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GNRO-2017/00061

November 3, 2017

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
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SUBJECT: License Amendment Request to Incorporate Tornado Missile Risk Evaluator into Licensing Basis.
Docket No. 50-416
License No. NPF-29

Ladies and Gentlemen:

Pursuant to 10 CFR 50.90, Entergy Operations, Inc. (Entergy), hereby submits a License Amendment Request (LAR) for the Grand Gulf Nuclear Station, Unit 1 (GGNS), to incorporate the Tornado Missile Risk Evaluator (TMRE) methodology into the GGNS Updated Final Safety Analysis Report. The TMRE methodology was transmitted to the NRC by the Nuclear Energy Institute as NEI, 17-02, Revision 1 on September 21, 2017, and is incorporated by reference into this LAR. The TMRE methodology is proposed as a means of complying with licensing basis requirements for tornado missile protection requirements.

This LAR is one of three pilot LARs supporting NRC approval of the TMRE methodology. Approval of the LAR is requested within six months of NRC staff acceptance to support utilization of the methodology by other licensees. Once approved, the amendment shall be implemented within 90 days.

This LAR contains no Regulatory Commitments.

In accordance with 10 CFR 50.91, Entergy is notifying the State of Mississippi of this LAR by transmitting a copy of this letter and enclosure to the designated State Official.

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

I declare under penalty of perjury that the foregoing is true and correct. Executed on November 3, 2017.

Sincerely,

Eric A. Larson
Site Vice President
EAL/amh

Enclosure: Evaluation of the Proposed Changes

Attachments:
1. Updated Final Safety Analysis Report Markups.
2. Probabilistic Risk Assessment Technical Adequacy Documentation

cc: with Attachments and Enclosure

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cc: without Attachments and Enclosure

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GNRO-2017/00061

Grand Gulf Nuclear Station, Unit No. 1
Docket No. 50-416 / License No. NPF-29

License Amendment Request to Incorporate
Tornado Missile Risk Evaluator
into Licensing Basis

ENCLOSURE:

Evaluation of the Proposed Changes

ATTACHMENTS:

1. SUMMARY DESCRIPTION

Pursuant to 10 CFR 50.90, Entergy Operations, Inc. (Entergy), hereby submits a License Amendment Request (LAR) for the Grand Gulf Nuclear Station, Unit 1 (GGNS), to incorporate the Tornado Missile Risk Evaluator (TMRE) methodology into the GGNS Updated Final Safety Analysis Report. The TMRE methodology was transmitted to the Nuclear Regulatory Commission (NRC) by the Nuclear Energy Institute (NEI) as NEI 17-02, Revision 1 (ADAMS Accession No. ML17268A036), and is incorporated by reference into this LAR. The TMRE methodology is proposed as a means for determining whether physical protection from tornado-generated missiles is warranted. The methodology can only be applied to discovered conditions where tornado missile protection should be provided and is not currently provided. Future modifications to the facility requiring tornado missile protection would not be evaluated using the TMRE methodology.

2. Detailed Description

2.1 Background Information

The NRC issued Regulatory Issue Summary (RIS) 2015-06, Tornado Missile Protection, on June 10, 2015 (ADAMS Accession No. ML15020A419). The RIS documented the following:

> Systems, structures, and components (SSCs) of nuclear power plants are designed to withstand natural phenomena such as earthquakes, tornadoes, hurricanes, and floods without the loss of capability to safely maintain the plant. In general, the design bases for these structures, systems, and components reflect: (1) appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated, (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena, and (3) the importance of the safety functions to be performed. The specific criteria for each nuclear power plant are contained in the individual plant's specific licensing basis.
>
> In the late 1970s and early 1980s several licensees identified components that did not conform to their plant specific licensing basis for tornado-generated missile protection. Examples of nonconforming items included components not located inside structures designed to protect against tornados and tornado-generated missiles, components not provided with tornado missile barriers, and components not designed to withstand tornados and tornado missiles. Topical reports were submitted by the Electric Power Research Institute (EPRI) for NRC review of the probability-based TORMIS methodology. The TORMIS methodology determines the probability of components being struck and disabled by a tornado-generated missile, and was accepted for use by the NRC. In cases where some components were not in conformance with a plant's licensing basis, licensees used the TORMIS methodology as a means for demonstrating that the probability of these components being struck by a tornado-generated missile was low enough to justify that protection from tornado-generated missiles was not required. Several licensees have incorporated the TORMIS methodology, or other probabilistic methodologies, into their plant specific licensing basis.

The Nuclear Energy Institute (NEI) developed another risk-informed methodology for identifying and evaluating the safety significance associated with structures, systems and components (SSCs) that are exposed to potential tornado-generated missiles. The TMRE methodology is an alternative methodology for determining whether protection from tornado-generated missiles is required. The methodology can only be applied to discovered conditions where tornado missile protection should be provided and is not currently provided. Future modifications to the facility requiring tornado missile protection would not be evaluated using the TMRE methodology.

2.2 Current Licensing Basis (CLB)

General Design Criteria

GGNS was designed to meet the General Design Criteria (GDC) in 10 CFR 50, Appendix A. The GGNS design basis protects its structures, systems and components (SSC) against certain tornado-generated missiles which were determined to be bounding cases. These bounding missiles, and the criteria for determining that these missiles were bounding, were evaluated and approved by the NRC during the original licensing review. GGNS received its Safety Evaluation Report (NUREG 0831) in June 1981. The NRC found that these bounding assumptions provide reasonable assurance that the safety function of SSCs required for shutdown at GGNS will not be impaired by missiles and that GGNS's approach to tornado missile protection complies with GDC 2 and 4.

Grand Gulf Nuclear Station Safety Evaluation Report

NRC staff issued NUREG 0831, Grand Gulf Nuclear Station Safety Evaluation Report, to document the scope of their review during the initial licensing process. Excerpts relevant to tornado missile protection from NUREG 0831 include:

Section 3.5.1

- The tornado missile spectrum was reviewed in accordance with SRP 3.5.1.4 (NUREG-0800). Conformance with the acceptance criteria formed the basis for the staff evaluation of the tornado-missile spectrum with respect to the applicable regulations of 10 CFR 50.

- The applicant has identified all safety-related structures, systems, and components requiring protection from externally generated missiles. All safety-related structures are designed to withstand postulated tornado-generated missiles without damage to the safety-related equipment they contain.

Section 3.5.2

- The applicant has identified all safety-related structures, systems, and components requiring protection from externally generated missiles. All safety-related structures are designed to withstand postulated tornado-generated missiles without damage to the safety-related equipment they contain. All safety-related systems and components and stored fuel are located within tornado-missile-protected structures or are provided with tornado-missile barriers. Buried safety-related systems such as piping and electrical circuits are protected by the overlaying earth.

- Based on the above, the staff concludes that the applicant's list of safety-related structures, systems, and components to be protected from externally generated missiles and the provisions in the plant design providing this protection are in accordance with the requirements of GDC 2 and 4 with respect to missile and environmental effects and the guidelines of Regulatory Guide 1.13; Regulatory Guide 1.27; and Regulatory Guide 1.117, concerning protection of safety-related structures, systems, and components from tornado generated missiles and is, therefore, acceptable.

Updated Final Safety Analysis Report (UFSAR) Revision 2016-00
The Grand Gulf licensing basis for tornado missiles is described in the UFSAR and is listed below.

Appendix 3A, Conformance with NRC Regulatory Guides

- Regulatory Guide 1.76, Design Basis Tornado for Nuclear Power Plants
  - GGNS complies with Regulatory Guide 1.76, Rev. 0.
- Regulatory Guide 1.117, Tornado Design Classification, Rev. 1
  - GGNS complies with Regulatory Guide 1.117 Rev 1.

Section 2.3, Meteorology,
Sub-Section 2.3.1.2.8 Design Basis Tornado Parameters

- The GGNS site lies within Region I for determining the Design Basis Tornado (Reference UFSAR Section 2.3.1.2.8). The Region I associated Design Basis Tornado parameters are as follows:

Maximum wind speed, mph	360
Rotational speed, mph	290
Translational speed;	
Maximum, mph	70
Minimum, mph	5
Radius of maximum rotational speed, ft.	150
Pressure drop, psi	3.0
Rate of pressure drop, psi/sec	2.0

Section 3.1 Compliance with NRC General Design Criteria

Criterion 2 - Design Bases for Protection Against Natural Phenomena

The Grand Gulf Nuclear Station fully satisfies and is in compliance with the General Design Criteria 2.

Criterion 4 - Environmental and Missile Design Bases.

The Grand Gulf Nuclear Station fully satisfies and is in compliance with the General Design Criteria 4.

Section 3.3 Wind and Tornado Loadings

Structures, systems, or components whose failure, due to design wind loading, tornado wind loading, or associated missiles, could prevent safe shutdown of the reactor, or result in significant uncontrolled release of radioactivity from the unit, are protected from such failure by one of the following methods:

a) the structure or component is designed to withstand design wind, tornado wind and tornado generated missiles, or

b) the system or components are housed within a structure which is designed to withstand the design wind, tornado wind and tornado generated missiles.

FSAR Table 3.3-1 lists all safety related structures and the method of wind/tornado protection as applicable.

Section 3.5 Missile Protection

Section 3.5.1 Missile Selection and Description

The following criteria were adopted for assessing the plant's capability to assure that, in the event of a generated missile of any type postulated in Section 3.5.1, there is:

a. No loss of containment function
b. No loss of function to systems required to shutdown the reactor and maintain it in a safe shutdown condition, or mitigate the consequences of the missile damage.
c. No offsite exposure exceeding the guidelines of 10 CFR 100
d. No loss of integrity of the spent fuel pool

Section 3.5.1.4, Missiles Generated by Natural Phenomena

Tornado-generated missiles were considered as the limiting natural-phenomena hazard in the design of all structures which are required for safe shutdown. The missiles considered in design are as listed below. Since tornado missiles are considered the design basis missiles, missiles generated from other natural phenomena are not considered critical.

Table 2-1 Grand Gulf Design Basis Missiles

	Missile	Weight	Horizontal Velocity (fps)	Vertical Velocity (fps)
a.	Wood Plank 4 in. x 12 in. x 12 ft.	115	272	190
b.	Steel Pipe 6 in. x 15 ft. schedule 40	286	170	119
c.	Steel Rod 1 in. x 3 ft	9	167	167
d.	Utility Pole 13½ in. x 35 ft	1123	180	126
e.	Steel Pipe 12 in. x 15 ft. schedule 40	749	154	108
f.	Automobile 20 ft contact area.	3991	194	136

2.3 Reason for the Proposed Change

In response to RIS 2015-06, Entergy performed walkdowns at GGNS to identify potential discrepancies with the GGNS CLB related to tornado missile protection. Those walkdowns identified conditions where the plant configuration did not conform to the design and licensing bases. The non-conforming conditions were entered into the corrective action program (CR-GGN-2015-04760) and are summarized in the table below.

Conditions that rendered the affected SSCs inoperable were processed in accordance with Enforcement Guidance Memorandum (EGM) 15-002 and DSS-ISG-2016-01, with short-term and long-term compensatory actions taken. That action resulted in those SSCs being restored to operable but nonconforming status. The compensatory actions will remain in effect until the SSCs have been restored to full qualification.

As documented by the NRC in EGM 15-002, Enforcement Discretion for Tornado-generated Missile Protection Non-Compliance, in general, tornado missile scenarios do not represent an immediate safety concern because their risk is bounded by the initiating event frequency and safety-related SSCs are typically designed to withstand the effects of tornados. The NRC staff study established that the core damage frequency (CDF) associated with tornado missile related non-compliances is well below a CDF requiring immediate regulatory action.

Table 2-2 Non-Conforming (Safety-Related) SSC Vulnerabilities

Item	System ID	Vulnerability Description	General Location
1	Diesel Generator Fuel Oil Storage Tanks (1P75-A003A, 1P75-A003B, and 1P81-A001)	Diesel Generator Fuel Oil Storage Tank Vents	Yard (above underground Diesel Generator Fuel Oil Storage Tanks)
2	P41 SSW Return Lines	SSW Vertical Piping between Basins and SSW Superstructures	SSW Cooling Tower Basin at Gridlines C2, C3, C6, & C7
3	Fuel Oil Day Tank (Q1P75A004A, Q1P75A004B, and Q1P81A002)	Diesel Generator Fuel Oil Day Tank Vents (Penetrations DC-20A, DC-21A, and DC-22A)	Diesel Generator Building (roof El. 172'-0")
4	P41 HPCS (Div. 3) Room Cooler (Q1T51B001-C)	SSW Supply and Return Headers (Penetrations DP-1A and DP-2A)	North End of Breezeway between Diesel Generator Building and Auxiliary Building
5	Various Cables to Control Room	Cable Chase Room 1A539 (Behind Door 1A501)	South End of Control Building (Access gained from the Auxiliary Building Roof)

Plant modifications to restore compliance with the CLB would have very limited safety benefit, but would require extensive resources and would divert those resources from more safety significant activities. NRC approval of the TMRE methodology and this license amendment request would revise the GGNS CLB to restore the non-conforming conditions to full qualification. Utilization of risk insights to the allocation of NRC staff and industry resources is consistent with the NRC policy.

2.4 Description of the Proposed Change

Entergy requests NRC approval to incorporate the TMRE methodology into the GGNS Updated Final Safety Analysis Report. The proposed change:

1. Revises the GGNS UFSAR Appendix 3A, Conformance to NRC Regulatory Guides related to Regulatory Guide 1.117, Tornado Design Classification. Regulatory Guide 1.117 describes a method acceptable to the NRC staff for identifying those structures, systems, and components of light-water-cooled reactors that should be protected from the effects of the Design Basis Tornado. This LAR proposes to add an alternative methodology to the GGNS UFSAR, TMRE, to describe a method to determine whether protection from tornado-generated missiles is required. The methodology can only be applied to discovered conditions where tornado missile protection should be provided and is not currently provided. Future modifications to the facility requiring tornado missile protection would not be evaluated using the TMRE methodology.

2. Revises the GGNS UFSAR section 3.5.1.4, Missiles Generated by Natural Phenomena, to conform that section to the use of the TMRE methodology.

3. Revises the GGNS UFSAR to add a new table as Table 3.5.1-4a, Safety-Related Structures, Systems And Components That Do Not Require Protection from Tornado Generated Missiles Based on Tornado Missile Risk Evaluator Methodology.

The GGNS UFSAR markups are in Attachment 1. The TMRE methodology was transmitted to the NRC by NEI as NEI 17-02, Revision 1, on September 21, 2017 and is hereby incorporated by reference into this LAR.

3. TECHNICAL EVALUATION

3.1 Tornado Missile Risk Evaluator Methodology

The NRC policy statement on probabilistic risk assessment (PRA) encourages greater use of the PRA technique to improve safety decision-making and improve regulatory efficiency. One significant activity undertaken in response to the policy statement is the use of PRA to support decisions to modify an individual plant's licensing basis. Regulatory Guide 1.174, An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-specific Changes to the Licensing Basis (LB), provides guidance on the use of PRA findings and risk insights to support licensee requests for changes to a plant's LB, as in requests for license amendments and technical specification changes under 10 CFR 50.90. The TMRE methodology is proposed as a PRA-based methodology for evaluating the risk impact of existing conditions where tornado missile protection is required in a licensee's CLB, but the required protection was not provided. For conditions that meet the acceptance criteria, the GGNS licensing basis would be revised.

GDC 2 requires that SSC important to safety be designed to withstand the effects of natural phenomena such as tornadoes without loss of capability to perform their safety functions. GDC 4 requires that SSC important to safety be designed to accommodate the effects of missiles that may result from events and conditions outside the nuclear power unit, which includes tornadoes. Regulatory Guide 1.117, Tornado Design Classification, Rev. 1, describes a method acceptable to the NRC staff for identifying those structures, systems, and components of lightwater-cooled reactors that should be protected from the effects of the Design Basis Tornado, including tornado missiles, and remain functional. The TMRE methodology is proposed as an alternative methodology for identifying whether certain SSCs must be protected from the effects of tornado missiles.

The TMRE methodology employs a simplified, conservative assessment of risks to core damage and large early release posed by tornado-generated missiles at nuclear plants. The guidance for use of the methodology is found in NEI 17-02, Tornado Missile Risk Evaluator Industry Guidance Document, Rev. 1, which is incorporated by reference into this LAR. The guidance document provides a detailed approach to gathering the necessary information and translating the information into a PRA model. The risk assessment methods and acceptance criteria of the NRC Regulatory Guide 1.174 are used to determine whether risks posed by potential tornado missiles at a site warrant protective measures

3.2 Traditional Engineering Considerations

Two of the five key principles of risk-informed decision making address the traditional engineering considerations of defense-in-depth and maintaining sufficient safety margins. Those two considerations are discussed below with respect to the proposed change to the GGNS licensing basis.

<u>The proposed change is consistent with a defense-in-depth philosophy.</u>

The proposed change is consistent with a defense-in-depth philosophy. Defense-in-depth is an approach to designing and operating nuclear facilities to prevent and mitigate accidents that release radiation or hazardous materials. The key is creating multiple independent and redundant layers of defense to compensate for potential human and mechanical failures so that no single layer, no matter how robust, is exclusively relied upon. No individual failure, including one caused by the impact of a tornado missile, would prevent the fulfillment of a safety function.

- A reasonable balance is preserved among prevention of core damage, prevention of containment failure, and consequence mitigation.
    - No new accidents or transients are introduced with the proposed change, and the facility is still well protected from tornado missiles.
    - The proposed change does not significantly impact the availability and reliability of SSCs that provide safety functions that prevent challenges from progressing to core damage. The magnitude of the change is consistent with the guidance of Regulatory Guide 1.174.
    - None of the five non-conforming conditions in the TMRE model only affect Large Early Release Frequency (LERF), which is an indication that there was no significant impact on prevention of containment failure.
    - The change does not significantly reduce the effectiveness of the emergency preparedness program including the ability to detect and measure releases of radioactivity, notify offsite agencies and the public, and shelter or evacuate the public as necessary.
- Over-reliance on programmatic activities as compensatory measures associated with the change in the LB is avoided.
    - Implementation of the proposed change does not require compensatory measures. The risk assessment associated with this LAR gave no credit to compensatory measures implemented in response to the non-conforming conditions.
    - No plant operating procedures will be changed to implement the proposed change.
    - The proposed change does not rely upon proceduralized operator actions within an hour of a tornado passing that would require operators to travel into areas that are not protected from the effects of the tornado or tornado missiles.

- System redundancy, independence, and diversity are preserved commensurate with the expected consequences of challenges to the system, and uncertainties.
    - The proposed change does not modify the redundancy, independence, or diversity described in the GGNS UFSAR. The proposed change does not result in a disproportionate increase in risk.
    - The proposed change has no impact on the assumptions in the GGNS safety analyses presented in the UFSAR, chapters 6 or 15.
    - The proposed change has no impact on the availability or reliability of SSCs that could either initiate or mitigate events, with the exception of tornado missile protection, which is thoroughly evaluated in this LAR.
    - Equipment available both onsite and offsite supporting Diverse and Flexible Coping Strategies (FLEX) could be utilized if needed to mitigate the impact of a tornado missile. Critical equipment is stored in structures that would prevent it from being impacted by a tornado or tornado missile.
- Defenses against potential common-cause failures are preserved, and the potential for introduction of new common-cause failure mechanisms is assessed.
    - The non-conforming conditions are physically distributed about the GGNS site, so there is a low likelihood of multiple SSCs being impacted by a single missile.
- Independence of barriers is not degraded.
    - Of the three fission product barriers, neither the fuel clad nor reactor coolant system piping is directly exposed to tornado missiles, and the containment remains a robust tornado missile barrier.
    - The proposed change does not significantly increase the likelihood or consequence of an event that challenges multiple barriers, and does not introduce a new event.
- Defenses against human errors are preserved.
    - Implementation of the proposed change will not create new human actions that are important to preserving the layers of defense, or significantly increase mental or physical demand on individuals responding to a tornado.
    - GGNS has a procedure that prescribes actions to be taken by plant staff in the event of a tornado watch, tornado warning, and after a tornado has passed. This includes post-tornado walkdowns for tornado missile vulnerable SSCs. It 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.
    - Proceduralization of safety-significant operator actions, coupled with training and standards for procedure compliance, preserve the defense against human errors.

- The intent of the plant design criteria is maintained.
  - This LAR only affects plant design criteria related to tornado missile protection, and a very small fraction of the overall system areas would remain not protected from tornado missiles. All other aspects of the plant design criteria are unaffected.
  - This LAR maintains the intent of the plant design criteria for tornado missile protection, which is to provide reasonable assurance of achieving and maintaining safe shutdown in the event of a tornado. The evaluation performed and documented in this LAR demonstrates that the risk associated with the proposed change is very small and within accepted guidance for protection of public health and safety.
  - The methodology cannot be used in the modification process for a future plant change to avoid providing tornado missile protection. Therefore, the intent of the plant's design criteria is maintained.
  - Protection of the identified SSCs would have assured they would not be damaged by design basis tornado missiles. In lieu of protection for the identified nonconforming SSCs, GGNS has analyzed the actual exposure of the SSCs, the potential for impact by damaging tornado missiles, and the consequent effect on CDF and LERF. While there is some slight reduction in protection from a defense-in-depth perspective, the impact is known, and it is negligible. Therefore, the intent of the plant's design criteria is maintained.

<u>The proposed change maintains sufficient safety margins.</u>

The vast majority of each system important to safety remains protected from tornado missiles, consistent with the CLB. The identified vulnerabilities represent a small fraction of the potential target area of the system. The likelihood of redundant trains both being impacted by tornado missiles is much lower than the likelihood of one train being impacted. The TMRE methodology includes a conservative treatment of conditions where a single tornado missile could impact more than one component through physical correlation. The number of potential missiles identified at GGNS is less than the number of missiles assumed by the TMRE methodology. GGNS has diverse and flexible coping strategies to restore critical safety functions in the event of a hypothetical loss of the primary functions. In some cases, non-safety related equipment could function to mitigate the impact of a hypothetical tornado missile strike to safety-related equipment.

Codes and standards (e.g., American Society of Mechanical Engineers (ASME), Institute of Electrical and Electronic Engineers (IEEE) or alternatives approved by the NRC) continue to be met. The proposed change is not in conflict with approved codes and standards relevant to the SSCs.

The safety analysis acceptance criteria in the licensing basis are unaffected by the proposed change. The requirements credited in the accident analyses will remain the same.

Therefore, the proposed change maintains sufficient safety margins and continues to protect public health and safety.

3.3 Risk Assessment

The TMRE methodology is used to estimate the quantitative risk associated with tornado-generated missiles associated with discrepancies with the GGNS CLB related to tornado missile protection. It makes use of the GGNS internal events PRA model, which was used to estimate the risk associated with the passage of a tornado over the GGNS site.

The TMRE is a hybrid methodology comprised of two key elements: (1) a deterministic element to establish the likelihood that a specific SSC ("target") will be struck by tornado-generated missile; and (2) a probabilistic element to assess the impact of the missile strikes on the core damage and large early release frequencies.

The output of the deterministic element is a calculated Exposed Equipment Failure Probability (EEFP) that is based largely on a simplified generic relationship between tornado strength and the population of materials at a typical nuclear power plant that may become airborne during a tornado. Site-specific inputs to the EEFP include the number of potential missiles and the size and location of the target SSC being evaluated. The site-specific frequency of a tornado striking the GGNS site is also used in the TMRE methodology.

The outcome of the probabilistic element is an estimation of an increase in core damage frequency and large early release frequency associated with not protecting certain SSCs from tornado missiles.

3.3.1 High Winds Equipment List

The TMRE high winds equipment list (HWEL) was developed using the current GGNS internal events PRA model using the TMRE methodology provided in NEI 17-02. The HWEL identifies potential vulnerable components that needed to be walked down. The list contained all basic events for the relevant GGNS loss of offsite power (LOOP) and station black out (SBO) accident sequences. The following were considered in the development and update of the HWEL, consistent with the NEI 17-02 methodology:

- The non-conforming items were added to the list.
- Items screened based on being in category I structures were reviewed for the presence of potential missile paths.
- The TMRE model uses the loss of offsite power (LOOP) sequences with no offsite power (NO LOOP) recovery, therefore PRA logic and components that do not support mitigating a LOOP can be screened.
- Operator actions were assessed based on the NEI 17-02 methodology. Internal events PRA data was used to perform the assessment of operator actions.

Note that Operator interviews for the credited operator actions were performed during the development of the internal events model that the TMRE model is based on. In addition, an SRO was interviewed during TMRE development for insights related to tornado events. The main insights were that auxiliary operators would take shelter in Category 1 structures if

possible and that operators can access the Auxiliary Building (AB) from the Control Building (CB) by using multiple paths in the Turbine Building (TB). Once in the AB, the operators can access the Diesel Building (DB) by exiting the AB to the DB breezeway and then enter any of the three EDG rooms.

3.3.2 Target Walkdowns

The scope of the walkdowns considered the following:

- Locate and identify the SSC; verify that the SSC is located where it is documented to be. Note support systems or subcomponents, such as electrical cabling, instrument air lines, and controllers.
- Document and describe barriers that could prevent or limit exposure of the SSC to tornado missiles. This may include barriers or shielding designed to protect an SSC from tornado missiles, as well as other SSCs that may preclude or limit the exposure of the target SSC to missiles (e.g., buildings, large sturdy components).
- Identify directions from which tornado missiles could strike the target.
- Determine and/or verify the dimensions of the target SSCs, including any subcomponents or support systems. Missile paths may limit target areas when missiles are blocked by barriers.
- Determine the proximity and potential correlation to other target SSCs. Correlated targets are SSCs that can be struck by the same tornado missile.
- Note any nearby large inventories of potential tornado missiles.
- Proximity of non-Class I structures to exposed target SSCs should be documented. A non-Class I structure may collapse or tip-over and cause damage to an SSC.
- Identify vent paths for tanks that may be exposed to atmospheric pressure changes.

3.3.3 Missile Walkdowns

The missile walkdown was performed in accordance with Section 3.4 of NEI 17-02. The area is defined by a 2500 ft radius from the approximate center of the Unit 1 Containment. To support the walkdowns the plant was divided into zones. The potential missile count for each zone was determined. The missile count is summarized in Table 3-1. The total missile estimate is 233,980. This missile count justifies the use of the generic missile count from the TMRE guidance which is 240,000.

Table 3-1 TMRE Tornado Missile Count Summary.

Zone	Total Number of Zonal Missiles (Non-Structural and Structural)
1	37477
2	11257
3	7978
4	16735
5	2857
6	16171
7	16304
8	22118
9	12380
10	26700
11	6460
12	17570
13	26293
Fence and Pole Missiles	13680
Total Number of Missiles on Site (Non-Structural and Structural)	233980

3.3.4 Tornado Hazard Frequency

The guidance in NEI 17-02 as well as NUREG/CR-4661 was used to determine the tornado initiating events for the GGNS TMRE PRA model. The result was site specific tornado frequencies for each relevant tornado category.

NUREG/CR-4661 tornado strike data for GGNS is provided with wind speeds associated with varying frequencies per year. The F'-scale (Fujita prime) was used to classify tornadoes. Using this data, a site-specific tornado frequency curve (hazard curve) was developed, and the frequency of all tornadoes considered in the TMRE (F'2 through F'6) was calculated. Since F' probabilities are not directly available, they must be derived from site specific Fujita scale data available in Table 6-1 of NUREG/CR-4661.

Using the trend line equation, exceedance probabilities for the upper ranges of each F' category, F'2 through F'6 was calculated, resulting in the following tornado initiating event frequencies.

Table 3-2 GGNS Plant Specific Initiating Event Frequency

Fujita Prime	Frequency Per Year
F'2	5.05E-04
F'3	1.19E-04
F'4	2.87E-05
F'5	5.00E-06
F'6	2.36E-07

3.3.5 Target Evaluation

The list of potentially vulnerable targets to tornado missiles that are modeled in the PRA are identified and characterized. These targets have been added to the TMRE model. The failure probability of the targets is calculated using the Exposed Equipment Failure Probability (EEFP). The EEFP is the conditional probability that an exposed target is hit and failed by a tornado missile, given a tornado of a certain magnitude. For each target, five EEFP values were calculated, one value for each tornado category F'2 through F'6.

The EEFP is defined as:

EEFP = (MIP) x (# of Missiles) x (Target Exposed Area) x Fragility

- The Missile Impact Parameters (MIP) is the probability of a tornado missile hit on a target, per target square area, per missile, per tornado. Generic MIP values are provided in Table 5-1 of NEI 17-02.
- # of Missiles is the number of damaging missiles. The generic values recommended in Table 5-1 and 5-2 of NEI 17-02 are used
- Target Exposed Area is determined for each specific target.
- Fragility is the conditional probability of the target failing to perform its function given that it is hit by a tornado missile. For the purposes of the TMRE, it is assumed to be 1.0.

The calculation of the EEFPs results is provided in Table 3-3.

Table 3-3 Summary of EEFPs Based on Tornado Category

Item	Description	System	Exposed Equipment Failure Probability for Tornado Category (1)				
			F'2	F'3	F'4	F'5	F'6
1	Diesel Fuel Oil Storage Tank Vents	Diesel Generator Fuel Oil Storage Tank (1P75-A003A, 1P75-A003B, 1P81-A001)	3.0E-04	9.9E-04	2.3E-03	6.8E-03	1.0E-02
2	Straight Vertical SSW Return Lines	Loop "A" (C2 & C3) SSW Pump (Q1P41C001A-A) & Loop "B" (C6 & C7) SSW Pump (Q1P41C001B-B)	6.1E-4 (Note 1)	2.0E-3 (Note 1)	4.6E-3 (Note 1)	1.4E-2 (Note 1)	2.1E-2 (Note 1)
3	Diesel Generator Fuel Oil Day Tank Vents	Fuel Oil Day Tank, Q1P75A004A (Div. 1), Q1P75A004B (Div. 2), and Q1P81A002 (Div. 3)	1.4E-05	4.5E-05	1.0E-04	3.1E-04	4.6E-04
4	SSW Supply Header and Return Header	HPCS (Div 3) Room Cooler, Q1T51B 01-C	2.3E-04	7.5E-04	1.7E-03	5.2E-03	7.8E-03
5	Cable Chase Room (Room 1A539) Behind Door 1A501	See Attachment B of ENTG#GG052-TMRE-002	3.7E-04 (Note 2)	1.2E-03 (Note 2)	2.8E-03 (Note 2)	8.3E-03 (Note 2)	1.2E-02 (Note 2)

Table 3-3 Notes:

1. For Item 2 Parts A & B, each loop is comprised of two (2) vertical runs. As a result, the EEFP for each loop will be twice that of each vertical run.
2. The EEFPs for doors used in the TMRE model were adjusted to account for a smaller number of missiles (45%) per Category G in Table 5-2 of NEI 17-02. The table shows the original (non-adjusted) values.

3.3.6 Model Development

The TMRE model was developed using the current internal events model. The GGNS model addresses, among other initiators, LOSP, SBO, consequential steam line break, and consequential loss of coolant accidents. The LOSP initiating event accident sequence addresses the tornado damage states expected based on a review of the vulnerable equipment and the LOSP. The Tornado initiating events for TMRE are added to the model at the LOSP initiating event location in the fault tree by modifying the initiating event frequency. The equipment vulnerable to tornado missiles were added to the model using the EEFP events identified.

3.3.7 Model Quantification.

The TMRE model is quantified in PRAQuant using the flag files and modified recovery rule files. The Core Damage Frequency (CDF) is truncated at 1E-12/yr and the Large Early Release Frequency (LERF) is truncated at 1E-13/yr. This is consistent with the GGNS base model.

The core damage frequency and large early release frequency for the degraded and compliant cases are in Table 3-4.

Table 3-4 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

Per Regulatory Guide 1.174, a risk-informed License Amendment Request (LAR) includes an evaluation of the change in risk (e.g., ΔCDF). For the purposes of the TMRE, a licensee needs to calculate this change in risk by comparing two different configurations: the Compliant Case (configuration with the plant built per the required design/licensing bases), and the Degraded Case (current plant configuration, including potential non-conformances for tornado missile protection).

The ΔCDF and ΔLERF are simply calculated as follows:

$$\Delta CDF = CDF_{Degraded} - CDF_{Compliant}$$
$$\Delta LERF = LERF_{Degraded} - LERF_{Compliant}$$

The TMRE results for GGNS are 1.43E-7 per year ΔCDF and 1.60E-8 per year ΔLERF.

3.3.8 Results

The tornado initiating event contribution is provided in Table 3-.5 for the degraded and compliant model result.

Table 3-5 Initiating Event CDF Contribution

Initiating Event	Frequency	% CDF Contribution Compliant	% CDF Contribution Degraded	Description
%GG-T-F2	5.05E-04	61.7%	54.4%	GGNS FREQ FOR F'2 TORNADO
%GG-T-F3	1.19E-04	17.5%	17.4%	GGNS FREQ FOR F'3 TORNADO
%GG-T-F4	2.87E-05	6.2%	7.7%	GGNS FREQ FOR F'4 TORNADO
%GG-T-F5	5.00E-06	12.5%	17.8%	GGNS FREQ FOR F'5 TORNADO
%GG-T-F6	2.36E-07	1.9%	2.6%	GGNS FREQ FOR F'6 TORNADO

The results were reviewed to identify the dominant target sets for the CDF contribution in the compliant and degraded results. The dominant contributor for the compliant case was the Condensate Storage Tank (CST) with a contribution of over 60%. This is followed by the Division 1 and 2 Standby Service Water (SSW) Cooling Tower fans, the Division 1 and 2 Diesel Generator Exposed cables, and the Division 1 and 2 Transformers, all of which contribute less than 10% each. The dominant contribution to the degraded case was the CST, again with a contribution of over 60%. For the degraded case, this is followed by the Division 1 and 2 SSW Cooling Tower fans, the Division 1 SSW return line, the Division 2 Diesel Generator Cables, and the Division 2 Transformer.

The dominant initiating event for both the compliant and degraded cases is the F'2 initiator, which has the largest frequency. Although the importance of the initiators would be expected to mirror the individual percent contributions to the total of all five initiators' frequencies, Table 3-5 shows that this is not the case. In particular, the degraded F'5 initiator CDF contribution is more than double the F'4 contribution and is 10% higher than the F'3 contribution instead of being lower. A review of the cut sets for the initiators showed that, although all three initiators had similar cut sets with similar failures, the F'5 cut sets with multiple tornado failure events were significantly higher than the similar F'4 and F'3 cut sets. The following example demonstrates why this difference exists.

<u>F'5 Initiator cut set</u>

Prob.	Inputs
1.94E-03	%GG-T-F5, FL_SCRAMMED, P41-TOR-F5-C003A, P41-TOR-F5-C003B, P41-TOR-F5-C003C, P41-TOR-F5-C003D

<u>F'4 Initiator cut set</u>

Prob.	Inputs
2.27E-05	%GG-T-F4, FL_SCRAMMED, P41-TOR-F4-C003A, P41-TOR-F4-C003B, P41-TOR-F4-C003C, P41-TOR-F4-C003D

<u>F'3 Initiator cut set</u>

Prob.	Inputs
2.27E-05	%GG-T-F3, FL_SCRAMMED, P41-TOR-F3-C003A, P41-TOR-F3-C003B, P41-TOR-F3-C003C. P41-TOR-F3-C003D

In the above example, the initiators (%GG-T-F3, %GG-T-F4 and %GG-T-F5) and flag event FL_SCRAMMED are set to true. The remaining events represent the failure of SSW cooling tower fans A, B, C and D from tornado missiles. The EEFP for failure of each fan from a F'3 tornado is 3.0E-02, F'4 tornado is 6.9E-02 and 2.1E-01 for a F'5 tornado. The increases in EEFP from F'3 to F'4 to F'5 are due to the missile impact parameter (MIP) increasing by a factor of 1.75 from F'3 to F'4, and about 2.5 from F'4 and F'5 and the missile count increasing from 155,000 to 205,000 to 240,000. Thus, when the initiators are set to true, the frequency for the F'5 cut set is almost an order of magnitude greater than the F'3 and F'4 cut sets. When the initiators are set to their normal frequencies (%GG-T-F3 = 1.19E-04, %GG-T-F4 = 2.87E-05 and %GG-T-F5 = 5.0E-06), the F'5 cut set frequency in the degraded scenario is 9.7E-09/yr compared to 6.5E-10/yr for F'4 and 9.64E-11 for F'3. Thus, the increase in EEFP for multiple tornado failure events in a single cut set for increasing tornado classes can have more impact than the decreasing initiator frequency of the higher classification tornado classes. This becomes apparent in the change from F'3 to F'5 and F'4 to F'5 tornado results.

3.3.9 Non-conformance Results

Screened non-conformances are evaluated as having a negligible impact on the TMRE risk contribution. Non-conformances addressed quantitatively are listed in Table 3-6.

Table 3-6 Non-Conformances Modeled in the GGNS TMRE Model

Item	Non-Conformance Description
1	Diesel Generator Fuel Oil Storage Tank Vents
2	SSW Vertical Piping between Basins and SSW Superstructures
3	Diesel Generator Fuel Oil Day Tank Vents (Penetrations DC-20A, DC-21A, and DC-22A)
4	SSW Supply and Return Headers (Penetrations DP-1A and DP-2A)
5	Cable Chase Room 1A539 (Behind Door 1A501)

3.3.10 Sensitivities and Uncertainties

NEI 17-02 identifies sensitivity studies that should be performed and documented if the ΔCDF or ΔLERF between the compliant and the degraded case exceed 10-7/yr or 10-8/yr, respectively. As indicated above the ΔCDF or ΔLERF both meet the criteria. Therefore, both sensitivities are examined for GGNS.

<u>Sensitivity 1–Zonal vs. Uniform Missile Distribution</u>

This sensitivity addresses concerns regarding the potential underestimation of target hit probability due to the missile distribution at the GGNS site, as compared to the missile distribution for the EPRI NP-768 Plant A simulations. In accordance with the guidance, the sensitivity evaluates SSCs with a tornado missile failure basic event RAW ≥ 2 and only applies

to basic events for tornado categories F'4, F'5 and F'6. The basic event failure probability for these events is multiplied by 2.75 and delta CDF and LERF are re-calculated.

The CDF and LERF frequencies for Sensitivity 1 are included in Table 3-7.

Table 3-7 Sensitivity 1 Results

	CDF /year	**LERF /year**
Compliant	8.13E-07	4.50E-08
Degraded	1.24E-06	9.47E-08
Delta	4.27E-07	4.97E-08

The TMRE results for Sensitivity 1 are 4.27E-7 per year ΔCDF and 4.97E-8 per year ΔLERF. Both values are slightly more than triple the corresponding base TMRE model ΔCDF and ΔLERF. However, both ΔCDF and ΔLERF meet the Regulatory Guide 1.174 criteria.

Sensitivity 2–Missile Impact Parameter

This sensitivity addresses concerns regarding the potential underestimation of target hit probability due to SSCs that are located or oriented in a way that exposes them to a higher missile impact probability than the average MIP. Based on the NEI guidance, this sensitivity evaluates highly exposed SSCs with a tornado missile failure basic event RAW ≥ 2 and only applies to basic events for tornado categories F'4, F'5 and F'6. The basic event failure probability for these events is multiplied 2.5 and delta CDF and LERF are re-calculated.

For the purposes of this sensitivity study, the term highly exposed refers to an SSC for which all of the following characteristics apply:

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

The CDF and LERF frequencies for Sensitivity 2 are included in Table 3-8.

Table 3-8 Sensitivity 2 Results

	CDF / year	LERF / year
Compliant	7.89E-07	4.32E-08
Degraded	1.14E-06	8.42E-08
Delta	3.51E-07	4.10E-08

The TMRE results for Sensitivity 2 are 3.51E-07 per year ΔCDF and 4.10E-8 per year ΔLERF. Both ΔCDF and ΔLERF meet the Regulatory Guide 1.174 criteria.

SSW Cooling Tower Fans Sensitivity

The SSW Cooling Tower (CT) fans are important in that they support operation of the emergency diesel generators and ECCS systems. This sensitivity assesses the impact of increased probabilities for the cooling tower fan EEFPs. The fan EEFPs are increased by a factor of two.

Table 3-9 SSW Cooling Tower Fans Increased Failure Sensitivity

	CDF / year	LERF / year
Compliant	1.14E-06	8.81E-08
Degraded	1.36E-06	1.14E-07
Delta	2.20E-07	2.59E-08

The TMRE results for this sensitivity are 2.20E-07 per year ΔCDF and 2.59E-8 per year ΔLERF. While this is an increase compared to the base quantification, both ΔCDF and ΔLERF meet the Regulatory Guide 1.174 criteria.

SSW Cooling Tower Fans Missile Barrier Sensitivity

The SSW Cooling Tower fans are protected from vertical missiles by steel bars. This protection was not credited in the base TMRE model. Since the tower fan missile basic events are modeled as vulnerabilities and not non-conformances, they were set to false in both the compliant and the degraded cut sets and the new compliant and degraded CDF and LERF values determined as shown in Table 3-10.

Table 3-10 Credit for SSW Cooling Tower Fan Missile Barriers

	CDF / year	LERF / year
Compliant	6.56E-07	2.98E-08
Degraded	7.70E-07	4.24E-08
Delta	1.14E-07	1.26E-08

The resulting ΔCDF is 1.14E-07 per year and ΔLERF is 1.26E-08 per year. These results show that crediting the SSW CT fan missile barrier results in delta CDF and LERF approximately twenty five percent lower than the base TMRE results.

Modeling Conservatisms
There is a potential that conservative assumptions can mask delta risk estimates in PRA results. There is potential to have a larger impact on the compliant model resulting in under estimating delta risk by over estimating the compliant model risk. The conservative assumptions can be bounded by performing a single sensitivity where the compliant risk model results are set to zero.

Table 3-11 Modeling Conservatism Sensitivity

	CDF / year	LERF / year
Degraded	8.81E-07	5.54E-08
Compliant	0	0
Delta Risk	8.81E-07	5.54E-08

Both ΔCDF and ΔLERF meet the Regulatory Guide 1.174 criteria

3.3.11 Conclusions

The TMRE guidance provided in NEI 17-02 was followed without exception and no deviations were applied.

The total change in risk associated with tornado missile damage to non-conforming conditions identified results in a risk increase of 1.43E-07 per year ΔCDF and 1.60E-08 per year ΔLERF. The tornado risk change for accepting GGNS non-conforming conditions results in a very small risk increase (Region III) per Regulatory Guide 1.174.

3.4 Technical Evaluation Conclusions

Utilization of TMRE, which employs a probabilistic approach permitted in regulatory guidance, is a sound and reasonable method of addressing tornado missile protection at GGNS for certain SSCs that are not fully protected from the effects of tornado missiles. The proposed change would revise the UFSAR to make TMRE part of the GGNS licensing basis for conformance to 10CFR 50 General Design Criteria 2 and 4. Future discovery of existing tornado missile protection non-conforming conditions will continue to be evaluated using the corrective action program. The TMRE methodology could be used to resolve those non-conforming conditions by revising the CLB under 10 CFR 50.59, provided the acceptance criteria are satisfied and conditions stipulated by the staff in the safety evaluation approving the requested amendment are met. Future modifications to the facility requiring tornado missile protection would not be evaluated using the TMRE methodology. The TMRE Guidance, provided in NEI 17-02, Revision 1, was followed without exception and no deviations were applied.

4. REGULATORY EVALUATION

4.1 Applicable Regulatory Requirements/Criteria

The NRC requires that nuclear power plants be designed to withstand the effects of natural phenomena, including tornado and high-wind-generated missiles, so as not to adversely impact the health and safety of the public in accordance with the requirements of 10 CFR 50, Appendix A, General Design Criterion 2, "Design Bases for Protection against Natural Phenomena," and GDC 4, "Environmental and Dynamic Effects Design Bases." Methods acceptable to the NRC to comply with the aforementioned regulations are described in Regulatory Guides 1.117, "Tornado Design Classification," Revision 1, and NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants", Section 3.5.1.4, "Missiles Generated by Natural Phenomena," and Section 3.5.2, "Structures, Systems, and Components to be Protected from Externally- Generated Missiles," Revision 2, July 1981.

The SRP, Sections 3.5.1.4 and 3.5.2, contain the current acceptance criteria governing tornado missile protection. These criteria generally specify that SSCs that are important to safety be provided with sufficient, positive tornado missile protection (i.e., barriers) to withstand the maximum credible tornado threat. The appendix to Regulatory Guide 1.117, lists the types of SSCs that should be protected from design basis tornadoes. However, SRP Section 3.5.1.4 permits relaxation of the above deterministic criteria if it can be demonstrated that the frequency of damage to unprotected essential safety-related features is sufficiently small.

To use this probabilistic criterion, the NEI developed the TMRE methodology, NEI 17-02, Rev. 1, transmitted to the NRC staff in September 2017, which is incorporated by reference into this LAR. NEI 17-02, Rev. 1, contains guidance for application of the methodology and the technical basis for its acceptability. This LAR requests NRC approval for use of the TMRE methodology in lieu of the deterministic methodology when assessing the need for positive tornado missile protection for specific safety-related plant features in accordance with the criteria of SRP Section 3.5.1.4.

This LAR utilizes a risk-informed change process consistent with the guidelines of Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk Informed Decision on Plant-Specific Changes to the Licensing Basis." As discussed in Regulatory Guide 1.174, in implementing risk-informed decision-making, licensing basis changes are expected to meet a set of key principles. Some of these principles are written in terms typically used in traditional engineering decisions (e.g., defense-in-depth). While written in these terms, it should be understood that risk analysis techniques can be, and are encouraged to be, used to help ensure and show that these principles are met. These principles include the following:

1. <u>The proposed change meets the current regulations unless it is explicitly related to a requested exemption.</u>

   The proposed change continues to meet current regulations including 10 CFR 50, Appendix A, GDC 2 and GDC 4. No exemptions are requested or required to implement this LAR upon approval by the NRC. Standard Review Plan section 3.5.1.4 permits relaxation of deterministic criteria if it can be demonstrated that the frequency of damage to unprotected safety-related features is sufficiently small. Regulatory Guide

1.174 establishes criteria, approved by the NRC, to quantify the "sufficiently small" frequency of damage. Application of the TMRE methodology to the unprotected features at GGNS demonstrates that the Regulatory Guide 1.174 criteria are met.

2. The proposed change is consistent with a defense-in-depth philosophy. This is discussed in Section 3.2 of this enclosure.

3. The proposed change maintains sufficient safety margins. This is discussed in Section 3.2 of this enclosure.

4. When proposed changes result in an increase in CDF or risk, the increases should be small and consistent with the intent of the Commission's Safety Goal Policy Statement.

   The NRC's policy statement on probabilistic risk assessment encourages greater use of this analysis technique to improve safety decision making and improve regulatory efficiency. One significant activity undertaken in response to the policy statement is the use of PRA to support decisions to modify an individual plant's licensing basis.

   Regulatory Guide 1.174 provides guidance on the use of PRA findings and risk insights to support licensee requests for changes to a plant's licensing basis, as in requests for license amendments under 10 CFR 50.90, "Application For Amendment Of License, Construction Permit, Or Early Site Permit." Regulatory Guide 1.174 describes an acceptable method for the licensee and NRC staff to use in assessing the nature and impact of licensing basis changes when the licensee chooses to support the changes with risk information.

   Regulatory Guide 1.174 also makes use of the NRC's Safety Goal Policy Statement. One key principle in risk-informed regulation is that proposed increases in CDF and risk are small and are consistent with the intent of the Commission's Safety Goal Policy Statement. The safety goals and associated quantitative health objectives define an acceptable level of risk that is a small fraction of other risks to which the public is exposed. The acceptance guidelines defined in Section 2.4 of Regulatory Guide 1.174 are based on subsidiary objectives derived from the safety goals and their quantitative health objectives.

   Application of the TMRE methodology to the unprotected features at GGNS demonstrates that the Regulatory Guide 1.174, section 2.4, criteria are met, and therefore, the change is small and consistent with the intent of the Commission's Safety Goal Policy Statement.

5. The impact of the proposed change should be monitored using performance measurement strategies.

   NEI 17-02, Section 8, describes post license amendment configuration change control. Entergy Operations Design Control programs that meet 10 CFR 50 Appendix B will ensure that subsequent configuration changes are evaluated for their impact on the TMRE risk basis for accepting the identified nonconforming conditions. Entergy Operations has confirmed that sufficient mechanisms to assure that any significant changes to site missile sources, such as a new building, warehouse, or laydown area, are evaluated for impact to the TMRE basis, even if not in the purview of the site Design

Control program. Temporary additional missiles from construction activities shall be addressed in the TMRE analysis. Permanent changes that increase the site missile burden within the 2500' missile radius established for TMRE shall be included in the TMRE analysis.

The risk evaluation supporting this change was performed using the GGNS Internal Events model. Regulatory Guide 1.200, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities", describes one acceptable approach for determining whether the technical adequacy of the PRA, in total or the parts that are used to support an application, is sufficient to provide confidence in the results, such that the PRA can be used in regulatory decision-making for light-water reactors.

The proposed change does not affect compliance with these regulations or guidance and will ensure that the lowest functional capabilities or performance levels of equipment required for safe operation are met.

4.2 No Significant Hazards Consideration Analysis

Pursuant to 10 CFR 50.90, Entergy, hereby submits a License Amendment Request for the Grand Gulf Nuclear Station, Unit 1, to incorporate the TMRE methodology into the GGNS UFSAR. TMRE is an alternative methodology for determining whether protection from tornado-generated missiles is required.

Entergy has evaluated whether a significant hazards consideration is involved with the proposed amendment(s) by focusing on the three standards set forth in 10 CFR 50.92, "Issuance of amendment," as discussed below:

1) **Will operation of the facility in accordance with this proposed change involve a significant increase in the probability or consequences of an accident previously evaluated?**

   Response: No.

   The proposed amendment is to incorporate the TMRE methodology into the GGNS UFSAR. The TMRE methodology is an alternative methodology for determining whether protection from tornado-generated missiles is required. The methodology can only be applied to discovered conditions where tornado missile protection was not provided, and cannot be used to avoid providing tornado missile protection in the plant modification process.

   The proposed amendment does not involve an increase in the probability of an accident previously evaluated. The relevant accident previously evaluated is a Design Basis Tornado impacting the GGNS site. The probability of a Design Basis Tornado is driven by external factors and is not affected by the proposed amendment. There are no changes required to any of the previously evaluated accidents in the UFSAR.

   The proposed amendment does not involve a significant increase in the consequences of a Design Basis Tornado. The TMRE methodology is a risk-informed methodology for determining whether certain safety-related features that are currently not protected from

tornado-generated missiles, require such protection. The criteria for significant increase in consequences was established in the NRC Policy Statement on probabilistic risk assessment, which were incorporated into Regulatory Guide 1.174, An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-specific Changes to the Licensing Basis. The TMRE calculations performed by Entergy Operations GGNS meet the acceptance criteria of Regulatory Guide 1.174, which therefore confirms that the proposed amendment does not involve a significant increase in the consequences of an accident previously evaluated.

2) **Will operation of the facility in accordance with this proposed change create the possibility of a new or different kind of accident from any accident previously evaluated?**

Response: No.

The proposed amendment is to incorporate the TMRE methodology into the GGNS UFSAR. The TMRE methodology is an alternative methodology for determining whether protection from tornado-generated missiles is required. The methodology can only be applied to discovered conditions where tornado missile protection was not provided, and cannot be used to avoid providing tornado missile protection in the plant modification process.

The proposed amendment will involve no physical changes to the existing plant, so no new malfunctions could create the possibility of a new or different kind of accident. The proposed amendment makes no changes to conditions external to the plant that could create the possibility of a new or different kind of accident. The proposed change will not create the possibility of a new or different kind of accident due to new accident precursors, failure mechanisms, malfunctions, or accident initiators not considered in the design and licensing bases. The existing Updated Final Safety Analysis Report accident analysis will continue to meet requirements for the scope and type of accidents that require analysis.

Therefore, the proposed amendment will not create the possibility of a new or different kind of accident than those previously evaluated.

3) **Will operation of the facility in accordance with this proposed change involve a significant reduction in a margin of safety?**

Response: No.

The proposed amendment is to incorporate the TMRE methodology into the GGNS UFSAR. The TMRE methodology is an alternative methodology for determining whether protection from tornado-generated missiles is required. The methodology can only be applied to discovered conditions where tornado missile protection was not provided, and cannot be used to avoid providing tornado missile protection in the plant modification process.

The change does not exceed or alter any controlling numerical value for a parameter established in the UFSAR or elsewhere in the GGNS licensing basis related to design basis or safety limits. The change does not impact any UFSAR Chapter 6 or 15 Safety

Analyses, and those analyses remain valid. The change does not reduce diversity or redundancy as required by regulation or credited in the UFSAR. The change does not reduce defense-in-depth as described in the UFSAR.

Therefore, the changes associated with this license amendment request do not involve a significant reduction in the margin of safety.

4.3 Conclusion

In conclusion, based on the considerations discussed above, (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

5 Environmental Consideration

A review has determined that the proposed amendment would change a requirement with respect to installation or use of a facility component located within the restricted area, as defined in 10 CFR 20, or would change an inspection or surveillance requirement. However, the proposed amendment does not involve (i) a significant hazards consideration, (ii) a significant change in the types or a significant increase in the amounts of any effluents that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed amendment meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed amendment.

6 REFERENCES

6.1 NEI 17-02, "Tornado Missile Risk Evaluator Industry Guidance Document", Rev. 1, September 21, 2017 (ADAMS Accession No. ML 17268A036).
6.2 Regulatory Issue Summary 2015-06, Tornado Missile Protection (RIS), on June 10, 2015 (ADAMS Accession No. ML15020A419).
6.3 Enforcement Guidance Memorandum 15-002, "Enforcement Discretion for Tornado Missile Protection Noncompliance" (ADAMS Accession No. ML15111A269).
6.4 Grand Gulf Nuclear Station, Unit 1, Updated Final Safety Analysis Report, Revision 2016-00.
6.5 NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," Revision 2, July 1981.
6.6 NUREG-0831, "Grand Gulf Nuclear Station Safety Evaluation Report", September 1981.
6.7 NUREG/CR-4461, "Tornado Climatology of the Contiguous United States," Revision 2, February 2007.
6.8 Regulatory Guide 1.117, "Tornado Design Classification," Revision 1, April 1978.
6.9 Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant Specific Changes to the Licensing Basis," Revision 2, May 2011.

GNRO-2017/00061

Grand Gulf Nuclear Station, Unit No. 1
Docket No. 50-416 / License No. NPF-29

License Amendment Request to Incorporate
Tornado Missile Risk Evaluator
into Licensing Basis

Attachment 1

Updated Final Safety Analysis Report Page Markups

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LIST OF TABLES

REGULATORY GUIDE 1.117, APRIL 1978, TORNADO DESIGN CLASSIFICATION

Regulatory Guide 1.117 Position

This guide describes a method acceptable to the NRC for identifying those structures, systems, and components of light-water-cooled reactors that should be protected from the effects of the design basis tornado (including tornado missiles) and remain functional.

GGNS **Position**

Section D of the Guide indicates that implementation of this guide is not applicable to Grand Gulf based upon the docket date. Therefore, Grand Gulf complies with the requirements of the guide only to the extent discussed in the referenced section. Alternatively, an alternate methodology, Tornado Missile Risk Evaluator (TMRE), can be used to determine whether protection from tornado-generated missiles is required. The TMRE methodology can only be applied to discovered conditions where tornado missile protection was not provided, and cannot be used to avoid providing tornado missile protection in the plant modification process.

FSAR Subsection

3.5.2.3 Barriers for Missiles Generated Outside of Plant Structures

A tabulation of protected components and the structures, shields, and barriers that are designed to provide protection from identified missiles generated outside these structures, shields, and barriers is given in Table 3.5-6. The missile barriers indicated are designed for the tornado and internally generated missiles using the procedures given in subsection 3.5.3. Structures which protect plant systems from missiles generated outside plant structures are identified in Figure 3.4-1.

3.5.2.4 Missile Barriers Within Plant Structures Other Than Containment

Missile barriers or restraints are provided within plant structures outside the containment, as necessary, to provide protection for components listed in Table 3.5-6.

For the pressurized and rotating component failure missiles identified in subsection 3.5.1.2 which originate outside the containment, the following steps are taken to identify the missiles and to protect the safety-related components:

a. Missiles are categorized as to the system in which they originate. (See Table 3.5-1 through 3.5-4.)

b. The components which are protected from a missile are identified.

   1. A determination is made as to whether the missile characteristics are severe enough to cause loss of function to protected components utilizing the procedures given in BC-TOP-9 (Ref. 4). Credit is taken for existing structures or components which are interposed between the missile origin and the protected component.

   2. A trajectory is altered by changing the orientation or position of the missile and/or the position of the protected component if this is feasible.

3. If loss of function of the protected component can occur due to missile damage, either suitable restraints are provided to prevent the missile from leaving its point of origin or barriers are installed to intercept the missile trajectory.

3.5.2.5 Missile Barriers for Outdoor Equipment

The protection against potential tornado missile damage which is afforded to partially exposed building openings and safety-related components located outdoors is listed in Table 3.5-8.

3.5.3 Barrier Design Procedures

Missile-resistant barriers and structures are designed to withstand and absorb missile impact loads to prevent damage to the protected structures, systems, and components. The layout and principal design features of structures serving primarily as missile-resistant barriers are shown in Figure 3.4-1.

3.5.3.1 Tornado Missile Barrier Design Procedures

Tornado resistant structures may sustain local missile damage such as partial penetration and local cracking and/or permanent deformation, provided that structural integrity is maintained and that perforation is precluded, and the contained Category I systems, components, and equipment are not subjected to damage by secondary missiles such as from concrete spalling and scabbing.

The wall and roof thicknesses provided to resist the effects of tornado-generated missiles are considered to be more than adequate. It is considered that a thickness of 24 in. for reinforced concrete with a minimum strength of 4000 psi for the walls and roof slabs of seismic Category I structures is adequate to resist the local impact effects (i.e., penetration and scabbing) of tornado-generated missiles in the horizontal and vertical directions. [HISTORICAL INFORMATION] [This criterion is based on the results of the test program, "Missile Impact Testing of Reinforced Concrete Panels," conducted by Calspan Corporation for Bechtel Corporation and reported in Calspan Report No. HC-5609-D-1, January 1975 (Ref. 2), and reported by A. E. Stephenson (Sandia Laboratories), "Tornado Vulnerability Nuclear Production Facilities," April 1975 (Ref. 3), and "Full Scale Tornado Missile Impact Tests" (Ref. 5).]

Barrier structural response was calculated using a time history approach. Equivalent dynamic models were developed for the wall and roof barriers. [HISTORICAL INFORMATION] [Conservative impact force time histories were derived from the available experimental evidence (Ref. 2, 5). The resulting maximum barrier deflections calculated from the dynamic analysis were used to determine structural stresses, reactions and ductilities in accordance with the design principles of BC-TOP-9A (Ref. 4).] The 24-inch thickness of concrete is kept constant and the reinforcing is changed to lower structural response, as needed.

Table 3.5-10 outlines the specific references to the significant protection parameters for the seismic Category I structures. All safety systems/components are protected from tornado-generated missiles by a concrete roof or wall. Where exhaust or intake openings exist, the openings are protected by a concrete maze enclosure which protects the essential equipment by preventing a linear missile trajectory. The intake and exhaust openings for the mechanical draft cooling towers are exceptions. In order to optimize the total system design of these structures (and allow effective flow of their air currents), these structures were allowed to remain open, without mazes. The standby service water cooling tower fans are protected from vertical

missiles by a 7-inch-thick steel grating, as shown in Figure 3.8-115. This protection is supplemented by the redundancy of the standby service water system, which is discussed in subsection 9.2.1.

3.5.3.2 Barrier Design Procedures for Internally Generated Missiles

In general, protection from internal missiles is provided by barriers. The procedures and calculations employed in design of missile-resistant barriers for turbine missiles and other internally generated missiles are described in Bechtel Topical Report, "Design of Structures for Missile Impact," BC-TOP-9A (Ref. 4).

3.5.3.3 Tornado Missile Risk Evaluator

The Nuclear Energy Institute (NEI) developed the Tornado Missile Risk Evaluator (TMRE) risk-informed methodology for identifying and evaluating the safety significance associated with structures, systems and components (SSCs) that are exposed to potential tornado-generated missiles. TMRE is an alternative methodology for determining whether protection from tornado-generated missiles is required. The methodology can only be applied to discovered conditions where tornado missile protection was not provided, and cannot be used to avoid providing tornado missile protection in the plant modification process. The TMRE methodology was transmitted to the NRC by NEI as NEI 17-02, Revision 1, on September 21, 2017 and is hereby incorporated by reference into this UFSAR.

3.5.4 References

1. NEI 17-02, Revision 1, "Tornado Missile Risk Evaluator (TMRE) Industry Guidance Document," September 2017

2. [HISTORICAL INFORMATION] ["Missile Impact Testing of Reinforced Concrete Panels," Calspan Report No. HC-56-9-D-1, Calspan Corporation, Buffalo, New York, January 1975.

3. Stephenson, A. E., "Tornado Vulnerability Nuclear Production Facilities," Sandia Laboratories, April 1975.

4. "Design of Structures for Missile Impact," BC-TOP-9A, Revision 2, Bechtel Power Corporation, San Francisco, California, September 1974.

5. Stephenson, A. E., "Full Scale Tornado Missile Impact Tests," EPRI Report No. NF-440, Sandia Laboratories, July 1977.]

TABLE 3.5-8: SAFETY-RELATED COMPONENTS LOCATED OUTDOORS

Component	Protection Against Tornado Generated Missiles, Turbine Missiles*, or a Seismic Event
1. Diesel Generator fuel oil storage tanks	Buried 10 feet below finished grade and protected with a 2'-0" thick reinforced concrete slab on top (see Figure 3.8-87)
2. Category I electrical manholes	Protected by a box section below grade with a 1'-0" thick reinforced concrete wall & 2'-0" thick reinforced concrete cover slab (see Figure 3.8-88)
3. Electrical Category I duct banks	Located 4 feet below finished grade or with an equivalent amount of concrete cover (see Figure 3.8-88)
4. SSW cooling tower	
a. 24-in. dia. SSW supply & return lines	Buried 37'-0"(+) below grade and checked per BC-TOP-4A Rev. 3 against seismic loadings
b. 10-in. dia. HPCS supply & return lines	Buried 5'-01"(+) below grade and checked per BC-TOP-4A Rev. 3 against seismic loadings
c. Fanstacks	Protected by a 2'-0" thick reinforced concrete cylindrical wall and 0'-7" heavy duty steel grating (see Figures 3.8-97, 3.8-98, 6r 3.8-115)
d. Air intake louvers with centerline at El. 151'-3"	Protected by a 2'-0" thick reinforced concrete barrier wall (see Figures 3.8-94 & 3.8-95)
e. Air exhaust louvers with centerline at El. 151'-3"	Protected by a 2'-0" thick reinforced concrete barrier wall (see Figures 3.8-94 & 3.8-95)
f. 16-in dia. SSW vertical piping between basins and SSW superstructures	Exposed to horizontal missiles between elevations 133'-0" and 141'-6" but shielded by SSW superstructures, pump rooms, and valve rooms.
5. Control Building	
a. Air intake louvers with centerline at El. 139'-2"	Protected by a 2'-0" thick reinforced concrete barrier wall (see Figure 3.8-103)
b. Air exhaust louvers with centerline at El. 194'-10"	Protected by a 2'-0" thick reinforced concrete barrier wall (see Figure 3.8-107)
c. HVAC outside air intake louver/damper. Centerline of louver at El. 208'-8"	Damper located horizontally on floor of elevator machine room and protected by 2'-0" thick reinforced concrete barrier wall and a 2'-0" thick reinforced concrete roof slab of machine room. Louver is exposed but shielded by turbine bldg. with roof El. 232'-0" located approximately 12 feet to the east (see Figure 3.8-117)
d. Elevator machine room intake air damper with centerline at El. 212'-4"	Exposed but shielded by turbine bldg. with roof El. 232'-0" located approximately 120 feet to the east (see Figure 3.8-117)
e. Elevator machine room service door at El. 207'-6"	Exposed but shielded by turbine bldg. with roof El. 232'-0" located approximately 120 feet to the east (see

	Figure 3.8-117)
f. Elevator machine room exhaust air check damper with centerline El. 212'-4"	Exposed but shielded by the partially completed Unit 2 Containment shell located approximately 90 feet to the north (see Figure 3.8-117)
g. Six inch dia. openings 81 on north face of wall	Exposed due to partial completion of Unit 2 Auxiliary Bldg., but shielded by the partially completed Unit 2 Containment shell located approximately 50 feet to the northwest.
h. Stairwell door elevation 133'-0"	Exposed but partially shielded by ESF21 transformer located approximately 20 feet to the west.
6. Diesel-generator Building	
a. Air exhaust louver with centerline at El. 163'-9"	Protected by adjacent Auxiliary Bldg. wall & diesel-generator bldg. with roof El. 172'-0" (see Figure 9.5-21)
b. Air exhaust louvers with centerline at El. 162'-0"	Protected by adjacent Auxiliary Bldg. wall & diesel-generator bldg. with roof El. 172'-0" (see Figure 9.5-21)
c. Air intake louvers with centerline at El. 159'-8"	Protected by a 2'-0" thick reinforced concrete barrier wall (see Figure 9.5-21)
d. Diesel generator exhaust pipes above roof El. 172'-0"	See subsection 9.5.8.3
e. Diesel generator lube oil sump vents top El. 175'-0"	Exposed but partially shielded from horizontal missiles by concrete parapet with top elevation of 174'-0"
f. Diesel generator fuel oil tank vent top El. 173'-6"	Exposed but shielded from horizontal missiles by concrete parapet with top elevation of 174'-0"
7. Auxiliary Building	
a. RHR room blowout shafts above El. 185'-0"	Protected by a 2'-0" thick reinforced concrete barrier structure (see Figure 3.8-81)
b. RHR pump room & RCIC room blowout shafts above El. 185'-0"	Protected by a 2'-0" thick reinforced concrete barrier structure (see Figure 3.8-81)
c. Steam tunnel blowout shaft above El. 185'-0"	Protected by a 2'-0" thick reinforced concrete barrier structure (see Figure 3.8-81)
d. Louver and door at El. 185'-0"	Protected by a 2'-0" thick reinforced concrete barrier wall (see Figure 3.8-81)
e. Door at roof El. 185'-0"	Protected by a 2'-0" thick reinforced concrete barrier wall (see Figure 3.8-81)
f. Main entrance door at El. 139'-0"	Protected by a 2'-0" thick reinforced concrete barrier wall & 2'-0" thick top slab (see Figure 3.8-79)
g. Exit door at El. 139'-0"	Protected by a 2'-0" thick reinforced concrete barrier wall & 2'-0" thick top slab (see Figure 3.8-79)

*For protection against turbine missiles, see subsection 3.5.1.3.3.

Table 3.5.1-4a, Safety-Related Structures, Systems And Components That Do Not Require Protection from Tornado Generated Missiles Based on Tornado Missile Risk Evaluator Methodology.

Table 3.5.1-4a Non-Conforming (Safety-Related) SSC Vulnerabilities

Item	System ID	Vulnerability Description	General Location
1	Diesel Generator Fuel Oil Storage Tanks (1P75-A003A, 1P75-A003B, and 1P81-A001)	Diesel Generator Fuel Oil Storage Tank Vents and Inlets	Yard (above underground Diesel Generator Fuel Oil Storage Tanks)
2	P41 SSW Return Lines	SSW Vertical Piping between Basins and SSW Superstructures	SSW Cooling Tower Basin at Gridlines B2, B3, C2, C3, C6, & C7
3	Fuel Oil Day Tank (Q1P75A004A, Q1P75A004B, and Q1P81A002)	Diesel Generator Fuel Oil Day Tank Vents (Penetrations DC-20A, DC-21A, and DC-22A)	Diesel Generator Building (roof El. 172'-0")
4	P41 HPCS (Div. 3) Room Cooler (Q1T51B001-C)	SSW Supply and Return Headers (Penetrations DP-1A and DP-2A)	North End of Breezeway between Diesel Generator Building and Auxiliary Building
5	(See Section 3.1.1.15, Reference GGNS-CS-17-00002)	Cable Chase Room 1A539 (Behind Door 1A501)	South End of Control Building (Access gained from the Auxiliary Building Roof)

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Grand Gulf Nuclear Station, Unit No. 1
Docket No. 50-416 / License No. NPF-29

License Amendment Request to Incorporate
Tornado Missile Risk Evaluator
into Licensing Basis

Attachment 2

Probabilistic Risk Assessment Technical Adequacy Documentation

J.1 Overview

This Attachment documents the necessary information to demonstrate that the internal events Probabilistic Risk Assessment (PRA) for the Grand Gulf Nuclear Station (GGNS) meets the requirements of the American Society of Mechanical Engineers/American Nuclear Society (ASME/ANS) PRA Standard [J.1] as endorsed by Regulatory Guide (RG) 1.200, Revision 2, "*An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities*," [J.2] at an appropriate capability category to support the GGNS Tornado Missile Risk Evaluator (TMRE) program. This enclosure provides documentation that is consistent with the requirements of Section 3.3 and Section 4.2 of RG 1.200, Revision 2:

- Section J.2 addresses the need for the PRA model to represent the as-built, as-operated plant,
- Section J.3 discusses permanent plant changes that have an impact on those systems, structures, and components (SSCs) modeled in the PRA but have not been incorporated in the baseline PRA model.
- Section J.4 demonstrates that the GGNS PRA has been performed consistent with the ASME/ANS PRA Standard requirements as endorsed in RG 1.200, Rev. 2. The peer review that has been conducted and the resolution of findings from those reviews are discussed in this section. The unique TMRE considerations for certain supporting requirements (SRs) with NRC clarifications from the TMRE guidance document, NEI 17-02 are also discussed in this section.
- The conclusion on the technical adequacy of the GGNS PRA are provided in Section J.5.

Other technical elements of the PRA, including but not limited to internal flooding, fire, and other external events, are not required for the TMRE and are not discussed in this document.

J.2 Basis to Conclude that the PRA Model Represents the As-Built, As-Operated Plant

The GGNS PRA Model of Record (MOR) is maintained as a controlled document and is updated on a periodic basis to represent the as-built, as-operated plant. Entergy procedures provide the guidance, requirements, and processes for the maintenance, update, and upgrade of the PRA:

a. The process includes a review of plant changes, relevant plant procedures, and plant operating data, as required, through a chosen freeze date to assess the effect on the PRA model.
b. The PRA model and controlling documents are revised as necessary to incorporate those changes determined to impact the

model.

c. The determination of the extent of model changes includes the following:
   - Accepted industry PRA practices, ground rules, and assumptions consistent with those employed in the ASME/ANS PRA Standard,
   - Current industry practices,
   - NRC guidance,
   - Advances in PRA technology and methodology, and
   - Changes in external hazard conditions.

For plant changes of small or negligible impact, the model changes can be accumulated and a single revision performed at an interval consistent with major PRA revisions. The results of each evaluation determine the necessity and timing of incorporation of a particular change into the PRA model. An electronic tracking database is utilized to document pending model changes and updates.

J.3 Identification of Permanent Plant Changes Not Incorporated in the PRA Model

The current GGNS Internal Events model (Revision 4a) is based on the plant configuration as of August 2012 (plus ELAP/FLEX changes noted below) and plant-specific data through August 2012. It is a complete model update of the Revision 3 model and includes a mini-update focused on including the ability to credit the operators declaring an extended loss of AC Power (ELAP) event in progress, and implementing FLEX strategies and equipment to respond to the ELAP. The GGNS ELAP/FLEX modifications were implemented in 2016.

Review of the PRA model change database as of August 2017 indicates that there are currently no identified permanent plant modifications that have not been incorporated into the Revision 4a PRA model of record.

J.4 Conformance with ASME/ANS PRA Standard

The following sections describe the conformance and capability of the GGNS PRA against the ASME/ANS PRA Standard. There have been two (2), formal internal events MOR revisions since 2008.

J.4.1 2008 Internal Events Update

The 2008 revision of the model of record, Revision 3, was a general update of the model that included the following changes.

- Updated plant specific data (thru 8-2006)
- Updated plant specific (thru 8-2006) and generic initiator frequencies
- New initiators
  - Loss of service transformer (ST11 and ST21)
  - Reactor Vessel Rupture
  - Loss of CRD
  - Break (LOCA) Outside of Containment

- Major changes to LOSP modeling
  - Added loss of preferred offsite power initiator
  - Added consequential loss of offsite power event as a result of transient initiator
  - Added consequential loss of offsite power event as a result of LOCA initiator
  - New industry data used for LOSP recovery analysis
- Separated loss of PCS initiator into Closure of MSIVs initiator and Loss of PCS due to other causes initiator
- Updated ISLOCA analysis
- Updated common cause analysis
- Updated human reliability analysis
- Included modeling for loss of ECCS pumps due to containment failure
- Revised instrument air system modeling to incorporate new Plant Air compressors
- Revised modeling of CRD—less credit for CRD
- Added more detailed modeling for failure to scram (C11 and C71 systems)
- Added more detail to power conversion model

J.4.2 2017 Internal Events Update

In 2015, due to the number of open model change requests (MCRs), physical plant changes, and operating philosophy changes such as changing to a 24 month refueling cycle, the GGNS PRA MOR was completely re-generated. In addition, a new, Internal Flooding Analysis was performed. This new Revision 4 MOR underwent a BWR Owners Group Peer Review in September 2015, and a final Peer Review Report was issued in February 2016 [J.3]. Following the Peer Review, the Revision 4 MOR was revised to address the Peer Review comments as documented in Reference J.4.

After completion of the Revision 4 MOR, but before the Revision 4 MOR was issued for use, a mini-update was performed to add FLEX capabilities into the Revision 4 MOR so that sensitivity studies associated with the use of FLEX equipment could be performed. As part of this mini-update, identified modeling issues were also identified and resolved as documented in Reference J.7. This mini-update is referred to as the GGNS Rev 4a PRA MOR, and is the current GGNS MOR. Changes incorporated into the Rev 4a PRA MOR of record since the last released MOR (Revision 3) include the following.

- Data
  - Plant specific data updated thru 8-2012
  - Updated maintenance unavailability
  - Updated LOSP frequencies and non-recovery data
- Initiating events
  - Updated plant specific initiating events using plant operating experience (thru 8-2012),
  - Updated Support System Initiating Event fault trees to reflect current design and data
  - Incorporated new generic data for other initiator frequencies

  - Breaks Outside Containment (feedwater line break and main steam line break) removed from at-power internal events model and included in internal flood analysis
- Success criteria updated
  - Additional HVAC analyses
  - New MAAP analyses to reflect plant power uprate
  - Update of HRA timing based on above analyses
  - Credit for High Pressure Containment Spray (HPCS) pump to function post containment failure added (U1LT branch on event trees)
  - Credit for control rod drive injection removed due to lack of flow and makeup capability.
- Accident sequence analysis
  - Updated to reflect success criteria changes and updated procedures
  - Updated ISLOCA and ATWS models
  - Updated to include potential to enter ELAP and credit FLEX equipment
- System models
  - Updated all models and documentation to incorporate current procedures and design
  - Expanded the modeling of support systems
  - Revised to reflect 24 month operating cycle
  - Addition of FLEX equipment and capabilities
- Human Reliability
  - Addition of new HFEs developed for system models and accident sequences
  - Use of Human Reliability Analysis Calculator
  - Update timing
  - Update of dependency assessment
  - Use of delay times
- LERF
  - Developed LERF specific model incorporating new MAAP analyses
  - Integrated with the Level 1 model
  - Incorporated containment isolation and hydrogen ignition systems into the model
  - Utilized plant specific inputs to support Capability Category II analysis
- Internal flooding
  - Complete revision using EPRI methodology and data
  - Used updated flooding piping assessment for most recent frequency data
  - Detailed flooding walkdowns
  - Integrated with internal events at-power PRA model

J.4.3 Internal Events PRA Peer Review

In 2015 the Revision 4 MOR underwent a BWR Owners Group Peer Review using the NEI 05-04 process, the ASME PRA Standard (ASME/ANS RA-Sa-2009) and Regulatory Guide 1.200, Rev. 2. The GGNS Peer Review was a full-scope review of the Technical Elements of the internal events and internal flooding, at-power PRA. A summary of the assessment against each of the eight technical elements (i.e. high-level requirements) of ASME/ANS RA-Sa-2009 is provided in Tables J.1 through J.8 of this attachment. Table J.9 lists those supporting

requirements (SRs) from the PRA Standard that have been identified in the TMRE Guidance Document as being applicable to the TMRE PRA. A systematic review of these SRs relative to the GGNS TMRE model development was performed and documented in the notes column of Table J.9.

Table J.10 provides a listing of the Finding level GGNS Peer Review Facts and Observations (F&O) [J.4]. The table also includes the resolution of each Finding. The Findings were resolved so as to meet the Capability Category II requirements of the ASME PRA Standard Supporting Requirements that were applicable to the Finding. All of the Findings are considered closed.

The resolution and closure of the Findings from the peer review have been subjected to a review in accordance with the NEI 05-04 Appendix X, "Close Out of Facts and Observations (F&Os)" finding closure review process [J.5]. The closure review determined that all of the findings were closed. Reference J.6 documents the closure review.

J.5 Conclusions on PRA Technical Adequacy

The GGNS PRA model is sufficiently robust and suitable for use in risk informed processes such as the TMRE Program. The peer review and closure of findings from the review demonstrate that the PRA has been performed in a technically correct manner. There are no open finding-level F&Os for the GGNS PRA. The assumptions and approximations used in development of the PRA have been reviewed and are appropriate for this application. Entergy procedures are in place for controlling an updating the models, and for assuring that the model represents the as-built, as-operated plant. The conclusion is that the GGNS PRA model is acceptable to be used as the basis for risk-informed applications including the Tornado Missile Risk Evaluator (TMRE).

References

J.1 ASME/ANS RA-Sa-2009, "Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications," American Society of Mechanical Engineers, 2009

J.2 US Nuclear Regulatory Commission, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk- Informed Activities", Regulatory Guide 1.200 Revision 2, March 2009

J.3 GGNS 2015 PRA Peer Review Report, Revision 0, BWR Owners Group, February 2016

J.4 PSA-GGNS-01-FNO-RES, Resolution of GGNS PRA Peer Review Facts and Observations, Revision 0, August 2017

J.5 NEI 05-04, Process for Performing Internal Events PRA Peer Reviews Using the ASME/ANS PRA Standard, Revision 3

J.6 ENERCON Report ENT#GG052-REPT-001, Grand Gulf Nuclear Station Probabilistic Risk Assessment Peer Review Findings Closure, Revision 0

J.7 PSA-GGNS-01-QU, Grand Gulf Nuclear Station Probabilistic Risk Assessment Model Integration and Quantification, Revision 1, July 24, 2017

Table J.1:
GGNS Assessment of Supporting Requirement (SR) Capability Categories
For Initiating Events (IE), ASME/ANS RA-Sa-2009 as endorsed by RG 1.200, Rev. 2

HLR	SR	Capability Category			Met	Not Met	N/A	SR TMRE Clarification
		I	II	III				
HLR-IE-A	IE-A1			ALL	X			X
	IE-A2			ALL	X			
	IE-A3			ALL	X			
	IE-A4		I/II		X			
	IE-A5		II		X			
	IE-A6		II		X			
	IE-A7			ALL	X			
	IE-A8		II		X			
	IE-A9		II		X			
	IA-10						X	
HLR-IE-B	IE-B1			ALL	X			
	IE-B2			ALL	X			
	IE-B3		II		X			
	IE-B4			ALL	X			
	IE-B5						X	
HLR-IE-C	IE-C1			ALL	X			X
	IE-C2			ALL	X			X
	IE-C3			ALL	X			X
	IE-C4			ALL	X			
	IE-C5		I/II		X			
	IE-C6			ALL	X			
	IE-C7		I/II		X			
	IE-C8			ALL	X			
	IE-C9			ALL	X			
	IE-C10			ALL	X			
	IE-C11			ALL	X			
	IE-C12			ALL	X			
	IE-C13		I/II		X			
	IE-C14		I/II		X			
	IE-C15			ALL		X(1)		X
HLR-IE-D	IE-D1			ALL	X			
	IE-D2			ALL	X			
	IE-D3			ALL	X			

Table J.2:
GGNS Assessment of Supporting Requirement (SR) Capability Categories
For Accident Sequences (AS), ASME/ANS RA-Sa-2009 as endorsed by RG 1.200, Rev. 2

HLR	SR	Capability Category			Met	Not Met	N/A	SR TMRE Clarification
		I	II	III				
HLR-AS-A	AS-A1			ALL	X			X
	AS-A2			ALL	X			
	AS-A3			ALL	X			X
	AS-A4			ALL	X			X
	AS-A5			ALL	X			X
	AS-A6			ALL	X			
	AS-A7		I/II		X			
	AS-A8			ALL	X			
	AS-A9		II		X			
	AS-A10		II		X			X
	AS-A11			ALL	X			
HLR-AS-B	AS-B1			ALL	X			X
	AS-B2			ALL	X			
	AS-B3			ALL	X			X
	AS-B4						X	
	AS-B5			ALL	X			
	AS-B6			ALL	X			
	AS-B7			ALL	X			X
HLR-AS-C	AS-C1			ALL	X			
	AS-C2			ALL	X			
	AS-C3			ALL	X			

Table J.3:
GGNS Assessment of Supporting Requirement (SR) Capability Categories
For Success Criteria (SC), ASME/ANS RA-Sa-2009 as endorsed by RG 1.200, Rev. 2

HLR	SR	Capability Category			Met	Not Met	N/A	SR TMRE Clarification
		I	II	III				
HLR-SC-A	SC-A1			ALL	X			
	SC-A2			II/III	X			
	SC-A3			ALL	X			
	SC-A4						X	N/A
	SC-A5			II/III	X			
	SC-A6			ALL	X			
HLR-SC-B	SC-B1		II		X			
	SC-B2			II/III	X			X
	SC-B3			ALL	X			
	SC-B4			ALL	X			
	SC-B5			ALL	X			
HLR-SC-C	SC-C1			ALL	X			
	SC-C2			ALL	X			
	SC-C3			ALL	X			

Table J.4:
GGNS Assessment of Supporting Requirement (SR) Capability Categories
For System Analysis (SY), ASME/ANS RA-Sa-2009 as endorsed by RG 1.200, Rev. 2

HLR	SR	Capability Category			Met	Not Met	N/A	SR TMRE Clarification
		I	II	III				
HLR-SY-A	SY-A1			ALL	X			
	SY-A2			ALL	X			
	SY-A3			ALL	X			
	SY-A4			II/III	X			X
	SY-A5			ALL	X			
	SY-A6			ALL	X			
	SY-A7		I/II		X			
	SY-A8			ALL	X			
	SY-A9			ALL	X			
	SY-A10			ALL	X			
	SY-A11			ALL	X			X
	SY-A12			ALL	X			X
	SY-A13			ALL	X			X
	SY-A14			ALL	X			X
	SY-A15			ALL	X			X
	SY-A16		I/II		X			
	SY-A17			ALL	X			X
	SY-A18			ALL	X			
	SY-A19			ALL	X			
	SY-A20			ALL	X			
	SY-A21			ALL	X			
	SY-A22		II		X			
	SY-A23			ALL	X			
	SY-A24			ALL	X			
HLR-SY-B	SY-B1			II/III	X			
	SY-B2		I/II		X			
	SY-B3			ALL	X			
	SY-B4			ALL	X			
	SY-B5			ALL	X			
	SY-B6			ALL	X			

Table J.4, continued:
GGNS Assessment of Supporting Requirement (SR) Capability Categories
For System Analysis (SY), ASME/ANS RA-Sa-2009 as endorsed by RG 1.200, Rev. 2

HLR	SR	Capability Category			Met	Not Met	N/A	SR TMRE Clarification
		I	II	III				
HLR-SY-B(cont'd)	SY-B7		II		X			X
	SY-B8			ALL	X			X
	SY-B9			ALL	X			
	SY-B10			II/III	X			
	SY-B11			ALL	X			
	SY-B12			ALL	X			
	SY-B13			ALL	X			
	SY-B14			ALL	X			X
	SY-B15			ALL	X			X
HLR-SY-C	SY-C1			ALL	X			
	SY-C2			ALL	X			
	SY-C3			ALL	X			

Note 1 – Based on the closure review of the Findings associated with SR, the SR is now met at CC-II or greater.

Table J.5:
GGNS Assessment of Supporting Requirement (SR) Capability Categories
For Human Reliability (HR), ASME/ANS RA-Sa-2009 as endorsed by RG 1.200, Rev. 2

HLR	SR	Capability Category			Met	Not Met	N/A	SR TMRE Clarification
		I	II	III				
HLR-HR-A	HR-A1			ALL	X			
	HR-A2			ALL	X			
	HR-A3			ALL	X			
HLR-HR-B	HR-B1						X	
	HR-B2						X	
HLR-HR-C	HR-C1			ALL	X			
	HR-C2	I			X			
	HR-C3			ALL	X			
HLR-HR-D	HR-D1			ALL	X			
	HR-D2		II		X			

Table J.5, continued:
GGNS Assessment of Supporting Requirement (SR) Capability Categories
For Human Reliability (HR), ASME/ANS RA-Sa-2009 as endorsed by RG 1.200, Rev. 2

HLR	SR	Capability Category			Met	Not Met	N/A	SR TMRE Clarification
		I	II	III				
HLR-HR-D(cont'd)	HR-D3			II/III	X			
	HR-D4			ALL	X			
	HR-D5			ALL	X			
	HR-D6			ALL	X			
	HR-D7		I/II		X			
HLR-HR-E	HR-E1			ALL	X			
	HR-E2			ALL	X			
	HR-E3			II/III	X			X
	HR-E4			II/III	X			X
HLR-HR-F	HR-F1		I/II		X			
	HR-F2	I				X(1)		
HLR-HR-G	HR-G1			III	X			
	HR-G2			ALL	X			
	HR-G3			II/III	X			
	HR-G4		II		X			
	HR-G5		II		X			X
	HR-G6			ALL	X			
	HR-G7			ALL		X(1)		X
	HR-G8			ALL	X			
HLR-HR-H	HR-H1		II		X			X
	HR-H2			ALL	X			X
	HR-H3			ALL	X			
HLR-HR-I	HR-I1			ALL	X			
	HR-I2			ALL	X			
	HR-I3			ALL	X			

Note 1 – Based on the closure review of the Findings associated with SR, the SR is now met at CC-II or greater.

Table J.6:
GGNS Assessment of Supporting Requirement (SR) Capability Categories
For Data Analysis (DA), ASME/ANS RA-Sa-2009 as endorsed by RG 1.200, Rev. 2

HLR	SR	Capability Category			Met	Not Met	N/A	SR TMRE Clarification
		I	II	III				
HLR-DA-A	DA-A1			ALL	X			X
	DA-A2			ALL	X			
	DA-A3			ALL	X			
	DA-A4			ALL	X			
HLR-DA-B	DA-B1		II		X			
	DA-B2		I/II		X			
HLR-DA-C	DA-C1			ALL	X			
	DA-C2			ALL	X			
	DA-C3			ALL		X(1)		
	DA-C4			ALL	X			
	DA-C5			ALL	X			
	DA-C6			ALL	X			
	DA-C7			II/III	X			
	DA-C8			II/III	X			
	DA-C9		I/II		X			
	DA-C10		II		X			
	DA-C11			ALL	X			
	DA-C12			ALL	X			
	DA-C13			II/III	X			
	DA-C14			ALL		X(1)		
	DA-C15			ALL	X			
	DA-C16			ALL	X			
HLR-DA-D	DA-D1		II		X			
	DA-D2			ALL	X			
	DA-D3		II		X			
	DA-D4			II/III	X			
	DA-D5		II		X			
	DA-D6		II		X			
	DA-D7						X	
	DA-D8		II		X			

Table J.6, continued:
GGNS Assessment of Supporting Requirement (SR) Capability Categories
For Data Analysis (DA), ASME/ANS RA-Sa-2009 as endorsed by RG 1.200, Rev. 2

HLR	SR	Capability Category			Met	Not Met	N/A	SR TMRE Clarification
		I	II	III				
HLR-DA-E	DA-E1			ALL		X(1)		
	DA-E2			ALL	X			
	DA-E3			ALL	X			

Note 1 – Based on the closure review of the Findings associated with SR, the SR is now met at CC-II or greater.

Table J.7:
GGNS Assessment of Supporting Requirement (SR) Capability Categories
For Quantification (QU), ASME/ANS RA-Sa-2009 as endorsed by RG 1.200, Rev. 2

HLR	SR	Capability Category			Met	Not Met	N/A	SR TMRE Clarification
		I	II	III				
HLR-QU-A	QU-A1			ALL	X			
	QU-A2			ALL		X(1)		
	QU-A3			II/III	X			
	QU-A4			ALL	X			
	QU-A5			ALL	X			X
HLR-QU-B	QU-B1			ALL	X			
	QU-B2			ALL	X			
	QU-B3			ALL	X			
	QU-B4			ALL	X			
	QU-B5			ALL	X			
	QU-B6			ALL	X			
	QU-B7			ALL	X			
	QU-B8			ALL	X			
	QU-B9			ALL	X			
	QU-B10						X	
HLR-QU-C	QU-C1			ALL	X			
	QU-C2			ALL	X			
	QU-C3			ALL	X			

Note 1 – Based on the closure review of the Findings associated with SR, the SR is now met at CC-II or greater.

Table J.7, continued:
GGNS Assessment of Supporting Requirement (SR) Capability Categories
For Quantification (QU), ASME/ANS RA-Sa-2009 as endorsed by RG 1.200, Rev. 2

HLR	SR	Capability Category			Met	Not Met	N/A	SR TMRE Clarification
		I	II	III				
HLR-QU-D	QU-D1			ALL	X			
	QU-D2			ALL	X			
	QU-D3			ALL	X			
	QU-D4			II/III		X(1)		
	QU-D5			ALL	X			X
	QU-D6			II/III	X			
	QU-D7			ALL	X			X
HLR-QU-E	QU-E1			ALL	X			X
	QU-E2			ALL	X			X
	QU-E3		II		X			
	QU-E4			ALL	X			X
HLR-QU-F	QU-F1			ALL	X			
	QU-F2			ALL	X			
	QU-F3			II/III		X(1)		
	QU-F4			ALL	X			
	QU-F5			ALL	X			
	QU-F6			ALL		X(1)		

Note 1 – Based on the closure review of the Findings associated with SR, the SR is now met at CC-II or greater.

Table J.8:
GGNS Assessment of Supporting Requirement (SR) Capability Categories
For LERF Analysis (LE), ASME/ANS RA-Sa-2009 as endorsed by RG 1.200, Rev. 2

HLR	SR	Capability Category			Met	Not Met	N/A	SR TMRE Clarification
		I	II	III				
HLR-LE-A	LE-A1			ALL	X			
	LE-A2			ALL	X			
	LE-A3			ALL	X			
	LE-A4			ALL	X			
	LE-A5			ALL	X			
HLR-LE-B	LE-B1		II		X			
	LE-B2		II		X			
	LE-B3			ALL	X			
HLR-LE-C	LE-C1		II		X			
	LE-C2	I				X(1)		
	LE-C3	I			X			X
	LE-C4		II		X			
	LE-C5		II		X			
	LE-C6			ALL	X			
	LE-C7			ALL	X			
	LE-C8			ALL	X			
	LE-C9			II/III	X			
	LE-C10	I			X			
	LE-C11			II/III	X			
	LE-C12	I			X			
	LE-C13			II/III	X			
HLR-LE-D	LE-D1		II		X			
	LE-D2		II		X			
	LE-D3	I			X			
	LE-D4		II		X			
	LE-D5						X	
	LE-D6						X	
	LE-D7		II		X			
HLR-LE-E	LE-E1			ALL	X			
	LE-E2		II		X			
	LE-E3	I			X			
	LE-E4			ALL	X			

Table J.8, continued:
GGNS Assessment of Supporting Requirement (SR) Capability Categories
For LERF Analysis (LE), ASME/ANS RA-Sa-2009 as endorsed by RG 1.200, Rev. 2

HLR	SR	Capability Category			Met	Not Met	N/A	SR TMRE Clarification
		I	II	III				
HLR-LE-F	LE-F1	I				X(1)		
	LE-F2			ALL		X(1)		
	LE-F3			ALL	X			
HLR-LE-G	LE-G1			ALL	X			
	LE-G2			ALL	X			
	LE-G3	I				X(1)		
	LE-G4			ALL	X			
	LE-G5			ALL		X(1)		
	LE-G6			ALL		X(1)		

Note 1 – Based on the closure review of the Findings associated with SR, the SR is now met at CC-II or greater.

Table J.9: SRs with Unique TMRE Considerations

TMRE - ASME PRA Standard Supporting Requirements Requiring Self-Assessment		NRC Comments (No comments if blank)	NEI 17-02 Section Addressing SR	Additional GGNS TMRE comments
IE-A	The initiating event analysis shall provide a reasonably complete identification of initiating events.			
IE-A1	Tornado initiating events will be consistent with the intervals defined in the TMRE process. TMRE considers all tornadoes will result in a LOOP. Tornado initiating event frequencies will be based on a hazard curve that uses site specific data provided in Table 6.1 of NUREG 4461 [IE-C1].	TMRE process should ensure that the initiating events caused by extreme winds that give rise to significant accident sequences and accurately capture the additional risk of the unprotected SSCs (that should be protected per the CLB) are identified and used for this application.	4.3, 6.2	The only initiating events caused by extreme winds that are considered in TMRE were tornados. Only tornados will produce tornado missiles. The TMRE process was followed as described. See sections 4.4 and 4.6.
IE-A10	For multi-unit sites with shared systems, INCLUDE multi-unit site initiators (e.g., multi-unit LOOP events or total loss of service water) that may impact the model.		6.2	N/A. GGNS is a single unit site.

Table J.9: SRs with Unique TMRE Considerations

TMRE - ASME PRA Standard Supporting Requirements Requiring Self-Assessment		NRC Comments (No comments if blank)	NEI 17-02 Section Addressing SR	Additional GGNS TMRE comments
IE-B	The initiating event analysis shall group the initiating events so that events in the same group have similar mitigation requirements (i.e., the requirements for most events in the group are less restrictive than the limiting mitigation requirements for the group) to facilitate an efficient but realistic estimation of CDF			
IE-B5	DO NOT SUBSUME multi- unit initiating events if they impact mitigation capability. Two unit sites should consider proximity of each unit to each other, the footprint of potential tornadoes for the region, and the systems shared between each unit.		6.2	N/A. GGNS is a single unit site.
IE-C	The initiating event analysis shall estimate the annual frequency of each initiating event or initiating event group.	The tornado IEFs should be based on a hazard curve that uses site-specific data, such as found in NUREG-4461.		
IE-C1	Tornado initiating event frequencies will be based on a hazard curve that uses site specific data provided in Table 6.1 of NUREG 4461		4.1	The TMRE process was followed as described. No additional comments. See section 4.4.

Table J.9: SRs with Unique TMRE Considerations

TMRE - ASME PRA Standard Supporting Requirements Requiring Self-Assessment		NRC Comments (No comments if blank)	NEI 17-02 Section Addressing SR	Additional GGNS TMRE comments
IE-C3	Do not credit recovery of offsite power.	Same comment as AS-A10	6.1, Appendix A	The TMRE process was followed as described. Offsite power recovery was not credited. See section 4.6.
IE-C15	CHARACTERIZE the uncertainty in the tornado initiating event frequencies and PROVIDE mean values for use in the quantification of the PRA results. NUREG 4461, Tornado Climatology, data includes uncertainty.		4.3	The TMRE process was followed as described. As mentioned, NUREG 4461, Tornado Climatology, data includes uncertainty. Additionally, the R-squared value is provided to help characterize the uncertainty of the GGNS initiating event best fit interpolated/ extrapolated frequencies. See section 4.4.
AS-A	Utilize the accident sequences (typically LOOP) provided in the internal events model and adjust as necessary to consider the consequences of a tornado event.			

Table J.9: SRs with Unique TMRE Considerations

TMRE - ASME PRA Standard Supporting Requirements Requiring Self-Assessment		NRC Comments (No comments if blank)	NEI 17-02 Section Addressing SR	Additional GGNS TMRE comments
AS-A1	Modify the internal events accident sequences in compliance with this SR		6.1, 6.3, 6.4, 6.5	The TMRE process was followed as described. The transient LOOP accident sequence event tree from the internal events model was utilized consider the consequences of a tornado event. SSCs are not credited in accordance with the TMRE process. Operator actions are adjusted as necessary according to the TMRE process. Section 4.0 describes the calculation process.
AS-A3	Review the FPIE success criteria and modify the associated system models as necessary to account for the tornado event and its consequences.		6.1, 6.3, 6.4, 6.5	The TMRE process was followed as described. SSCs are not credited in accordance with the TMRE process. See section 4.0.
AS-A4	Review the FPIE success criteria and modify the associated operator actions as necessary to account for the tornado event and its consequences.		6.4	The TMRE process was followed as described. Operator actions are adjusted as necessary according to the TMRE process. See section 4.1.

Table J.9: SRs with Unique TMRE Considerations

TMRE - ASME PRA Standard Supporting Requirements Requiring Self-Assessment		NRC Comments (No comments if blank)	NEI 17-02 Section Addressing SR	Additional GGNS TMRE comments
AS-A5	Modify the FPIE accident sequence model in a manner that is consistent with the plant- specific: system design, EOPs, abnormal procedures, and plant transient response. Account for system functions that, as a consequence of the tornado event, will not be operable or potentially degraded, and operator actions that will not be possible or impeded.		6.1, 6.3, 6.4, 6.5	The TMRE process was followed as described. The transient LOOP accident sequence event tree from the internal events model was utilized consider the consequences of a tornado event. Certain exposed SSCs are not credited in accordance with the TMRE process. Operator actions are adjusted as necessary according to the TMRE process. See section 4.0.

Table J.9: SRs with Unique TMRE Considerations

TMRE - ASME PRA Standard Supporting Requirements Requiring Self-Assessment		NRC Comments (No comments if blank)	NEI 17-02 Section Addressing SR	Additional GGNS TMRE comments
AS-A10	Capability Category I. In modifying the accident sequence models, INCLUDE, for each tornado initiating event, INDIVIDUAL EVENTS IN THE ACCIDENT SEQUENCE SUFFICIENT TO BOUND SYSTEM OPERATION, TIMING, AND OPERATOR ACTIONS NECESSARY FOR KEY SAFETY FUNCTIONS.	In constructing the accident sequence models, support system modeling, etc. realistic criteria or assumptions should be used, unless a conservative approach can be justified. Use of conservative assumptions in the base model can distort the results and may not be conservative for delta CDF/LERF calculation. While use of conservative or bounding assumptions in PRA models is acceptable, a qualitative or quantitative assessment may be needed to show that those assumptions do not underestimate delta CDF/LERF estimates.	6.3, 7.2.3, Appendix A	The TMRE process was followed as described. The diesel driven fire water pumps were modeled (PRA-1 and PRA-3) because of their potential for injecting water to the reactor vessel. Several components (e.g. PRA-27, turbine trip valves) were modeled to not fail in the compliant case, but fail due to tornado in the degraded case. This maximizes the delta CDF. Other active components not in Cat I structures are not credited in accordance with the TMRE process. This conservative assumption can distort the delta CDF/LERF. A specific sensitivity was performed to address that possibility. See section 4.11 for all sensitivities.
AS-B	Dependencies that can impact the ability of the mitigating systems to operate and function shall be addressed.			

Table J.9: SRs with Unique TMRE Considerations

TMRE - ASME PRA Standard Supporting Requirements Requiring Self-Assessment		NRC Comments (No comments if blank)	NEI 17-02 Section Addressing SR	Additional GGNS TMRE comments
AS-B1	For each tornado event, IDENTIFY mitigating systems impacted by the occurrence of the initiator and the extent of the impact. INCLUDE the impact of initiating events on mitigating systems in the accident progression either in the accident sequence models or in the system models.		6.1, 6.3, 6.5, 6.6	The TMRE process was followed as described. Impacts on mitigating systems were included for all modeled tornado initiating events as described in section 4.6.
AS-B3	IDENTIFY the phenomenological conditions created by the accident progression. Consider concurrent impacts related to tornado missiles (e.g., the possibility of multiple missile strikes in a given sequence. Also high winds and rains after the tornado event could result in hazardous conditions (e.g. debris and structural instabilities) for actions outside the control room.		5.6, 6.3, 6.4, 6.6	The TMRE process was followed as described. Unique weather phenomena such as intense rain could be an issue during tornado initiating events for structures that are not designed to withstand the winds. Except as noted above (AS-A10) active components in non- Cat I structures were not credited in accordance with the TMRE process. Operator actions that require travel through non-Cat I structures or areas are not credited. See section 4.0.

Table J.9: SRs with Unique TMRE Considerations

TMRE - ASME PRA Standard Supporting Requirements Requiring Self-Assessment		NRC Comments (No comments if blank)	NEI 17-02 Section Addressing SR	Additional GGNS TMRE comments
AS-B7	Review FPIE time phased dependencies to identify model changes needed to address all the concurrent system functions failed by the tornado event; e.g. LOOP, instrument air, fire protection……etc. Do not model offsite recovery.		6.1	The TMRE process was followed as described. Time phased dependencies were reviewed and no model changes were identified for the TMRE model. See section 4.0.
SC-A	The overall success criteria for the PRA and the system, structure, component, and human action success criteria used in the PRA shall be defined and referenced, and shall be consistent with the features, procedures, and operating philosophy of the plant.			
SC-A4	Consider impact on both units for the same tornado including the mitigating systems that are shared.		6.1	N/A. GGNS is s single unit site.

Table J.9: SRs with Unique TMRE Considerations

TMRE - ASME PRA Standard Supporting Requirements Requiring Self-Assessment		NRC Comments (No comments if blank)	NEI 17-02 Section Addressing SR	Additional GGNS TMRE comments
SY-A	The systems analysis shall provide a reasonably complete treatment of the causes of system failure and unavailability modes represented in the initiating events analysis and sequence definition			
SY-A4	Capability Category II. Walkdowns focusing on targets vulnerable to tornado missiles will be performed. Walkdown will include a missile inventory and a review of pathways available to the operators for ex-control room actions.		Section 3	The TMRE process was followed as described. Walkdowns were performed focusing on targets vulnerable to tornado missiles. The results were recorded in the walkdown report. The walkdowns also surveyed the plant for the missile inventory. Pathways for operator x-control room actions were discussed with the site personnel; however, operator actions that require travel through non- Cat I structures or areas are not credited.

Table J.9: SRs with Unique TMRE Considerations

TMRE - ASME PRA Standard Supporting Requirements Requiring Self-Assessment		NRC Comments (No comments if blank)	NEI 17-02 Section Addressing SR	Additional GGNS TMRE comments
SY-A11	New basic events will be added to address all the failure modes of the system targets exposed to tornado missiles; safety related and non-safety related. The exclusions of SY-A15 do not apply for SSCs impacted by tornado missiles.		6.3, 6.5, 6.6	The TMRE process was followed as described. New basic events and flags were added to address all the failure modes of the safety related system targets exposed to tornado missiles in accordance with the TMRE process.

Table J.9: SRs with Unique TMRE Considerations

TMRE - ASME PRA Standard Supporting Requirements Requiring Self-Assessment		NRC Comments (No comments if blank)	NEI 17-02 Section Addressing SR	Additional GGNS TMRE comments
SY-A12	DO NOT INCLUDE in a system model component failures that would be beneficial to system operation, unless omission would distort the results. For example, do not assume a vent pipe will be sheered by a high energy missile verses crimped unless it can be shown this is true for all missiles at all speeds. Exceptions would be components that are intentionally designed to "fail" favorably when struck by a missile; e.g. a frangible plastic pipe used as a vent is designed to break off and not crimp when struck by a missile.		5.2	The TMRE process was followed as described. No additional comment for the TMRE model.
SY-A13	Consider the target's potential to cause a flow diversion when struck by a tornado missile.		8.5	The TMRE process was followed as described. Targets potential to cause a flow diversion when struck by a tornado missile were considered. Beyond steam breaks around main steam lines, no additional flow diversions were required to be modeled.

Table J.9: SRs with Unique TMRE Considerations

TMRE - ASME PRA Standard Supporting Requirements Requiring Self-Assessment		NRC Comments (No comments if blank)	NEI 17-02 Section Addressing SR	Additional GGNS TMRE comments
SY-A14	Missile targets will be assessed for all failure modes - some new failure modes may be identified that are not in the FPIE model. The exclusions of SY-A15 do not apply for SSCs impacted by tornado missiles.		6.5	The TMRE process was followed as described. SSCs were assessed for all failure modes. Section 4.3 describes the walkdown review for targets considering additional failure modes.
SY-A15	The failure of SSCs due to tornado missiles shall not use the exclusions of SY-A15.	The failure by tornado missiles should be included in the model for all unprotected targets that are supposed to be protected according to the CLB and any unprotected targets that are not in the CLB but are in the PRA model. This is to facilitate sensitivity studies regarding possible correlation of tornado missile damage across systems. It is not expected that the number of basic events added to the model for this analysis will be so large that this screening is necessary.	6.5	The TMRE process was followed as described. The failure by tornado missiles was included in the model for all unprotected targets that are supposed to be protected according to the CLB and any unprotected targets that are not in the CLB but are in the PRA model.

Table J.9: SRs with Unique TMRE Considerations

TMRE - ASME PRA Standard Supporting Requirements Requiring Self-Assessment		NRC Comments (No comments if blank)	NEI 17-02 Section Addressing SR	Additional GGNS TMRE comments
SY-A17	Certain post initiator HFEs will be modified to account for the tornado event.		4.4	The TMRE process was followed as described. The HFE review is documented in section 4.1.
SY-B	The thermal/hydraulic, structural, and other supporting engineering bases shall be capable of providing success criteria and event timing sufficient for quantification of CDF and LERF, determination of the relative impact of success criteria on SSC and human actions, and the impact of uncertainty on this determination.			
SY-B7	Capability Category I. BASE support system modeling on the use of CONSERVATIVE SUCCESS CRITERIA AND TIMING. Sensitivity studies will be performed to identify where conservative assumptions may be distorting risk and adjusted accordingly.	Same comment as AS-A10	5.2.3	The TMRE process was followed as described. The systems analysis from the internal events was the foundation for the TMRE model. Credit given to available PRA SSCs was in accordance with the TMRE process. Sensitivities are provided in section 4.11.

Table J.9: SRs with Unique TMRE Considerations

TMRE - ASME PRA Standard Supporting Requirements Requiring Self-Assessment		NRC Comments (No comments if blank)	NEI 17-02 Section Addressing SR	Additional GGNS TMRE comments
SY-B8	Consider spatial relationships between components to identify correlated failures. Where the same missile can impact targets that are in close proximity to each other.		5.6	The TMRE process was followed as described. Correlation was considered where the same missile can impact targets that are in close proximity to each other.
SY-B14	Statistical correlation of tornado missile damage between redundant and spatially separated components is NOT required.	The industry indicated in earlier discussions that information is available to show that statistical correlation of tornado missile damage for specially separated components is insignificant. Until that information is reviewed and accepted by the staff, this SR should be met (spans all capability categories) and dependent failures of multiple SSCs should be considered.	Appendix B.4.4	There are no deviations taken from the TMRE guidance document.
SY-B15	INCLUDE new operator interface dependencies across systems or trains related to the tornado event.		6.4	The TMRE process was followed as described. No new operator interface dependencies across systems or trains were identified in the TMRE model development. See section 4.1.

Table J.9: SRs with Unique TMRE Considerations

TMRE - ASME PRA Standard Supporting Requirements Requiring Self-Assessment		NRC Comments (No comments if blank)	NEI 17-02 Section Addressing SR	Additional GGNS TMRE comments
HR-E	A systematic review of the relevant procedures shall be used to identify the set of operator responses required for each of the tornado accident sequences			
HR-E3	Operators will be interviewed (if necessary) to assess the need for changes to operator actions for the tornado initiating events.		6.4	The TMRE process was followed as described. Operator interviews for the credited actions were performed during the development of the internal events model that the TMRE model is based on. Furthermore, during the TMRE development a GGNS SRO was consulted for further considerations. See section 4.1.

Table J.9: SRs with Unique TMRE Considerations

TMRE - ASME PRA Standard Supporting Requirements Requiring Self-Assessment		NRC Comments (No comments if blank)	NEI 17-02 Section Addressing SR	Additional GGNS TMRE comments
HR-E4	Operators talk-throughs or simulator observations will be conducted (if necessary) to assess the need for changes to operator actions for the tornado [Note: this applies to new sequences or failure combinations not accounted for in the internal events model. It is not intended that operator action timing needs be changed due to the tornado event alone]		6.4	The TMRE process was followed as described. Operator interviews/ talk throughs for the credited actions were performed during the development of the model that the TMRE model is based on. Furthermore, during the TMRE development a GGNS SRO was consulted for further considerations. See section 4.1.
HR-G	The assessment of the probabilities of the post-initiator HFEs shall be performed using a well-defined and self-consistent process that addresses the plant-specific and scenario-specific influences on human performance, and addresses potential dependencies between human failure events in the same accident sequence.			

Table J.9: SRs with Unique TMRE Considerations

TMRE - ASME PRA Standard Supporting Requirements Requiring Self-Assessment		NRC Comments (No comments if blank)	NEI 17-02 Section Addressing SR	Additional GGNS TMRE comments
HR-G5	Operators will be interviewed and simulator observations conducted (if necessary) to assess the need for changes to operator action timing as a result of the tornado event. [Note: this applies to new sequences or failure combinations not accounted for in the internal events model. It is not intended that operator action timing needs be changed due to the tornado event alone]		6.4	The TMRE process was followed as described. Operator interviews/ talk throughs for the credited actions were performed during the development of the internal events model that the TMRE model is based on. Furthermore, during the TMRE development a GGNS SRO was consulted for further considerations. See section 4.1.
HR-G7	Dependencies will be recalculated when the model is quantified or modified by inspecting cutsets.		6.4	The TMRE process was followed as described. No new combinations were created or credited.

Table J.9: SRs with Unique TMRE Considerations

TMRE - ASME PRA Standard Supporting Requirements Requiring Self-Assessment		NRC Comments (No comments if blank)	NEI 17-02 Section Addressing SR	Additional GGNS TMRE comments
HR-H	Recovery actions (at the cutset or scenario level) shall be modeled only if it has been demonstrated that the action is plausible and feasible for those scenarios to which they are applied. Estimates of probabilities of failure shall address dependency on prior human failures in the scenario.			
HR-H1/H2	Do not credit recovery actions to restore functions, systems, or components unless an explicit basis accounting for tornado impacts on the site and the SSCs of concern is provided.		6.4	The TMRE process was followed as described. Recovery actions to restore functions, systems, or components were not credited.
DA-A	Each parameter shall be clearly defined in terms of the logic model, basic event boundary, and the model used to evaluate event probability.			

Table J.9: SRs with Unique TMRE Considerations

TMRE - ASME PRA Standard Supporting Requirements Requiring Self-Assessment		NRC Comments (No comments if blank)	NEI 17-02 Section Addressing SR	Additional GGNS TMRE comments
DA-A1	Develop new basic events for tornado missile targets (all failure modes) in accordance with this SR.		8.3, 8.5, 8.6	The TMRE process was followed as described. New basic events and flags were added to address all the failure modes of the safety related and non-safety related system targets exposed to tornado missiles in accordance with the TMRE process. See section 4.0.
QU-A	The level 1 quantification shall quantify core damage frequency and shall support the quantification of LERF.			
QU-A5	Do not credit recovery actions to restore functions, systems, or components unless an explicit basis accounting for tornado impacts on the site and the SSCs of concern is provided.		6.4	The TMRE process was followed as described. Recovery actions to restore functions, systems, or components were not credited.
QU-C	Model quantification shall determine that all identified dependencies are addressed appropriately.			

Table J.9: SRs with Unique TMRE Considerations

TMRE - ASME PRA Standard Supporting Requirements Requiring Self-Assessment		NRC Comments (No comments if blank)	NEI 17-02 Section Addressing SR	Additional GGNS TMRE comments
QU-C1	Identify new operator action dependencies created as a result of the changes to the internal events PRA model or failures associated with tornado events.		6.4	The TMRE process was followed as described. No new operator actions or combinations were created or credited.
QU-D	The quantification results shall be reviewed, and significant contributors to CDF (and LERF), such as initiating events, accident sequences, and basic events (equipment unavailabilities and human failure events), shall be identified. The results shall be traceable to the inputs and assumptions made in the PRA.			
QU-D5	Review nonsignificant cutset or sequences to determine the sequences are valid		7.3	The TMRE process was followed as described. Cutsets were reviewed including significant and non-significant cutsets to ensure the sequences are valid.

Table J.9: SRs with Unique TMRE Considerations

TMRE - ASME PRA Standard Supporting Requirements Requiring Self-Assessment		NRC Comments (No comments if blank)	NEI 17-02 Section Addressing SR	Additional GGNS TMRE comments
QU-D7	Review BE importance to make sure they make logical sense.		7.3	The TMRE process was followed as described. BE importances were reviewed to ensure they make logical sense.
QU-E	Uncertainties in the PRA results shall be characterized. Sources of model uncertainty and related assumptions shall be identified, and their potential impact on the results understood.			
QU-E1	Identify sources of uncertainty related to MIP and missiles		7.1, Also see Appendices A and B for bases.	The TMRE process was followed as described.
QU-E2	Identify assumptions made that are different than those in the internal events model		Section 6	The TMRE process was followed as described. Assumptions are listed in section 3.
QU-E4	Identify how the model uncertainty is affected by assumptions related to MIP and missiles		7.1, Appendix A	The TMRE process was followed as described. Assumptions related to MIP and missiles unique to GGNS are described in section 3.
LE-C	The accident progression analysis shall include identification of those sequences that would result in a large early release.		7.1, 7.3	The TMRE process was followed as described. No additional comments.

Table J.9: SRs with Unique TMRE Considerations

TMRE - ASME PRA Standard Supporting Requirements Requiring Self-Assessment		NRC Comments (No comments if blank)	NEI 17-02 Section Addressing SR	Additional GGNS TMRE comments
LE-C3	Do not credit recovery of offsite power. Do not credit recovery actions to restore functions, systems, or components unless an explicit basis accounting for tornado impacts on the site and the SSCs of concern is provided.	Same comment as AS-A10	6.3, 7.2.3, Appendix A	The TMRE process was followed as described. No additional comments.

Table J.9: SRs with Unique TMRE Considerations

TMRE - ASME PRA Standard Supporting Requirements Requiring Self-Assessment		NRC Comments (No comments if blank)	NEI 17-02 Section Addressing SR	Additional GGNS TMRE comments
Multiple SRs		Changes made for application of the PRA to tornado missile impact risk determination such as those to initiating event analysis, accident sequences, systems analysis, human reliability analysis, and parameter estimation should be documented, as described in Various documentation SRs for each HLR. The documentation should be sufficient to understand basis and facilitate review. Examples of such SRs include IE-D1 through IE-D3, SY-C1 through SY-C3, and DA-E1 through DA-E3. It is recognized that the documentation of changes to the PRA and their basis will be captured in the template of the license amendment request.	Section 8	The TMRE process was followed as described. No additional comments.

Table J.10 Peer Review Findings

F&O Number	Supporting Requirement	Description of F&O	Resolution of F&O
2-1 (F)	IE-C15	The mean values provided in the IE Notebook were not used in the quantification of the PRA results. The values from Table 9 in the IE Notebook were not correctly used in the CAFTA model. (This F&O originated from SR IE-C15)	The Initiating Events notebook was updated to ensure that it specified which column of values should be used in the CAFTA rr file, and the rr file used for quantification was updated to ensure it contains the values from the column entitled "Frequency Mean (/rx- yr)".
3-1 (F)	IE-C12 IE-C4	(This F&O originated from SR IE-C12) Table 6 of the initiating events report shows data used for Bayesian updating of plant specific initiating events. In some cases it appears that the plant experience would imply a substantially higher frequency than the prior data. For example for %T2 the prior is 1.12E-2 /yr whereas the plant specific experience is ~0.3/yr. Also for %TSTT1 the prior is 8.80E-3 /yr whereas the plant experience is ~0.13/yr. These differences are large enough that the prior may not be appropriate for Bayesian updating. Some explanation of this difference is warranted especially with regard to the Bayesian process. Also since the experience timeframe covers a period of much earlier GGNS operation, it is possible that more recent data is better because of plant fixes.	Based on a review of Reference 43, and Table 9 – there is a typo in the Prior Frequency Mean value and corresponding spreadsheet in Appendix D. The value should be 1.12E-1 instead of 1.12E-2 – values have been updated in Table 6 of Reference 3, Appendix spreadsheet, and rr file. The concern associated with %TSTT1 was a mis-application of the boundary conditions associated with the transformer ST11. The initial analysis incorrectly included the Loss of Switchyard Power Lines in both the LOOP and the %TSTT1 IE frequencies, and should have only included them in the LOOP frequency. The underlying methodology was not changed, but the classification of the events was corrected to only have them impact the LOOP event. The initial methodology used initiating event fault trees to model support system initiators, and the fault trees associated with ST11 and ST12 were revised to address this concern. The revision to the initiating event boundary conditions has reduced the frequency to being comparable to the generic estimate. The current value is 9.19E-3/yr (Table 9 of Reference 3).

F&O Number	Supporting Requirement	Description of F&O	Resolution of F&O
3-2 (F)	IE-C15 IE-C2	(This F&O originated from SR IE-C15) Table 9 of the Initiating Events Notebook includes a summary of the Initiating Events Frequencies derived from the updated IE analysis. The Frequency per reactor year (the fourth column from the left) shows the final updated number that should be used for quantification. However, the IE frequencies used for quantification have come from other columns that do not represent the most recent data.	The Initiating Events notebook was updated to ensure that it specified which column of values should be used in the CAFTA rr file, and the rr file used for quantification was updated to ensure it contains the values from the column entitled "Frequency Mean (/rx- yr)".
5-4 (F)	AS-B7 SC-A5	DC battery life is presented as 4 hours in the SC notebook, but the Div II battery was credited to 10 hours per the LOSP notebook. The documentation is not consistent, and it is not clear if an operator action for load shedding is required	A review of the LOSP analysis shows that the lifetimes calculated in App G do NOT credit load shedding - but are based on the actual battery design instead of assuming the minimum 4 hour lifetime. However, as stated in Assumption 7, Batteries 1A3 and 1B3 are designed (and assumed by the model) to supply power to required dc loads for four hours after the loss of both battery chargers. Although the actual depletion times of the 1A3 and 1B3 batteries are considerably longer than the designed depletion time of four hours, as shown in Appendix G, no credit is currently taken for these longer lifetimes. This is consistent with the DC Power notebook and the Mathcad calculations for offsite power recovery. The purpose of MAAP run RSCCALMAP-2014-0705 is to determine the timing of loss of RCIC post-SBO regardless of whether suction is taken from the CST or SP. The run indicates that RCIC would be lost within 5.78 hours due to inadequate RPV pressure to support the RCIC turbine caused by procedural depressurization. So this is the limiting factor rather than the battery depletion time

F&O Number	Supporting Requirement	Description of F&O	Resolution of F&O
			if the 10 hours were to be used. This limitation may change if suction from the Upper Containment Pool is credited in the EOP network of procedures n the future. No change to RCIC, DC Power or Accident Sequence notebooks were required. These were documentation changes only, and do not impact quantification or other notebooks.
5-6 (F)	AS-B7	AC power recoveries are developed on a cutset level to account for timing in the LOSP notebook (report PSA-GGNS-01-IE-01). Spot checks of the Qrecover file compared to the notebook identified the following errors/inconsistencies: ZHE-OSP-DSG0-NW - utilized the "averaged" recovery value of 6.56E-1 ZHE-OSP-DLG0-NW - was entered into the Qrecover file with a probability of 1.22E-2 instead of 1.22E-1. Approximately 10 other events were spot checked and found to be entered properly. Additionally, the normal weather offsite power recovery data were applied to all the LOSP initiating events. The weighted average of the offsite power recovery probabilities did not include the severe weather portion in the weighting. This makes the application of the non-recovery probabilities non-conservative	The single typo documented in the review located in the recovery factors was corrected. Note that even the review found no additional differences. The loss of offsite power recoveries were updated to the "normal" recovery rate which includes weather related events. The timing for long term scenarios was addressed by the documented sensitivity study in the peer reviewed quantification notebook (RSC 14-15/PSA-GGNS-01- QU, Rev. 0) and has been included in the base model.
5-7 (F)	AS-A7	The very small LOCA (%S3) was identified as an initiating event in the IE analysis. In Table 1 of the AS notebook, it was listed as being treated as a transient. However, no basis is given, and the %S3 initiating event is not included in the CAFTA model.	The %S3 has been added to the list of transient events since it can be mitigated by the same equipment as a transient initiating event. For ease of review, the %S3 Initiating Event has been separated from the %T3A initiator and included in the model in the same locations as the other transient initiating events that are not "grouped"

F&O Number	Supporting Requirement	Description of F&O	Resolution of F&O
			under the general transient initiator. This is a modeling convention choice, but the underlying methodology associated with identifying and grouping initiating events is not changed.
5-8 (F)	AS-B1	The small and medium LOCA ATWS scenarios do not appear to have considered the LOCA effects on system success criteria, such as SLC. Large LOCA ATWSs have not been addressed with either a valid qualitative argument or a quantitative evaluation. A success criteria basis could not be found for using RCIC to depressurize to allow SDC in transients or ATWS. In transient sequences with success of depressurization, SDC is credited to prevent core damage, which disagrees with the MAAP calculation RSC-CALMAP- 2014-1202, which shows this sequence as core damage.	The LOCA would not impact the RPS (Mechanical or Electrical) system, the ability to manually scram, the ability to perform alternate rod insertion, or the ability to trip the recirculation pumps. Therefore, the only system in question is SLC. Based on SDC-C41 - the system design criteria for SLC - In accordance with GDC 4, structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents. Therefore, SLC is designed to operate following a LOCA. Conservatively, SLC is not credited for medium LOCA cases. As stated in Section 4.7 of this notebook, "Due to the circumstances involved with SBO and LLOCA sequences with a failure to scram, core damage occurs." Therefore, LLOCA ATWS scenarios are modeled as resulting in core damage in the GGNS PRA. RCIC is not credited as a method of depressurization in the transient or ATWS accident sequences. Decay heat removal options with successful RCIC injection are limited to W1 (RHR in Suppression Pool Cooling Mode) and W3 (RHR in Containment Spray Mode). Decay heat removal via W2 (RHR in Shutdown Cooling Mode) is not credited as a viable option when RCIC is injecting

F&O Number	Supporting Requirement	Description of F&O	Resolution of F&O
			for inventory control. RSC-CALMAP-2016-0601 assesses a transient with depressurization in which LPCI and SPC alternate based on RPV level. The assessment indicates that the plant is in a safe stable state after 24 hours with no core damage occurring. The run can also apply to SDC since it has a similar flow rate to SPC and uses the same heat exchangers. Therefore depressurization/SDC can be credited.
5-9 (F)	SC-B1 SC-B2	GGNS assumes that suppression pool makeup is required in combination with containment venting in order to avoid cavitation of ECCS pump suction in containment heat-up sequences. The assumption that venting fails the ECCS pumps is conservative, which is noted in Topic 7 of Table 11 of the QU notebook. Regarding SPMU successfully facilitating pump operation, there is no analytical basis for this success criteria, but instead is based upon the expert judgment of the modeler. While this may be a reasonable assumption, it would be better to have an analytical basis or at least carry this item as an additional source of modeling uncertainty. Since these assumptions are a significant driver to the CDF and LERF, consideration should be given to attempt to refine the assumption. At a minimum, sensitivity analyses should be performed to ensure the impact of these SC assumptions are fully understood for risk characterization.	RSC-CALMAP-2014-1103 [64] indicates that SP level is just slightly above 15 ft after 24 hours following a transient with ED and failure of containment heat removal. Boiloff occurs following containment venting or failure. Based on the SP level plot associated with the MAAP analysis, SP level would decrease to the SPMU limit of 14.5 ft about 1-2 hours after the mission time. This would be close enough to require SPMU; however, this analysis assumes that no injection from the CST or other external source occurs. As long as an external source is available, the SP level will not reach the SPMU limit until well beyond the 24 hour PRA mission time. Therefore SPMU is determined not to be required for any additional initiators other than the previously required MLOCA and LLOCA. The ECCS pumps can pump saturated water as long as SP level remains above 14.5 ft (the level below which the suction lines become uncovered). This limit will not be reached if an external source such as the CST is available to provide suction for the ECCS pumps. However, per Reference 28, "The HPCS pump may not be able to move fluid at times during the event due to a combination of flashing of the SP water, steam entrapment,

F&O Number	Supporting Requirement	Description of F&O	Resolution of F&O
			cavitation, or a pump trip when containment fails." Boiling and voiding could create conditions leading to a pump trip which would require a restart but failure of the pump would not occur. However, injection of CST volume will increase level in the SP and the potential for trip is eliminated in the majority of cases. The use of HPCS after containment failure is now addressed in Event U1LT, discussed in Section 3.2.8.
4-10 (F)	HR-H3 HR-G7	The independent evaluation of HFEs did not include any delay time to the cue. This carried forward into the dependency analysis where all HFEs were evaluated to have the same delay time of zero. This paired events that should be separated in the accident sequence by hours together resulting in dependent combinations that should not exist or have a lower dependency. With all of the actions having the same delay time, complete dependence was calculated resulting in much higher dependent failure probabilities than actually exist. The HRA calculator software has overrides available to offset delay times or reduce dependence, but these were not used. There also does not appear to be any evaluation of intervening successes which would remove the dependence between actions.	Time delays have been added into the HRA calculator, and the dependency analysis has been redone using the new information, including the consideration of intervening dependencies. Although the delay times were not included in the HRA calculator, and the default dependency was complete dependence, as part of the dependency review, the dominant Operator Action combinations were reviewed for separation of events and for intervening success. When long times between actions or intervening successes were identified, the default dependency was changed in the HRA calculator software. Although this was not done for ALL combinations, this methodology was used in the analysis for the dominant combinations. The inclusion of the delay times reduced the number of instances where the dependency override was required, but did not change the actual methodology.
4-4 (F)	HR-F1	There are multiple HFEs for performing the same action, only on a different piece of equipment. For example, there are three different HFEs for failing to start standby air compressors. If an operator fails to start a compressor, they likely fail to start any compressor, not just one in particular. There should be	A review of the HRAs in the GGNS MOR was performed to identify those that for performing the same action, only on a different piece of equipment within the same system. These individual HFEs have been replaced with a common HFE for the action.

F&O Number	Supporting Requirement	Description of F&O	Resolution of F&O
		only one failure for the operator to start a compressor that fails the action for all air compressors. Otherwise there are failed and unfailed actions in the model to start the compressor.	The methodology used for the calculation of the HEP values are not impacted by this change. The "combined" HEP has the same value that the individual HEPs originally had, but instead of assigning a dependency of 1.0 during the dependency analysis, this applies the 1.0 dependency as part of the initial analysis. The first operator action listed in the table below are the new operator actions that replaced the other operator actions listed below them in the table. These changes were made in the Rev 4a MOR, but the system notebooks still need to be revised to reflect these changes. Operator Action Prob Description P43-XHE-FO-TBCWABC 1.36E-05 HUMAN ERROR FAIL TO OPERATE EITHER TBCW TRAIN A, B OR C P43-XHE-FO-TBCWA 1.36E-05 HUMAN ERROR FAIL TO OPERATE TBCW TRAIN A P43-XHE-FO-TBCWB 1.36E-05 HUMAN ERROR FAIL TO OPERATE TBCW TRAIN B P43-XHE-FO-TBCWC 1.36E-05 HUMAN ERROR FAIL TO OPERATE TBCW TRAIN C P51-XHE-FO-C001ABC 5.54E-04 OPERATOR FAILS TO START EITHER C001A, B OR C WHEN IT IS IN SHUTDOWN MODE.

F&O Number	Supporting Requirement	Description of F&O	Resolution of F&O
			P51-XHE-FO-C001A 5.54E-04 OPERATOR FAILS TO START C001A WHEN IT IS IN SHUTDOWN MODE. P51-XHE-FO-C001B 5.54E-04 OPERATOR FAILS TO START C001B WHEN IT IS IN SHUTDOWN MODE. P51-XHE-FO-C001C 5.54E-04 OPERATOR FAILS TO START C001C WHEN IT IS IN SHUTDOWN MODE. P64-XHE-FO-F10ABL 3.96E-03 OPERATOR FAILS TO OPEN MOV FA10A OR FA10B LOCALLY FOLLOWING A LOSS OF POWER P64-XHE-FO-F10AL 3.96E-03 OPERATOR FAILS TO OPEN MOV FA10A LOCALLY FOLLOWING A LOSS OF POWER P64-XHE-FO-F10BL 3.96E-03 OPERATOR FAILS TO OPEN MOV FA10B LOCALLY FOLLOWING A LOSS OF POWER P75-XHE-FO-DG112 2.67E-03 FAILURE TO MANUALLY START DIVISION I OR DIVISION II DIESEL GENERATOR P75-XHE-FO-DG11 2.67E-03 FAILURE TO MANUALLY START DIVISION I DIESEL GENERATOR P75-XHE-FO-DG12 2.67E-03 FAILURE TO MANUALLY START DIVISION II DIESEL GENERATOR X77-XHE-FO-C001AB2 1.36E-05 FAILURE TO TRANSFER DIV 1, 2 OR 3 DIESEL OUTSIDE AIR FAN TO HIGH SPEED

F&O Number	Supporting Requirement	Description of F&O	Resolution of F&O
			X77-XHE-FO-C001A 2.72E-03 FAILURE TO TRANSFER DIV 1 DIESEL OUTSIDE AIR FAN TO HIGH SPEED X77-XHE-FO-C001B 2.72E-03 FAILURE TO TRANSFER DIV 2 DIESEL OUTSIDE AIR FAN TO HIGH SPEED X77-XHE-FO-C002 1.36E-05 FAILURE TO TRANSFER DIV 3 DIESEL OUTSIDE AIR FAN TO HIGH SPEED Y47-XHE-FO-1C01AB2 7.84E-04 Failure to Manually Start 1Y47-C001A, B or 2Y47-C001A Fan after Auto-Start Failure Y47-XHE-FO-1C01A 7.84E-04 Failure to Manually Start 1Y47-C001A Fan after Auto-Start Failure Y47-XHE-FO-1C01B 7.84E-04 FAILURE TO MANUALLY START 1Y47- C001B FAN AFTER AUTO-START FAILURE Y47-XHE-FO-2C01A 7.84E-04 Failure to Manually Start 2Y47-C001A Fan after Auto-Start Failure
4-5 (F)	HR-F2 HR-H2	The timing of cues is not explicitly documented in the HRA calculator. The time delay to the cue is set to zero in every instance. The time delay is an important step because it can limit the amount of time in the scenario to recover from the action. The only timing listed in the time window is the median response and execution time. Operator recovery is based on the remaining time available, but without the time delay to the cue included, more time is allowed to recover than is actually available.	Time delays have been added into the HRA calculator, and the dependency analysis has been redone using the new information, including the consideration of intervening dependencies. The HRA calculator is used for the calculation of the HFE values. Inclusion of the timing of cues does not impact the HFE calculated, but could impact the "order" of the HFEs in the dependency analysis. The methodology used for the dependency analysis is not changed by including

F&O Number	Supporting Requirement	Description of F&O	Resolution of F&O
			the timing of cues, but the inclusion of the cues helps to reduce the level of review required during the dependency analysis.
4-6 (F)	HR-F2 HR-G4	Scenario timeframes are included in the evaluation of the HFE. However, there are no references to where the scenario timeframes are calculated. There was some indication that MAAP had been used in the past to develop the scenarios, but nothing could be found to support the times used. Following plant uprate a scaling evaluation of the increased power was performed to revise the scenario times. Additional MAAP cases were performed following the uprate, but these have not been incorporated into the HFE analysis.	Scenario time frames were looked at and addressed by adding in the delay times for the cues, and adding in timing notes into the HRA calculator files to show where the timing comes from. Although the basis for some of the timeframes was not originally included in the HRA calculator, the timeframes were based on expected plant response times determined from operator interviews or supporting MAAP analyses. Therefore, the methodology used by the HRA calculator to calculate the HFEs was not impacted, but the justification (documentation) for the selected time frames was desired to help verify the appropriate time frames were used.
4-7 (F)	HR-G2	All operator actions include an estimation of the failure in cognition. However, a number of operator actions had the execution failure probability set to zero stating that the action is memorized and practiced routinely. These actions are in the first few minutes following an initiating event and based on the time available may have high HEPs.	The updated HRA evaluation no longer sets the execution probability to zero and instead is based on the maximum combined value for CBDTH/HCR approach. Most of the HRA events include execution actions. For the events where no execution actions were previously included, the execution actions were added using the same methods as for all other operator actions. Underlying methodology was not impacted by adding additional detail into some of the HFE evaluations.
4-12 (F)	DA-B2	One outlier was identified when grouping equipment for the battery chargers. Battery charger 1C5 is always in standby as a backup to battery charger 1C4. In the model 1C5 is set to standby with a probability of	Determined the correct grouping for this battery charger, the exposure time for this outlier was removed from consideration for the BCC LP type code. The type code was updated in sections 5.2

F&O Number	Supporting Requirement	Description of F&O	Resolution of F&O
		1. It is grouped with the rest of the battery chargers that are normally in operation. Its failure probability is calculated the same as the other battery chargers.	and 5.3.
4-13 (F)	DA-C3	A number of component types were excluded from the evaluation including motor operated valves, air operated valves, and temperature switches in PSA-GGNS-01-DA-01. These component types were not reviewed for plant specific failures to determine if bayesian updating of the generic failure data should be performed. (This F&O originated from SR DA-C3)	Additional plant-specific data was obtained for various valves and air compressors which were previously not included in the PRA. The new data includes number and type of failures, demand data, and exposure data per component and type code, and this data was analyzed consistent with the established data notebook methodology. The new data was compiled into the spreadsheets in References 21 and 23, and all changes and additions were incorporated into the plant-specific data collection in section 5.2, the Bayesian update performed in section 5.3, and the final plant specific database in section 5.4 of the Data notebook. The same methodology for Bayesian updating was used for the new component types evaluated. No new methodology was employed.
4-14 (F)	DA-C3	The failures removed from consideration do not have adequate justification for disregarding previous plant failures. Many failures were removed in previous model revisions, but there is no documentation as to why the failures were no longer applicable. (This F&O originated from SR DA-C3)	The bases for failure inclusion and exclusion are established in section 5.2 of Reference 7, where it is stated that all failures included in the PRA must have occurred during the PRA time frame (September 1, 2006 through August 31, 2012) and must meet the definition of a PRA functional failure. Failures outside the time frame of interest were discarded.
4-15 (F)	DA-C13	One discrepancy was identified for battery charger unavailability. In the notebook unavailability was calculated for the L51 battery chargers based on past history. However, the reliability database had zero unavailability for each of the battery chargers.	The unavailability data for the chargers and for several other identified components were reviewed and updated in the database to ensure they were consistent with actual plant operating history as documented in the data notebook. This is the same methodology that was employed for determining unavailability's of other components modeled in the

F&O Number	Supporting Requirement	Description of F&O	Resolution of F&O
			PRA. No new methodology was employed. The model unavailabilities for 125V DC battery chargers were updated consistent with the MCR GG- 4962 response documented in section 7.1 of the Data notebook. All unavailability distributions were reviewed for similar concerns, and the following were impacted: DC power components (resolved by MCR GG-4962), radial well pumps and air compressors (resolved by MCR GG-4904), and AC circuit breakers and switchyards (resolved by MCR GG-4908).
4-17 (F)	DA-C14	Coincident unavailability was identified to occur in the data analysis timeframe (PSA-GGNS-01-DA-01). This unavailability is not included in the model so is therefore not included in the final results. (This F&O originated from SR DA-C14)	After thoroughly examining previous analyses and the current system notebooks, it was determined that the previously identified coincident unavailabilities did not meet the criteria for inclusion. Upstream or downstream unavailability is accounted for in the model and did not meet the standard for coincident unavailability. It was determined that no more than one safety related system was scheduled to be in maintenance at any given time. The data notebook has been updated to provide this rationale.
4-19 (F)	DA-E1	There are numerous conflicts between the two data analysis notebooks and the two common cause notebooks. This is likely due to a two year gap between publishing of the notebooks. Information is not consistent between notebooks and even within the same notebook. The final data rollup notebook appears to be accurate, but its information is based off the plant specific notebook which has information that is out of date, not used, and results in contradictory information to the data development notebook. The same is true of the common cause	Conflicts between notebooks were resolved by aggregation of all data from both notebooks and both CCF calculations into a single data notebook. The Excel spreadsheets that previously evaluated the data (References 21-17 of the previous Data Notebook) have been incorporated directly into the current Data notebook, and the basis for the formulae used in the spreadsheets has also been added into the methodology section. The combination of notebooks and calculations impacts all of subsection 5.0 and is responsible for the addition of section 6.0 to the data notebook.

F&O Number	Supporting Requirement	Description of F&O	Resolution of F&O
		notebooks. Much of the plant specific data (run and demand estimates, maintenance unavailability data) was not found in the notebooks, but in spreadsheets provided separately. This information should be included in the notebook for ease in identification (This F&O originated from SR DA-E1)	
1-3 (F)	QU-D4	This was not addressed as a comparison of results to similar plants was not conducted.	A comparison to the three other BWR-6 plants has been included in the Rev 4a Summary Report.
1-6 (F)	QU-F2	The documentation does not describe significant accident sequences in sufficient detail. A sensitivity study on LOOP recovery may be appropriate as the base case (Table 15). The key sequences use a battery lifetime of 4 hours. Appears division II battery lifetime is 10 hours. (This F&O originated from SR QU-F2)	A detailed discussion of the significant accident sequences for both CDF and LERF has been added into the Integration and Quantification notebook for the internal events model. See Section 6 of PSA- GGNS-01-QU Rev 1a for details. Similarly, a detailed discussion of the significant accident sequences for both CDF and LERF has been added into the Internal Flood Analysis for the flood scenarios. See Section 14 of PSA-GGNS-01-IF Rev 2 for details. During the Peer Review, a sensitivity study on the LOOP initiators was performed, and based on the sensitivity study, the Recovery Rule files were changed from using the normal weather recovery probabilities to using the average weather recovery probabilities. A review of the LOSP analysis shows that the lifetimes calculated in App G do NOT credit load shedding - but are based on the actual battery design instead of assuming the minimum 4 hour lifetime. However, as stated in Assumption 7, Batteries 1A3 and 1B3 are designed (and assumed by the model) to supply power to required dc loads for four hours after the loss of both battery chargers.

F&O Number	Supporting Requirement	Description of F&O	Resolution of F&O
			Although the actual depletion times of the 1A3 and 1B3 batteries are considerably longer than the designed depletion time of four hours, as shown in Appendix G, no credit is currently taken for these longer lifetimes. This is consistent with the DC Power notebook and the Mathcad calculations for offsite power recovery.
1-7 (F)	QU-F6	A quantitative definition of significant is not provided. (This F&O originated from SR QU-F6)	The quantitative definition of " significant" has been included in the GGNS PRA Rev 4 and Rev 4A Summary Reports, and in the GGNS PRA Rev 4A Uncertainty and Sensitivity report.. These reports also identify the risk significant accident sequences based on this definition. Although the specific definition of Significant was not provided in the documentation previously, the evaluation of the results was performed against the definition of significant as provided in the Standard. This was a documentation only issue that does not impact methodologies used in the analysis.
1-8 (F)	QU-A2	RSC 14-15 provides results. Fault tree linking is used. Significant is not defined but sequences are rank ordered and provide a high percentage of the CDF results. (This F&O originated from SR QU-A2)	The quantitative definition of " significant" has been included in the GGNS PRA Rev 4 and Rev 4A Summary Reports, and in the GGNS PRA Rev 4A Uncertainty and Sensitivity report.. These reports also identify the risk significant accident sequences based on this definition. Although the specific definition of Significant was not provided in the documentation previously, the evaluation of the results was performed against the definition of significant as provided in the Standard. This was a documentation only issue that does not impact methodologies used in the analysis.
1-12 (F)	LE-E4	The LERF is quantified using the same general process as the CDF, and is documented in the QU notebook. The review of the LE quantification against the	The updated quantification of the Internal Events PRA and the Internal Flood PRA both now show convergence for both the pre-recovery and the

F&O Number	Supporting Requirement	Description of F&O	Resolution of F&O
		requirements of Tables 2-2.7-2(a), (b) and (c) is essentially identical to the CDF reviews documented under the QU High Level Requirement. Direct linking of the Level 1 sequences with the CET provides assurance that all system dependencies are captured, etc. A LERF truncation sensitivity was performed, but does not meet the criterion identified in the QU notebook. However, the truncation was as low as could be achieved, and the lack of convergence does not significantly affect the results. Also when uncertainty is considered LERF mean value is calculated to exceed mean CDF value. This is not possible.	post- recovery cases. Although convergence was not previously obtained, this was due to a computer memory and software limitation. If the software and computer memory issues did not exist, convergence would have been obtained for the prior model. A review of the LERF model identified an error where a gate that was supposed to be an AND gate was inadvertently modeled as an OR gate. Additionally, the LERF model reviewed by the Peer Review Team double counted early and late hydrogen events in many of the cut sets which resulted in overestimation of LERF. With these modeling issues corrected, convergence was obtained, and the LERF was calculated to be ~10X lower than CDF – as should be expected. This was a modeling issue, but not a methodology issue. The same methodology for quantification was employed.
5-10 (F)	LE-A2	The characteristics identified as important in A1 are documented in Section 1 of the LE notebook (PSA-GGNS-01-LE). However, the LE notebook does not provide any bases for the binning of sequences (e.g., determination of which sequences are high pressure and which are low). Per the Grand Gulf PRA team, selection was based on information from MAAP gathered from both success criteria and LERF-specific assessments and the engineer's experience working on other BWR 6 designs. This SR is considered met because the binning appears reasonable in most cases, but documentation of more definitive bases is needed. Some examples of sequences for which the high/low pressure binning are	Added wording to Section 1.2.2 to clearly define the high to low pressure transition at 200 psig. Also clarified that only the pressure at the time of RPV failure is relevant for this binning criterion. This changes the binning of SLOCA sequences with successful depressurization prior to RPV failure to low pressure. The methodology used for binning was not well described in the analysis, but the methodology itself was determined to be appropriate. However, additional level of detail was desired to explain binning criteria that was not readily obvious.

F&O Number	Supporting Requirement	Description of F&O	Resolution of F&O
		not obvious are: P-009 (SORV, RCIC initially successful, but LPI fails and RX depressurization not questioned) is "Low" pressure, and all Small LOCAs (even with depressurization successful) are binned as high pressure.	
5-12 (F)	LE-C10 LE-C12 LE-F2 LE-C3 LE-G3 LE-G6	There is no quantitative definition of significant accident progression sequences. There are SRs that require documenting the quantitative definition, as well as review of the significant severe accident progression sequences for possible credit for repairs and engineering analyses to provide a more realistic analysis. An example of the lack of reviews for excess conservatism is that the operator action for turning on the H2 igniters was set to 1.0 in the analysis, yet is very significant to the results.	Accident sequences are quantitatively assessed in the new MAAP analysis notebook [RSC 16-02, Rev 1]. Although not included in the documentation, the ASME Standard definition of Significant accident progression sequences was used in the analysis. The results were reviewed for excess conservatism, and the single operator action identified in the Finding was determined to be the only significant conservatism that should be refined. This HFE has been evaluated using the same HRA methodology used for the other HFEs included in the model. Updates to the igniter operator actions are added to the LERF basic events table (Table 11) and they are discussed in the updated HRA notebook . The correct HEPs are introduced into the model during the recovery rules process.
5-13 (F)	LE-C1 LE-C2	The approach to the LE analysis was the NUREG/CR-6595 analysis, with a more detailed evaluation of the loss of DHR sequences. Since the Level 1 and LE results are dominated by loss of DHR, this SR was evaluated as met to Category II. However, the following items are also noted from the peer review: - The Level 1 SR review identified many items that will change the CDF risk results (incorrect IE frequencies utilized, incorrect offsite power recoveries applied, etc.).	As stated in the finding, the methodology used is correct and applicable, but the results were impacted by corrections to technical inconsistencies/errors in the Level 1 PRA model, and the calculation of an HEP value for Operators turning on the igniters (removing the excess conservatism introduced by having this operator action set to a probability of 1.0). No methodology changes were required (NUREG/CR- 6595

F&O Number	Supporting Requirement	Description of F&O	Resolution of F&O
			methodology is the still being used), but updated insights were obtained, and the LERF notebook was revised to reflect the new insights. A new "Basis for Value" column was also added to the LERF basic events table (Table 11 of LERF notebook) to explain the bases for the values used.
5-14 (F)	LE-E1 LE-C2 LE-C4 LE-C7	No credit is given to operator actions in the LE analysis. There is no documentation of a review of Grand Gulf procedures for severe accident responses by operations. There is a HEP identified for turning on hydrogen igniters, but it is set to 1.0 in the model.	The LERF notebook was updated to include the following discussion on Procedure Reviews: As part of the LERF sequence model development, a review of the EOPs, AOPs, and SOPs was performed to identify the operator actions that would be employed to respond to the LERF sequence in progress. As part of this review, the systems that could be used by the operators to respond to the scenario were also identified. For the systems that were identified that were not credited in the CDF model, new system logic was developed, including the operator actions associated with the use of the system. For the systems that could be used to respond to the LERF scenario that were also used in the CDF model, the system analyst ensured that the operator actions required to respond to the LERF scenario were included in the system model. Once all the LERF related operator actions were identified, they were evaluated as part of the Human Reliability Analysis [15]. Updates to the igniter HEPs are performed in the HRA notebook [15] and the values are added to Table 9 of this notebook
5-16 (F)	LE-D3	Per the containment capacity report (GGNS 92-0034), the failure location with the lowest mean pressure is the basemat (65 psid). The containment failure location	Although the CDF accident progression sequences do consider the potential that the location of the containment failures could impact the survivability

F&O Number	Supporting Requirement	Description of F&O	Resolution of F&O
		was not considered in the LE analysis (all overpressurization was considered a large release, after the 0.5 scrubbing credit for the Auxiliary Building).Since basemat failures could potentially result in underground releases to allow significant scrubbing, the approach taken is conservative. It is noted that other containment failure locations have mean failure pressures that are not much higher than the basemat failures, but some credit could be given to reduce the LERF.	of the HPCS pump based on the MAAP runs performed in response to GG-5471 (Finding 5-9), the LERF analysis does not credit any fission product scrubbing based on Containment Failure location. Additional GOTHIC room heatup analyses were also run to evaluate the environment that would be present in the HPCS and LPCS rooms following a Containment failure at a location other than at the base mat. The specific locations reviewed were based on the same design basis Containment performance calculation used to identify the base mat as the weakest point. Since no approved methodology for crediting scrubbing due to Containment failure location currently exists, no credit has been taken in the GGNS PRA LERF model.
5-18 (F)	LE-C1 LE-E3	The GG LE analysis does not provide a quantitative definition of 'Large' releases, and does not document the evaluation of sequences as resulting in a 'Early' release. Discussions with the GG PRA team identified that the 'Early' evaluations were based on comparison of MAAP-predicted containment failure time for the dominant sequence (loss of DHR) with the time of declaration of a general emergency. This is acceptable, but the evaluation needs to be documented. The evaluation of 'Large' was qualitative, but appears reasonable (e.g., ISLOCA, Containment isolation, Containment rupture), but needs to be documented, and the bases should be tied to a quantitative definition of 'Large.'	A specific definition of Large and Early were used in the analysis, but these definitions were not documented. Documentation of these definitions was a documentation enhancement, but does not result in a change in methodology. The new MAAP analysis notebook [RSC 16-02, Rev 1] defines 'Large' and 'Early' releases and documents the results of the LERF MAAP analyses versus the defined criteria. Section 2.8 of RSC 16-02 defines the criteria and summarizes the MAAP runs that contribute to LERF. The definitions of Early and Large are also discussed in the updated LERF notebook.

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5-20 (F)	LE-F1 LE-F2 LE-G3	The Quantification notebook (PSA-GGNS-QU-01) presents the total LERF, the top 100 LERF cutsets, and some LERF importance analyses. There is no presentation of the relative contribution to LERF from various contributors other than the importance analysis.	The Summary Report the presents the relative contribution to LERF from various contributors, and also provides a discussion of the significant LERF scenarios on a sequence level.
5-22 (F)	LE-G5	Limitations in the analysis have not been identified. The LE analysis should be examined to identify how any simplifying assumptions can impact applications.	The Limitations of the LERF analysis have been added into the LERF documentation.
1-13 (F)	IFPP A-5	Walkdowns are documented in RSC 13-20 Internal Flooding Walkdown Documentation. In general, this information was found to substantiate the flood zone definition discussions in Section 4.0 of RSC 13-37, Revision 0. Flooding scenarios associated with Control Building area 0C125, which contribute to approximately 5% CDF may be overly conservative. Based on discussions with GG PRA consultants, these scenarios were dominant due to the presence of DC equipment in this room, as documented in the GG equipment database. However, this critical equipment is not located in this area. (This F&O originated from SR IFPP-A5)	The DC equipment was inadvertently identified as being in OC125 when it should have been in OC215. This was essentially a typo in the input, but not a methodology impact. The Equipment was mapped to correct location (OC215) in TIFA to support resolution of the concern. Room OC215 has no flood sources, so no new scenarios were introduced by the addition of this equipment. TIFA, FRANX, and the integrated model were updated to reflect this equipment in the new room, and removed from OC125.
7-1 (F)	IFSO B-3 IFSN B-3 IFEV B-3 IFQU B-3	There is no apparent documentation of an uncertainty analysis for any of the following: internal flood plant partitioning; internal flood sources; flood-induced initiating events; accident sequences and quantification	The uncertainty associated with internal flood plant partitioning; internal flood sources; flood- induced initiating events; accident sequences and quantification has been added into Table 1 of the Rev 4 GGNS Uncertainty and Sensitivity Report. Rev 4A moved these into the Internal Flood report. Documentation of the limitations of the analysis does not impact the LERF results or methodology, but provides insights to an analyst when the LERF is required to be used for a risk informed application.

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7-2 (F)	IFSO A-3 IFSN A-13	The EDG building is screened from further analysis based upon a statement in FSAR "pipe cracks are not postulated inside the diesel generator building;"	The report has been updated to provide the following basis that reflects the inability of a flood within the EDG building to result in a reactor trip. A flood in the DG building will not lead directly to a reactor trip since offsite power is not affected. Any administrative need to shutdown would not occur for several hours and the likelihood of mitigation is high. Therefore, DG building flooding events are screened from further consideration. Additionally, since the failure of multiple diesel generators from an internal flood is not feasible, safe shutdown could be achieved using one of the two other diesel generators. On the basis of this assessment, the diesel generator building is excluded from the analysis
7-4 (F)	IFEV A-3	The flood induced initiating event defaults to loss of power conversion system plant initiator (T-2) is conservative (This F&O originated from SR IFEV-A3)	The flood induced initiating events default to loss of power conversion system plant initiator unless the pipe break itself is associated with a system that induces a reactor trip (e.g. PSW, Circ Water, etc.) in which case it is mapped to the initiator associated with the pipe that is impacted. This clarification was not clear within the documentation, but was readily obvious when looking at the mapping done within FRANX. This is not a change in methodology, but is a level of detail in the documentation only. Mapping is now shown in the tables in Appendix E of this report, and a discussion was added to Section 9.1 on the selection of initiating events.
7-5 (F)	IFQU A-1	It is not evident that accident sequences were performed and documented. There is little evidence contained in RSC-CALKNX-2015-0803	The internal flood is integrated with the internal events model, and the internal flood accident sequences are quantified using the same

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			methodology that was used for the internal events model. However, the documentation of this quantification required additional detail and discussion. The Summary Report for Rev 4 contains sequence level quantification and discussions. In Rev 4a, these discussions were moved into the Internal Flood Notebook.
7-6 (BP)	IFSN A-6	SSC damage and susceptibility to flooding effects due to submergence, spray, jet impingement, and HELB have been discussed in Sections 6.0, 7.0, and 8.0 of GGNS Internal Flood Notebook RSC 13-37.	Nothing to resolve since this was considered to be a "Best Practice".
7-7 (F)	IFQU A-1 IFQU A-2 IFQU A-3 IFQU A-4 IFQU A-7 IFQU A-10 IFQU B-1 IFQU B-2	In Table 1, reference to Section 14.0 seems incorrect	Table 1 has been revised to reference the correct sections and/or other reports as necessary.
7-8 (F)	IFQU A-10	Although it is apparent that quantification of the flooding model was performed as documented RSC- CALKNX-2015-0803, it is not evident that the LERF analysis was reviewed and documented.	A review of the Internal Flood LERF analysis was performed and documented. This review included cut set reviews for the IF LERF as documented in Section 14.1, a review and discussion of the significant LERF accident sequences as documented in Section 14.3, a review and discussion of the significant LERF cut sets as documented in Section 14.4.2, and identification of the top LERF basic events, HFEs, Maintenance events, CCF events, and initiating events based on Fussell-Vesely and RAW as documented in Section 14.4.3. As stated in the Finding, the internal flood model was quantified using the same methodology as the

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			internal events model, but documentation of the LERF portion of the internal flood analysis required additional detail.