |
| E61-XHE-FO-MSH13 | FAILURE TO TURN ON HYDROGEN IGNITERS | No | Action performed in MCR |
| P64-XHE-FO-PT98H | FAILURE TO ALIGN FIREWATER INJECTION PATHWAY #9 THROUGH FW TRAIN A OR B (+8H) | Failed | Action performed in yard and Turbine Building |
| P75-XHE-FO-DG112 | FAILURE TO MANUALLY START DIVISION I OR DIVISION II DIESEL GENERATOR | No | Action performed in MCR |
| R21-XHE-FO-DGXTIE | FAILURE TO CROSS-TIE DIVISION III DIESEL TO DIVISION I OR II DG | No | Action performed in Control Building |
| R21-XHE-FO-LSSRS | FAILURE TO RESET LSS PANEL AFTER INADVERTENT LOAD SHED | No | Action performed in MCR |
| X77-XHE-FO-C001AB2 | FAILURE TO TRANSFER DIV 1, 2 OR 3 DIESEL OUTSIDE AIR FAN TO HIGH SPEED | No | Action performed in MCR |
| Y47-XHE-FO-1C01AB2 | Failure to Manually Start 1Y47-C001A, B or 2Y47-C001A Fan after Auto-Start Failure | No | Action performed in MCR |
| Z77-XHE-FO-B001A | FAILURE TO START STANDBY SWITCHGEAR AND BATTERY ROOM SUPPLY FAN A | No | Action performed in MCR |
| Z77-XHE-FO-C001A | FAILURE TO START STANDBY SWITCHGEAR AND BATTERY ROOM EXHAUST FAN Z77-C001A | No | Action performed in MCR |

| Event Name | Description | Failed | Basis |
|---|---|---|---|
| Z77-XHE-FO-C001B | FAILURE TO START STANDBY SWITCHGEAR AND BATTERY ROOM EXHAUST FAN Z77-C001B | No | Action performed in MCR |
| Z77-XHE-FO-LSSSP | FAILURE TO SHUTDOWN LSS PANEL GIVEN A PARTIAL LOSS OF SSBRV | No | Action performed in MCR |

**NRC RAI 19**

Tables 2-2 and 3-3 of the Enclosure to the submittal lists the "non-conforming (safety related) SSC vulnerabilities" used for the licensee's TMRE evaluation. The list in the above-mentioned tables in the submittal does not appear to include the SSCs presented in the pre-submittal meeting slides (ADAMS Accession No. ML17283A412). One of the items listed in Section 3.2 of the Enclosure to the submittal refers to a licensee procedure that includes "post-tornado walkdowns for tornado missile vulnerable SSCs." It is further stated that the procedure "includes a table of plant vulnerabilities to tornado-generated missiles and recovery actions that reduce the impact of a tornado missile affecting the identified SSCs." Further, Attachment 1 of the Enclosure to the submittal provides the proposed changes to the licensee's Updated Final Safety Analysis Report (UFSAR) where several of the vulnerabilities that were listed in the pre-submittal meeting slides are included in the proposed revision to UFSAR Table 3.5-8 "Safety Related Components Located Outside" and are categorized using terms such as "exposed" and "partially shielded".

a. Explain, with justification, the rationale for not including several of the vulnerabilities listed in the pre-submittal meeting slides in the proposed revision to UFSAR Table 3.5-8 or Table 3.5.1-14a given that the vulnerabilities are "safety related" and found to be "exposed" and/or "partially shielded". Section 5.3.2, "Target Shielding," of NEI 17-02, Revision 1 provides guidance for partial shielding. Provide additional detail on whether partial shielding is credited in in TMRE assessment.

b. Provide a list of all non-conformances and vulnerabilities modeled in the licensee's TMRE model. Include the surface area, robust target credit, number of missiles, MIP, and EEFP for each item identified in the list and cite the source for any robust target credit used.

c. Discuss whether plant vulnerabilities identified in the table in the cited procedure were considered and included in the licensee's TMRE PRA and provide the rationale for any exclusions.

d. Provide mark-up of all UFSAR section that have proposed changes. Section 2.4 of LAR specifies changes in UFSAR Section 3.5.1.4, however Attachment 1 to LAR does not reflect any markup to that UFSAR section.

e. According to Table 3.5-8 in Attachment 1 of the Enclosure to the submittal, eighty-one (81) six-inch diameter openings exist on the north face of the Control Building exterior wall and those openings are exposed due to the partially complete Unit 2 auxiliary building. The submittal seems to be missing any discussion or screening criteria for acceptability of leaving eighty-one (81) 6-inch control room penetrations (partially exposed) unprotected. If the penetrations are included in the licensee's TMRE, describe the approach used for their modeling and inclusion. If the penetrations are not included in the licensee's TMRE, justify their exclusion.

**Entergy Response to RAI 19e**

e. The eighty-one (81) six-inch diameter control building penetrations are located on the Unit 2 Control Building exterior wall. Walkdowns were performed on the penetrations to determine if the penetrations were positioned to allow for a missile to impact Unit 1. The walkdowns confirmed that only 6 of the penetrations would expose Unit 1 equipment (cables) to tornado missiles. Of these 6 penetrations, 3 had plugs installed that were evaluated to withstand 300 mph missiles. The remaining 3 penetrations were evaluated in the TMRE PRA evaluation. The TMRE results including these penetrations are a delta risk for CDF and LERF of 1.35E-07 per year $\Delta$CDF and 1.25E-09 per year $\Delta$LERF. These results meet the RG 1.174 criteria of risk acceptability and no further action is required for these penetrations.

**NRC RAI 20**

Regulatory Position 1, "A Technical Acceptable PRA," of 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) addresses the technical acceptability of a PRA. Regulatory Position 2, "Consensus PRA Standards and Industry PRA Programs," further states that one acceptable approach to demonstrate conformance with Regulatory Position 1 is to use a national consensus PRA standard or standards that address the scope of the PRA used in the decision-making and that a peer review is needed to determine if the intent of the requirements in the standard is met. Regulatory Position 3.3, "Demonstration of Technical Adequacy of the PRA," in RG 1.200, Revision 2, states that one of the aspects to demonstrating the technical adequacy of the pieces of the PRA supporting an application is assurance that those pieces have been performed in a technically correct manner.

Table J.10 in Attachment L to the Enclosure to the submittal provides the finding level Facts and Observations (F&Os) from the 2015 full-scope peer-review that was performed against the 2009 version of the American Society of Mechanical Engineers/American Nuclear Society (ASME/ANS) PRA Standard.

a. Facts and Observations 5-9(F), related to SRs SC-B1 and SC-B2, notes the lack of an analytical basis for assuming successful emergency core cooling system (ECCS) pump operation with availability of suppression pool make-up (SPMU) and recommended including the assumption as a source of modeling uncertainty. The resolution of the F&O does not provide an analytical basis, but states that availability of injection from the condensate storage tank (CST) or other external source will preclude the need for SPMU and that "SPMU is determined not to be required for any additional initiators other than the previously required [medium break loss-of-coolant accident] MLOCA and [large break LOCA] LLOCA." Further, with regard to high pressure core spray (HPCS) operation, the resolution states that "injection of CST volume will increase level and the potential for trip is eliminated in the majority of cases." Section 3.3.8 of the Enclosure to the submittal states that the dominant contributor to the degraded and compliant TMRE cases was the CST. As a result, it appears that the assumption in the resolution of F&O 5-9(F) can be impacted, which in turn can impact the results of the licensee's TMRE model. In the context of the cited F&O, discuss, with justification, the impact of the dominant contribution of the CST failure in the licensee's TMRE model on this application.

Section J.4.2 of Attachment 2 to the Enclosure to the LAR states that the current GGNS internal events model-of-record (MOR), "GGNS Rev 4a PRA", includes "FLEX capabilities" and the same were added to the PRA model subsequent to the 2015 full-scope peer-review.

b. Clarify whether any FLEX equipment is modeled and credited in the TMRE PRA model used to support this application.

c. If such equipment is credited in the TMRE PRA model used to support this application,

   i. Clarify whether incorporation of mitigating strategies in GGNS internal events PRA model has been peer-reviewed. If the incorporation of mitigating strategies has not peer-reviewed, justify why the addition of mitigating strategies is not considered a PRA upgrade. If this change qualifies as an upgrade, provide the results from the focused-scope peer review including the associated F&Os and their resolution.

   ii. Identify the equipment including whether it is portable or permanently installed.

   iii. Describe, with justification, the failure rates used for each credited FLEX equipment and their associated human error probabilities (HEPs). Describe whether and how these HEPs consider environmental conditions, training and procedures relevant to this application. Alternatively, demonstrate the impact of the credited FLEX equipment on the TMRE PRA analysis using a sensitivity study that removes such credit.

iv. Describe the approach for future use of FLEX equipment in the licensee's TMRE PRA model considering (i) the NRC staff's comments from the assessment of NEI 16-06 (ADAMS Accession No. ML17031A269) including the post-license amendment use of FLEX equipment in a PRA model, and (ii) the identification of FLEX equipment as a defense-in-depth measure in Section 3.2 of the Enclosure to the submittal.

**Entergy Response to RAI 20b and 20c**

b. Entergy performed a mini-update to the GGNS Revision 4 PRA MOR to add FLEX capabilities into the model. This model is referred to as the Revision 4A PRA MOR. Subsequent to issuance of the Revision 4A PRA MOR, Entergy performed an interim maintenance update to the PRA to address modeling issues and regain MSPI margin. This interim update is referred to as the Revision 4B PRA MOR. Although the FLEX equipment and strategies are modeled in the base PRA (both the Revision 4A and Revision 4B PRA MORs) and the TMRE PRA, they are not credited in either analysis. A flag file used for both analyses set the event "FLX-XHE-FO-FLEX" (OPERATORS DO NOT DECLARE SBO TO BE AN ELAP) to "True" during the quantification of the model so that the FLEX equipment and strategies are failed and thus not credited in the analysis results.

c. i/ii/iii – As discussed in response to question b, although the FLEX equipment and strategies are modeled in the base PRA and the TMRE PRA, they are not credited in either analysis.

   iv – In the future, the PRA model may credit FLEX in accordance with NRC and industry accepted standards. Therefore, future missile evaluations and their impact on the TMRE analysis may credit FLEX, if appropriate.

**NRC RAI 23**

Regulatory Position 1 of RG 1.200, Revision 2, addresses the technical acceptability of a PRA and Regulatory Position 1.1 states that the scope of a PRA is defined by the challenges included in the analysis and the level of analysis performed. Regulatory Position 3.2 of RG 1.200, Revision 2, states that the licensee needs to identify the pieces of the PRA for each hazard group required to support a specific application. Based on Attachment 2 to the Enclosure it appears that the licensee's internal events PRA model, which is the base for the TMRE PRA model, includes multiple loss-of-offsite power (LOOP or LOSP) initiators. Examples include "transient LOOP", "consequential" LOOP "as a result of transient initiator", and "loss of preferred offsite initiator."

a. Identify the different LOOP initiators in the licensee's internal events PRA model and clarify which LOOP initiator(s) was considered for the licensee's TMRE PRA model.

b. Clarify which LOOP initiator was used to develop licensee's TMRE PRA model and justify use of the selected LOOP initiator. An ideal response will discuss whether all LOOP initiators in the licensee's internal events PRA model have the same event tree, credit the same systems for mitigation and the differences between LOOP initiators.

**Entergy Response to RAI 23**

a. The GGNS Internal Events PRA model includes 2 different LOOP initiators:

- %T1 – Loss of Offsite Power Initiator
- %T1P – Loss of 500 KV Power

For the GGNS TMRE PRA model, the %T1 "Loss of Offsite Power Initiator" logic was used.

b. The first step in developing the TMRE model is establishment of the accident sequence logic that is reasonably expected to represent the tornado initiating events in the TMRE PRA. One of the basic assumptions of the TMRE method is that a tornado event that creates tornado missiles will, at a minimum, cause a Loss of Offsite Power (LOSP) and reactor trip. Given that assumption, the transient event sequence logic initiated by a LOSP event (%T1) and station blackout sequence logic is considered the most representative logic for TMRE. For the GGNS TMRE PRA model, the %T1 "Loss of Offsite Power Initiator" logic was used, which is the LOSP event that is used in the base case PRA model. The other LOOP initiator, %T1P, does have the same event tree logic and response systems as the %T1.

**NRC RAI 24**

Regulatory Position 2 in RG 1.174, Revision 2, states that the licensee should appropriately consider uncertainty in the analysis and interpretation of findings. Regulatory Position 3 states that decisions concerning the implementation of licensing basis changes should be made after considering the uncertainty associated with the results of the traditional and probabilistic engineering evaluations.

Regulatory Position 3 in RG 1.174, Revision 2, states that careful consideration should be given to implementation of the proposed change and the associated performance monitoring strategies. This Regulatory Position further states that an implementation and monitoring plan should be developed to ensure that the engineering evaluation conducted to examine the impact of the proposed changes continues to reflect the actual reliability and availability of SSCs that have been evaluated. This will ensure that the conclusions that have been drawn from the evaluation remain valid.

Section 7.2, "Sensitivity Analysis," of NEI 17-02, Revision 1, address the steps that should be taken if the change in CDF and LERF from the sensitivity analyses exceed $10^{-6}$ per year and $10^{-7}$ per year, respectively.

a. Describe the GGNS process if change-in-risk estimates from sensitivity analyses exceed the RG 1.174, Revision 2, acceptance guidelines for "very small" change in risk in implementation of TMRE methodology.

b. Describe how the importance measures are determined from the TMRE PRA model in the context of the 'binning' approach for the tornado categories employed in the model. Describe whether and how the same basic events, which were discretized by binning during the development of the TMRE PRA model, are combined to develop representative importance measures. For same basic events that are not combined, provide a justification that includes discussion of any impact on the results.

c. Identify the non-conforming conditions and vulnerabilities that met all the characteristics of a "highly exposed" SSC per Section 7.2.1, "TMRE Sensitivities," of NEI 17-02, Revision 1.

The discussions in Section 7.2 of NEI 17-02, Revision 1, do not address whether sensitivity analyses will be aggregated in future implementations of the TMRE methodology. For example, it is unclear whether the licensee will combine the sensitivity analyses related to any future open PRA facts and observations (F&Os), sensitivities that address compliant case conservatism and TMRE sensitivity analyses.

d. Describe, with justification, whether sensitivity analyses in NEI 17-02, Revision 1, will be aggregated in future implementation of the TMRE methodology.

The discussion in Section 7.2.3, "Compliant Case Conservatisms," and Section A.2.1.3, "Non-Category I Structures and Exposed Non-Safety Related SSCs," of NEI 17-02, Revision 1, recognizes that the TMRE PRA could produce non-conservative change-in-risk results if conservatively assumed failures in the Compliant Case mask change-in-risk. Accordingly, Section 7.2.3 of NEI 17-02, Revision 1, states, in part, that:

> [the] licensee should review cut sets in the top 90% of the TMRE compliant case to identify conservatisms related to equipment failure (opposed to offsite power recovery or operator actions) that could impact results.

Section 7.2.3 of NEI 17-02, Revision 1, also explains that the licensee should perform sensitivity studies associated with these conservatisms as directed in Appendix D of the TMRE guideline for PRA standard supporting requirements (SRs) AS-A10, LE-C3, and SY-B7 to address equipment failures in the compliant case that may be masking change-in-risk but does not provide guidance on how such a sensitivity can be performed.

Section 3.3.10 "Sensitivities and Uncertainties", of the Enclosure to the submittal describes a sensitivity assessment performed to ensure conservative modeling treatments in the compliant case do not affect the risk assessment conclusions.

e. Describe any future sensitivity analysis that will be performed to assess the impact of conservatisms associated with modeling the equipment failures in the compliant case of the TMRE PRA model.

Modeling operator actions, could contribute to underestimating the change-in-risk calculation associated with non-conforming SSCs. Appendix D, "Technical Basis for TMRE Methodology," of NEI 17-02, Revision 1, does not appear to address the concern described above could also apply to conservative human reliability analysis modeling (e.g., SR HR-G3 and HR-G7).

f. Describe how GGNS will address the potential impact of TMRE assumptions related to certain human error probabilities within 1 hour after the accident on the compliant case.

**Entergy Response to RAI 24**

a. Currently, the GGNS TMRE analysis has determined that the sensitivity results do not exceed the "very small" risk change thresholds for risk acceptability as identified in RG 1.174. If the ΔCDF or ΔLERF values of a future GGNS TMRE revision, or any of the required sensitivity studies, exceeds the acceptance guidelines of RG 1.174, NRC prior approval would be required if the apparent change in risk cannot be reduced with refinements.

b. The importance measures for the SSCs were determined by first identifying the basic events that had been binned with the F'4, F'5, and F'6 tornados. This approach does not consider the importance of F'2 and F'3 SSC basic events, since they are not affected by the sensitivity calculation. This list of Basic Events was then reviewed to determine which had a Risk Achievement Worth (RAW) greater than or equal to 2 based on the results of the Degraded Case quantification for CDF and LERF. Per the guidance in Enclosure 2 of Reference 2 for performing sensitivity analysis for the missile distribution, those target SSCs with RAWs of less than 2 were totaled in order to ensure that the sensitivity captured those SSCs of significance. The result of this sensitivity analysis can be seen in response to RAI #25 of this submittal.

   This approach does not consider the importance of F'2 and F'3 SSC basic events, since they are not affected by the sensitivity calculation. However, it does account for the cumulative importance of the SSCs for the F'4 through F'6 tornado intensities. NEI 17- 02, Section 7.2.1 states that this sensitivity "only applies to tornado missile basic events for tornado categories F'4, F'5, and F'6. Basic events for F'2 and F'3 tornado missile failures are not considered in this sensitivity."

   The RAW values for the F'4 - F'6 basic events are used to determine the sensitivity targets, since the F'4 - F'6 basic events are the ones being affected by the sensitivity study. A RAW value of 2 was chosen to reflect the importance of the events with respect to increasing the basic event failure probability. The RAW values of the F'2 and F'3 basic events are indicative of the overall risk increase associated with failure probabilities for just the F'2 and F'3 basic events, which are not relevant to the sensitivity study. They do not provide information about the potential risk increase associated with higher F'4- F'6 basic event values. As an extreme example, if the RAW for an F'2 basic event is greater than 2, but the RAW values for all the other tornado intensities are 1.0, there is no need to perform the sensitivity analysis, since there would be no change to the ΔCDF or ΔLERF.

c. The non-conforming conditions and vulnerabilities that meet all the characteristics of a "highly exposed" SSC per Section 7.2.1 of NEI 17-02, Revision 1, are those that meet the following characteristics:

- The SSC is not located inside a Category I structure (i.e., they are outside or in a non-Category I structure)
- SSC is not protected against horizontal missiles
- The SSC has an elevation less than 30' above grade

Since this Sensitivity is limited to Tornado Missile Failure Basic Events with a RAW/RAWTotal $\geq$ 2, the following table includes all the Tornado Missile Failure Basic Events that have a RAW $\geq$ 2 and evaluates them against the three bullets listed above. For SSCs that are not highly exposed, the characteristic(s) not met are provided in the final column.

| SSC | Highly Exposed | Notes |
|---|---|---|
| Non-Conformance – Cable Chase Room 1A539 Cables (Behind Door 1A501) | No | Target is above 30 feet. |
| Non-Conformance – Straight Vertical SSW Return Lines for Pump P41C001A | Yes | Meets all criteria for highly exposed target. |
| Non-Conformance – Straight Vertical SSW Return Lines for Pump P41C001B | Yes | Meets all criteria for highly exposed target. |
| Non-Conformance - Diesel Generator Fuel Oil Storage Tank (1P75-A003A, 1P75-A003B, 1P81-A001) Inlet Connections | Yes | Meets all criteria for highly exposed target. |

| SSC | Highly Exposed | Notes |
|---|---|---|
| Non-Conformance - Diesel Generator Fuel Oil Day Tank Vents Penetrations DC-20A, DC-21A, and DC-22A) | No | Target is above 30 feet. |
| Vulnerabilities - Diesel Generator Exhaust Pipes | No | Target is above 30 feet. |
| Vulnerabilities - Diesel Generator Lube Oil Sump Vents | No | Target is above 30 feet. |
| Vulnerabilities - Diesel Generator Crank Case Vents | No | Target is above 30 feet. |
| Vulnerability – Div 2 DG Exposed equipment/Cable Failure Z77Y703B | Yes | Meets all criteria for highly exposed target. |
| Vulnerability – SSW Cooling Tower Basin Pump House/Valve Room Door 1M110 | No | Target is an exterior door. The target of interest is an electrical cabinet inside the room and is inside a Category 1 building. |
| Vulnerability – SSW Cooling Tower Basin Pump House/Valve Room Door 2M110 | No. | Target is an exterior door. The target of interest is an electrical cabinet inside the room and is inside a Category 1 building. |
| SSW Supply Header and Return Header, Penetrations DP-1A and DP-2A | Yes | Meets all criteria for highly exposed target. |
| Vulnerability – Eighty-one (81) 6" dia. Openings in Control Building North Wall | No | Target is above 30 feet. |

d. Industry guidance will be followed in relation to aggregating sensitivity analysis in future implementations of the TMRE methodology. The most recent industry guidance as disclosed in Enclosure 2 of Reference 3 eliminates one of the sensitivities from the previous version of NEI 17-02, Revision 1. In the most recent version of the industry guidance, the highly exposed target criterion was evaluated. The sensitivity analysis was revised to perform the missile distribution sensitivity in lieu of the Zonal versus Uniform sensitivity and the Missile Impact Analysis sensitivity.

e. Sections 7.2.3 and A.4 of Enclosure 2 of Reference 3 provides guidance and potential methods that can be used to evaluate the potential impact of compliant case conservatisms on the ΔCDF and ΔLERF.

   The results of the GGNS TMRE evaluation, which includes the increased MIPs and evaluates the secondary effects of the SSW piping, determined that potential compliant case conservatisms would not significantly affect the CDF or LERF results since the degraded case results are 7.02E-07/yr. and 8.79E-09/yr., respectively. Assuming a compliant case of 0.0 would still result in a ΔCDF and a ΔLERF which are still below the acceptance criteria for RG 1.174.

   These results show that potential conservatisms in the compliant case will not change the conclusions of the TMRE analysis results for ΔCDF or ΔLERF.

   GGNS will follow the guidance in Sections 7.2.3 and A.4 of Enclosure 2 of Reference 3, if such sensitivity analyses are required in the future.

f. Short-term operator actions (defined as occurring within 1 hour of the tornado event) that require transit or execution outside Category I structures are also assumed to fail in the TMRE method. These are reasonable assumptions and generally consistent with current high wind PRAs. NEI 17-02 Section A.2.1.2 has been updated to provide some considerations for this treatment.

   Therefore, no evaluation is required to assess the potential impact of the 1-hour operator action on the compliant case risk.

**<u>NRC RAI 25</u>**

Regulatory Position 2 in RG 1.174, Revision 2, states that the licensee should appropriately consider uncertainty in the analysis and interpretation of findings. Regulatory Position 3 states that decisions concerning the implementation of licensing basis changes should be made after considering the uncertainty associated with the results of the traditional and probabilistic engineering evaluations.

The discussion in Section A.7, "Zonal vs. Uniform (Z vs U) Sensitivity," of Appendix A, "Technical Basis for TMRE Methodology," to NEI 17-02, Revision 1, recognizes differences between zonal and uniform missile distributions without justification. Targets were categorized in Appendix A to separate intuitive from non-intuitive trends and an adjustment factor is proposed to account for zonal distribution of missiles.

Describe, with justification, how uncertainties associated with the impact of the missile distribution on the licensee's target hit probability are handled in the GGNS TMRE methodology.

**Entergy Response to RAI 25**

The sensitivity to address uncertainty in missile distributions has been updated per Enclosure 2 of Reference 2. The procedure is summarized as follows:

1. For highly exposed SSCs with a tornado missile failure basic event RAW/RAWTotal > 2, multiply the basic event failure probability by 2.75. This only applies to tornado missile basic events for tornado categories F'4, F'5, and F'6. Basic events for F'2 and F'3 tornado missile failures are not considered in this sensitivity. The basis for the 2.75 multiplier has not changed; it is provided in Section A.7 of NEI 17-02.

2. In addition to the conditions described above (highly exposed target with RAW >2), an additional MIP multiplier (i.e., a target-specific MIP) is required if a large number of missiles are close to such a target (defined as greater than 1,100 missiles within 100 feet of the target). The potential concern with this situation is that the risk associated with a highly exposed and risk significant target with a large concentration of nearby missiles may be underestimated using the 2.75 MIP multiplier. The basis for the criteria (1,100 missiles within 100 feet of the target is provided in Section A.7.6 of Enclosure 2 to Reference 2).

   a. Prior to determining the target-specific MIP and performing a sensitivity, qualitative factors can be provided to justify not applying a higher target specific MIP. The justification should address how certain factors can mitigate the potentially higher frequency of missile impacts on the target. Factors to consider are listed in Section 7.2.1 of the updated NEI 17-02, Revision 1B (i.e., Enclosure 2 to Reference 3).

   b. If the target(s) in question are still considered susceptible to a MIP multiplier higher than 2.75 after assessing qualitative factors, a target-specific MIP shall be calculated and included in the sensitivity study, with the other targets that meet the highly exposed and RAW >2 conditions. The process for calculating the additional MIP multiplier is provided in Section 7.2.1 of Enclosure 2 to Reference 3.

3. The TMRE Missile Distribution Sensitivity is performed by applying either the generic MIP multiplier of 2.75 or the target-specific MIP multiplier to the appropriate basic events, recalculating the ΔCDF and ΔLERF, and comparing the results to the acceptance criteria.

The GGNS ΔCDF and ΔLERF meet the threshold for performing the sensitivity associated with missile distribution uncertainty; therefore, a sensitivity is required to be performed on the current TMRE results for this LAR. The missile distribution sensitivity was performed in accordance with the information provided above. In addition to the current analysis in support of the LAR, if the threshold is met in the future at GGNS, a sensitivity analysis will be performed in accordance with industry guidance.

The GGNS sensitivity evaluates SSCs with a tornado missile failure basic event RAW or SSC RAWTotal ≥ 2 and only applies to basic events for tornado categories F'4, F'5, and F'6. Walkdowns were performed to determine if a missile count of greater than 1100 missiles existed within 100 feet of the non-conformances. It was determined that the missile count within 100 feet is below the 1100 missile criteria justifying the use of the 2.75 MIP multiplier in the sensitivity analysis. The probability of the SSCs meeting the quantitative and qualitative criteria was multiplied by 2.75, entered into the TMRE model, and the model quantified.

The results of this quantification for ΔCDF and ΔLERF are 4.48E-07/yr. and 4.70E-09/yr., respectively. The ΔCDF and ΔLERF for this sensitivity case are both below RG 1.174 acceptance criteria.

## NRC RAI 26

Regulatory Position 1 of RG 1.200, Revision 2, addresses the technical acceptability of a PRA. Regulatory Position 2 further states that one acceptable approach to demonstrate conformance with regulatory position 1 is to use a national consensus PRA standard or standards that address the scope of the PRA used in the decision-making and that a peer review is needed to determine if the intent of the requirements in the standard is met.

Section 3.3.7, "Model Quantification," of the Enclosure to the submittal provides the quantification results for the licensee's TMRE model and discusses the truncation used for the model quantification. Comparison against corresponding values provided in the pre-submittal meeting slides (ADAMS Accession No. ML17283A412) shows a marked difference in the 'compliant case' results.

The truncation used for the licensee's TMRE model quantification is stated to be "consistent with the GGNS base model." However, the licensee's TMRE model quantification results are substantially lower than the base internal events model. Use of an inappropriate truncation level can adversely impact the risk insights and quantification. Supporting requirement QU-B3 in the 2009 ASME/ANS PRA Standard provides the requirements for truncation limits and provides an example of sufficient convergence as being when successive reductions in truncation value of one decade result in decreasing changes in CDF or LERF, and the final change is less than 5 percent.

Section 3.3.8 "Results", of the Enclosure to the submittal provides a discussion of the results and states that the dominant contributor for the 'compliant' and 'degraded' cases is the CST. However, the CST does not appear in Tables 2-2 and 3-3 of the Enclosure to the submittal which list the non-conformances included in the licensee's TMRE evaluation.

a. Justify the truncation level used for the licensee's TMRE model quantification and explain how the selected truncation level meets the SRs, such as QU-B3 and QU-F2, in Part 2 of the ASME/ANS PRA Standard as endorsed by RG 1.200, Revision 2.

b. Explain, with justification, the change in the quantification of the licensee's TMRE model presented in Table 3-4 of the Enclosure to the LAR, especially the change in the 'compliant' case, as compared to that provided in the pre-submittal meeting slides.

c. Explain the rationale for the CST being a dominant contributor to the risk based on the licensee's TMRE model considering that CST is not identified as a vulnerability or non-conforming condition.

**Entergy Response to RAI 26**

a. The CDF is truncated at 1E-12/yr. and the LERF is truncated at 1E-15/yr. This is point of convergence for the TMRE model as documented in Attachment 2 of Reference 1.

   The CDF model for the degraded case was solved at decreasing truncation levels. The CDF truncation cutoff value was established by an iterative process that started at 1E-9 and was repeated at successively lower truncation values until 1E-13. Similarly, the LERF truncation cutoff value was established by an iterative process that started at 1E-10 and was repeated at successively lower truncation values until 1E-16.

   The two primary objectives for selecting truncation is the inclusion of dependencies and convergence toward a stable value. The data shows that the CDF is converging at 1E-12 and LERF is converging at 1E-15.

   Specifically, the standard requirement for CDF convergence provided by Supporting Requirement QU-B3 of Ref. 2.23 is:

   > "For example, convergence can be considered sufficient when successive reductions in truncation value of one decade result in decreasing changes in CDF or LERF, and the final change is less than 5%."

   A decade change of less than 5% was produced for the chosen truncation limits of both CDF and LERF.

   Supporting Requirement QU-F2 is associated with the documentation of the model integration process, including any recovery analysis, and the results of the quantification, including uncertainty analysis. Since the TMRE PRA model started with the Peer Reviewed Internal Events model, there was no model integration process required, although changes made to that model to develop the TMRE model are documented in the TMRE analysis. The process followed for quantifying the TMRE PRA model, including discussion of the recovery rules, quantification results, and sensitivity studies performed are also provided in the TMRE analysis.

b. The pre-submittal meeting slides provided preliminary quantification results as shown in the table below.

Preliminary TMRE Evaluation – Quantification Results

| | CDF / year | LERF / year |
|---|---|---|
| **Compliant** | 5.89E-07 | 2.72E-08 |
| **Degraded** | 8.13E-07 | 5.06E-08 |
| **Delta** | 2.25E-07 | 2.34E-08 |

Table 3-4 of the LAR provides the final quantification results as shown in the table below.

LAR TMRE Evaluation – Quantification Results

| | CDF / year | LERF / year |
|---|---|---|
| **Compliant** | 7.38E-07 | 3.94E-08 |
| **Degraded** | 8.81E-07 | 5.54E-08 |
| **Delta** | 1.43E-07 | 1.6E-08 |

In the pre-submittal slides, there were 18 potential vulnerabilities identified. At the time of the pre-submittal, these potential vulnerabilities were all evaluated as non-conformances and the resulting Compliant case results reflected that modeling. However, subsequent walkdowns performed by GGNS identified that of the 18 initial vulnerabilities identified in the pre-submittal meeting slides, only five (5) of them met the criteria to be classified as non-conformances, and the remainder were retained as potential vulnerabilities. When the TMRE PRA model was updated to reflect only five non-conformances, this directly impacted the quantified results for both the compliant and degraded cases.

The most recent results to be considered in the LAR evaluation can be seen in the table below. These results reflect the recent increase in MIP values by approximately 30% and include secondary effects of SSW pipe, and are based on the interim updated Revision 4B PRA MOR.

| | CDF / year | LERF / year |
|---|---|---|
| **Compliant** | 5.67E-07 | 7.54E-09 |
| **Degraded** | 7.02E-07 | 8.79E-09 |
| **Delta** | 1.35E-07 | 1.25E-09 |

c. The CST is identified in the GGNS TMRE analysis and is considered to be a vulnerability. Based upon the 100 mph wind loading limit for the CST, the CST is assumed to fail for all category tornados. These failures are modeled by assigning the CST a failure probability of 1.0 for the F'2 through F'6 tornados and contribute significantly to the overall risk.

**<u>NRC RAI 27</u>**

Section 7.2.1, TMRE Sensitivities," of NEI 17-02, Revision 1, identifies certain sensitivity studies and provides guidance on their performance. Section 3.3.10, "Sensitivities and Uncertainties," of the Enclosure to the submittal describes the sensitivity studies performed by the licensee to support this application. It appears that the sensitivity studies in Section 3.3.10 of the Enclosure to the submittal were performed by multiplying both the compliant and degraded case which will impact the vulnerabilities in both cases. The guidance provided in Section A.6.2 of Appendix A of NEI 17-02, Revision 1, states that "the sensitivity will be performed by recalculating target EEFPs by multiplying the nominal values calculated for the Degraded Case". Similarly, the procedure for performing the sensitivities in Section 7.2.1 of NEI 17-02, Revision 1, states that "[f]or SSCs with a tornado missile failure basic event multiply the basic event failure probability".

a. Describe the implementation of the guidance in NEI 17-02, Revision 1, on vulnerabilities when performing sensitivity analyses, especially the zonal versus uniform missile distribution sensitivity ("Sensitivity 1") and the missile impact parameter sensitivity ("Sensitivity 2"). If applicable, describe and provide the results of any updated sensitivity analyses considering the response to separate information requests on the basis for the MIP and the sensitivities (information requests 1, 4, and 24).

b. Describe the implementation of the guidance in NEI 17-02, Revision 1, on vulnerabilities when performing sensitivity analyses in future use of the licensee's TMRE PRA model.

**Entergy Response to RAI 27**

a. The base case TMRE analysis results were revised to include new MIP values (increase of approximately 30%) from that provided in NEI 07-02, Revision 1. Subsequently, a new sensitivity analysis was performed in accordance with the section 7.2 of Enclosure 2 to Reference 3 for missile distribution sensitivity in lieu of the "Sensitivity 1" and Sensitivity 2" described in the RAI question. The results of this sensitivity were provided in response to RAI #25 and are also presented in the table below. The ΔCDF or ΔLERF values are well within the acceptance criteria of RG 1.174.

| | CDF / year | LERF / year |
|---|---|---|
| **Compliant** | 9.62E-07 | 1.05E-08 |
| **Degraded** | 1.41E-06 | 1.52E-08 |
| **Delta** | 4.48E-07 | 4.70E-09 |

b. The most recent industry guidance as disclosed in Enclosure 2 of Reference 2 provides guidance on the performance of sensitivities. This guidance will be followed in relation to performing sensitivity analysis on vulnerabilities in future implementations of the TMRE methodology.

**NRC RAI 28**

Section 3.3.2, "Assessment of Assumptions and Approximations," of RG 1.200, Revision 2, states, in part, that:

> [f]or each application that calls upon this regulatory guide, the applicant identifies the key assumptions and approximations relevant to that application. This will be used to identify sensitivity studies as input to the decision making associated with the application.

Further, Section 4.2, "Licensee Submittal Documentation," of RG 1.200, Revision 2, states, in part, that:

> [t]hese assessments provide information to the NRC staff in their determination of whether the use of these assumptions and approximations is appropriate for the application, or whether sensitivity studies performed to support the decision are appropriate.

RG 1.200, Revision 2, defines the terms "key assumption" and "key source of uncertainty" in Section 3.3.2, "Assessment of Assumptions and Approximations."

Section J5 of Attachment J of the Enclosure to the submittal states, in part, that assumptions and approximations used in the development of the GGNS internal events PRA which forms the basis for the TMRE PRA "have been reviewed and are appropriate for this application". The submittal does not appear to describe the key assumptions and key sources of uncertainties that were identified in GGNS internal events PRA model and how those assumptions and uncertainties were addressed.

a. Describe the key assumptions and key sources of uncertainties in GGNS internal events PRA that may impact this application.

b. Describe how each key assumption and key source of uncertainty was dispositioned for this application.

**Entergy Response to RAI 28**

a/b. To identify the key assumptions and key sources of uncertainty associated with the GGNS internal events and internal flooding PRA, the Uncertainty and Sensitivity Analysis Report associated with the Revision 4B GGNS PRA was reviewed. Based on this review, the following key assumptions and key sources of uncertainty that might be considered in relation to the TMRE analysis were identified:

| Assumption/Uncertainty | Impact on Internal Events PRA | Impact on TMRE and Disposition |
|---|---|---|
| Initiating Event Frequency | The selection of the initiating events can lead to some variability and potential for incomplete selection based on assumptions on the level of modeling detail related to initiating events and impacts. Uncertainties in event frequency collected for use in the statistical uncertainty analysis. | The TMRE analysis uses the Tornado Initiating Event Frequencies calculated following the methodology in NEI 17-02, Revision 1. Since this methodology relies on inputs that have uncertainty associated with them (number of missiles generated, MIP, etc.) the calculated values have uncertainty associated with them. To address this uncertainty, the NEI 17-02, Revision 1 specified sensitivity analyses were performed. |

| Assumption/Uncertainty | Impact on Internal Events PRA | Impact on TMRE and Disposition |
|---|---|---|
| Human Reliability Analysis | Human action assessment has uncertainty related to not only statistical methods and data but in the inherent uncertainty of operator actions. Timing studies are also limited and in some cases require interpretation of the procedure in terms of many different scenarios. | To minimize the uncertainty associated with the HRA, in the TMRE analysis, Operator actions outside of Category I buildings are not credited. |
| Data Development | Statistical uncertainty is introduced related to statistical properties of the component failure rates. Distributions are utilized to address both randomness and methods uncertainty. The impact of component boundaries, as well as physical and deterministic inputs, leads to uncertainty. | Although the statistical uncertainty associated with the failure rate data used in the Internal Events PRA model also exists in the TMRE PRA model, since the TMRE analysis is evaluating the delta CDF and delta LERF, the impact of the data uncertainty is considered to be the same on both the compliant and the degraded cases. Therefore, the impact on calculated delta CDF and delta LERF is minimal. |
| Large Early Release Frequency Phenomena Evaluation | The phenomena associated with accident progression are uncertain due to the many variables that impact inputs to the LERF model such as hydrogen generation or RCS pressure.<br>The probabilities assigned are not statistical in nature but are based on knowledge uncertainties in the modeling and in the level of uncertainty with respect to these parameters. The influence is best addressed through sensitivity studies. | Although the uncertainty associated with the LERF Phenomena Evaluation in the Internal Events PRA model also exists in the TMRE PRA model, since the TMRE analysis is evaluating the delta CDF and delta LERF, the impact of the LERF Phenomena Evaluation uncertainty is assumed to be the same on both the compliant and the degraded cases. Therefore, the impact on calculated delta CDF and delta LERF is minimal. |

| Assumption/Uncertainty | Impact on Internal Events PRA | Impact on TMRE and Disposition |
|---|---|---|
| Grid Stability: LOOP Initiating Event Frequency Values | Since the loss of offsite power initiating event is a significant contributor, the loss of offsite power aspect is an uncertainty candidate. Specifically, the impact of localized severe weather is more plausible for the GGNS location than some other sites and the completeness of events are considered as sensitivity studies. | Although the TMRE analysis uses the LOOP response logic, the LOOP Initiating Event frequency is not the basis for the analysis, the Tornado Initiating Event frequencies are used in the analysis. Therefore, the LOOP Initiating Event Frequency uncertainty does not impact the TMRE analysis. |
| Impact of Containment Venting on Core Cooling System NPSH / Core Cooling Success Following Containment Failure or Venting Through Non-Hard Pipe Vent Paths | Plant-specific analyses were performed that indicate ECCS pump continued operation is possible following either venting or containment overpressure.<br><br>Failure of long-term decay heat removal due to containment or venting failure is modeled.<br>Credit is limited to HPCS for cases of containment overpressure failure to reduce uncertainties taken for other pumps following loss of containment heat removal. | The uncertainty associated with the Impact of Containment Venting on NPSH and Core Cooling Success in the Internal Events PRA model also exists in the TMRE PRA model. The TMRE walkdowns did not identify any vulnerabilities or non-conformances associated with the equipment used to perform containment venting, and the operator action is performed within a Category I building. Since the TMRE analysis is evaluating the delta CDF and delta LERF, the impact of the Impact of Containment Venting on NPSH and Core Cooling Success uncertainty is assumed to be the same on both the compliant and the degraded cases. Therefore, the impact on calculated delta CDF and delta LERF is minimal. |

## 3. REFERENCES

1) Entergy letter to NRC, "License Amendment Request to Incorporate Tornado Missile Risk Evaluator into Licensing Basis," dated November 3, 2017 (ML17307A440)

2) SNC letter to NRC, "SNC Response to NRC Request for Additional Information," dated July 26, 2018 (ML18207A876)

3) Duke Energy letter to NRC, "License Amendment Request to Incorporate Tornado Missile Risk Evaluator into Licensing Basis – Supplement and Request for Additional Information Response (EPID L-2017-LLA-0355)," dated September 19, 2018 ML18262A328