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GNRO-2012/00072

July 19, 2012

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

SUBJECT: Response to Request for Additional Information (RAI) on Severe Accident Mitigation Alternatives dated May 21, 2012
Grand Gulf Nuclear Station, Unit 1
Docket No. 50-416
License No. NPF-29

REFERENCE: NRC Letter, "Request for Additional Information on Severe Accident Mitigation Alternatives for the Review of the Grand Gulf Nuclear Station, Unit 1, License Renewal Application Environmental Review," dated May 21, 2012 (GNRI-2012/00121) (ML12115A101)

Dear Sir or Madam:

Entergy Operations, Inc is providing, in Attachment 1, the response to the referenced Request for Additional Information (RAI). Attachment 2 includes the Phase I Candidate SAMA Analysis list and Attachment 3 contains Release Mode Frequencies for Analysis Cases requested in RAI's.

This letter contains no new commitments. If you have any questions or require additional information, please contact Christina L. Perino at 601-437-6299.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 19th day of July, 2012.

Sincerely,

MP/jas

Attachment(s): (see next page)

Attachments(s):
1. Response to Request for Additional Information (RAI)
2. Phase I Candidate SAMA Analysis
3. Release Mode Frequencies for Analysis Cases

cc: with Attachment(s)

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Attachment 1 to

GNRO-2012/00072

Response to Requests for Additional Information (RAI)

Request

1. Provide the following information regarding the Probabilistic Risk Assessment (PRA) used for the Severe Accident Mitigation Alternative (SAMA) analysis. References to Section E are to Section E of the Environmental Report (ER).

   a. Section E.1.1 indicates there have been no major plant changes since August 2006 that would have a significant impact on the results of the SAMA analysis. Define "significant" and how this determination was made.

   b. Section E.1.4 provides a summary of the Core Damage Frequency (CDF) and Large Early Release Frequency (LERF) from Grand Gulf Nuclear Station (GGNS) probabilistic safety analysis modeling between 1992–2010. Section E.1.4.2 indicates that the update included plant changes through refueling outage 11, but does not specifically list these changes. Identify the major changes with the greatest influence on the SAMA analysis.

   c. Section E.1.4.3 indicates the last plant data update covers the period through August 2006. Provide assurance that there are no equipment reliability degradation issues since this update that would adversely impact the SAMA analysis.

   d. On page E.1-23, the ER indicates that the ratio of the 95th percentile to the mean is about 2.38. Since point estimates of the CDF and release category frequencies were used rather than mean values, provide the 95th-, 50th-, and 5th-percentile CDF results of the uncertainty analysis as well as the point estimate CDF of the model and truncation used for the uncertainty analysis.

   e. Differences exist within the license renewal application among quantitative results for CDF, release category frequencies, and Risk Reduction Worth (RRW). The total CDF was presented as 2.05E-06 per year, from the sum of contributions by initiator (Table E.1-1) and sum of the release frequencies (Table E.1-8), and 2.92E-06 per year from the sum of the accident classes (Table E.1-7). The applicant's submittal states that the 2.9E-06 value is higher than the others due to non-minimal cutsets, which result from quantifying at the sequence level. Although some difference is expected, the difference of approximately 40% appears to be unusually large for this cause. Further, the sum of the release category frequencies would be expected to be higher since it is also the result of a sequence by sequence quantification. The CDF contribution from various failures implied by RRW values in Table E.1-2 are also significantly different in some cases from those given in Table E.1-1 or Table E.2-2. For example:

      - Table E.1-1 showed the CDF initiated by loss of offsite power (LOSP) as 14% of the total CDF, yet Table E.1-2 indicated a RRW value of 1.6289 for LOSP, which corresponds to a 38.6% contribution.
      - Case 1 was evaluated by eliminating all cutsets for station blackout (SBO), and the CDF is stated to be reduced by 13.6%. Table E.1-1 indicates that SBO contributes to 36.6% of the CDF. Based on the values of RRW, the elimination of basic events "ZSBO" and "ZT1B" cited for Case 1 supports a 36.3% reduction in CDF.
      - Case 22 on improved availability of the diesel generator system through heating, ventilation, and air conditioning (HVAC) improvements was stated to be evaluated by eliminating HVAC failure in diesel generator rooms which results in a 9.2% reduction of CDF. Basic event X77-FF-CFSTARTU, "X77 common cause

start failures," has a RRW of 1.2754, which corresponds to a 21.6% reduction in CDF.

- SAMA Number 63 cited for basic event E51-043-G, "Lube oil cooling line hardware failure," in Table E.1-2 is evaluated by Case 46. The CDF reduction given in Table E.2-2 was 4.7%. The RRW given for this basic event is 1.0839, which corresponds to a CDF reduction of 7.7%.

In light of these differences among results, further support for the validity of the model quantification (i.e., CDF, release category frequencies, and RRW) in the SAMA analysis is needed. Provide reasons for these differences and more details on how the quantification was performed for each situation, including examples related to this request. Describe specific contributions to the approximate 40% difference in CDF, such as some of the non-minimal cutsets or other reasons. Justify use of the lower CDF, rather than the higher CDF, for determining cost risk in the SAMA analysis.

f. Section E.1.4.5 indicates that all of the 'B' priority comments have been addressed except for one documentation item related to the internal flood modeling. If any facts and observations (F&Os) were addressed by internal reviews that concluded that changes to the model were not needed or the F&O was incorrect, identify and discuss these F&Os and confirm their disposition remains applicable to the PRA used for the SAMA analysis.

g. Discuss the process and procedures for assuring technical quality of PRA updates since the peer review.

h. Section E.1.4 includes an unnumbered table of changes in contribution to CDF per initiator group for each model revision, beginning on page E.1-70 titled "Contribution to CDF Changes in PRA Models." The percentage contributions shown for R3 EPU (Revision 3, Extended Power Uprate version of the PRA model) are significantly different from those shown in Table E.1-1. Explain the basis for the unnumbered table in Section E.1.4 and the reasons for the differences from Table E.1-1.

Response 1a

The Probabilistic Risk Assessment (PRA) Maintenance and Update procedure describes the process for maintaining the PRA models current with the as-built and as-operated plants. It describes the model change request (MCR) database used to track plant changes, procedure revisions, nuclear licensing revisions, and model improvements that impact the PRA models. The MCR database has the following four tier grading system to prioritize the change requests.

GRADE	DEFINITION
A	Extremely important and necessary to assure the technical adequacy or quality of the PRA.
B	Important and necessary to address, but may be deferred until the next model update.
C	Considered desirable to maintain maximum flexibility in risk-informed applications and consistency in the industry, but not likely to significantly affect results or conclusions.
D	Editorial or minor technical item.

A plant change with the potential to alter or create a significant contributor to core damage frequency (CDF) or large early release frequency (LERF) would be an important

change and, therefore, would receive a grade 'A' or 'B' designation. So, if a change warranted a grade 'A' or 'B' designation in the MCR database, it may have a significant impact on the results of the SAMA analysis.

The MCRs initiated after August 1, 2006 were reviewed for impact on the SAMA analysis, with particular attention on the grade A and B MCRs.

There was one grade 'A' MCR which was related to the Equipment Out Of Service (EOOS) model. The EOOS model had to be changed to adjust the slider bar used to assess the risk of plant configurations when a low pressure feedwater heater is taken out of service. Since this MCR related only to a temporary condition in the EOOS model, it does not impact the SAMA analysis.

There were twelve grade 'B' MCRs. One of the grade 'B' MCRs was related to the partial update of the fire PRA model which was not used in the SAMA analysis (see response to RAI 3.a). Six of the grade 'B' MCRs were changes to systems that are not risk significant. The impact of the remaining five grade 'B' changes would be a reduction in CDF. Thus, they would not cause basic events to become more important or SAMAs to become more beneficial.

Therefore, there have been no major plant changes since August 2006 that would have a significant impact on the results of the SAMA analysis.

Response 1b

Influential changes made during the GGNS 2002 (R2) model update were as follows.

- Changed modeling to reflect installation of new type of plant service water radial well pumps and support systems.
- Added heating, ventilation and air conditioning systems to the model, including addition of the new standby service water pump-house high temperature alarm.
- Modeled changes to the backup scram valves and logic in the Anticipated Transient Without Scram (ATWS) portion of the fault tree.
- Used more comprehensive human reliability analysis methods.
- Used the convolution method for recovery of loss of offsite power (LOSP).

Influential changes made during the GGNS 2010 (R3) model update were the use of updated plant-specific failure and initiating event data, changes to the LOSP modeling to include consequential losses of offsite power, and use of updated industry data in the LOSP recovery analysis.

Response 1c

The maintenance rule system health reports indicate no unresolved equipment reliability issues that would adversely impact the SAMA analysis. Also, no unresolved plant data issues were identified during the expert panel reviews of the model updates or during the expert panel review of the Level 2 cutsets.

Therefore, there is reasonable assurance that there are no equipment reliability degradation issues since the August 2006 data update that would adversely impact the SAMA analysis.

Response 1d

The uncertainty results were generated using a cutset file with a truncation of 1E-12/Rx-yr and a point estimate of 2.82E-06/Rx-yr. This point estimate is slightly higher than the

baseline because a failure flag event for Reactor Core Isolation Cooling (RCIC) has been subsumed in the baseline cutset file. This is not expected to have a significant impact on the uncertainty analysis. The uncertainty results are as follows.

point estimate	2.82E-06/yr
mean	3.00E-06/yr
5%	9.31E-07/yr
50%	2.19E-06/yr
95%	7.14E-06/yr
standard deviation	5.69E-06/yr

Response 1e

The "lower CDF" utilized for the SAMA analysis is based on the GGNS level 2 model. The "higher CDF" seen in some of the tables is based on the GGNS level 1 model. Since the SAMA analysis requires the release frequencies from the level 2 GGNS model, it would not be feasible to perform a SAMA analysis with only a level 1 model.

The total CDF from the level 2 model utilized for the GGNS SAMA analysis is 2.05E-06 when each of the 13 release categories is solved. This model and quantification method were used for the baseline and individual SAMA analysis cases. The initiator contributions from this model and quantification method are presented in Table E.1-1 and the sum of the release frequencies is presented in Table E.1-8. The SBO and ATWS contributions in Table E.1-1 are exceptions. The Table E.1-1 value for SBO was approximated by multiplying the total CDF obtained by quantifying the level 2 model (2.05E-06 per year) by the percentage contribution to CDF from SBO sequences in the level 1 model. The value for ATWS was obtained in the same manner. These approximations are provided to reflect the relative magnitude of the CDF contribution from SBO and ATWS sequences when compared to the total CDF and to the CDF contributions from other types of sequences.

The values in Table E.1-7 and the RRW correlations in Table E.1-2 were obtained from accident sequence level quantification of the level 1 model at a truncation limit of 1E-12/yr. It is acceptable to provide some information from the level 1 model because the values in Table E.1-7 are illustrative in nature and are not used in the SAMA analysis. Also, the RRW correlations in Table E.1-2 are used to ensure SAMAs have been identified for high-risk contributors, but the exact RRW values are not germane or significant. The note beneath Table E.1-7 is misleading. The total CDF from the level 1 model presented in Table E.1-7 is slightly higher than the single top solution in which non-minimal cutsets are subsumed. ER Table E.1-7 is changed as shown below with strikethrough for deletions and underline for additions.

Note: The total CDF is not the same as the baseline single top solution CDF ~~in Table E.1.1~~ due to non-minimal cutsets created when quantifying at the sequence level.

The results should not be compared directly since one result is from the level 1 model and one is from the level 2 model. The differences in percentage contributions are due to the following.

1. Calculations are approximated in Computer Aided Fault Tree Analysis (CAFTA) using a "min cut upper bound" technique and this approximation

carries uncertainties. When handling split fractions or other large probabilities like those in the level 2 model it can increase or decrease contributions.
2. The level 2 model was quantified using a ONE-TOP quantification (i.e., all accident sequences contributing to each release category are quantified at one time) whereas the level 1 model was quantified using an accident sequence level quantification (i.e., each sequence is quantified individually and resulting cutsets are merged). The accident sequence level quantification can lead to more non-minimal cutsets which may change the percent contributions and affects the overall base "CDF" number.
3. The level 2 LOSP recoveries in the cutsets are different than the level 1 recoveries, which is lowering the percent contribution of an SBO in the level 2 model.

Specific responses to the bullets in the RAI follow.

- Table E.1-1, which lists the percent contributions to the level 2 model, shows an LOSP-initiated contribution of 14%. Table E.1-2, which is the RRW correlations of the level 1 GGNS model, indicates a higher LOSP-initiated contribution. This is due to the fact that the level 2 model has different offsite power recoveries which affect the percentage contribution of the LOSP initiator.
- Case 1 was evaluated by eliminating the SBO cutsets in the level 2 model, while the RRW CDF contributions listed in Table E.1-2 are based on the level 1 model. Also, the Table E.1-1 SBO value is an approximation as described above.
- The RRW of 1.2754 for basic event X77-FF-CFSTARTU, "X77 common cause start failures," is based on the level 1 model. Case 22 on improved availability of the diesel generator system through heating, ventilation, and air conditioning (HVAC) improvements which results in a 9.2% reduction is based on the level 2 model. The GGNS level 1 model and level 2 models are expected to have differences in the risk profile.
- The CDF reduction for case 46 given in Table E.2-2 of 4.7% was based on the level 2 model. The RRW given for basic event E51-043-G, "Lube oil cooling line hardware failure," in Table E.1-2 of 1.0839 is based on the GGNS level 1 model. The GGNS level 1 model and level 2 models are expected to have differences in the risk profile.

Response 1f
Several F&Os generated during the boiling water reactor owner's group (BWROG) peer review in 1997 were reviewed by Entergy staff who concluded that the F&O level of significance was incorrect or that changes to the model were not needed. The items for which the level of significance was not correct were re-assessed as directly related to documentation in order to better support the model. The six CDF-related items that required no changes are discussed below.

In addition, following Revision 2 of the Level 1 update, a decision was made to develop a Large Early Release Frequency (LERF) model rather than update the Individual Plant Examination (IPE) Level 2 model. The LERF model was developed using the methods described in NUREG/CR-6595, Rev. 1, *An Approach for Estimating the Frequencies of Various Containment Failure Modes and Bypass Events*, and is directly linked to the Revision 2 Level 1 model. Because of the different method, Level 2 peer review

observations were not applicable and were not addressed. The LERF model was completed and issued in December 2003.

For the following F&Os, internal reviews concluded that changes to the model were not needed or the F&O was incorrect. As indicated, the dispositions for these F&Os remain applicable to the PRA model used for the SAMA analysis.

1. Observation 28 (Element IE-10)
   "The GGNS PSA has developed a thorough list of initiating events. It is desirable to document the process used to develop this list and to ensure that support system initiators are adequately covered."

   Observation 28 Disposition
   This is a documentation enhancement issue. No changes would result in the GGNS PRA model as a result of addressing this issue. Entergy PRA procedures address the initiating events analysis and provide guidance on development of initiating events to consider.

   Since this is only a documentation issue, the disposition remains applicable to the PRA used for the SAMA analysis.

2. Observation 81 (Element AS-9)
   "SBO Impacts to be Included AC power recovery is included in the PSA for station black out (SBO). For sequences with RCIC available, up to 10 hours were credited. However, this requires a number of assumptions that may not hold true. The evaluation of potential SBO impacts to explicitly model in the accident sequence include the following: a) Exceeding HCTL at 30 minutes to 6 hours (depending on the reactor pressure vessel (RPV) pressure) and how that is included in the SBO evaluation is an important sequence specific procedure. (See other AS-9 F&O) b) apparent lack of drywell (DW) temperature indication under SBO sequences (see P. 11 of ENERCON Report MS194/SERISB01). This may require premature emergency depressurization if DW temperature is unknown. c) It is non-conservative to credit RPV repressurization because of loss of direct current (DC) when calculations show DC is available from Division 2 for 11 to 12 hours. d) Battery depletion on Division 1 requires RCIC gland seal load shed and inclusion of an HEP for this action. (See also other AS-9 F&O) e) Inability to use high pressure core spray (HPCS) diesel generator (DG) (HPCS DG) for electrical cross tie when RPV level drops below Level 2."

   Observation 81 Disposition
   a) The emergency procedures (EPs) have been revised since Revision 1 of the PRA. The new EPs incorporate revised curves for the Heat Capacity Temperature Limit (HCTL). The single curve from the previous EPs was replaced with a family of curves of suppression pool temperature versus reactor pressure for various suppression pool levels. Theses curves allow the operators to control reactor pressure above 60 psi for almost all cases. Therefore, the revised curve allows operators to ensure that RCIC remains operable since it can operate with pressures down to 60 psig. Based on recent calculations, it is reasonable to assume that RCIC can operate for 6 to 7 hours depending on the suppression pool temperature and battery life.

      The success criteria in the PRA used for the SAMA analysis is RCIC operation for 6 hours under SBO conditions. Therefore, this disposition remains applicable to the PRA used for the SAMA analysis.

b) The revised EPs direct emergency depressurization if the drywell temperature cannot be maintained below 330°F. Even if drywell instrumentation is not available, the pressure associated with a saturated water temperature of 330°F is 103 psia. Since SBO scenarios (with RCIC operating) result in the slow heat-up of containment and the ultimate pressure of the containment is close to 67 psig, these temperatures are not possible for SBO scenarios until there is core damage or the scenario extends for a significant period of time. Analysis indicates that drywell temperature would be 225°F at 4 hours in a SBO scenario in which RCIC is operating. It is not expected that operators would emergency depressurize and remove the only source of injection (RCIC) during an SBO because they do not know the DW temperature, when they can lower pressure in accordance with other procedures. The emergency response organization would also be in place and would be able to provide guidance before temperature became a concern. Therefore, the issue is not a concern and no change is needed.

This disposition remains applicable to the PRA used for the SAMA analysis.

c) The SBO analysis does not credit re-pressurization. Once RCIC fails, the reactor must be maintained depressurized so that firewater can be use as an injection source. Event tree top X3 is used to model depressurizing the vessel with RCIC (bypassing all trips). This requires Attachment 3 of the EPs which defeats all RCIC isolation and non-mechanical interlocks.

This disposition remains applicable to the PRA used for the SAMA analysis.

d) A realistic analysis of battery life determined that the Division 1 battery life is 6.68 hours with the gland seal compressor operating and 9.55 hours without the compressor operating. Both of these consider only the battery aging factor. Since RCIC is expected to fail due to high suppression pool water temperature at about the same time the Division 1 battery discharges with the compressor operating, there is no need to add a human failure event for stripping the gland seal compressor since there is no impact. The Division 2 battery is expected to last ~11.5 hours. This division would allow continued depressurization with the safety relief valves (SRVs) up until that time. The Loss of AC Power EP does require the operators to strip the gland seal compressor in an SBO.

This disposition remains applicable to the PRA used for the SAMA analysis.

e) The EP for Loss of Offsite Power has been revised to add steps for defeating logic associated with Level 2 initiation of HPCS that would prevent the cross-tie of the Division 3 DG to the Division 1 or 2 bus.

This disposition remains applicable to the PRA used for the SAMA analysis.

3. <u>Observation 85 (Element AS-9)</u>
"There is a slight problem in the chronology of the event tree headings associated with containment heat removal or venting and low pressure injection. The general transient tree shows the sequence for RCIC operating to ask for RCIC, residual heat removal (RHR), Venting, and then HPCS and Low Pressure Injection. The result is that sequences are assigned to vented containment even if low pressure systems fail. This would certainly not be the case when EOPs are followed. For TQUV sequences, core damage would occur in the sequence at the time of depressurization on HCTL, i.e., ~ 4 hours. Venting would not generally occur until 22.5 psig in containment, i.e., about 24 hours. Therefore, there are "vented" core

damage end states in the PRA that are improperly labeled. Examples include: T-16, T-20, and T-21."

Observation 85 Disposition
The transient event tree shows several non-minimal sequences with respect to core damage that are not quantified as follows: T-16 is subsumed by T-13, T-24 is subsumed by T-20, and T- 25 is subsumed by T-21. The end states for T-16, T-24, and T-25 are correct (vented containment) and provide insight into the Level 2 PRA core-damage binning process. Therefore, no changes are needed.

Also, the HCTL limit would not occur at 4 hours, but would occur at a later time (approximately 7 to 8 hours) with the current EPs. Based on Modular Accident Analysis Program (MAAP) evaluations, 22.5 psig in the containment would not occur until approximately 12 hours. However, the operators would likely initiate venting before that time based on whether they believe that containment pressure can be maintained below 22.4 psig.

This disposition remains applicable to the PRA used for the SAMA analysis.

4. Observation 87 (Element AS-18)
"Sequence #37 - The fire protection injection is used for successful RPV makeup following an SBO without HPCS but successful RCIC and stuck-open relief valve (SORV). This is judged by the Certification Team to result in loss of injection in approximately 2 hours. This means the 8 fire protection hoses must be aligned by this time under SBO conditions. No thermal hydraulic basis could be found to assess the HEP allowed time for the fire water cross tie for this sequence. It is judged that this operator action for this sequence has a much higher HEP than 0.013."

Observation 87 Disposition
No changes are needed. RCIC has been determined to be capable of mitigating a steamline break size of 0.13 sq ft. The flow through a single SRV is 18.43 sq in which is 0.128 sq ft. The RCIC performance analysis also credits control rod drive (CRD) flow at 20 lb/sec or ~144 gpm. This flow rate is not considered large enough to change the conclusions that RCIC alone can handle the SRV) transient. In this analysis, vessel pressure drops to a low of approximately 200 psi and level never drops to within ~ 80 inches of the top of active fuel (TAF). The analysis also does not assume an unrealistic operator action to prevent isolation of RCIC on high water level. By the time reactor pressure has reached 200 psig, the steam loss through the SORV equates to ~300 gpm and RCIC can easily continue to make up the required flow.

Also a GOTHIC model was run to evaluate temperatures in the containment for SBO cases. The only change was to add in a single SORV. This evaluation indicates that reactor pressure drops into the 120 to 150 psi range in the 1.5 to 2 hour time frame. It stays in that range out to the length of the evaluation, ~9 hours. Suppression pool temperature reaches 200°F at approximately 4 hours. The containment pressure rises gradually from atmospheric to ~16 psia at 5 hours and then increases to approximately 30 psia at 8.5 hours. These results are consistent with those from the RCIC performance analysis. Therefore, RCIC is expected to operate at least 4 hours under this scenario. After that time, Net Positive Suction Head (NPSH) might become a concern.

The human reliability analysis for firewater alignment assumes a total time of 3 hours to perform the task. This includes ~1.75 hours to perform the alignment tasks and 30 minutes to realize that firewater should be aligned, leaving 45 minutes for diagnosis. The total of 3 hours is based on a transient event time to boil-off after core has been cooled for 6 hours and no SORV. The time to boil-off with a SORV at 4 hours following a scram may be shorter. Scenarios involving less time to diagnosis and perform the task were considered in the update of the firewater alignment human error probability (HEP) in Revision 2 of the PRA model.

This disposition remains applicable to the PRA used for the SAMA analysis.

5. Observation 89 (Element AS-18)
"Cutset 11 - LOOP initiator with ECCS suction strainer clogging and fail to recover offsite power within 10 hours. This must assume RCIC operates for 8 - 10 hours and HPCS cannot be used from the CST. Are both of these assumptions realistic?"

   Observation 89 Disposition
   The observation is a misinterpretation of the cutset. Failure to recover offsite power within 10 hours is not in the cutset because RCIC operates for 8-10 hours but because the standby service water crosstie operates until the containment spray initiation signal is generated. The containment spray signal was estimated to occur in the 8 to 10 hour time frame. Also, the model assumes that HPCS and RCIC are initially lined up to the Condensate Storage Tank (CST) and will switch to the suppression pool after the CST is exhausted. HPCS and RCIC are susceptible to common cause failure due to clogging of the Emergency Core Cooling System (ECCS) suction strainer. No changes are necessary.

   This disposition remains applicable to the PRA used for the SAMA analysis.

6. Observation 97 (Element TH-8)
"MAAP indicates that HCTL at 1000 psig (~120°F) is reached in 2 to 4 hours. 185°F is reached in 6 hours. Both of these are reached before the 8 hour assumed battery life is exhausted in the SBO analysis. The requirement to maintain RCIC for 8 hours would appear to be compromised by this assumption. The ability to reach 10 hours does not appear to be justified."

   Observation 97 Disposition
   The HCTL will allow operation of RCIC until the suppression pool temperature approaches 200 to 210°F. Based on MAAP analysis, this temperature will occur in approximately 8 hours which is the battery life during SBO scenarios. Therefore, no change to the model is required.

   See the disposition to Observation 81.a which indicates that the success criteria in the PRA used for the SAMA analysis is "RCIC operation for 6 hours under SBO conditions". Therefore, this disposition remains applicable to the PRA used for the SAMA analysis.

Response 1g
As mentioned in response to RAI 1.a, the PRA Maintenance and Update procedure describes the process for maintaining the PRA models current with the as-built and as-operated plants. It describes the MCR database used to track plant changes, procedure revisions, nuclear licensing revisions, and model improvements that impact the PRA models.

This procedure is in place for PRA model maintenance in order to ensure that the model remains current with the as-built, as-operated plant and to ensure that industry standards, experience, and technology are appropriately incorporated into the models. This procedure gives specific instructions for identifying model change requests, documenting those requests, and incorporating those requests into the PRA model.

The PRA analysts performing model updates are experienced, trained professionals and each change is reviewed by a second, experienced, trained PRA analyst. In addition, as described in ER Section E.1.4.5, expert panel reviews are used to enhance the technical quality of the PRA updates. Changes from the expert panel review for an update are immediately incorporated into that update of the model.

Finally, the methods used for the GGNS PRA updates have been applied to other Entergy PRA models (Arkansas Nuclear One (ANO)-1, ANO-2, Waterford 3, and River Bend Station). Each of those sites has undergone a successful RG 1.200 peer review. Therefore, the GGNS PRA models are of sufficient technical quality for use in the SAMA analysis.

Response 1h

The table on page E.1-70 titled "Contribution to CDF Changes in PRA Models" is part of the PRA model revision history section and lists the percentage contribution of the initiators from the level 1 internal events model. Table E.1-1 provides the contributions of the major initiators for the level 2 model that was utilized for the SAMA analysis.

The percentages are based on two separate models, one is a level 1 model and one is a level 2 model. As described in the response to RAI 1.e, differences are to be expected between the initiator contributions.

Request

2. Provide the following information relative to the Level 2 analysis:

   a. Provide a brief history of the Level 2 Probabilistic Safety Assessment and key modeling changes that may have influenced the release category frequencies. Identify steps taken to assure technical adequacy.

   b. Section E.2.2.6 provides a summary of how a value for each release-to-environment mass fraction was obtained from the representative Modular Accident Analysis Program (MAAP) calculation per Containment Event Tree (CET) sequence. Table E.1-8 results of the CET quantification and identifies total annual release frequency per Level 2 release category. Provide further information on:

      i. Criteria used for assignment of release categories to each CET endpoint

      ii. Process to determine the representative sequence for quantifying the release fractions for each release category

      iii. How the weighting of release fractions discussed on page E.1-54 affects the evaluation of benefit for potential SAMAs.

   c. Identify and describe the representative sequences for each release category. If the representative sequence for each release category is the one with the highest frequency but is not the one with the highest source term, justify this selection for determining the

benefit of potential SAMAs, particularly for impacts to the sequences with higher source terms that may be greater than the impact to the representative sequence.

d. Section E.1.2 defines release category (RC) based on the magnitude of CsI (Cesium iodide) release with High (H) being > 10%, Medium (M) being between 1% and 10 %, etc. The release fractions given in Table E.1-9 are not necessarily consistent with these definitions. For example, the RC High/Early (H/E) frequency is given as the LERF yet the Cs release fraction is less than 10%. Provide the rationale for the release fraction selection and discuss its impact on the validity of the SAMA benefit analysis.

e. Figure E.1-1 indicates that negligible releases (NCE or NCF for no containment failure) account for 44% of the total CDF. Identify the CET end states that comprise this release category and how the frequency for this release category was determined.

f. In Table E.1-9 (Sheet 1 of 2), some release timings do not agree with the Release Mode timing categories. For example, the start of release minus the warning time is 16 hours for Release Mode Medium/Early (M/E), but the timing for an early (E) release is defined to be less than 4 hours. The start of release minus the warning time is 12 minutes for Release Modes Low/Intermediate (L/I) and Low-Low/Intermediate (LL/I), but the timing for an intermediate (I) release is defined to be between 4 and 24 hours. Discuss the reasons for this lack of agreement, including the plant damage states and CET end states that contribute to these Release Modes, and the impact on the SAMA assessment.

g. Table E.1-9 (Sheet 2 of 2) does not include source terms for the NCF release category, and it is not included in the consequence analysis. For this category, Table E.1-5 indicates a release fraction of 0 for cesium iodide and describes it as negligible. With a frequency for NCF many times higher than the other categories, design basis leakage without containment failure might lead to atmospheric releases similar to or even higher than those given for Low-Low/Early (LL/E) and Low-Low/Intermediate (LL/I) release categories in Table E.1-9. Provide further support for exclusion of the NCF release category from the consequence analysis and confirm that design basis leakage is considered in developing the source terms for the LL/E and LL/I release categories.

h. At the time of the Grand Gulf extended power uprate submittal, there was a peer review comment related to failure to model vacuum breakers, low suppression pool level, and personnel hatch seal, which had not been addressed in the Level 2 model. Provide the resolution status of this peer review comment. If not treated in the current Level 2 model for license renewal, justify the current modeling with respect to this issue and describe its impact on the SAMA assessment.

Response 2a

As indicated in the response to RAI 1.f, following Revision 2 of the Level 1 update, a decision was made to develop a Large Early Release Frequency (LERF) model rather than update the IPE Level 2 model. The LERF model was developed using the methods described in NUREG/CR-6595, Rev. 1, *An Approach for Estimating the Frequencies of Various Containment Failure Modes and Bypass Events*, and is directly linked to the Revision 2 internal events model. The LERF model was completed and issued in December 2003 and was updated along with the Level 1 model in the R3 and EPU revisions of the model.

The steps to ensure the technical adequacy of the Level 2 model are the same as those for the Level 1 model described in the response to RAI 1.g. In other words, the PRA analysts performing model updates are experienced, trained professionals and each change is reviewed by a second, experienced, trained PRA analyst. In addition, expert panel reviews are used to enhance the technical quality of the PRA updates and changes from the expert panel review for an update are immediately incorporated into that update of the model.

Prior to the SAMA analysis, a new Level 2 model was created to derive the radionuclide release categories and frequencies that characterize the severe accident spectrum. This Level 2 analysis consists of the following.

- Characterization of containment capability under severe accident challenges
- Detailed containment event trees (CETs)
- Quantification of the functional nodes using system logic and phenomena associated with severe accident progression
- Quantification of accident sequences from initiating event in Level 1 through radionuclide release and explicit treatment of dependencies
- Binning of accident sequence release frequencies based on timing and magnitude

The new Level 2 model may also be used for the determination of those accident sequences with the potential for radionuclide releases that are both large and early, leading to the Large Early Release Frequency (LERF).

The following tasks were undertaken to create the new Level 2 model.

- Restructuring the old LERF event trees to add the following nodes.
  - SI: Debris Cooling
  - HR: Containment Heat Removal Via Residual Heat Removal (RHR)
  - VC: Containment Heat Removal Via Vent
  - SP: Suppression Pool Bypass
  - CZ: Drywell Intact
  - WW: Wetwell Airspace Breach
  - CSS: Containment Spray Operates
- Updating the EOPs and severe accident guidelines (SAGs) used in the HRA to the latest version
- Direct linking of the Level 1 accident sequences to the Level 2 to allow explicit accounting of dependencies by the CAFTA code calculation
- Modifying the end states to include radionuclide release end states other than LERF (High/Early)
- Incorporating plant specific MAAP 4.0.6 radionuclide release calculations for the EPU configuration
- Incorporating the Grand Gulf emergency action levels, evacuation estimates, and MAAP 4.0.6 accident sequence timing into the definition of LERF

Technical adequacy was assured by taking the following steps.

- The developing contractor performed a self-assessment of the Level 2 model against the American Society of Mechanical Engineering (ASME)/American Nuclear Society (ANS) PRA Standard implemented in accordance with R.G. 1.200 to provide assurance that the LERF calculation and the associated processes are of Capability Category II, such that there is high confidence in the quality of the Level 2 PRA.
- A technical acceptance review was performed by Entergy with comments resolved by the contractor.
- An expert panel review of the Level 2 cutsets was performed as further assurance of the quality of the Level 2 PRA. The expert panel consisted of members of the Grand Gulf engineering, PRA and operations departments.

Response 2b

i. The spectrum of possible radionuclide release scenarios is represented by a discrete set of categories or bins which represent a group of severe accidents that have similar characteristics.

The release categories are defined based on two parameters: timing and severity. Timing and magnitude of the release for each sequence is based on MAAP 4.0.6 calculations of the sequence chronology. The classification of release magnitude is also based on MAAP 4.0.6 calculations. The inputs for determining the plant specific characteristics of the radionuclide release bins are the plant model, the MAAP 4.0.6 plant specific calculations, the Emergency Plan, e.g., the Emergency Action Levels (EALs), the magnitude of releases that can contribute to public health effects, and the evacuation timing.

The assignment of timing to the release bins is dependent on both the Level 1 accident sequence and the status of the CET functional events. Combining the results of the MAAP calculations, the EALs, and the evacuation leads to the assessment of the timing of the General Emergency (GE) declaration relative to the radionuclide release timing. This evaluation is used to characterize "early" radionuclide releases as any release initiated less than four (4) hours following the declaration of a General Emergency.

Each of the accident sequence classes from the Level I can have a strong influence on the timing of a release. For example, treatment of ATWS events generally leads to the assertion that the radionuclide release will be initiated relatively early in the accident sequence. Level 2 effects can also modify the timing determination. Using these dependencies, the radionuclide release categories at the end of every sequence can be defined.

The rules for assigning release magnitude categories are described below.

There are several fundamental variables; level 1 accident sequence, initial containment failure mode, Reactor Pressure Vessel (RPV) pressure at RPV breach, water availability, and auxiliary building effectiveness. An evaluation of these variables, to a large degree, determines the release magnitude.

There are energetic failures of the containment drywell at approximately the time of RPV failure. It is assumed based on a spectrum of MAAP analyses that a sufficient fraction of CsI is airborne to result in the ejection of a large CsI release. Therefore, sequences involving CZ functional node failures are ranked as high (H) release categories.

Containment isolation failure is treated conservatively in the assignment of radionuclide release end states, sequences are assigned a moderate (M) release in the case of isolation failure even though the failures could be relatively small, the failures could be from the wetwell airspace, and the failures could be into closed or filtered systems (e.g., Standby Gas Treatment System (SGTS)). Nevertheless, the large failure to isolate that bypasses the auxiliary building is assumed to lead to a high release.

Containment isolation failure has a varying potential for release depending on the status of the containment sprays.

Events during which the containment flood contingency is successfully implemented and completed are determined by MAAP calculations to be sufficiently well represented by other severe accident sequences such that they do not require separate characterization in the CETs. With effective mitigation by debris cooling the release is classified as low.

Scenarios involving wetwell airspace failure or wetwell vent (with no other containment failures) are treated as scrubbed releases when there is no suppression pool bypass (this includes adequate subcooled water above the horizontal vents), and are assigned a severity class of low-low (LL). (Non-LERF).

Suppression pool bypass is modeled in two ways in the CET; first, as a method of potential containment challenge during blowdown (CX node) and second, it is modeled as either a leakage failure (e.g., the vacuum breaker in the wetwell to drywell interface) or as the horizontal vents become uncovered that allows some radionuclides to bypass the suppression pool. The impact of bypassing the suppression pool is modeled as an increase of a factor of 10 in the radionuclide release using GGNS specific analyses for guidance.

Containment sprays, RPV injection post RPV breach, or containment flooding are all effective mitigation measures to reduce or eliminate containment failures. These mitigation measures are explicitly included in the Level 2 PRA. Their effects on the source term have been quantified using the MAAP code.

It is also necessary to estimate the source term for severe accidents for which the containment remains substantially intact. Estimates of source terms by members of Nuclear Regulatory Commission staff indicate that for scenarios where the containment remains intact, but leaking at its maximum technical specification leakage rate, that the escape fraction of CsI would be 2E-4 for the initial one hour of the release. Therefore, with no reactor building filtration or holdup effectiveness, the leakage escape fraction could translate into a release fraction of 0.0048 to the environment over 24 hours (i.e., the low (L) category). If the reactor building remains effective in removing some of the radionuclides through condensation, inertial deposition, or gravitational settling, then the release fraction is estimated to be between .0001 and .001, i.e., the low-low (LL) category. Additionally, if SGTS is operational, a very small CsI release is expected. This leads to a non-LERF determination for cases with containment intact.

The enclosure building effectiveness is not credited in the quantified model.

The wetwell water space failures are assumed to occur at a location that results in loss of sufficient water to create a direct bypass of the suppression pool for all releases from the RPV after RPV breach. This is assumed to result in a release path that is similar to an unmitigated release failure path.

ii. The predominant accident class (based on frequency) that contributes to each of the radionuclide release categories was identified. Once the accident class was identified, the timings and magnitudes of the releases from the results of the various Level 2 MAAP runs for that accident class were reviewed to select an appropriate sequence to represent the release category.

iii. The discussion about weighting of release fractions discussed on page E.1-54 was intended to provide further explanation of how the representative sequences for determining the release fractions were selected. No actual weighting or summing of the sequence release data was performed.

As described above, accident classes that contribute to each of the radionuclide release categories were "weighed" to determine the predominant accident classes. Then, from the predominant accident class, a MAAP sequence that best represents the timing and release characteristics of the bin was selected to represent the release category. The timing and magnitude data from this representative MAAP sequence was then directly used in the Level 3 analysis.

Response 2c

As described below, a MAAP run from the predominant release category was selected for the consequence analysis for each release category. With the exception of the MAAP run selected for the H/E release category (see below), the representative sequence has a source term release within, or greater than, the release severity range specified for the release category in ER Table E.1-5.

The MAAP run selected for the H/E release category is from the predominant release category, but does not meet the > 10% CsI severity level specified for high releases in ER Table E.1-5. The response to RAI 2.d discusses this further and justifies this selection.

Release category H/E

Predominant accident class is IBE, accident sequences involving a station blackout and loss of coolant inventory makeup. (Class IBE is defined as "Early" Station Blackout events with core damage at less than 4 hours.)

MAAP run ID# GG10503 – SBO with containment isolation failure, no injection, 5 SRVs at TAF, no suppression pool cooling (SPC) or containment spray, no igniters, and no upper pool dump.

Release category H/I

Predominant accident class is IIIC, accident sequences initiated or resulting in medium or large LOCAs for which the reactor is at low pressure and no effective injection is available.

MAAP Run ID# GG10516 – Large LOCA with containment isolation successful, no injection, no SRVs, no SPC or containment sprays, igniters initially on, and no upper pool dump.

Release category H/L

Predominant accident class is ID, accident sequences involving a loss of coolant inventory makeup in which reactor pressure has been successfully reduced to 200 psi.

MAAP Run ID# GG10505 – Loss of makeup at low pressure with containment isolation successful, no injection, 7 SRVs at TAF, no SPC or containment spray, no igniters, and with upper pool dump.

Release category M/E
Predominant accident class is II, accident sequences involving loss of containment heat removal.

MAAP Run ID# GG10510 – Loss of offsite power with containment isolation successful, MSIVs closed, Low Pressure Core Spray (LPCS) available, 7 SRVs at HCTL or TAF, no SPC or containment sprays, no igniters, and no upper pool dump.

Release category M/I
Predominant accident class is IIIC, accident sequences initiated or resulting in medium or large LOCAs for which the reactor is at low pressure and no effective injection is available.

MAAP Run ID# GG10516IG – Large LOCA with containment isolation successful, no injection, no SRVs, no SPC or containment sprays, igniter failure, and no upper pool dump.

Release category M/L
Predominant accident class is ID, accident sequences involving a loss of coolant inventory makeup in which reactor pressure has been successfully reduced to 200 psi.

MAAP Run ID# GG10506 – Loss of makeup at low pressure with containment isolation successful, no injection, 7 SRVs at TAF, no SPC or containment spray, igniters available, and with upper pool dump.

Release category L/E
Predominant accident class is IV, accident sequences involving failure of adequate shutdown reactivity.

MAAP Run ID# GG10517 – ATWS event with standby liquid control failure, feedwater available, high pressure injection available, 2 SRVs at HCTL or TAF, SPC at 95°F suppression pool temperature, no containment sprays, no igniters, and with upper pool dump.

Release category L/I
Predominant accident class is IA, accident sequences involving loss of inventory makeup in which the reactor pressure remains high.

MAAP Run ID# GG10501C – Loss of makeup at high pressure with containment isolation failure, no injection, no SRVs, no SPC or containment spray, igniters on at 11.9% H_2, and with upper pool dump.

Release category L/L
Predominant accident class is IBE, accident sequences involving a station blackout and loss of coolant inventory makeup. (Class IBE is defined as "Early" Station Blackout events with core damage at less than 4 hours.)

MAAP Run ID# GG10504 – SBO with containment isolation successful, no injection, 5 SRVs at TAF, no SPC or containment spray, no igniters, and no upper pool dump.

Release category LL/E
Predominant accident class is IA, accident sequences involving loss of inventory makeup in which the reactor pressure remains high.

MAAP Run ID# GG10502D – Loss of makeup at high pressure with containment isolation successful, low pressure injection available, no SRVs, no SPC, with

containment sprays and RHR heat exchangers available, no igniters, and with upper pool dump.

Release category LL/I
Predominant accident class is IA, accident sequences involving loss of inventory makeup in which the reactor pressure remains high.

MAAP Run ID# GG10500F – Loss of makeup at high pressure with containment isolation successful, low pressure injection successful, no SRVs, with suppression pool cooling and RHR heat exchangers available, no containment sprays, igniters initiated at TAF, and with upper pool dump.

Release category LL/L
Predominant accident class is IA, accident sequences involving loss of inventory makeup in which the reactor pressure remains high.

MAAP Run ID# GG10502A – Loss of makeup at high pressure with containment isolation successful, no injection, no SRVs, no SPC, with containment sprays and RHR heat exchangers available, no igniters, and no upper pool dump.

Response 2d
As stated in ER Section E.1.2.2.7, "input to the Level 3 GGNS model from the Level 2 model is a combination of radionuclide release fractions, timing of radionuclide releases, and frequencies at which the releases occur." This combination of information is used in the selection of input to the Level 3 analysis shown in Table E.1-9.

The predominant accident class for the H/E release category is class IBE, followed by accident classes ID and IA. Because the IBE accident class is the predominant accident class for the release category, a representative accident sequence was chosen from the IBE accident class. This accident sequence, GG10503, reflects an early SBO with loss of coolant inventory and represents the earliest possible release within the accident class.

While this MAAP run represents the predominant accident class IBE, the release fractions are consistent with an M/E release scenario due to the CsI fraction of 2%. However, as part of the evaluation and binning of the scenarios in the Level 2 analysis, MAAP case GG10503 was increased from a medium release scenario (as defined by an IB with failure of containment isolation) to a high release scenario. This increase to a high release was due to the failure of the drywell which had not been previously accounted for in the nodal analysis. This increase is consistent with the energetic combined failure of both the containment and drywell used to alter the release magnitude categories of these sequences using the rules from Appendix D.4 of the Level 2 calculation. Thus, the accident sequence GG10503 was conservatively assigned to release category H/E.

An alternate MAAP case from a non-dominant accident class, but with larger radioactive releases was evaluated as a sensitivity to assess the impact of the H/E selection. Table D.3-0 of the Level 2 calculation suggests using MAAP Run ID# GG10500 to represent the H/E category. A description of GG10500 and its source term information are provided below. The sensitivity case using GG10500 resulted in no change in the cost-beneficial status of SAMAs.

MAAP run ID# GG10500 – SBO with containment isolation initially successful, no injection, no SRVs, no suppression pool cooling (SPC) or containment spray, no igniters, and with upper pool dump.

general emergency declaration	0.75 hr
warning time	1264.28 sec
energy release	7.50E+05 W
elevation of release	32 m
release start	93600 sec
release end	259200 sec
release duration	165600 sec
NG release fraction	1.00E+00
I release fraction	1.78E-01
Cs release fraction	1.13E-01
Te release fraction	1.82E-01
Sr release fraction	4.23E-06
Ru release fraction	7.33E-07
La release fraction	2.26E-07
Ce release fraction	4.66E-06
Ba release fraction	3.79E-06

Response 2e

The Figure E.1-1 label for negligible releases contains a typographical error. NCE should be identified as NCF. See change to ER figure E.1-1 below with strikethrough for deletions and underline for additions.

Negligible (NC~~E~~F)
8.73E-07
44%

The CET endstates labeled "OK" are those that make up the NCF release category, which is defined as a radiological release that is less than or equal to the containment design base leakage, or no containment failure.

The frequency for this release category was determined by quantifying the "OK" gate in the CAFTA fault tree which consists of all the CET endstates labeled "OK".

Response 2f

Table E.1-9 contains the specific MAAP Level 2 information used in the MACCS2 code analysis. The release timings shown in Table E.1-9 are obtained from the MAAP results as follows.

- "Warning Time (sec)" reflects the time from the start of the accident to core uncovery.
- "Release Start (sec)" reflects the time from the start of the accident to containment failure or to exceed core temp > 1800 °F in cases with containment isolation failures.

The release timing classifications in Table E.1-5 reflect the time from the declaration of a general emergency to the start of the release and pertain to the release category bin

assignments. The general emergency declaration time (from the start of the accident) for each release category is provided below.

Release Category	Time to Declaration of General Emergency (hrs)
H/L	0.75
H/E	0.75
H/I	0.50
M/E	18.50
M/I	0.50
M/L	0.75
L/E	0.58
L/I	0.75
L/L	0.50
LL/E	0.75
LL/I	0.75
LL/L	0.75

As detailed in ER Section E.1.2.2.6, the binning of each CET sequence into the release categories is provided in the level 2 analysis using inferred timing from both the Level 1 and Level 2 analyses. For the examples cited in the question, a discussion of the timing for the selected MAAP run as it pertains to the timing criteria from Table E.1-5 is provided below.

- Release category (CET endstate) M/E, predominant plant damage state II – Class II sequences are long-term loss of containment heat removal sequences with the Reactor Coolant System (RCS) intact so the time to core damage and release is longer than for other release categories (~19.8 hrs). Although a general emergency could be declared in Class II sequences when the containment design pressure is exceeded regardless of RCS integrity or fuel condition, Class II sequences are conservatively assumed to result in declaration of a general emergency when the core temperature exceeds 1800 °F (~18.5 hrs). The difference between this and the time of release is 1.3 hrs which is consistent with the early release definition of < 4 hrs from the time of declaration of a general emergency.
- Release category (CET endstate) L/I, predominant plant damage state IA – Class IA scenarios involve loss of inventory makeup at high pressure and may have unsuccessful containment isolation allowing for earlier releases. It is conservative to use a MAAP case with early release timing for an intermediate release category.
- Release category (CET endstate) LL/I, predominant plant damage state IA – Class IA scenarios involve loss of inventory makeup at high pressure and may have unsuccessful containment isolation allowing for earlier releases. It is conservative to use a MAAP case with early release timing for an intermediate release category.

More information on the binning of sequences into release modes is provided in the responses to RAIs 2.b and 2.c. A conservative approach was applied to the timing evaluation in the SAMA analysis.

Response 2g

The NCF release category, defined as a radiological release that is less than or equal to the containment design basis leakage, was excluded from the SAMA analysis by the assumption that it had a negligible impact on the consequence analysis. This design basis leakage was not included in the LL/E and LL/I release categories.

To confirm the assumption that the NCF category contribution is negligible, a sensitivity analysis was conducted to determine the increase in offsite consequences from including this contribution.

MAAP run GG10502D is an intact accident scenario with radionuclide releases consistent with design leakage rates. This MAAP scenario was selected to represent the LL/E release category in the consequence analysis. Since the CsI release fraction for severe accidents in which the containment remains substantially intact would fall into the low-low (LL) category, MAAP case GG10502D was used in the NCF sensitivity evaluation. A description of MAAP run GG10502D may be found in the response to RAI 2.c and the source term information is the same as that for category LL/E in ER Table E.1-9.

The impact of including an NCF release category was evaluated by adding the source term for MAAP scenario GG10502D, as the 13th release category in the MACCS2 analysis, with a frequency of 8.73E-07/year. The addition of the NCF release category resulted in a 0.07% increase in the PDR and a 0.03% increase in the OECR. This increased the maximum benefit from $74,673 to $74,684.

Therefore the impact of the NCF release category is negligible to the consequence analysis and introduced no new cost beneficial SAMAs.

Response 2h

This peer review comment has been resolved in the Level 2 model used for the SAMA analysis. Failure of the vacuum breakers is modeled in CET node CZ (drywell remains intact) and node SP (no suppression pool bypass). Low suppression pool level is also modeled in CET node SP.

In the Level 2 model used for the SAMA analysis, hatch seal failures due to high temperatures were negligible when compared with hatch failures due to either overpressurization or buckling (equipment hatch). Thus, hatch seals were not assessed as potential failure locations. Addition of this failure mode to the model would not impact the SAMA assessment.

Therefore, vacuum breaker failures, low suppression pool level and personnel hatch seal failures were appropriately considered in the Level 2 model used for the SAMA analysis.

Request

3. Provide the following information with regard to the treatment and inclusion of external events in the SAMA analysis:

   a. Section E.1.3.2 states that Table E.1-10 presents the results of the current GGNS Individual Plant Examinations for External Events (IPEEE) fire analysis. Explain what is meant by "current" as it relates to IPEEE. If the IPEEE analysis has been revised or new fire analyses performed, describe the revision and present its results.

b. Section 4.21.5.4 indicates that seismic risk is negligible in the estimation of external events multiplier. The August 2010 report, "Generic Issue 199 (GI-199), entitled Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States on Existing Plants, shows a decrease in the GGNS seismic CDF when the 2008 United States Geological Survey (USGS) seismic hazards curve is used compared to the seismic CDF resulting from the 1994 Lawrence Livermore National Laboratory hazard curves but an increase compared to the seismic CDF based on the Electric Power Research Institute (EPRI) hazard curves. For the simplified approach to estimate the CDF from a seismic margins analysis using the latest published USGS seismic hazards information, GGNS seismic CDF may be about or slightly less than 10^{-5}/year. Discuss the impact of the aforementioned considerations on the SAMA analysis.

c. Section 3.2.1 discusses conservatisms in the GGNS IPEEE fire analysis. Recent research and guidance reported in NUREG/CR-6850, specifically in the areas of hot short probabilities, fire ignition frequencies, and non-suppression probabilities, indicate that the fire analysis methodologies utilized for the Individual Plant Examinations (IPEs) may underestimate fire risk. Provide assurance that consideration of this information is not expected to impact the selection of cost beneficial SAMAs for GGNS. Discuss the impact on the evaluation of potential SAMAs for fire risk contributors in addition to the use of the external events multiplier.

d. For SAMAs 240–244, Table E.2-1 states:

> "The IPEEE showed the risk from external flooding at GGNS is minor. Thus this potential modification is assumed not to be cost beneficial, which follows the same assumption in the NRC safety evaluation report."

The GGNS IPEEE (p. 116) includes the following:

> "Applying the new criteria, the bulk of the precipitation would occur over a shorter time frame, and markedly higher rainfall intensities would result. As a result, the GGNS site is not expected to be completely protected against external flooding without making some site modifications. Evaluation reveals that the following site drainage/flood protection improvements would allow for adequate protection of the site against external flooding due to the revised criteria. However, they are not necessarily the only combination of potential changes for consideration. Given the small probability of occurrence for the PUTP, as described in the preceding paragraph, the relative cost and benefit for potential improvements will be considered prior to implementation of any physical improvements."

While the staff review of the IPEEE as documented in the IPEEE SER did not require implementation of the items listed as SAMAs 240–244, this alone does not imply that they should be eliminated from further consideration. In light of the second sentence from the GGNS IPEEE above, provide a discussion of the cost benefit analysis concerning external flood modifications and its influence on conclusions of the SAMA analysis.

Response 3a

Table E.1-10 presents the results of the GGNS IPEEE fire analysis, which are current because they have not been superseded.

A partially updated fire analysis was performed using Revision 2 of the internal events model and crediting additional equipment for safe shutdown following a fire. The original IPEEE fire modeling and control room analysis were not changed. This update resulted in lower CDF values for the analyzed compartments but was not used to develop the external events multiplier for SAMA.

Thus, conservatism was added to the SAMA analysis by using the IPEEE fire results to develop the external events multiplier.

Response 3b

As discussed in ER Section 4.21.5.4, a multiplier of 11 was used on the averted cost estimates for internal events to represent the SAMA benefits from both internal and external events. This multiplier was selected based on the available external events information for fire, seismic and other. Specifically, the IPEEE showed that

- high winds, floods, and other external events contribute less than 1E-06 per year,
- seismic events are not dominant contributors to external event risk, and
- the sum of the unscreened fire zone CDF values is approximately 8.92E-06 per year, while the sum of the screened and unscreened fire zone CDF values is approximately 2.74E-05 per year.

Section 3.1.2.4 of NEI 05-01, Rev. A indicates that a plant that used the seismic margins assessment (SMA) method for the IPEEE may select a multiplier based on the sum of the unscreened fire zone CDF and may even use a reduction factor on the baseline fire results to account for conservatisms in that analysis.

For GGNS, the sum of the unscreened fire zone CDF values is approximately 8.92E-06 per year, which results in a multiplier of 5 when compared to the internal events CDF. In addition, a partially updated fire analysis resulted in lower CDF values for the analyzed compartments (see response to RAI 3.a), supporting use of a smaller multiplier. Nevertheless, to ensure a bounding analysis, an external events multiplier of 11 was used in the SAMA analysis.

If the GGNS seismic CDF was assumed to be 1E-05 based on the simplified estimate of CDF using the latest published United States Geological Survey (USGS) seismic hazards information, adding that to the sum of the unscreened fire zone CDF values would result in an external CDF of 1.89E-05 per year and a multiplier of 10.

Therefore, the external events multiplier of 11 used in the SAMA analysis more than compensates for a postulated increase in seismic CDF due to the latest published USGS seismic hazards information.

Response 3c

The RAI indicates that NUREG/CR-6850 indicates the fire analysis methodologies utilized for the Individual Plant Examinations (IPEs) may underestimate fire risk. However, we believe that use of NUREG/CR-6850 methods may result in an overestimate of the fire risk. See *Roadmap for Attaining Realism in Fire PRAs*, NEI, December 2010 at ADAMS ML110210990 which concludes, "Based on the results and insights from industry fire PRAs, it has been identified that the methods described in NUREG/CR-6850/EPRI TR-1011989 contain excess conservatisms that bias the results and skew insights. While the prior FAQ process made some incremental progress in addressing areas of excessive conservativism, many more remain in need of

enhancement." Thus, we do not believe that the results of the initial NUREG/CR-6850 analyses should be used to draw conclusions about the IPEEE fire risk estimates.

Nevertheless, the SAMA analysis includes conservatisms that compensate for the fact that the IPEEE fire risk estimate contains uncertainty and could be an underestimate. Most notably, as discussed in the response to RAI 3.b, a conservative external events multiplier of 11 was used in the SAMA analysis. This multiplier is more than double what would have been calculated using the sum of the unscreened fire zone CDF values from the IPEEE. In addition, GGNS is a newer, more spacious plant with better cable separation than older plants and the partially updated fire analysis mentioned in the response to RAI 3.a resulted in lower CDF values for the analyzed compartments. Therefore, this multiplier is judged to adequately compensate for the impact of any lack of conservatism indicated by NUREG/CR-6850.

Two potential SAMAs were evaluated to address fire risk contributors. The conclusion that these SAMAs are not cost-beneficial is also expected to be unaffected by NUREG/CR-6850 information.

1. SAMA 54, to add automatic fire suppression systems to the dominant fire zones was evaluated via analysis Case 38 which is described in more detail below. The bounding analysis in Case 38 indicates that removing all CDF (9.37E-7/yr) from the division 1 switchgear room fires would result in a benefit of about $102,000. This SAMA was estimated to cost at least $375,000 to implement.

   This analysis case is very conservative because it assumes that improving the reliability of the critical switchgear room suppression system would remove all CDF contribution from fires in the critical switchgear room. Also, it uses the sum of the unscreened and screened fire area CDF values from the IPEEE. Given these conservatisms and the large margin between the benefit and implementation cost, consideration of NUREG/CR-6850 information is not expected to change the conclusion for this SAMA.

   <u>Analysis Case 38</u>
   This analysis case (adding automatic fire suppression systems to the critical switchgear rooms) is an external events SAMA, which would not mitigate internal event risk. Many of the switchgear rooms have automatic CO_2 suppression systems. The Div I switchgear room in the control building that is a large contributor in the IPEEE is compartment CC202, which has a partial automatic sprinkler system. This SAMA would improve the reliability and effectiveness of that system. A bounding analysis was performed by assuming the SAMA would eliminate the contribution to fire CDF from fires in the critical switchgear room CC202. Since the total fire CDF is 2.74E-05/yr and the critical switchgear room fire CDF is 9.37E-07/yr, fires in the critical switchgear rooms contribute 3.42% of the total fire CDF.

   The internal events model cannot be used to assess the benefit from this external event SAMA. However, the consequences resulting from fire-induced core damage and internal event-induced core damage would be comparable. Since we have already estimated the maximum benefit from removing all internal event risk, the maximum benefit of removing all fire risk was estimated by reducing the maximum internal event benefit by the ratio of the total fire CDF to the internal event CDF. Since this SAMA analysis case would eliminate 3.42% of the total fire risk, the benefit for this SAMA analysis case was estimated to be 3.42% of the total fire benefit as shown below.

Given,
Maximum internal benefit is $74,673
Total fire CDF (including screened zones) = 2.74E-05/rx-yr
Internal events CDF = 2.05E-06/rx-yr

Maximum fire benefit = Maximum internal benefit x Total fire CDF/Internal events CDF

Maximum fire benefit = $74,673 x (2.74E-05/2.05E-06)= $997,559
SAMA case 38 benefit = 3.42% x (Maximum fire benefit) = 0.0342 x $997,559
SAMA case 38 benefit = $34,115
Applying the uncertainty factor of 3,
SAMA case 38 benefit with uncertainty = $34,115 x 3 = $102,345

2. SAMA 55, to upgrade the alternate shutdown system panel to include additional controls for the opposite division was evaluated via analysis Case 39. The bounding analysis in Case 39 indicates that removing all CDF from control room fires (3.85E-6/yr) would result in a benefit of about $421,000. This SAMA was estimated to cost at least $786,991 to implement.

   In analysis case 39, a bounding analysis similar to case 38 was performed by assuming the SAMA would eliminate the contribution to fire CDF from fires in the control room (compartment CC502). Since the total fire CDF is 2.74E-05/yr and the control room fire CDF is 3.85E-06/yr, fires in the control room contribute 14.05% of the total fire CDF.

   This analysis case is also very conservative because it assumes that upgrading the alternate shutdown system (ASDS) panel would remove all CDF contribution from fires in the control room. Also, it uses the sum of the unscreened and screened fire area CDF values from the IPEEE. Given these conservatisms and the large margin between the benefit and implementation cost, consideration of NUREG/CR-6850 information is not expected to change the conclusion for this SAMA.

In conclusion, consideration of the research and guidance reported in NUREG/CR-6850 is not expected to impact the selection of cost-beneficial SAMAs for GGNS.

<u>Response 3d</u>
The external flood modifications recommended in the IPEEE were not considered further in the SAMA analysis because the IPEEE was conducted in 1995 and many changes to the site have taken place since that time. For example, a mechanical-draft cooling tower was added to supplement the existing natural draft cooling tower. The old Bechtel administration building was removed. Also, security-related changes were made following the September 11, 2001 destruction of the World Trade Center, including installation of vehicle barriers, guard houses, chain-link fences, and jersey barriers (to prohibit intruder access). These changes have impacted the topography and drainage characteristics of the site.

Also, the site was re-evaluated during the 2011 Mississippi River flood and was determined to be adequately protected against external flooding. During a three month period of inspection (3/28/11 – 6/27/11) NRC resident and region inspectors performed a review of the flooding procedures and site actions for seasonal extreme flooding of the Mississippi River. As part of this evaluation, the inspectors checked for obstructions that could prevent draining, checked that the roofs did not contain obvious loose items that could clog drains in the event of heavy precipitation, and determined that barriers

required to mitigate flooding were in place and operable. Additionally, the inspectors performed an inspection of the protected area to identify any modifications to the site that would inhibit site drainage or that would allow ingress past a barrier during a probable maximum precipitation event. No recommendations for improved flood protection were identified. Thus, the specific changes recommended in the IPEEE are no longer recommended to improve flood protection.

In addition, the following calculation shows that modifications similar to those in SAMAs 240-244 are not potentially cost-beneficial.

The maximum benefit from internal events, with a CDF of 2.05E-06/rx-yr is $74,673 and the probability of inundation of the GGNS site reported in the IPEEE is only 2.1E-08/rx-yr. Thus, the maximum benefit that could be realized from these improvements is $765 ($2,295 with the uncertainty multiplier) and each individual SAMA would not eliminate 100% of the total external flooding risk. Since site drawings and documentation would have to be updated to reflect each modification, the implementation cost for each proposed external flood SAMA would exceed the potential benefit. Therefore, external flood SAMAs 240 through 244 are not potentially cost-beneficial and the SAMA analysis conclusions are unchanged.

Request

4. Provide the following information relative to the Level 3 analysis:

   a. In Section E.1.5.2.1, it was stated that "Louisiana and Mississippi state tourism data was used to calculate a transient to permanent population ratio to increase each county's projected population to account for visitors." Clarify how transient population was used in the SAMA analysis.

   b. Section E.1.5.2.6 indicated meteorological data from 2009 were selected for the analysis because they resulted in the highest release quantities. Describe the source of precipitation data, modeling of precipitation events, and precipitation influence on calculated doses. Quantify the amount of missing meteorological data, which were estimated using data substitution.

   c. Table E.1-12 lists radionuclides in the GGNS core and provides the core inventory for each radionuclide. Table E.1-9 presents release fraction groups used in the Level 3 analysis for calculating radiological doses. Confirm that all radionuclides in the core inventory were used in the radiological dose calculations or explain any differences.

   d. Indicate if any changes in future fuel management practices or fuel design are planned or being considered that would change the core inventory presented in Section E.1.5.2.8.

Response 4a

The websites for the state tourism agencies were accessed to obtain the most recent tourist (transient) information. The latest available tourist information for Louisiana was 2008 data, while 2009 data was the latest available for Mississippi. Fine geographical-level tourism data (e.g. tourist per year per county) is not collected by states for the area within the 50-mile radius of GGNS. Louisiana and Mississippi collect these data at the state level only.

To calculate the annual visitor days, the reported annual visitor numbers were multiplied by the average stay values. The annual visitor days was then divided by 365 to calculate the transient population in person days. A ratio of the transient population over the permanent population was calculated to produce the transient/permanent ratio.

Assuming an even distribution of transients across each state the transient/permanent ratio is the same for each county or parish in each respective state. The transient/permanent ratio was assumed to be constant with time because it is an economic value proportional to population changes. The transient/permanent ratios were multiplied by the permanent population of the county or parish for 2044 to produce the estimated transient population for the county or parish. For the SAMA analysis, the transient population for the 50-mile region was summed with the permanent population.

Response 4b

The primary meteorological system was the data source for the precipitation data. The GGNS raw meteorological data files provided hourly precipitation values in the format X.XX inches. These values were converted to the MACCS2 input format by multiplying each value by 100 to provide precipitation in hundredths of an inch. For example, an hourly precipitation value of 1.05 inches was converted to 105 hundredths of an inch. Zero precipitation was assumed if a data hour was missing precipitation data; this provides conservative results from the MACCS2 model.

The modeling of precipitation events is governed by the boundary weather conditions specified below.

Boundary Weather Conditions:
Boundary Weather Mixing Layer Height:
M2BNDMXH001 = 862.5 m (based on GGNSMET2009.inp)
Boundary Weather Stability Class Index:
M2IBDSTB001 = 4 (neutral, D-Stability) (based on GGNSMET2009.inp)
Boundary Weather Wind Speed:
M2BNDWND001 = 2 m/s (based on GGNSMET2009.inp)
Number of Rain Distance Intervals for Binning (modeling choice):
M4NRNINT001 = 5
Endpoints of Rain Distance Intervals for Binning (modeling choice):
M4RNDSTS001 = 8.05 16.10 32.21 48.31 80.52 km
Number of Rain Intensity Breakpoints (modeling choice):
M4NRINTN001 = 2
Rain Intensity Breakpoints for Weather Binning (modeling choice):
M4RNRATE001 = 99.9, 100. mm/hr
Number of Samples per Bin (modeling choice):
M4NSMPLS001= 8

The selection of meteorological data from 2009 was performed by running MACCS2 with the meteorological input file for each year 2005 through 2009 and calculating the total population dose and offsite economic cost. Thus, the precipitation influence on calculated doses was not determined, but the total annual meteorological input on calculated doses was determined.

Of the 8,760 consecutive hourly meteorological input data records in the 2009 data set, 95 hours were missing lower wind data, 1 hour was missing precipitation data, and 131 hours were missing temperature difference data. This means that less than 3% of the records required some form of data substitution.

Specifically, the 2009 data set had the following missing data blocks.

- Month 1 Day 3 Time 15:00 through Month 1 Day 7 Time 13:00 (95 hours). Ninety-five hours of lower wind direction data were missing. The upper wind direction data were used to substitute for the lower wind direction data.
- Month 6 Day 29 Time 14:00 (1 hour). One hour of precipitation data was missing. To be conservative, zero was used to substitute the missing precipitation values.

The following hours had missing temperature difference data. Data from Jackson Airport National Weather Service was used as a substitute (NCDC 2005-2009).

- Month 2 Day 13 Time 17:00 through Month 2 Day 14 Time 12:00 (20 hours).
- Month 3 Day 13 Time 17:00 through Month 3 Day 15 Time 8:00 (40 hours).
- Month 3 Day 16 Time 1:00 through Month 3 Day 16 Time 15:00 (15 hours).
- Month 5 Day 11 Time 23:00 through Month 5 Day 12 Time 11:00 (13 hours).
- Month 10 Day 4 Time 23:00 through Month 10 Day 5 Time 15:00 (17 hours).
- Month 12 Day 10 Time 10:00 through Month 12 Day 10 Time 12:00 (3 hours).
- Month 12 Day 15 Time 0:00 through Month 12 Day 15 Time 9:00 (10 hours).
- Month 12 Day 31 Time 3:00 through Month 12 Day 31 Time 13:00 (11 hours).

Response 4c

All of the nuclides contained in the core inventory, shown in environmental report Table E.1-12, are included in the Level 3 analysis. All of the nuclides are in the MACCS2 input file and correspond to parameters CORINV001 through CORINV060. Each of the nuclides is grouped into one of nine MACCS2 nuclide groups as designated by the parameters ISOTPGRP001 through ISOTPGRP060. The nine nuclide groups, shown in Table E.1-9, are called NG (Xe/Kr), I, Cs, Te, Sr, Ru, La, Ce and Ba.

Response 4d

As indicated in the environmental report, the core fission product inventory given in Table E.1-12 is from calculations supporting the extended power uprate to 115% (4408 MWt) of the original licensed thermal power. This fission product inventory also considers the extension to 24 month refueling cycles. No additional changes in fuel management practices or fuel design are planned or being considered that would impact the core fission product inventory.

Request

5. Provide the following information with regard to the selection and screening of Phase I SAMA candidates:

   a. Provide the complete Phase I candidate SAMA list as described in Section E.2.1, SAMA List Compilation.

   b. Describe basic event B21-FO-HEDEP2-I, "Operator fails to manually depressurize vessel with non-ADS valves," given in Table E.1-2. Comment on the potential for improvements in procedures and training to reduce this event.

c. A number of basic events in Table E.1-2 fail the High Pressure Core Spray (HPCS) or the Reactor Core Isolation Cooling (RCIC) and have relatively high RRWs in particular those involving HPCS valves, E22 F004 and E22 F012-C, and the RCIC steam supply valves. In all but one case, the potential SAMAs cited for these basic events involve costly major modifications. Describe the above cited valves and considerations of lower cost alternatives for reducing the impact of these HPCS or RCIC failures.

d. Basic events N21-FO-HEPCS-G, "Human error: Failure to properly align the PCS for injection," NRC-FO-FWSACT, "Failure to align FPW for long term injection," and P53-FOHECOOLIAS, "Operator fails to align SSWB to IAS compressor upon loss of TBCW," have high failure probabilities (1.0, 0.57, and 1.0, respectively). Discuss the potential for improved procedures and training (or possibly staging necessary equipment) to reduce these failure probabilities.

Response 5a
The complete Phase I candidate SAMA list is included in Attachment 2 to this letter

Response 5b
Table E.1-2 shows a failure probability of 1.0 for this event, but this does not mean that this action is never successful. Rather, a failure probability of 3.2E-04 is applied to cutsets containing B21-FO-HEDEP2-1 via event NRS-DEP-SHORT in the recovery rule file. Therefore, these two events represent the same failure. The RRW values for B21-FO-HEDEP2-1 and NRS-DEP-SHORT in Table E.1-2 are not the same because some cutsets containing B21-FO-HEDEP2-1 are recovered by events like NRS-PCS-DEP and NRS-PCSL8&DEP which account for dependencies between B21-FO-HEDEP2-1 and other manual actions.

The action represented by B21-FO-HEDEP2-1 and NRS-DEP-SHORT involves manual depressurization with SRVs as directed by the EOPs. Emergency depressurization is directed on RPV water level below -192 inches, on unsafe heat capacity temperature limit, on containment temperature above 185°F, on drywell temperature above 330°F, on unsafe pressure suppression pressure, and on suppression pool level below 14.56 feet or above 24.4 feet. This operator action is based on depressurization due to low RPV water level for a transient event.

The failure probability is based on the cause-based analysis, not on timing, but the EOP steps for emergency depressurization are already graphically distinct. The steps are branch points that send the EOP user to a different procedure step and are colored and shaped differently than other EOP steps. The operators are trained on emergency depressurization as part of regular simulator training.

Thus, improvements in procedures or training would not noticeably reduce the probability of this event.

Response 5c
Valve 1E22F004 is the isolation valve in the HPCS line to the reactor vessel. It is a 12" Anchor Darling gate valve with a Limitorque motor operator.

Valve 1E22F012-C is the isolation valve in the HPCS minimum flow line to the suppression pool. It is a 4" Anchor Darling gate valve with a Limitorque motor operator.

Valves E51F063 and E51F064 are the inboard and outboard steam supply valves to the RCIC turbine. They are William Powell 10" gate valves with Limitorque motor operators.

Consideration has been given to lower cost alternatives to reduce the impact of these HPCS and RCIC failures. All 144 SAMAs from NEI 05-01 Rev. A, Table 13 were considered SAMA candidates in Phase I. In addition, all of the cost beneficial SAMAs from several BWR SAMA analyses were considered SAMA candidates in Phase I, including those from James A. FitzPatrick Nuclear Power Plant, Vermont Yankee Nuclear Power Station, Pilgrim Nuclear Power Station, Oyster Creek Nuclear Generating Station, Monticello Nuclear Generating Plant, Brunswick Steam Electric Plant, Units 1 and 2, Duane Arnold Energy Center, Susquehanna Steam Electric Station, and Cooper Nuclear Station.

Phase I SAMA 85, which is already installed, evaluated developing guidance to allow local, manual control for RCIC operation. In addition a number of other Phase I SAMAs evaluated improvements for other methods of core cooling.

Response 5d

As described below, procedures and training are already in place for these actions and appropriate equipment is staged. Further procedure improvement, training, or staging would not reduce the failure probabilities.

N21-FO-HEPCS-G

Table E.1-2 shows a failure probability of 1.0 for N21-FO-HEPCS-G, but as with B21-FO-HEDEP2-1 in the response to RAI 5.b, this does not mean that this action is never successful.

A failure probability of 8.3E-04 is applied to cutsets containing N21-FO-HEPCS-G via event NRS-FO-FDWRINJ in the recovery rule file. The RRW values for N21-FO-HEPCS-G and NRS-FO-FDWRINJ are not the same because some cutsets containing N21-FO-HEPCS-G are recovered by events like NRS-PCS&DEP and NRS-PCS&CS which account for dependencies with other manual actions.

The action represented by N21-FO-HEPCS-G and NRS-FO-FDWRINJ is to reduce feedwater flow to the reactor by tripping one of the two feedwater pumps and controlling RPV level until the startup level control system is placed in service as directed by the EOPs. The operators are trained to trip one of the feedwater pumps and control RPV level as part of regular simulator training. This action is taken in the control room and staged equipment is not needed. Thus, improvements in procedure, training, or staging would not noticeably reduce the failure probability for this event.

NRC-FO-FWSACT

Table E.1-2 shows a failure probability of 0.57 for NRC-FO-FWSACT. This recovery event is applied to cutsets containing basic event P64-FO-HE-G in short-term SBO sequences (diesel fails to continue to run). In longer SBO sequences, recovery event NRC-FO-FWS8HR with a failure probability of 0.011 is applied to cutsets containing basic event P64-FO-HE-G.

The action represented by these events is to align the Fire Protection Water system for injection per EOP Attachment 26. EOP Attachment 26 provides eight pathways to align Fire Protection Water into the RPV. All eight paths are needed to provide sufficient injection to the RPV to prevent a late core melt.

The procedure indicates that all actions are taken on the same elevation of the auxiliary building and that the necessary tools and components are available nearby. Operators are trained on this EOP action via simulated walk-throughs. Thus, improvements in

procedure, training, or staging would not noticeably reduce the failure probability for this event.

P53-FO-HECOOLIAS

Table E.1-2 shows a failure probability of 1.0 for P53-FO-HECOOLIAS, but as with B21-FO-HEDEP2-1 in the response to RAI 5.b, this does not mean that this action is never successful.

A failure probability of 2.2E-04 is applied to cutsets containing P53-FO-HECOOLIAS via event NRS-FO-SSWIA in the recovery rule file. The RRW values for P53-FO-HECOOLIAS and NRS-FO-SSWIA in Table E.1-2 are essentially the same. P53-FO-HECOOLIAS is not included in any combination recoveries, but a few cutsets containing this event may have a different recovery applied by the rule file, resulting in the small difference between the two RRW values.

The action represented by P53-FO-HECOOLIAS and NRS-FO-SSWIA is to manually align SSW to cool the instrument air and service air compressors following a loss of TBCW. The operators would start SSW train B and open the crosstie valves to TBCW. The action is directed by the EOPs and SSW system operating instructions. The operators are trained in this action as part of regular simulator training. This action is taken mostly in the control room and staged equipment is not needed. Thus, improvements in procedure, training, or staging would not noticeably reduce the failure probability for this event.

Request

6. Provide the following information with regard to the Phase II cost-benefit evaluations:

   a. For many potential SAMAs, cost is taken from the Cooper Nuclear Station or other SAMA analyses. Although this may be valid for some potential SAMAs such as adding major systems/components, its validity is less certain for modifications to plant electrical or other systems for which the GGNS design may differ from the referenced plant (e.g., SAMA Numbers 4, 6, 26, 34, 47, 54, and 55). Discuss steps taken to assure that the cited cost estimates are either valid for GGNS or underestimate the anticipated cost at GGNS.

   b. Provide the release category frequencies for each Phase II SAMA.

   c. The descriptions for Case 6, Reduce Loss of Off-Site Power During Severe Weather, and Case 10, Reduce Plant-Centered Loss of Off-Site Power, indicate that LOSP initiating event frequencies were multiplied by 19/24 and 9/24 to account for severe weather and plant-centered causes of LOSP, respectively. This appears to imply that severe weather caused 5 of a total of 24 LOSP events while plant centered failures caused 15 of 24 LOSP events. Provide the basis for these values.

   d. SAMA Number 14 {Provide a portable EDG [Emergency Diesel Generator] fuel oil transfer pump} was evaluated by Case 8 to eliminate failure of EDGs to run. The list of basic events set to zero does not include P81-FR-DG-G13-C, "DG13 fails to run." Considering values of RRW, inclusion of this basic event might increase the CDF reduction to 5% and could make this potential SAMA cost beneficial. Discuss why DG13 was not included in the assessment, including its impact on the SAMA analysis.

e. Explain how eliminating failure of hydrogen igniters in Case 32 leads to a 15.9% reduction in CDF.

f. The description for Case 41, Trip/Shutdown Risk, indicates that certain initiating event frequencies were reduced by 10%. Table E.2-2 states they were reduced by a factor of 2. Confirm the amount of reduction.

g. With reference to the final paragraph of Section 4.21.5 of the ER, describe briefly the GGNS corrective action process incorporating the condition reports which have been initiated to implement the potentially cost-beneficial SAMAs.

Response 6a

Engineering judgment by project engineers familiar with the costs of modifications at Entergy plants was used to determine if the cited cost estimates from Cooper Nuclear Station (CNS) or other SAMA analyses were valid for GGNS. If the project engineers' rough conceptual estimate of the modification was larger than the other plant's estimate, the other plant's estimate was adopted without further detailed cost analysis.

Some contributing factors to the higher rough estimates include the fact that GGNS is a spacious plant compared to many of the plants from which estimates were obtained, meaning that lengths of pipes and cable runs are longer, thus costing more. Also, many of the CNS estimates were actually from other plants and were, therefore, estimated several years ago. The method and charges used today to obtain capital money make most modifications more costly.

Therefore, the cited cost estimates (including those for SAMAs 4, 6, 26, 34, 47, 54, and 55) underestimate the anticipated cost at GGNS.

Response 6b

The release category frequencies for each analysis case are included in Attachment 3 to this letter. Environmental report Table E.2-2 indicates the Phase II SAMA(s) associated with each analysis case.

Response 6c

There are twenty-four LOSP events from 1996 to August 2006, from the references below that are applicable to the GGNS at-power model (EPRI category IV events were excluded for the at-power model). Five of those events were weather related, while fifteen of them were plant- or switchyard-related failures, and four were grid-related failures. The classification of these events is based on the methods described in NUREG/CR-6890 (see below) and is consistent with the LOSP references given below.

Analysis Case 10, Reduce Plant-Centered Loss of Off-Site Power, conservatively removes the contribution from switchyard-related failures in addition to plant-centered failures because the LOSP data does not discriminate between plant and switchyard transformer failures. Since SAMA 18 is not cost beneficial with this conservative benefit estimate, the exact number of plant-centered transformer failures was not determined.

LOSP event references -

1. SECY-2001-0133, July 2001, "Status Report on Study of Risk-Informed Changes to the Technical Requirements of 10 CFR Part 50 (Option 3) and Recommendations on Risk-Informed Changes to 10 CFR 50.46 (ECCS Acceptance Criteria)."

2. NUREG/CR-6890, December 2005, "Reevaluation of Station Blackout Risk at Nuclear Power Plants."
3. EPRI TR-110398, April 1998, "Losses of Off-Site Power at U.S. Nuclear Power Plants – Through 1997," Final Report.
4. EPRI TR-1000158, July 2000, "Losses of Off-Site Power at U.S. Nuclear Plants – Through 1999," Final Report.
5. EPRI TR-1009889, April 2004, "Losses of Off-Site Power at U.S. Nuclear Plants – Through 2003," Final Report.
6. EPRI TR-1013239, March 2006, "Losses of Off-Site Power 2005," Final Report.

Response 6d

DG13 was not included in the assessment because it does not have a common fuel oil transfer pump with DG1 and DG2. The purpose of the SAMA is to eliminate the common cause failure of the DG's due to the fuel oil transfer pump failure. Since the only diesels that have a common cause failure are the DG 1&2 class 1E diesels, and since the fraction of EDG fail-to-run events that is due to fuel transfer pump failures is less than 1, eliminating failure of those diesels to run conservatively bounds the impact of providing a portable backup fuel transfer pump for those diesels.

If DG13 was included in the assessment, either two portable fuel transfer pumps would be needed, or the pump would have to be moved to fill the additional day tank. This would result in an implementation cost increase.

Therefore, inclusion of DG13 in this assessment would not change the analysis conclusion.

Response 6e

Case 32 is a bounding analysis which sets the level 2 gate for failure of the hydrogen igniters to FALSE in the fault tree (gate E61-001). Setting this gate to FALSE effectively eliminates all cutsets that contain hydrogen ignition failure from the level 2 analysis. Thus, although failure of the hydrogen igniters does not contribute to core damage, removal of these cutsets from the analysis changes the CDF remaining in the analysis.

Response 6f

The description of Case 41, which indicates that certain initiating event frequencies were reduced by 10%, is correct. Table E.2-2 inadvertently contains wording from a draft analysis.

The assumption for analysis case 41 in Table E.2-2 of the ER is revised to read as follows. Deletions are shown with strikethrough and additions with underline.

> Reducing all initiating events except pipe breaks, floods, and LOSP by ~~a factor of 2~~ <u>10%</u>.

Response 6g

The GGNS corrective action process is described in Section B.0.3 of the license renewal application.

> *"GGNS quality assurance (QA) procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. Conditions adverse to quality, such as failures,*

malfunctions, deviations, defective material and equipment, and nonconformances, are promptly identified and corrected. In the case of significant conditions adverse to quality, measures are implemented to ensure that the cause of the nonconformance is determined and that corrective action is taken to preclude recurrence. In addition, the root cause of the significant condition adverse to quality and the corrective action implemented are documented and reported to appropriate levels of management.

GGNS QA procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. The GGNS Quality Assurance Program applies to GGNS safety-related structures and components. Corrective actions and administrative (document) control for both safety-related and nonsafetyrelated structures and components are accomplished in accordance with the established GGNS Corrective Action Program (CAP) and Document Control Program. The confirmation process is part of the CAP and includes the following:

- *Reviews to assure that corrective actions are adequate.*
- *Tracking and reporting of open corrective actions.*
- *Review of corrective action effectiveness.*

Any follow-up inspection required by the confirmation process is documented in accordance with the CAP."

The condition description for CR-GGN-2011-07358 states the following.

"The GGNS Severe Accident Mitigation Alternative (SAMA) analysis for License Renewal has identified three procedure changes which are potentially cost-beneficial enhancements for mitigating the consequences of a severe accident at GGNS.

The attached document provides more information about these three severe accident procedure enhancements which should be evaluated for implementation. The document describes the benefit of the enhancements in terms of decreased core damage frequency, decreased population dose risk, and decreased offsite economic cost risk that could be achieved by implementing each of the procedure changes. The SAMA analysis used conservative assumptions to determine these benefits using GGNS-specific PRA models.

It is recommended that GGNS Operations Department should review the attached document, evaluate the enhancements, and follow-up to implement the enhancements if it is agreed that they are desirable. It is recommended that the review and follow-up be performed via a condition report, which would allow assignment of actions as necessary to confirm the SAMA analysis benefit results, to determine the best method of implementation for each of the enhancements, and to revise the appropriate procedures."

Request

7. Provide the following information with regard to the sensitivity and uncertainty analyses:

As provided in Section E.1.1, an uncertainty multiplier of 3 was applied to the cost-benefit analysis for potential SAMAs as a conservative selection to account for differences in the 95th-percentile CDF to the mean CDF. With uncertainty applied, Table E.2-2 indicates that

three potential SAMAs (Numbers 13, 14, and 63) are within $10,000 of the stated cost estimate. Comment on the representativeness of the stated cost estimates compared to actual costs at GGNS and provide estimates of cost margin for these potential SAMAs.

Response 7

SAMA 13 – Proceduralize battery charger high-voltage shutdown circuit inhibit

This SAMA has a benefit of $40,793 and an implementation cost estimate of $50,000. The implementation cost estimate is at the low end of the GGNS range for a procedure change with engineering or training required ($50k - $200k per ER Section E.2.3). Therefore, the implementation cost is likely to be larger at GGNS. Therefore, the expected margin between the benefit and actual implementation cost estimates is greater than $10,000.

Also, the benefit was calculated by assuming that this procedure change would remove all core damage contribution from battery charger failure. The procedure change would direct the operators to disable the charger high-voltage trip circuit when the batteries have failed, allowing the chargers to continue to supply power. This procedure change could not possibly remove all core damage contribution from charger failure because the chargers will still have a random failure probability and the human action will also have a failure probability.

Since the estimated cost of implementation exceeds the benefit, SAMA 13 is not cost-beneficial.

SAMA 14 – Provide a portable EDG fuel oil transfer pump

This SAMA has a benefit of $91,044 and an implementation cost estimate of $100,000. The implementation cost estimate is at the low end of the range for hardware changes. This modification would require piping changes to the safety-related diesel fuel oil system to permit hook-up of the portable pump. Therefore, the design and implementation of this modification would cost more than $200,000. Thus, the margin between the benefit and actual implementation cost estimates is greater than $10,000.

Since the estimated cost of implementation exceeds the benefit, SAMA 14 is not cost-beneficial.

SAMA 63, Add a redundant RCIC lube oil cooling path

This SAMA has a benefit of $92,683 and an implementation cost estimate of $100,000. The implementation cost estimate is at the low end of the range for hardware changes. This modification would require piping changes to a safety-related system. Therefore, the design and implementation of this modification would cost more than $200,000. Thus, the margin between the benefit and actual implementation cost estimates is greater than $10,000.

Since the estimated cost of implementation exceeds the benefit, SAMA 63 is not cost-beneficial.

Request

8. For certain SAMAs considered in the GGNS Environmental Report, there may be lower-cost alternatives that could achieve much of the risk reduction. In this regard, provide an evaluation of the following SAMAs:

   a. Phase II SAMA Numbers 30, 32, and 33 for adding or enhancing Emergency Diesel Generator (EDG) HVAC hardware were considered for basic events involving EDG

HVAC failures. SAMA Numbers 30 and 33 involve expensive hardware modifications. Evaluate the possibilities of opening doors and use of portable fans and ducts. SAMA Number 32 calls for adding diverse EDG HVAC logic. Consider procedures for operators to manually initiate EDG HVAC if the existing automatic logic fails. If no alarms are expected for any of these failures, procedures for the plant auxiliary operators to check on any automatic start of the EDG could allow HVAC failures to be discovered and might eliminate the need for alarms.

b. For SAMA Number 25 (Install a bypass switch to allow operators to bypass low reactor pressure interlock circuitry), consider providing directions to use jumpers to bypass the interlock.

c. For SAMA Number 35, consider the use of other air compressors (service air) that might be connected to the instrument air system instead of providing new compressors.

d. For Case 39 concerning control room fires, consider improving control room fire detection system response for a limited number of key cabinets.

Response 8a

Phase I SAMAs 125, 126 and 127 were considered for procedure changes for operators to open doors or use portable fans and ducts following loss of EDG HVAC. It was postulated that these SAMAs would require a high temperature alarm as evaluated in Phase II SAMA 30.

However, as suggested in this RAI, the loss of AC power procedure does indicate that a running diesel generator should be periodically monitored locally. The EDG operating procedure indicates that an hourly check-sheet should be completed if the diesel is to run for more than one hour. Thus, an operator should be in the DG room once each hour and would be able to notice that the ventilation was not working. Thus, if the automatic start logic for the EDG HVAC system fails, it could be manually started. Or, if the EDG HVAC system fails, the doors could be opened or portable fans could be used.

The benefit with uncertainty for analysis case 22, which eliminates failure of cooling for the three diesel generator rooms, is $227,963. The GGNS range for a procedure change with engineering or training required is $50k - $200k per ER Section E.2. Since the cost of the procedure change is less than the potential benefit, a SAMA is retained to revise procedures to direct that the operator monitoring a running diesel ensure the ventilation system is running, or take action to open doors, or use portable fans.

A condition report to implement this potentially cost-beneficial SAMA has been initiated within the corrective action process.

Response 8b

SAMA 25 was evaluated assuming that the new bypass switch would eliminate all possible ECCS permissive and interlock failures, resulting in a benefit with uncertainty of $30,093.

Due to the logic, at least two interlocks would have to fail and require bypass to permit opening one train of low pressure injection valves (more if a common cause failure occurred) and at least four interlocks would have to be bypassed to permit opening both trains of valves. With this level of complexity, it is expected that human reliability analysis would show that an action to use jumpers to bypass the interlocks would fail

with a probability of 1.0. Since the benefit would not be realized, this SAMA would not be cost-beneficial.

Response 8c

A modification has been performed to join the service air and instrument air systems. Also, procedures exist to use two portable air compressors to supply instrument air if necessary (see Phase I SAMAs 133 and 134). Although they are not reflected in the model used for the SAMA analysis, these SAMAs have already been implemented.

Response 8d

The control room underfloor area (containing cable) is protected by an automatic halon system which uses smoke detectors. The remainder of the control room has smoke detectors in every cabinet except P680, which is the console at which the operator sits.

Also, the control room is continuously occupied, which provides the capability of prompt detection and suppression as defined in NUREG/CR-6850. Although "very early warning" or "incipient" detection systems have been developed that can warn of impending fires, these systems do not provide a significant improvement in continuously manned areas such as the control room.

Thus, improving control room fire detection system response would not provide significant benefit and would not be cost-beneficial.

Attachment 2 to

GNRO-2012/00072

Phase I Candidate SAMA Analysis

Table 1 Phase I SAMA Analysis

Phase I SAMA ID number	SAMA Title	Source Reference of SAMA	Result of Potential Enhancement	Screening Results	Disposition	Improvement Category
1	Provide additional DC battery capacity.	NEI 05-01 [1]	Extended direct current (DC) power availability during a station blackout (SBO).	Retain	This SAMA would extend high pressure coolant injection (HPCI) and reactor core isolation cooling (RCIC) operability and allow more credit for alternating current (AC) power recovery. The GGNS batteries are designed to provide an adequate amount of energy for all required emergency loads following the loss of AC power for four hours with Divisions I and II and for two hours with Division III.	AC and DC power
2	Replace lead-acid batteries with fuel cells.	NEI 05-01 [1]	Extended DC power availability during an SBO.	Retain	This SAMA would extend HPCI and RCIC operability and allow more credit for AC power recovery.	AC and DC power

Table 1 Phase I SAMA Analysis						
3	Add additional battery charger or portable, diesel-driven battery charger to existing DC system.	NEI 05-01 [1]	Improved availability of DC power system.	Retain	The Engineered Safety Features (ESF) DC power system is divided into three divisions: Div I, Div II and Div III. Each division is a 125V DC system consisting of two battery chargers, a bank of batteries and appropriate distribution panels. For Div III, normally one charger supplies the loads. For Div I and Div II, two chargers normally supply the loads. This SAMA is being retained to add a new permanent charger.	AC and DC power
4	Improve DC bus load shedding.	NEI 05-01 [1]	Extended DC power availability during an SBO.	#3 - Already installed	Plant DC load-shedding procedures are in place to increase the probability of successful load shed under SBO conditions.	AC and DC power
5	Provide DC bus cross-ties.	NEI 05-01 [1]	Improved availability of DC power system.	Retain	The DC buses at GGNS do not contain cross-ties.	AC and DC power

Table 1 Phase I SAMA Analysis						
6	Provide additional DC power to the 120/240V vital AC system.	NEI 05-01 [1]	Increased availability of the 120 V vital AC bus.	#3 - Already installed	The 120V AC essential instrument power system consists of redundant distribution panels fed through transformers connected to separate ESF motor control centers. The Unit 1 Class 1E 120V AC uninterruptible power system (UPS) is separated into four divisions with one inverter and one distribution panel assigned to each division. The class 1E UPS system consists of four class 1E inverters with four class 1E alternate sources. The inverter is the normal source of power to the UPS distribution panel. Should the inverter develop trouble the static transfer switch will automatically transfer the load to the alternate source. The 120/240V AC uninterruptible power system consists of six inverters for Unit 1. Normally, the non-Class 1E uninterruptible AC power system receives its power from an inverter static switch arrangement. Due to this multiple redundancy, the probabilistic risk assessment (PRA) model does not require the UPS buses as a dependency.	AC and DC power

Table 1 Phase I SAMA Analysis						
7	Add an automatic feature to transfer the 120V vital AC bus from normal to standby power.	NEI 05-01 [1]	Increased availability of the 120 V vital AC bus.	#3 - Already installed	The 120V UPS contains an inverter static switch arrangement which automatically transfers the load to the alternate source.	AC and DC power
8	Increase training on response to loss of two 120V AC buses which causes inadvertent actuation signals.	NEI 05-01 [1]	Improved chances of successful response to loss of two 120V AC buses.	#3 - Already installed	04-1-02-1H13-P601 provides instructions for actions to take if 120VAC logic A, B, C, or D power is lost. It references Off-Normal procedures 05-1-02-III-2, Loss of one or both reactor protection system (RPS) buses and 05-1-01-III-5, Automatic Isolations. GLP-OPS-R2100 provides training on loss of AC power.	AC and DC power

Table 1 Phase I SAMA Analysis						
9	Reduce DC dependence between high-pressure injection system and ADS.	NEI 05-01 [1]	Improved containment depressurization and high-pressure injection following DC failure.	#2 - Similar item is addressed under other proposed SAMAs	The 125 VDC System supplies power to the high pressure core spray (HPCS) initiation logic, valve position indication, valve control logic and the HPCS pump breaker control power. The 125 VDC System supplies power to the Div. I and Div. 2 automatic depressurization system (ADS)/safety relief valve (SRV) logic and SRV pilot solenoid valves. Distribution panel 1DA1 provides power to Div. 1 and distribution panel 1DB1 provides power to Div. 2. SAMAs 27 and 28 will analyze adding a portable generator to supply power to the DC system which will reduce the DC dependence between high-pressure core spray and ADS.	AC and DC power
10	Provide an additional diesel generator.	NEI 05-01 [1]	Increased availability of on-site emergency AC power.	Retain	GGNS currently has two emergency diesel generators (EDGs) and one High Pressure Core Spray Diesel Generator.	AC and DC power

Table 1 Phase I SAMA Analysis						
11	Revise procedure to allow bypass of diesel generator trips.	NEI 05-01 [1]	Extended diesel generator operation.	#3 - Already installed	Many trips, including all engine trips except engine overspeed and generator differential, are automatically bypassed on emergency diesel generator (EDG) emergency start. Off-Normal event procedure, Loss of AC Power provides guidance on bypassing diesel generator trips.	AC and DC power
12	Improve 4.16-kV bus cross-tie ability.	NEI 05-01 [1]	Increased availability of on-site AC power.	Retain	The 4160V system is highly diverse and reliable. Each of the ESF buses has the capability of sharing the same ESF transformer feed. The division 3 DG13 may be cross-tied to either division 1 bus 15AA or division 2 bus 16AB during an SBO. These instructions are contained in the GGNS Loss of AC Power Off-Normal Event Procedure 05-1-02-1-4. See SAMA 33. This SAMA is being retained to increase the reliability of the cross-tie between division 3 to either division 1 or division 2.	AC and DC power
13	Create AC power cross-tie capability with other unit (multi-unit site).	NEI 05-01 [1]	Increased availability of on-site AC power.	#1 - N/A	GGNS is a single unit site.	AC and DC power

Table 1 Phase I SAMA Analysis

14	Install an additional, buried off-site power source.	NEI 05-01 [1]	Reduced probability of loss of off-site power.	Retain	The Grand Gulf to Port Gibson 115 KV line does not cross over or under any of the 500 KV offsite power supply lines, except on the east side of the 500 KV switchyard at Grand Gulf. At this point the 115 KV line is installed underground so that a failure of the 500 KV line cannot cause a failure of the 115 KV power line. Neither of the Grand Gulf 500 KV lines nor the Grand Gulf to Port Gibson 115 KV line are on any common towers or common right-of way.	AC and DC power
15	Install a gas turbine generator with tornado protection.	NEI 05-01 [1]	Increased availability of on-site AC power. The use of gas fuel for a turbine generator would provide diversity plus additional redundancy.	Retain	GGNS already has a redundant and diverse emergency AC power system, with the three EDGs, but has no gas turbine generators.	AC and DC power
16	Install tornado protection on gas turbine generator.	NEI 05-01 [1]	Increased availability of on-site AC power.	#1 - N/A	GGNS does not have a gas turbine generator. When SAMA 15 is evaluated the tornado protection will also be evaluated.	AC and DC power

Table 1 Phase I SAMA Analysis

17	Install a steam-driven turbine generator that uses reactor steam and exhausts to the suppression pool.	NEI 05-01 [1]	Increased availability of on-site AC power.	#1 - N/A	See section A.4.9.1 of advanced boiling water reactor (ABWR) severe accident mitigation design alternative (SAMDA) [28]. SAMA would require excessive modifications that would not be feasible for an existing plant.	AC and DC power
18	Improve uninterruptible power supplies.	NEI 05-01 [1]	Increased availability of power supplies supporting front-line equipment.	#3 - Already installed	The PRA model does not require the UPS buses as a dependency. See SAMA 6.	AC and DC power
19	Create a cross-tie for diesel fuel oil (multi-unit site).	NEI 05-01 [1]	Increased diesel generator availability.	#1 - N/A	GGNS is a single unit site.	AC and DC power
20	Develop procedures for replenishing diesel fuel oil.	NEI 05-01 [1]	Increased diesel generator availability.	#3 - Already installed	The fuel oil storage tank has a capacity of 75,000 gallons, which is sufficient to operate the diesel generator for seven days while supplying post-loss of coolant accident (LOCA) maximum load demands. The storage tank has an above ground fill connection with an in-line basket strainer to remove particles from the incoming fuel oil. The system operating procedure for the diesel generator (DG) system contains steps to refuel the DG fuel oil with a tanker and to transfer DG fuel oil from Div 3 to the Div 1 or 2 storage tanks.	AC and DC power

Table 1 Phase I SAMA Analysis

21	Use fire water system as a backup source for diesel cooling.	NEI 05-01 [1]	Increased diesel generator availability.	Retain	Each EDG is cooled by its independent jacket water cooling system. The Standby Service Water System is the primary source of water for cooling the EDG jacket water.	AC and DC power
22	Add a new backup source of diesel cooling.	NEI 05-01 [1]	Increased diesel generator availability.	Retain	Each EDG is cooled by its independent jacket water cooling system. The Standby Service Water System is the primary source of water for cooling the EDG jacket water. See SAMA 21.	AC and DC power
23	Develop procedures to repair or replace failed 4 KV breakers.	NEI 05-01 [1]	Increased probability of recovery from failure of breakers that transfer 4.16 kV non-emergency buses from unit station service transformers.	#3 - Already installed	No new procedure is required. GGNS has already implemented procedures to replace 4160V breakers.	AC and DC power
24	In training, emphasize steps in recovery of off-site power after a SBO.	NEI 05-01 [1]	Reduced human error probability during off-site power recovery.	#3 - Already installed	Restoring power from offsite sources after SBO is proceduralized. Operators at GGNS are trained to the Loss of AC Power off-normal event procedure.	AC and DC power
25	Develop a severe weather conditions procedure.	NEI 05-01 [1]	Improved off-site power recovery following external weather-related events.	#3 - Already installed	GGNS has a procedure for severe weather conditions to reduce the impact on loss of off-site power.	AC and DC power

Table 1 Phase I SAMA Analysis						
26	Bury off-site power lines.	NEI 05-01 [1]	Improved off-site power reliability during severe weather.	#3 - Already installed	The Grand Gulf to Port Gibson 115 KV line does not cross over or under any of the 500 KV offsite power supply lines, except on the east side of the 500 KV switchyard at Grand Gulf. At this point the 115 KV line is installed underground so that a failure of the 500 KV line cannot cause a failure of the 115 KV power line. Neither of the Grand Gulf 500 KV lines nor the Grand Gulf to Port Gibson 115 KV line are on any common towers or common right-of way.	AC and DC power
27	Portable generator for direct current (DC) power: This SAMA involves the use of a portable generator to supply DC power to the battery chargers during a station blackout.	Brunswick [7] SAMA 1	Increased time available for AC power recovery.	Retain	GGNS does not currently utilize any portable DC chargers in case of loss of the normal plant chargers or station blackout. This SAMA is being retained to add a portable generator to feed the battery chargers.	AC and DC power
28	Portable generator for direct current (DC) power: This SAMA involves the use of a portable generator to supply DC power to the individual panels during a station blackout.	Brunswick [7] SAMA 1	Increased time available for AC power recovery.	Retain	GGNS does not currently utilize any portable DC chargers in case of loss of the normal plant chargers or station blackout. This SAMA is being retained to add a portable generator to supply an individual panel or bus.	AC and DC power

Table 1 Phase I SAMA Analysis

29	Provide alternative feeds to panels supplied only by DC bus 2A-1: This SAMA involves the installation of alternate DC feeds, which may reduce plant risk through diversification of the power supplies.	Brunswick [7] SAMA 1	Increased time available for AC power recovery	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 28.	AC and DC power
30	Proceduralize battery charger high-voltage shutdown circuit inhibit: This SAMA involves disabling the charger high-voltage trip circuit when the batteries are disconnected from the DC circuit, thereby preventing the trip and allowing the chargers to remain online.	Brunswick [7] SAMA 25	Extended DC power availability.	Retain	GGNS does not have a procedure in place to disable the charger high-voltage trip circuit when the batteries are disconnected from the DC circuit.	AC and DC power
31	Provide a portable EDG fuel oil transfer pump: This SAMA provides additional means of supplying the EDG day tank in the event a common cause failure prevents operation of the existing pumps.	Brunswick [7] SAMA 29	Extended diesel generator operation.	Retain	GGNS has two diesel oil transfer pumps. Each transfer pump can supply fuel from the dedicated main storage tank to the DGs day tank. Each DG has its own separate fuel oil system (including main tanks with fuel oil transfer pump).	AC and DC power

Table 1 Phase I SAMA Analysis						
32	Use DC generators to provide power to operate the switchyard power control breakers while a 480-V AC generator could supply the air compressors for breaker support.	Brunswick [7] SAMA 34	Improved recovery of offsite power after station batteries have been depleted.	Retain	GGNS has three offsite power sources; two 500 kV lines (Franklin and Baxter Wilson substations) and one 115 kV line (Port Gibson substation). Two 125 volt batteries in the 500 kV switchyard supply the control power for the 500 kV breakers. Each battery has its own charger with redundant AC power supplies. The 115 kV breaker control power comes from the plant balance-of-plant (BOP) DC batteries. The AC power in the 500 kV switchyard is depicted in UFSAR Figure 8.2-4. There is a primary AC source and two backup sources. Two of the three AC sources are derived from separate ESF buses which can be fed from the diesel generator. The other supply originates from the 13.8 kV bus in the 115 kV switchyard. The switchyard breakers are two generations of Mitsubishi SF6 breakers. Vendor manual 460004000 for the Mitsubishi breakers indicates that air pressure is used for opening the breakers, but spring force is used for closing the breakers.	AC and DC power

Table 1 Phase I SAMA Analysis						
33	Proceduralize all potential 4-kV AC bus cross-tie actions.	Brunswick [7] SAMA 6	Improved availability of 4-kV power system.	#3 - Already installed	The 4160V system is highly diverse and reliable. Each of the ESF buses has the capability of sharing the same ESF transformer feed. The Division 3 DG13 may be cross-tied to either division 1 bus 15AA or division 2 bus 16AB during an SBO. These instructions are contained in the GGNS Loss of AC Power off-normal event procedure 05-1-02-1-4.	AC and DC power
34	Provide a diverse swing diesel generator air start compressor.	Brunswick [7] SAMA 16	Reduces the common cause failure to start term of EDG starting air compressors.	Retain	Each EDG has a dedicated starting air system which consists of a motor driven air compressor and diesel driven air compressor. There is no cross-tie or swing compressor installed.	AC and DC power
35	Provide alternate feeds to essential loads directly from an alternate emergency bus.	Brunswick [7] SAMA 18	Increased availability of on-site AC power.	Retain	Alternate feed breakers to essential loads are not installed.	AC and DC power
36	Enhance DC power availability by providing a direct connection from the diesel generator, the security diesel, or another source to the 250 V battery chargers or other required loads.	Monticello [6] SAMA 2	Increases time available for AC power recovery.	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 27	AC and DC power

Table 1 Phase I SAMA Analysis

37	Modify procedures and training to allow operators to cross-tie emergency AC Buses 1C and 1D under emergency conditions that require operation of critical equipment.	Oyster Creek [5] SAMA 91	Increased availability of on-site AC power.	#3 - Already installed	See SAMA 33.	AC and DC power
38	Provide portable DC battery charger capable of supplying 125-V buses in order to preserve isolation condenser and electromagnetic relief valve operability along with adequate instrumentation.	Oyster Creek [5] SAMA 109/125A	Improved availability of DC power system.	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 28.	AC and DC power
39	Increase combustion turbine building integrity to withstand higher winds so that combustion turbines would be capable of withstanding a severe weather event.	Oyster Creek [5] SAMA 130	Increased availability of on-site AC power during severe weather.	#1 - N/A	GGNS does not have a gas turbine generator. When SAMA 15 is evaluated the tornado protection will also be evaluated.	AC and DC power
40	Modify procedures to allow switching of the combustion turbines to buses while running.	Oyster Creek, [5] SAMA 132.	Increased availability of on-site AC power.	#1 - N/A	GGNS does not have combustion turbines.	AC and DC power

Table 1 Phase I SAMA Analysis

41	Protect transformers from failure.	Oyster Creek [5] SAMA 138	Loss of off-site power (LOOP) frequency increased by 1 × 10E-2 per year to incorporate impact of postulated transformer explosions.	Retain	This SAMA will evaluate protecting the transformers from explosive failure. Building a wall between the transformers is not feasible because the structure would need to be quite substantial and would interfere with normal access to equipment. Thus this SAMA will evaluate protecting the offsite supply circuitry by excavating a bus duct and relocating the associated cables.	AC and DC power
42	Install key-locked control switches to enable AC bus cross-ties and modify procedures to enhance the reliability of the AC power system.	Pilgrim [4] SAMA 30	Increased availability of on-site AC power.	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 12.	AC and DC power
43	Modify plant procedures to use DC bus cross-ties to enhance the reliability of the DC power system.	Pilgrim [4] SAMA 34	Improved reliability of DC power system.	#1 - N/A	See SAMA 5. The DC buses at GGNS do not contain cross-ties.	AC and DC power
44	Provide redundant power to the direct torus vent valves.	Pilgrim [4] SAMA 56	This SAMA would improve the reliability of the direct torus vent valves and enhance the containment heat removal capability.	Retain	GGNS containment vent valve line fails closed on a loss of one of the four (two 120VAC, two 125 VDC) power supplies. Adding redundant power supplies to each valve would increase the availability of the containment venting.	AC and DC power

Table 1 Phase I SAMA Analysis

45	Modify plant procedures to allow use of the diesel fire pump hydroturbine in the event that EDG A fails or fuel oil transfer pump is unavailable.	Pilgrim [4] SAMA 57	This SAMA would increase capability to provide makeup to the fire pump day tank to allow continued operation of the diesel fire pump, without dependence on electrical power.	#1 - N/A	GGNS does not have a hydroturbine fuel oil transfer pump.	AC and DC power
46	Modify plant procedures to allow alternately feeding B1 loads via B3 when A5 is unavailable post-trip, and alternately feeding B2 loads via B4 when A6 is unavailable post-trip.	Pilgrim [4] SAMA 58	Completely eliminate loss of 4.16 kV bus A5 events.	#3 - Already Installed	See SAMA 33.	AC and DC power
47	Use the security diesel generator to extend the life of the 125 VDC batteries.	Pilgrim [4]	Improved availability of DC power system.	#1 - N/A	GGNS does not have a security diesel generator. GGNS utilizes the non-1E battery backup and the Div 1 and 2 diesel generators for back-up power for the security systems.	AC and DC power
48	Use a portable diesel generator to extend the life of the 125 VDC batteries.	Vermont Yankee [3]	Improve DC power reliability	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 27.	AC and DC power
49	Use a portable generator to provide power to individual 125VDC MCCs upon loss of a DC bus.	Vermont Yankee [3]	Improve DC power reliability	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 28.	AC and DC power

Table 1 Phase I SAMA Analysis						
50	Provide additional DC battery capacity to ensure longer battery capability during the station blackout event, which would extend HPCI/RCIC operability and allow more time for AC power recovery.	Fitzpatrick [2] SAMA 26	SAMA would ensure longer battery capability during an SBO, which would extend HPCI/RCIC operability and allow more time for AC power recovery.	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 1.	AC and DC power
51	Modify plant equipment to provide 16-hour SBO injection.	Fitzpatrick [2] SAMA 30	Extended DC power availability during an SBO.	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 1.	AC and DC power
52	Modify plant equipment to extend DC power availability in an SBO event.	Fitzpatrick [2] SAMA 36	Extended DC power availability during an SBO.	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 1.	AC and DC power
53	Modify plant procedures to allow use of a portable power supply for battery chargers	Fitzpatrick [2] SAMA 61	Increased time available for AC power recovery.	#1 - N/A	There are no portable generators at GGNS that could supply the battery chargers. See SAMA 27, which will evaluate obtaining a portable generator to power the battery chargers.	AC and DC power
54	Use of a portable generator to extend the coping time in loss of AC power events (to power battery chargers).	Fitzpatrick [2]	Improve DC power reliability	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 27.	AC and DC power

Table 1 Phase I SAMA Analysis						
55	Provide a portable generator to supply DC power to individual panels during a SBO, increasing the time available for AC power recovery.	(Cooper [33] SAMA 14)	Increased time available for AC power recovery.	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 28.	AC and DC power
56	Install minimal hardware changes and modify procedures to provide crosstie capability between the 4 kV AC emergency buses.	Susquehanna [32] SAMA 2a	Improved availability of 4-kV power system.	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 12.	AC and DC power
57	Improve cross-tie capability between 4 kV AC emergency buses, i.e., between A or D emergency buses and B or C emergency buses (a more flexible crosstie option than SAMA 2a).	Susquehanna [32] SAMA 2b	Improved availability of 4-kV power system.	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 12.	AC and DC power
58	Modify portable station diesel generator to automatically align to 125 V DC battery chargers.	Susquehanna [32] SAMA 5	Improve DC power reliability	#1 - N/A	GGNS does not have a portable station diesel generator.	AC and DC power

Table 1 Phase I SAMA Analysis

59	Procure an additional portable 480 V AC station diesel generator to power battery chargers in scenarios where AC power is unavailable.	Susquehanna [32] SAMA 6	Improve DC power reliability	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 27.	AC and DC power
60	Install an independent active or passive high pressure injection system.	NEI 05-01 [1]	Improved prevention of core melt sequences.	Retain	GGNS has multiple high pressure injection sources: Condensate, HPCS, control rod drive (CRD), and RCIC.	Core cooling systems
61	Provide an additional high pressure injection pump with independent diesel.	NEI 05-01 [1]	Reduced frequency of core melt from small LOCA and SBO sequences.	#3 - Already installed	At GGNS, HPCS (Division 3) has its own independent diesel generator.	Core cooling systems
62	Raise HPCI/RCIC backpressure trip set points.	NEI 05-01 [1]	Increased HPCI and RCIC availability when high suppression pool temperature exists.	Retain	The current RCIC back pressure trip setpoint is 25 psig. This SAMA is being retained to raise the RCIC backpressure trip set-points. HPCS does not utilize steam as a motive force.	Core cooling systems
63	Revise procedure to allow bypass of RCIC turbine exhaust pressure trip.	NEI 05-01 [1]	Extended RCIC operation.	#3 - Already installed	Emergency/Severe accident procedures reference 05-S-01-EP-1 (Emergency/Severe Accident Procedure Support Documents) which contains guidance in attachments 1 and 3 to defeat RCIC interlocks. Attachment 3 contains guidance which allows bypass of the turbine exhaust pressure trip.	Core cooling systems

Table 1 Phase I SAMA Analysis						
64	Revise procedure to allow intermittent operation of HPCI and RCIC.	NEI 05-01 [1]	Extended HPCI and RCIC operation.	#3 - Already installed	Emergency operating procedure (EOP) flow charts direct intermittent reactor pressure vessel (RPV) flooding as necessary due to plant conditions. This includes the use of HPCI and RCIC.	Core cooling systems
65	Revise procedure to control torus temperature, torus level, and primary containment pressure to increase available net positive suction head (NPSH) for injection pumps.	NEI 05-01 [1]	Increased probability that injection pumps will be available to inject coolant into the vessel.	#3 - Already installed	The EOPs allow the operators to control the primary containment pressure, torus temperature, and torus level. Procedures contain limits which will increase available net positive suction head (NPSH) for injection pumps.	Core cooling systems
66	Revise procedure to manually initiate HPCI and RCIC given auto initiation failure.	NEI 05-01 [1]	Increased availability of HPCI and RCIC given auto initiation signal failure.	#3 - Already installed	This operator action is taken in response to provide an alternate high pressure injection capability during small or medium LOCAs and transients. GGNS EOPs assure initiation of those automatic actions important for controlling reactor coolant.	Core cooling systems

Table 1 Phase I SAMA Analysis

67	Modify automatic depressurization system components to improve reliability.	NEI 05-01 [1]	Reduced frequency of high pressure core damage sequences.	Retain	The GGNS SRVs use a solenoid air valve to operate a pneumatic piston/cylinder and linkage assembly to open the valve. When operating in relief mode, two pilot solenoid valves, attached to each valve, are opened to supply air to each SRV pneumatic actuator. Energizing either pilot solenoid will admit air to the actuator and open the associated SRV. The pilot solenoid valves are powered from separate divisions of 125 VDC power. Accumulators for each ADS SRV contain sufficient air for two actuations if instrument air is unavailable. This SAMA is being retained to add larger accumulators to the 8 ADS SRVs, thus increasing reliability during SBOs.	Core cooling systems
68	Add signals to open safety relief valves automatically in an MSIV closure transient.	NEI 05-01 [1]	Reduced likelihood of SRV failure to open in a main steam isolation valve (MSIV) closure transient reduces the probability of a medium LOCA.	Retain	GGNS has no signals to open SRVs automatically in an MSIV closure transient.	Core cooling systems

Table 1 Phase I SAMA Analysis

69	Revise procedure to allow manual initiation of emergency depressurization.	NEI 05-01 [1]	Improved prevention of core damage during transients, small and medium LOCAs, and anticipated transient without scram (ATWS).	#3 - Already installed	This operator action is taken in response to depressurize the reactor to allow the low pressure injection systems to provide coolant makeup to the reactor pressure vessel during transients, small and medium LOCAs, and ATWS. This operator action has already been implemented at GGNS.	Core cooling systems
70	Revise procedure to allow operators to inhibit automatic vessel depressurization in non-ATWS scenarios.	NEI 05-01 [1]	Extended HPCI and RCIC operation.	#3 - Already installed	EOPs allow operators to inhibit ADS.	Core cooling systems
71	Add a diverse low pressure injection system.	NEI 05-01 [1]	Improved injection capability.	Retain	GGNS has diverse, multiple low pressure injection sources, including low pressure core spray (LPCS) and the low pressure coolant injection (LPCI) mode of residual heat removal (RHR).	Core cooling systems
72	Increase flow rate of suppression pool cooling.	NEI 05-01 [1]	Improved suppression pool cooling.	#3 - Already installed	The suppression pool cooling mode operation of the RHR system is already sized to accommodate flow to remove all decay heat assumed for reactor shutdown.	Core cooling systems

Table 1 Phase I SAMA Analysis

73	Provide capability for alternate injection via diesel-driven fire pump.	NEI 05-01 [1]	Improved injection capability.	#3 - Already installed	GGNS has two diesel driven 1500 gpm fire pumps that can be used for alternate injection. Emergency Procedure 05-S-01-EP-1, attachment 26 provides instructions for injection into the RPV with the fire protection water system.	Core cooling systems
74	Provide capability for alternate injection via reactor water cleanup (RWCU).	NEI 05-01 [1]	Improved injection capability.	#3 - Already installed	Step 3.4 of off-normal event procedure 05-1-02-III-1, Rev. 32, Inadequate Decay Heat Removal, indicates that procedure 04-1-01-G33-1, Reactor Water Cleanup, should be used for RWCU alternate shutdown cooling operation if RHR shutdown cooling and ADHRS capability has been completely lost. Section 5.3 of 04-1-01-G33-1 provides instructions for using RWCU for reactor vessel cooling.	Core cooling systems
75	Revise procedure to align EDG and allow use of essential CRD for vessel injection.	NEI 05-01 [1]	Improved injection capability.	#3 - Already installed	Use of CRD for vessel injection is covered in the existing EOPs. The normal AC power to essential CRD equipment is from the onsite emergency power sources. On loss of offsite power the EDGs provide the required power for CRD injection.	Core cooling systems

Table 1 Phase I SAMA Analysis						
76	Revise procedure to allow use of condensate pumps for injection.	NEI 05-01 [1]	Improved injection capability.	#3 - Already installed	The use of the condensate pumps for injection is covered in the EOPs. Condensate transfer is an alternate injection system using the condensate transfer pumps.	Core cooling systems
77	Revise procedure to allow use of suppression pool jockey pump for injection.	NEI 05-01 [1]	Improved injection capability.	#3 - Already installed	The use of the emergency core cooling system (ECCS) jockey pumps for alternate injection is covered in the EOPs.	Core cooling systems
78	Revise procedure to re-open MSIVs.	NEI 05-01 [1]	Regains the main condenser as a heat sink.	#3 - Already installed	Existing EOPs direct this including bypass of MSIV isolation interlocks as necessary.	Core cooling systems
79	Improve ECCS suction strainers.	NEI 05-01 [1]	Enhanced reliability of ECCS suction.	#3 - Already installed	The suppression pool suction strainer is designed to prevent passage of any particles larger than 0.1" into the RHR and RCIC pumps and subsequently into the reactor vessel. In response to NRC Bulletin 96-03, Potential Plugging of Emergency Core Cooling Suction Strainers by Debris in Boiling Water Reactors, a large passive strainer was installed for the ECCS and RCIC pumps.	Core cooling systems
80	Revise procedure to align LPCI or core spray to CST on loss of suppression pool cooling.	NEI 05-01 [1]	Improved injection in loss of suppression pool cooling scenarios.	#1 - N/A	05-S-01-PSTG states that NPSH will be available for the ECCS pumps as long as the suppression pool water level is above the suction strainers.	Core cooling systems

Table 1 Phase I SAMA Analysis						
81	Remove LPCI loop select logic.	NEI 05-01 [1]	Enables use of LPCI A loop for injection in the event of a B injection path failure.	#1 - N/A	The GGNS RHR system does not have LPCI loop select logic.	Core cooling systems
82	Replace two of the four electric safety injection pumps with diesel-powered pumps.	NEI 05-01 [1]	Reduced common cause failure of the safety injection system. This SAMA was originally intended for the Westinghouse-CE System 80+, which has four trains of safety injection. However, the intent of this SAMA is to provide diversity within the high- and low-pressure safety injection systems.	#3 - Already installed	HPCS is operated from offsite power or the separate diesel power supply, RCIC is steam driven, and LPCI is electric driven. The injection pumps are already diverse in power and common cause failures of the pumps are not risk significant.	Core cooling systems
83	Install an inter-unit CRD cross-tie as a potential means of recovering from a loss of CRD at a given unit.	(Brunswick [7] SAMA 13)	Improved prevention of core melt sequences.	#1 - N/A	GGNS is a single unit site.	Core cooling systems
84	Install a direct drive diesel injection pump as additional high pressure injection system.	Monticello [6] SAMA 4	Improved prevention of core melt sequences.	#3 - Already Installed	See SAMA 61.	Core cooling systems

Table 1 Phase I SAMA Analysis						
85	Develop guidance to allow local, manual control for RCIC operation.	Monticello [6] SAMA 37	Increased availability of RCIC given auto initiation signal failure.	#3 - Already Installed	RCIC control is available in the Control Room and at the Remote Shutdown Panel. Attachment VI of the RCIC system operating procedure (04-1-01-E51-1) provides instructions for emergency RCIC manual start/shutdown which provides guidance to allow local, manual control of RCIC.	Core cooling systems
86	Dedicated alternate low-pressure injection/drywell spray system	Monticello [6] SAMA 9	Improved injection capability and containment heat removal.	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 71.	Core cooling systems
87	Modify procedures and training to operate the isolation condensers with no support systems available.	Oyster Creek [5] SAMA 99	Reduced operator error associated with operating isolation condensers when DC power is unavailable.	#1 - N/A	GGNS does not have isolation condensers, thus this SAMA is not applicable.	Core cooling systems
88	Revise procedure to provide direction for cooldown following loss of reactor building closed cooling water by reducing RPV pressure.	Oyster Creek [5] SAMA 106	Reduced seal LOCA probability.	#3 - Already installed	GGNS has a procedure to trip recirc pumps and reactor on a total loss of component cooling water (CCW).	Core cooling systems

Table 1 Phase I SAMA Analysis

89	Modify procedures to allow operators to defeat the low reactor pressure interlock circuitry that inhibits opening the low-pressure coolant injection (LPCI) or core spray injection valves following sensor or logic failures that prevent all low pressure injection valves from opening.	Vermont Yankee [3] SAMA 65	Eliminate probability of ECCS low pressure permissives failing.	#2 - Similar item is addressed under other proposed SAMAs	Table 2 of GFIG-OPS-E1200 indicates that it's not physically possible to bypass the interlocks. SAMA 90 will evaluate adding a bypass switch along with modifying the procedures.	Core cooling systems
90	Install a bypass switch to allow operators to bypass the low reactor pressure interlock circuitry that inhibits opening the LPCI or core spray injection valves following sensor or logic failures that prevent all low pressure injection valves from opening.	Vermont Yankee [3] SAMA 66	Eliminate probability of ECCS low pressure permissives failing.	Retain	Both the LPCI Injection shutoff valves and LPCS injection shutoff valve have low pressure permissives that do not allow valve opening unless RPV is below 476 psig. There is no EOP action to bypass this permissive.	Core cooling systems
91	Develop procedures to allow bypass of the reactor core isolation cooling (RCIC) turbine exhaust pressure trip, extending the time available for RCIC operation.	Cooper [33] SAMA 25	Extended RCIC operation.	#3 - Already installed	See SAMA 63.	Core cooling systems

Table 1 Phase I SAMA Analysis						
92	Improve training on alternate injection via the fire water system, increasing the availability of alternate injection.	Cooper [33] SAMA 78	Reduced failure of operator to align fire protection system for injection	#3 - Already installed	GGNS has two diesel driven 1500 gpm fire pumps that can be used for alternate injection. Emergency Procedure 05-S-01-EP-1, attachment 26 provides instructions for injection into the RPV with the fire protection water system. GLP-OPS-EP07 indicates that the operators are trained on use of the fire water system for RPV injection.	Core cooling systems
93	Increase the reliability of the low pressure ECCS RPV low pressure permissive circuitry. Install manual bypass of low pressure permissive.	Duane Arnold [31] SAMA 166	Eliminate probability of ECCS low pressure permissives failing.	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 90.	Core cooling systems
94	Modify procedures to stagger RPV depressurization when fire protection system injection is the only available make-up source.	Susquehanna [32] SAMA 3	Improved fire protection system injection capability.	#1 - N/A	Susquehanna was recommending "staggering" depressurization of each of the two units so that fire water would be able to be used at its full flow-rate on one unit at a time. Since GGNS is a single unit site and full fire water flow is available, this would not be necessary.	Core cooling systems

Table 1 Phase I SAMA Analysis

95	Change procedures to allow cross connection of motor cooling for RHRSW pumps.	NEI 05-01 [1]	Continued operation of both residual heat removal service water (RHRSW) pumps on failure of one train of service water (SW).	#1 - N/A	The standby service water pump motor bearings are cooled by SSW from the discharge of the respective pump. The motors are cooled whenever the respective SSW pump is running and does not depend on any other source of cooling.	Cooling water
96	Add redundant DC control power for SW pumps.	NEI 05-01 [1]	Increased availability of SW.	#3 - Already installed	GGNS UFSAR section 8.3.1 states that "each division of class IE and BOP circuit breaker control circuitry is provided with separate and redundant DC control power".	Cooling water
97	Replace ECCS pump motors with air-cooled motors.	NEI 05-01 [1]	Elimination of ECCS dependency on component cooling system.	#3 - Already installed	All GGNS ECCS pump motors are air-cooled.	Cooling water
98	Provide self-cooled ECCS seals.	NEI 05-01 [1]	Elimination of ECCS dependency on component cooling system.	#3 - Already installed	LPCS and HPCS pumps do not depend on other systems for seal cooling.	Cooling water

Table 1 Phase I SAMA Analysis						
99	Enhance procedural guidance for use of cross-tied component cooling or service water pumps.	NEI 05-01 [1]	Reduced frequency of loss of component cooling water and service water.	#3 - Already installed	Plant service water normally supplies CCW, chillers and AC units, turbine building closed cooling water (TBCCW), alternate decay heat removal, switchgear room coolers and other misc loads. This system can be backed up by one of the standby service water loops. The SSW Cross-Tie system must be manually aligned from the control room by handswitches HS-M640 and HS-M641 on panel H13-P601-17C or by handswitch H22-HS-M241 on the remote shutdown panel.	Cooling water
100	Implement modifications to allow manual alignment of the fire water system to RHR heat exchangers.	NEI 05-01 [1]	Improved ability to cool RHR heat exchangers.	Retain	GGNS has two independent RHR heat exchangers with two independent SSW loops. Manual alignment of the fire water system to RHR heat exchangers is not implemented. Fire water may be used for vessel injection through 9 different paths.	Cooling water
101	Add a service water pump.	NEI 05-01 [1]	Increased availability of cooling water.	Retain	The GGNS SSW system utilizes two service water pumps and one HPCS service water pump.	Cooling water

Table 1 Phase I SAMA Analysis

102	Enhance the screen wash system.	NEI 05-01 [1]	Reduced potential for loss of SW due to clogging of screens.	#1 - N/A	GGNS utilizes a closed loop natural draft cooling tower system for condenser cooling. Standby service water utilizes forced draft cooling towers with a supply basin large enough for 30 days of decay heat removal. This basin is supplied from wells. Plant Service Water (PSW) takes suction from the radial wells, which don't have a screen wash system.	Cooling water
103	Enhance alternate injection reliability by including the residual heat removal service water and fire water cross-tie valves in the maintenance program.	Monticello [6] SAMA 11	Reduced valve failure probability.	#3 - Already Installed	SSW cross-tie and fire water cross-ties are included in the maintenance rule program. Page 12 of GLP-MM-MRP indicates that the operators record the OOS times and Attachment III of 01-S-18-6 indicates that these cross-ties are included in EOOS.	Cooling water
104	Revise procedures to allow manual alignment of the fire water system to the RHR heat exchangers, providing improved ability to cool the RHR heat exchangers in a loss of SW.	Cooper [33] SAMA 30	Improved ability to cool RHR heat exchangers.	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 100.	Cooling water

Table 1 Phase I SAMA Analysis

105	Revise procedures to allow the ability to cross-connect the circulating water pumps and the SW going to the turbine equipment cooling system heat exchangers, allowing continued use of the power conversion system after SW is lost.	Cooper [33] SAMA 68	Continued use of the power conversion system after service water is lost.	#1 - N/A	GLP-GPST-P4300 indicates that PSW is the heat sink for the TBCCW heat exchangers. GLP-GPST-N7100 indicates that a loss of PSW would result in a loss of makeup water to the cooling tower and subsequent loss of NPSH to the circulating water pumps.	Cooling water
106	Revise procedures to allow use of the RHRSW system without a SW booster pump, increasing availability of the RHRSW system.	Cooper [33] SAMA 79	Improved RHRSW system	#1 - N/A	GGNS does not utilize service water booster pumps.	Cooling water
107	Provide an alternate source of water for the RHRSW/ESW pit.	Duane Arnold [31] SAMA 156	Improved inventory for the service water systems.	#1 - N/A	GGNS has a water capacity of 15 million gallons in the SSW cooling tower basins. This is ample water inventory for any accident. The system can operate for at least 30 days without requiring any makeup water.	Cooling water
108	Install a digital feedwater upgrade.	NEI 05-01 [1]	Reduced chance of loss of main feedwater following a plant trip.	#3 - Already Installed	GGNS has installed a digital feedwater upgrade.	Feedwater and condensate

Table 1 Phase I SAMA Analysis

109	Create ability for emergency connection of existing or new water sources to feedwater and condensate systems.	NEI 05-01 [1]	Increased availability of feedwater.	#3 - Already Installed	The B.5.b procedure referenced in the NRC inspection report (Procedure 05-S-01-STRATEGY, *Alternate Strategy*) provides instructions for adding fire water to the condenser hotwell and to the CST. Also, NRC Temporary Instruction 2515/183 Inspection Report of 5/13/11 (Fukushima follow-up ML11133A249) indicates that GGNS operators are sufficiently trained on all B5b strategies.	Feedwater and condensate
110	Install an independent diesel for the condensate storage tank makeup pumps.	NEI 05-01 [1]	Extended inventory in CST during an SBO.	#1 - N/A	170,000 gal. is reserved in the CST for HPCS and RCIC. After this is depleted, HPCS and RCIC swap to the suppression pool. Since these pumps can pump saturated water, there is no dependency on suppression pool cooling. HPCS has its own independent diesel.	Feedwater and condensate

Table 1 Phase I SAMA Analysis						
111	Add a motor-driven feedwater pump.	NEI 05-01 [1]	Increased availability of feedwater.	Retain	GGNS has turbine driven feedwater pumps. GGNS also has HPCS which is a motor driven pump with a dedicated diesel generator power supply, and RCIC which is a turbine driven pump, available for high pressure injection if normal power becomes unavailable.	Feedwater and condensate
112	Add emergency level control sensor and control valve to the hotwell.	Monticello [6] SAMA 40	Eliminate all risk for Class 2 sequences due to fires that require operator-based hotwell makeup.	#3 - Already installed	GLP-OPS-N1900 indicates that the hotwell level control system automatically maintains the main condenser hotwells at ~3' from the bottom of the hotwells, either by introducing water (hotwell makeup) from, or rejecting water (hotwell reject) to, the CST.	Feedwater and condensate
113	Develop a procedure to refill the CST with fire water system.	Monticello [6] SAMA 28	Increased availability of feedwater.	#3 - Already installed	See SAMA 109.	Feedwater and condensate
114	Provide for the ability to establish an emergency connection of existing or new water sources to feedwater and condensate systems, increasing availability of feedwater.	Cooper [33] SAMA 33	Increased availability of feedwater.	#3 - Already installed	See SAMA 109.	Feedwater and condensate

Table 1 Phase I SAMA Analysis						
115	Provide reliable power to control building fans.	NEI 05-01 [1]	Increased availability of control room ventilation.	#3 - Already installed	The safety related portions of the control room heating ventilation and air conditioning (HVAC) system are required to be operable during a loss of offsite power.	Heating, Ventilation, and air conditioning
116	Provide a redundant train or means of ventilation.	NEI 05-01 [1]	Increased availability of components dependent on room cooling.	Retain	Consideration should be given to LPCS pump room, SSW pump room, safeguard switchgear and battery room, and HPCS room. DG building HVAC is addressed in SAMAs 118, 123, 124, and 125. Other areas are not dependent on room or area cooling.	Heating, Ventilation, and air conditioning
117	Enhance procedures for actions on loss of HVAC.	NEI 05-01 [1]	Increased availability of components dependent on room cooling.	#3 - Already installed	Consideration should be given to LPCS pump room, SSW pump room, safeguard switchgear and battery room, and HPCS room. SSW, safeguard switchgear battery, LPCS, and HPCS rooms already have procedures to provide alternate room cooling for loss of HVAC. EDG building HVAC is addressed in SAMAs 118, 123, 124, and 125. Other areas are not dependent on room or area cooling.	Heating, Ventilation, and air conditioning

Table 1 Phase I SAMA Analysis

118	Add a diesel building high temperature alarm or redundant louver and thermostat.	NEI 05-01 [1]	Improved diagnosis of a loss of diesel building HVAC.	Retain	The GGNS EDG building has temperature elements but no alarm. This SAMA is being retained to consider adding a diesel building high temperature alarm.	Heating, Ventilation, and air conditioning
119	Create ability to switch HPCI and RCIC room fan power supply to DC in an SBO event.	NEI 05-01 [1]	Increased availability of HPCI and RCIC in an SBO event.	Retain	RCIC is not dependent on room cooling for the 24 hour accident mission time. HPCS is dependent on room cooling for the 24 hour accident mission time.	Heating, Ventilation, and air conditioning
120	Enhance procedure to trip unneeded RHR or core spray pumps on loss of room ventilation.	NEI 05-01 [1]	Extended availability of required RHR or core spray pumps due to reduction in room heat load.	#1 - N/A	The GGNS RHR pumps do not depend on room cooling. There is only one low pressure core spray pump. The HPCS pump depends on room cooling, but there is only one pump in the room.	Heating, Ventilation, and air conditioning
121	Stage backup fans in switchgear rooms.	NEI 05-01 [1]	Increased availability of ventilation in the event of a loss of switchgear ventilation.	#1 - N/A	The GGNS ESF switchgear room does not depend on HVAC for 24 hour success.	Heating, Ventilation, and air conditioning
122	Add a switchgear room high temperature alarm.	NEI 05-01 [1]	Improved diagnosis of a loss of switchgear HVAC.	#1 - N/A	The GGNS ESF switchgear room does not depend on HVAC for 24 hour success.	Heating, Ventilation, and air conditioning

Table 1 Phase I SAMA Analysis

123	Diverse EDG HVAC logic: This SAMA involves installation of a diverse set of fan actuation logic, which would reduce the reliance of operators to perform a fan start on loss of the automatic actuation logic.	Brunswick [7] SAMA 15	Increased availability of EDG room ventilation.	Retain	The two ventilation supply fans, one for each room, are interlocked to automatically start but may be started manually if required.	Heating, Ventilation, and air conditioning
124	Install additional fan and louver pair for EDG heating, ventilation, and air conditioning.	Monticello [6] SAMA 6	Increased availability of EDG room ventilation.	Retain	Each diesel generator room has two heating and ventilation systems to provide cooling for equipment performance. A small fan coil unit is used during normal power operation to maintain the area temperature. A large ventilation supply fan starts automatically when the diesel generator starts. The two ventilation supply fans, one for each room, are interlocked to automatically start with an automatic EDG start, but may be started manually if required.	Heating, Ventilation, and air conditioning
125	Operator procedure revisions to provide additional space cooling to the EDG room via the use of portable equipment.	Vermont Yankee [3]	Increased availability of the EDG system.	#2 - Similar item is addressed under other proposed SAMAs	Procedure changes by themselves would not do much good if the operators don't have a high temp alarm in the diesel rooms. Thus, the alarms would have to be added similar to SAMA 118.	Heating, Ventilation, and air conditioning

Table 1 Phase I SAMA Analysis

126	Develop a procedure to open the door to the EDG buildings upon the high temperature alarm.	Fitzpatrick [2] SAMA 62	This SAMA would improve the reliability of the EDGs following high temperatures in the EDG buildings.	#1 - N/A	GGNS does not have an EDG building high temperature alarm. See SAMA 118 to add a diesel building high temperature alarm.	Heating, Ventilation, and air conditioning
127	Revise procedures to provide additional space cooling to the EDG room via the use of portable equipment, increasing availability of the EDG.	Cooper [33] SAMA 40	Increased availability of the EDG system.	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 125.	Heating, Ventilation, and air conditioning
128	Provide cross-unit connection of uninterruptible compressed air supply.	NEI 05-01 [1]	Increased ability to vent containment using the hardened vent.	#1 - N/A	GGNS is a single unit site.	Instrument Air Supply
129	Provide ability to align diesel power to more air compressors.	NEI 05-01 [1]	Increased availability of instrument air after a LOOP.	Retain	The Unit 1 instrument air compressor is powered from critical 4.16 kV bus 16AB. The other compressors are powered from non-critical buses. Thus, only the instrument air compressor will receive diesel power following a loss of offsite power. This SAMA is being retained to provide procedural guidance following a loss of offsite power to align diesel power to the other air compressors.	Instrument Air Supply

Table 1 Phase I SAMA Analysis						
130	Replace service and instrument air compressors with more reliable compressors which have self-contained air cooling by shaft driven fans.	NEI 05-01 [1]	Elimination of instrument air system dependence on TBCCW and service water cooling.	Retain	The air compressors and the aftercoolers require cooling water from the turbine building cooling water system to cool down the compressed air. The SSW is a backup to the TBCCW system	Instrument Air Supply

Table 1 Phase I SAMA Analysis						
131	Install nitrogen bottles as backup gas supply for safety relief valves.	NEI 05-01 [1]	Extended SRV operation time.	Retain	The purpose of this SAMA is to provide a redundant pneumatic source that does not depend on a mechanical device such as an air compressor. The GGNS ADS SRV pneumatics are supplied by 4 large air receivers supplying smaller redundant accumulators, two for each valve. Two receivers provide pneumatic supply for steam lines A and C and the other two provide for steam lines B and D. This redundancy in itself is comparable to other BWRs that have a single Nitrogen tank as a primary supply and nitrogen bottles as a backup. In addition to the above, GGNS has nitrogen bottles that can be connected to the ADS pneumatic system that will provide a backup to the ADS receivers. This SAMA was retained to provide a permanent Nitrogen bottle connection and automatic tie in to the instrument air (IA) system.	Instrument Air Supply

Table 1 Phase I SAMA Analysis						
132	Improve SRV and MSIV pneumatic components.	NEI 05-01 [1]	Improved availability of SRVs and MSIVs.	Retain	The SRVs and MSIVs have accumulators installed for air. This SAMA is being retained to improve the non-ADS SRVs by replacing them or adding accumulators. SAMA 67 is being retained to add larger accumulators to the 8 ADS SRVs.	Instrument Air Supply
133	Provide an alternate means of supplying the instrument air header: This SAMA involves procurement of an additional portable compressor to be aligned to the supply header to reduce the risk associated with loss of instrument air.	Brunswick [7] SAMA 19	Increased availability of instrument air.	#3 - Already installed	GGNS has two portable air compressors capable of delivering a minimum of 1200 SCFM at 130 psig. SOI 04-1-01-P51-1 provides instructions to supply air to the service air and IA systems.	Instrument Air Supply
134	Provide an alternate means of supplying the instrument air header, increasing availability of instrument air.	Cooper [33] SAMA 45	Increased availability of instrument air.	#3 - Already installed	GGNS has two portable air compressors capable of delivering a minimum of 1200 SCFM at 130 psig. SOI 04-1-01-P51-1 provides instructions to supply air to the service air and IA systems.	Instrument Air Supply

Table 1 Phase I SAMA Analysis						
135	Install an independent method of suppression pool cooling.	NEI 05-01 [1]	Increased availability of containment heat removal.	Retain	An independent suppression pool cooling system could consist of a heat exchanger approximately the size of the RHR Heat Exchanger, a circulating pump, piping to tie in to RHRSW for cooling water, motor operated valves, power and instrument cabling.	Containment Phenomena
136	Revise procedure to initiate suppression pool cooling during transients, LOCAs and ATWS.	NEI 05-01 [1]	Improved containment pressure control and containment heat removal capability.	#3 - Already installed	This operator action is taken in response to provide containment heat removal during transients, LOCAs, and ATWS. EP-3 will initiate suppression pool cooling.	Containment Phenomena
137	Change procedure to cross-tie open cycle cooling system to enhance drywell spray system.	NEI 05-01 [1]	Increased availability of containment heat removal.	Retain	GGNS has an RHRSSW crosstie that can be aligned for vessel injection flow or containment spray header flow. However, containment spray header flow is not proceduralized. This SAMA will investigate using the SSW system to backup containment spray.	Containment Phenomena
138	Enable flooding of the drywell head seal.	NEI 05-01 [1]	Reduced probability of leakage through the drywell head seal.	#1 - N/A	Mark I issue only.	Containment Phenomena
139	Create a reactor cavity flooding system.	NEI 05-01 [1]	Enhanced debris cool ability, reduced core concrete interaction, and increased fission product scrubbing.	#3 - Already Installed	GGNS has procedures in place to flood the reactor cavity in the event of a severe accident.	Containment Phenomena

Table 1 Phase I SAMA Analysis

140	Install a passive drywell spray system.	NEI 05-01 [1]	Improved drywell spray capability.	Retain	GGNS does not contain a passive drywell spray system.	Containment Phenomena
141	Use the fire water system as a backup source for the drywell spray system.	NEI 05-01 [1]	Improved drywell spray capability.	Retain	GGNS has several firewater injection paths, but none that could supply the containment sprays.	Containment Phenomena
142	Enhance procedures to refill CST from demineralized water or service water system.	NEI 05-01 [1]	Reduced risk of core damage during station blackouts or LOCAs that render the suppression pool unavailable as an injection source.	Retain	In addition to the demin water storage tank, inventory is also available in the refueling water storage tank (RWST) and the upper containment pool. Current procedures govern transfer of inventory from the demin water storage tank and suction transfer to the RWST; however, these are not for SBOs or LOCAs.	Containment Phenomena
143	Enhance procedure to maintain ECCS suction on CST as long as possible.	NEI 05-01 [1]	Reduced chance of pump failure due to high suppression pool temperature.	#1 - N/A	The GGNS ECCS pumps are designed to successfully operate with suction from a saturated suppression pool.	Containment Phenomena
144	Modify containment flooding procedure to restrict flooding to below the top of active fuel.	NEI 05-01 [1]	Reduced forced containment venting.	#3 - Already installed	In the severe accident management guidance (SAMGs) the only viable method to attain adequate core and core debris cooling is submergence as per Boiling Water Reactor Owners Group (BWROG) guidelines. The core and core debris are submerged when the containment is flooded to above top of active fuel.	Containment Phenomena

Table 1 Phase I SAMA Analysis

145	Install an unfiltered, hardened containment vent.	NEI 05-01 [1]	Increased decay heat removal capability for non-ATWS events, without scrubbing released fission products.	#3 - Already installed	The GGNS containment vent system is a "scrubbed path", because it vents from the containment. Fission products in the drywell atmosphere are "scrubbed" by bubbling through the suppression pool when the containment vent path is used.	Containment Phenomena
146	Install a filtered containment vent to remove decay heat Option 1: Gravel Bed Filter Option 2: Multiple Venturi Scrubber	NEI 05-01 [1]	Increased decay heat removal capability for non-ATWS events, with scrubbing of released fission products.	Retain	The GGNS containment vent system is a "scrubbed path", because it vents from the containment. Fission products in the drywell atmosphere are "scrubbed" by bubbling through the suppression pool when the containment vent path is used. However, during suppression pool bypass sequences, no scrubbing is currently available through the containment vent. Venting through the Containment Ventilation and Filtration System is not effective as this system was not designed for post core damage venting.	Containment Phenomena

Table 1 Phase I SAMA Analysis						
147	Enhance fire water system and standby gas treatment system hardware and procedures.	NEI 05-01 [1]	Improved fission product scrubbing in severe accidents.	#1 - N/A	Current fire water and standby gas treatment systems do not have sufficient capacity to handle the loads from severe accidents that result in a bypass or breach of the containment. Loads produced as a result of RPV or containment blow down would require large filtering capacities. These filtered vented systems have been previously investigated and found not to provide sufficient cost benefit.	Containment Phenomena
148	Modify plant to permit suppression pool scrubbing.	NEI 05-01 [1]	Increased scrubbing of fission products by directing vent path through water in the suppression pool.	#3 - Already installed	The GGNS containment vent system is a "scrubbed path", because it vents from the containment. Fission products in the drywell atmosphere are "scrubbed" by bubbling through the suppression pool when the containment vent path is used.	Containment Phenomena
149	Enhance containment venting procedures with respect to timing, path selection, and technique.	NEI 05-01 [1]	Improved likelihood of successful venting.	#3 - Already installed	GGNS EOPs and severe accident guidelines (SAGs) provide the guidance for containment venting. Supporting procedures provide details for each path.	Containment Phenomena

Table 1 Phase I SAMA Analysis						
150	Control containment venting within a narrow band of pressure.	NEI 05-01 [1]	Reduced probability of rapid containment depressurization thus avoiding adverse impact on low pressure injection systems that take suction from the torus.	#1 - N/A	GGNS has determined that venting containment when the primary containment pressure limit (PCPL) is reached will not fail the ECCS pumps taking suction from the suppression pool due to NPSH loss. Therefore, control of containment venting within a narrow band of pressure is not necessary.	Containment Phenomena
151	Improve vacuum breaker reliability by installing redundant valves in each line.	NEI 05-01 [1]	Decreased consequences of a vacuum breaker failure to reseat.	#3 - Already Installed	GGNS has 4 vacuum breaker flow paths. Two 10 inch paths are associated with the Combustible Gas Control Drywell Purge system. Each path has a motor operated valve in series with two check valves. The two remaining paths merge into the 10 inch drywell vacuum relief line that is part of the Post-LOCA Vacuum Relief System. Each of these paths have a motor operated valve in series with a check valve.	Containment Phenomena
152	Enhance air return fans (ice condenser plants).	NEI 05-01 [1]	Reduced probability of containment failure in SBO sequences.	#1 - N/A	GGNS is not an ice condenser plant.	Containment Phenomena
153	Provide post-accident containment inerting capability.	NEI 05-01 [1]	Reduced likelihood of hydrogen and carbon monoxide gas combustion.	Retain	GGNS utilizes a non-inerted containment.	Containment Phenomena

Table 1 Phase I SAMA Analysis						
154	Create a large concrete crucible with heat removal potential to contain molten core debris.	NEI 05-01 [1]	Increased cooling and containment of molten core debris. Molten core debris escaping from the vessel is contained within the crucible and a water cooling mechanism cools the molten core in the crucible, preventing melt-through of the base mat.	#1 - N/A	Core retention devices have been investigated in previous studies. IDCOR concluded, "core retention devices are not effective risk reduction devices for degraded core events". Other evaluations have shown the worth value for a core retention device to be on the order of $7000 (averted cost-risk) compared to an estimated implementation cost of over $1 million.	Containment Phenomena
155	Create a core melt source reduction system.	NEI 05-01 [1]	Increased cooling and containment of molten core debris. Refractory material would be placed underneath the reactor vessel such that a molten core falling on the material would melt and combine with the material. Subsequent spreading and heat removal from the vitrified compound would be facilitated, and concrete attack would not occur.	#1 - N/A	See disposition on SAMA 154.	Containment Phenomena

Table 1 Phase I SAMA Analysis

156	Strengthen primary/secondary containment (e.g., add ribbing to containment shell).	NEI 05-01 [1]	Reduced probability of containment over-pressurization.	#1 - N/A	This SAMA is for a new plant; it is not practical to back fit this modification into a plant, which is already built, and operating. In addition, GGNS is a Mark III containment.	Containment Phenomena
157	Increase depth of the concrete base mat or use an alternate concrete material to ensure melt-through does not occur.	NEI 05-01 [1]	Reduced probability of base mat melt-through.	#1 - N/A	It is not practical to back fit this modification into a plant, which is already built and operating. The cost of implementation would far outweigh the benefit of this modification.	Containment Phenomena
158	Provide a reactor vessel exterior cooling system.	NEI 05-01 [1]	Increased potential to cool a molten core before it causes vessel failure, by submerging the lower head in water.	#1 - N/A	The GGNS containment can be flooded as noted in the disposition for SAMA 139. This SAMA has been analyzed at Pilgrim Nuclear Power Station, Vermont Yankee Nuclear Power Station, and James A. FitzPatrick Nuclear Power Plant and has been determined to be not cost beneficial. The highest averted cost risk was $640,000 with an estimated implementation cost of $2.5 million.	Containment Phenomena
159	Construct a building to be connected to primary/secondary containment and maintained at a vacuum.	NEI 05-01 [1]	Reduced probability of containment over-pressurization.	#1 - N/A	GGNS uses containment sprays and vents to reduce containment pressure. The cost of converting to a sub-atmospheric containment, let alone the cost of the new building, would likely far outweigh any gains.	Containment Phenomena

Table 1 Phase I SAMA Analysis						
160	Institute simulator training for severe accident scenarios.	NEI 05-01 [1]	Improved arrest of core melt progress and prevention of containment failure.	#3 - Already installed	The technical support center and Control Room would be manned in a severe accident evolution to provide additional support by personnel familiar with SAGs.	Containment Phenomena
161	Improve leak detection procedures.	NEI 05-01 [1]	Increased piping surveillance to identify leaks prior to complete failure. Improved leak detection would reduce LOCA frequency.	#3 - Already installed	Leakage is detected by monitoring drywell temp, pressure, sump flow rates and temperatures, RPV levels, and drywell atmosphere radiation and fission product levels.	Containment Phenomena
162	Install an independent power supply to the hydrogen recombiners control system using either new batteries, a non-safety grade portable generator, existing station batteries, or existing AC/DC independent power supplies, such as the security system diesel.	NEI 05-01 [1]	Reduced hydrogen detonation potential.	#3 - Already installed	GGNS has two Hydrogen Recombiners, each powered from a different division. They are backed up by hydrogen igniters and a drywell purge system. GGNS has a portable generator used to supply temporary power to one division of hydrogen igniters during B.5.b events. The B.5.b procedure referenced in the NRC inspection report provides instructions for providing alternate power to the hydrogen recombiners. Also, lesson plan GLP-OPS-B5BH2 provides ops training on this action.	Containment Phenomena

Table 1 Phase I SAMA Analysis

163	Install a passive hydrogen control system.	NEI 05-01 [1]	Reduced hydrogen detonation potential.	Retain	GGNS incorporates a Hydrogen Ignition system, a Hydrogen Recombiner System, and a Drywell Purge system. None of these systems are passive. A passive system would be a Nitrogen overpressure system.	Containment Phenomena
164	Erect a barrier that would provide enhanced protection of the containment walls (shell) from ejected core debris following a core melt scenario at high pressure.	NEI 05-01 [1]	Reduced probability of containment failure.	#1 - N/A	To implement the barrier would outweigh the gains. The containment walls already provide a sufficient amount of protection and to implement this modification would not be feasible for an existing plant.	Containment Phenomena
165	Use fire-fighting water as a backup for containment spray: This SAMA would provide redundant containment spray function without the cost of installing a new system.	Brunswick [7] SAMA 36	Improved drywell spray capability.	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 141.	Containment Phenomena
166	Provide passive overpressure relief by changing the containment vent valves to fail open and improving the strength of the rupture disk.	Monticello [6] SAMA 16	Increased decay heat removal capability.	Retain	Since having containment isolation valves that fail open on loss of power is not desirable this SAMA is being evaluated to convert the existing torus vent to a passive design. The containment vent currently does not have a rupture disc.	Containment Phenomena

Table 1 Phase I SAMA Analysis

167	Install alternate path to the torus hard pipe vent via the wet well using a rupture disk.	Oyster Creek [5] SAMA 10	Increased decay heat removal capability.	#2 - Similar item is addressed under other proposed SAMAs	GGNS has only one vent path. Similar to SAMA 166.	Containment Phenomena
168	Enable manual operation of all containment vent valves via local controls.	Oyster Creek [5] SAMA 84	Improved availability of the containment vent valves.	Retain	The containment vent valves at GGNS must have instrument air to be operated. They also require jumpering an interlock.	Containment Phenomena
169	Control containment venting within a narrow pressure band.	Pilgrim [4] SAMA 53	Reduced probability of rapid containment depressurization thus avoiding adverse impact on low pressure injection systems that take suction from the torus.	#1 - N/A	GGNS has determined that venting containment when PCPL is reached will not fail the ECCS pumps taking suction from the suppression pool due to NPSH loss. Therefore, control of containment venting within a narrow band of pressure is not necessary.	Containment Phenomena
170	Control containment venting within a narrow pressure band.	Vermont Yankee [3] SAMA 63	Reduced probability of rapid containment depressurization thus avoiding adverse impact on low pressure injection systems that take suction from the torus.	#1 - N/A	GGNS has determined that venting containment when PCPL is reached will not fail the ECCS pumps taking suction from the suppression pool due to NPSH loss. Therefore, control of containment venting within a narrow band of pressure is not necessary.	Containment Phenomena

Table 1 Phase I SAMA Analysis						
171	Install additional pressure or leak monitoring instruments for detection of ISLOCAs.	NEI 05-01 [1]	Reduced interfacing systems loss of coolant accident (ISLOCA) frequency.	#3 - Already installed	For successful ISLOCA isolation, plant operators have numerous indications for identifying an ISLOCA-type breach in the control room. These indications include: reactor building pressure differential, high and low pressure alarms, system pressure indicators, reactor building water level, reactor building temperature, reactor building local radiation, system pressure, and torus high level alarm.	Containment Bypass
172	Add redundant and diverse limit switches to each containment isolation valve.	NEI 05-01 [1]	Reduced frequency of containment isolation failure and ISLOCAs.	#3 - Already installed	GGNS' present design is redundant and diverse, with switches controlling the close function. Limit switches enable position display for the containment isolation valves.	Containment Bypass
173	Increase leak testing of valves in ISLOCA paths.	NEI 05-01 [1]	Reduced ISLOCA frequency.	Retain	The GGNS inservice inspection program includes ISLOCA pathways. Although ISLOCA is not risk significant, this SAMA is conservatively retained.	Containment Bypass

Table 1 Phase I SAMA Analysis

174	Improve MSIV design.	NEI 05-01 [1]	Decreased likelihood of containment bypass scenarios.	Retain	Redundant MSIVs are designed to isolate during accidents that could lead to radionuclide release and bypass containment. The MSIV are leak tested to ensure their adequacy. The Maintenance Rule program monitors the performance of the MSIVs providing feedback on degradation.	Containment Bypass
175	Install self-actuating containment isolation valves.	NEI 05-01 [1]	Reduced frequency of isolation failure.	#3 - Already installed	The lines which penetrate the primary containment are equipped with automatic isolation logic. Specific logic groups isolate on reactor and containment parameters significant to the associate group in order to provide automatic valve closure appropriate for a given set of conditions.	Containment Bypass
176	Locate residual heat removal (RHR) inside containment	NEI 05-01 [1]	Reduced frequency of ISLOCA outside containment.	#1 - N/A	ISLOCA is not a significant contributor to risk at GGNS, so modifications to prevent ISLOCA will have a negligible impact on the risk profile. Locating RHR inside containment is an extensive change, the cost of which would obviously exceed the very small expected benefit. Lower cost alternatives (SAMAs 173, 178 and 179) to reduce the risk from ISLOCA are being evaluated.	Containment Bypass

Table 1 Phase I SAMA Analysis

177	Ensure ISLOCA releases are scrubbed. One method is to plug drains in potential break areas so that break point will be covered with water.	NEI 05-01 [1]	Scrubbed ISLOCA releases.	#1 - N/A	ISLOCA is not a significant contributor to risk at GGNS, so modifications to prevent ISLOCA will have a negligible impact on the risk profile. Plugging drains in potential break areas would require extensive revision of flooding analyses, the cost of which would obviously exceed the very small expected benefit. Lower cost alternatives (SAMAs 178 and 179) to reduce the risk from ISLOCA are being evaluated.	Containment Bypass
178	Revise EOPs to improve ISLOCA identification.	NEI 05-01 [1]	Increased likelihood that LOCAs outside containment are identified as such. A plant had a scenario in which an RHR ISLOCA could direct initial leakage back to the pressurizer relief tank, giving indication that the LOCA was inside containment.	Retain	This is more of a Pressurized Water Reactor (PWR) issue. Although ISLOCA is not risk significant, this SAMA is conservatively retained.	Containment Bypass
179	Improve operator training on ISLOCA coping.	NEI 05-01 [1]	Decreased ISLOCA consequences.	Retain	GGNS has instruments to monitor and alarm moderate and high energy line leaks outside the primary containment. Although ISLOCA is not risk significant, this SAMA is conservatively retained.	Containment Bypass

Table 1 Phase I SAMA Analysis

180	Create cross-connect ability for standby liquid control (SLC) trains.	NEI 05-01 [1]	Improved availability of boron injection during ATWS.	#3 - Already installed	The two SLC pump discharge lines are cross connected to a common injection line. Also, GGNS has the capability of injecting boron with RCIC or HPCS.	ATWS
181	Revise procedures to control vessel injection to prevent boron loss or dilution following SLC injection.	NEI 05-01 [1]	Improved availability of boron injection during ATWS.	#3 - Already installed	SLC initiation and existing procedures guard against dilution (RWCU isolation). The GGNS design auto-isolates RWCU on SLC injection by closing the associated RWCU isolation valves. In addition ADS is inhibited when SLC is initiated, to prevent boron dilution.	ATWS
182	Provide an alternate means of opening a pathway to the RPV for SLC injection.	NEI 05-01 [1]	Improved probability of reactor shutdown.	#3 - Already installed	GGNS has the capability of injecting boron with RCIC or HPCS.	ATWS
183	Increase boron concentration in the SLC system.	NEI 05-01 [1]	Reduced time required to achieve shutdown concentration provides increased margin in the accident timeline for successful initiation of SLC.	Retain	Tech Spec table 3.1.7-1 and the ops training document (GLP-OPS-C4100) indicate that the minimum GGNS weight % of sodium pentaborate in the SLC tank (when it's full) is 13.6%.	ATWS
184	Add an independent boron injection system.	NEI 05-01 [1]	Improved availability of boron injection during ATWS.	#3 - Already installed	GGNS has the capability of injecting boron with RCIC or HPCS.	ATWS

Table 1 Phase I SAMA Analysis						
185	Provide ability to use control rod drive (CRD) or RWCU for alternate boron injection.	NEI 05-01 [1]	Improved availability of boron injection during ATWS.	#3 - Already installed	GGNS has the capability of injecting boron with RCIC or HPCS. In order to use RCIC or HPCS for boron injection, sodium pentaborate is added to the CST. Thus, any system that can take suction from the CST, such as CRD, may be used for alternate boron injection.	ATWS
186	Add a system of relief valves to prevent equipment damage from pressure spikes during an ATWS.	NEI 05-01 [1]	Improved equipment availability after an ATWS.	#3 - Already installed	This is a PWR insight. BWRs are already equipped with adequate pressure control methods even for the worst case ATWS. The overpressure protection function of the twenty safety/relief valves, eight of which are ADS controlled, in the nuclear pressure relief system is self-actuating with setpoints such that the reactor vessel pressure never exceeds its pressure vessel code limit of 1325 psig during normal operation, abnormal operation, or accident conditions.	ATWS

Table 1 Phase I SAMA Analysis

187	Increase safety relief valve (SRV) reseat reliability.	NEI 05-01 [1]	Reduced risk of dilution of boron due to SRV failure to reseat after SLC injection.	Retain	This SAMA is retained to Increase SRV reseat reliability. The SRVs used at GGNS are Dikkers valves and are a later design than the two stage Target Rock valves. They may have better reclosure characteristics and history than the earlier valves. The UFSAR, however, does not mention this hazard. Transient Group T3c occurs when an SRV sticks open due to an operator error or equipment malfunction allowing steam to be discharged into the suppression pool. The 1997 PRA Update mean frequency for T3c is 0.012.	ATWS

Table 1 Phase I SAMA Analysis						
188	Provide an additional control system for rod insertion (e.g., AMSAC).	NEI 05-01 [1]	Improved redundancy and reduced ATWS frequency.	#3 - Already installed	GGNS has installed Alternate Rod Insertion (ARI) for alternate means of injecting the control rods and Recirculation Pump Trip (RPT) to limit pressure excursion immediately following the ATWS event and for the insertion of negative reactivity by increasing the core void level. The ARI and RPT systems are initiated by the sensors and logic, which are separate and diverse from the normal scram instrumentation used for the RPS in accordance with 10CFR-50.62. In addition GGNS has backup scram valves to vent the scram air header.	ATWS
189	Install an ATWS sized filtered containment vent to remove decay heat.	NEI 05-01 [1]	Increased ability to remove reactor heat from ATWS events.	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 146. One filtered vent could be added to remove fission products for ATWS and non-ATWS scenarios.	ATWS

Table 1 Phase I SAMA Analysis

190	Revise procedure to bypass MSIV isolation in turbine trip ATWS scenarios.	NEI 05-01 [1]	Affords operators more time to perform actions. Discharge of a substantial fraction of steam to the main condenser (i.e., as opposed to into the primary containment) affords the operator more time to perform actions (e.g., SLC injection, lower water level, depressurize RPV) than if the main condenser was unavailable, resulting in lower human error probabilities.	#3 - Already installed	Procedures are in place to bypass MSIV isolation in turbine trip ATWS scenarios. EP-2A directs operators to "Use the main condenser as a heat sink, open MSIVs if necessary, OK to defeat interlocks."	ATWS
191	Revise procedure to allow override of low pressure core injection during an ATWS event.	NEI 05-01 [1]	Allows immediate control of low pressure core injection. On failure of high pressure core injection and condensate, some plants direct reactor depressurization followed by five minutes of automatic low pressure core injection.	#3 - Already Installed	GGNS already has procedures in place to give the operators full authority over all injection modes, including LPCI, during an ATWS event.	ATWS

Table 1 Phase I SAMA Analysis

192	Increase boron concentration or enrichment.	Duane Arnold [31] SAMA 117	Reduced time required to achieve shutdown concentration provides increased margin in the accident timeline for successful initiation of SLC.	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 183.	ATWS
193	Seal penetrations between turbine building basement and switchgear rooms.	NEI 05-01 [1]	Increased flood propagation prevention.	#1 - N/A	The switchgear rooms are at elevation 111' or higher, whereas the turbine basement is at the 93' elevation, one level below the location of the switchgear rooms. Flood damage will be confined to the turbine building until it reaches the 248' level. The lowest penetration is at the 237' level and it is sealed.	Internal Flooding
194	Improve inspection of rubber expansion joints on main condenser.	NEI 05-01 [1]	Reduced frequency of internal flooding due to failure of circulating water system expansion joints.	#1 - N/A	Although the main condenser has a rubber expansion joint at the condenser neck, it is well above the hotwell water line and not a flood source.	Internal Flooding
195	Modify swing direction of doors separating turbine building basement from areas containing safeguards equipment.	NEI 05-01 [1]	Prevents flood propagation.	#1 - N/A	There is no effective flooding pathway from the GGNS turbine building basement (Elevation 93') to areas containing safeguards equipment.	Internal Flooding

Table 1 Phase I SAMA Analysis						
196	Install an interlock to open the door to hot machine shop and change swing direction of door to plant administration building to divert water from turbine building 931-foot elevation east.	Monticello [6] SAMA 36	Reduced internal flood risk.	#1 - N/A	This is a Monticello-specific SAMA, not applicable to GGNS. The GGNS internal flooding analysis revealed two flooding scenarios that required detailed model evaluation. These are examined separately to determine if new SAMAs could be proposed.	Internal Flooding

Table 1 Phase I SAMA Analysis						
197	Improve internal flooding procedures.	Oyster Creek [5] SAMA 129	Reduced internal flooding risk.	#3 - Already installed	GGNS procedure 05-1-02-VI-1 provides instructions following flooding due to system rupture. It includes steps to secure pumps, close valves and close watertight doors to protect important equipment from internally initiated floods. The GGNS internal flooding analysis considers actions to mitigate the impact of the flood scenarios and concludes that, "… no individual flooding scenario has an estimated core damage frequency exceeding 1.21 x 10^{-7}/reactor year and that the total contribution of internal flooding to the predicted core damage frequency is 8.73 x 10^{-7}/reactor year. In light of this small contribution, no recommendations are made for additional measures to guard against internal flooding and its consequences."	Internal Flooding

Table 1 Phase I SAMA Analysis

198	Increase seismic ruggedness of plant components.	NEI 05-01 [1]	Increased availability of necessary plant equipment during and after seismic events.	#3 - Already installed	GGNS components whose seismic ruggedness could be improved were identified in the IPEEE and seismic qualification utility group (SQUG) programs. These items have been addressed in response to those efforts and satisfy the intent of this SAMA.	Reduce Seismic Risk
199	Provide additional restraints for CO2 tanks.	NEI 05-01 [1]	Increased availability of fire protection given a seismic event.	#1 - N/A	Section 4.8.2.1 of the GGNS IPEEE indicates that the risk of seismically-induced fires is low. GLP-GPST-P6400 indicates that the areas with Cardox suppression are cable spreading, switchgear, remote shutdown, and electrical penetration rooms. These areas are unlikely to have significant flammable gas or liquid sources that could result in post-earthquake fire concerns.	Reduce Seismic Risk

Table 1 Phase I SAMA Analysis

200	Modify safety related condensate storage tanks.	NEI 05-01 [1]	Improved availability of CSTs following a seismic event and reduced potential for flooding from CSTs following a seismic event.	#3 - Already installed	The two condensate storage tanks were evaluated and walked down to support the GGNS IPEEE seismic margins assessment. They were determined to be properly designed and to satisfy the concerns raised for flat bottom tanks in URI A-40 per NUREG-1233. The 2 condensate storage tanks are surrounded with a seismically qualified reinforced concrete retaining dike that will hold 650,500 gal. The HPCS suction piping is sized such that the seismically qualified portion will provide adequate inventory to allow time for the automatic suction swap to the suppression pool and isolation from the CST to occur in the event of a CST rupture.	Reduce Seismic/Flood Risk
201	Replace anchor bolts on diesel generator oil cooler.	NEI 05-01 [1]	Improved availability of diesel generators following a seismic event.	#3 - Already installed	The GGNS diesel generator building was walked down by the seismic margins review team. This team found no seismic concerns with the diesel generator oil coolers.	Reduce Seismic Risk

Table 1 Phase I SAMA Analysis

202	Reinforce block wall 53.	Oyster Creek [5] SAMA 124	Eliminated seismic core damage frequency (CDF) contribution from block wall failure.	#1 - N/A	This is an Oyster Creek-specific SAMA, not applicable to GGNS.	Reduce Seismic Risk
203	Replace mercury switches in fire protection system.	NEI 05-01 [1]	Decreased probability of spurious fire suppression system actuation.	#1 - N/A	During the IPEEE the fire protection system was analyzed for seismically-induced inadvertent actuation of fire suppression systems that could affect (seismic margins assessment) SMA equipment. Corrective actions to preclude adverse effects were implemented for equipment identified as potentially affected.	Reduce Fire Risk
204	Upgrade fire compartment barriers.	NEI 05-01 [1]	Decreased consequences of a fire.	#3 - Already installed	GGNS fire compartment barriers are maintained to reduce fire propagation. Surveillance procedures are used to verify the integrity of fire barriers at least once every 18 months. Work was completed by 1996 to upgrade existing Thermo-Lag enclosures, and qualify all Appendix R fire barrier enclosures for electrical raceways.	Reduce Fire Risk
205	Install additional transfer and isolation switches.	NEI 05-01 [1]	Reduced number of spurious actuations during a fire.	#2 - Similar item is addressed under other proposed SAMAs	Similar to SAMA 213.	Reduce Fire Risk

Table 1 Phase I SAMA Analysis						
206	Enhance procedures to use alternate shutdown methods if the control room becomes uninhabitable.	NEI 05-01 [1]	Increased probability of shutdown if the control room becomes uninhabitable.	#3 - Already installed	GGNS has remote shutdown capabilities per referenced procedures. The procedures outline the remote shutdown activities necessary to safely shutdown the plant in the event that the control room becomes uninhabitable.	Reduce Fire Risk
207	Enhance fire brigade awareness.	NEI 05-01 [1]	Decreased consequences of a fire.	#3 - Already installed	The fire brigade is trained and maintained per the referenced documents and has quarterly requalification and drills.	Reduce Fire Risk
208	Enhance control of combustibles and ignition sources.	NEI 05-01 [1]	Decreased fire frequency and consequences.	#3 - Already installed	Procedures to control combustible materials, flammable materials, and ignition sources are in place at GGNS.	Reduce Fire Risk
209	Improve alternate shutdown panel.	Brunswick [7] SAMA 30	Increased probability of shutdown if the control room becomes uninhabitable.	#2 - Similar item is addressed under other proposed SAMAs	GGNS has procedure 04-1-01-C61-1 in place for direction. The procedure outlines the remote shutdown activities necessary to safely shutdown the plant in the event that the control room becomes uninhabitable. SAMA 213 will evaluate upgrading the alternate shutdown system ASDS panel to include additional system controls for the opposite division.	Reduce Fire Risk

Table 1 Phase I SAMA Analysis

210	Improved alternate shutdown training and equipment.	Brunswick [7] SAMA 31	Increased probability of shutdown if the control room becomes uninhabitable.	#3 - Already installed	GGNS already has an adequate shutdown panel and procedure (Off Normal Event Procedure Shutdown from the Remote Shutdown Panel). Operators are trained to this procedure.	Reduce Fire Risk
211	Add automatic fire suppression system.	Brunswick [7] SAMA 32	Reduced fire risk.	Retain	GGNS has automatic suppression systems in place such as the wet pipe sprinkler, preaction sprinkler, deluge sprinkler, CO2, and halon systems. The dominant fire zones reported in the IPEEE are the control room and control building switchgear rooms. The control room has Halon suppression in the control room floor sections. Many of the switchgear rooms have automatic CO2 suppression systems. The Div I switchgear room in the control bldg that is a large contributor in the IPEEE is zone 0C214 has a partial automatic sprinkler system. This SAMA would improve the reliability and effectiveness of those systems.	Reduce Fire Risk

Table 1 Phase I SAMA Analysis

212	Proceduralize the use of a fire pumper truck to pressurize the fire service water system.	Monticello [6] SAMA 12	Reduced fire risk.	#3 - Already installed	GGNS has a fire pumper truck used in various B.5.b strategies. The B.5.b procedure referenced in the NRC inspection report provides instructions for use of the fire truck. Also, lesson plan GLP-OPS-B5B01 provides ops training on this action.	Reduce Fire Risk
213	Upgrade the ASDS panel to include additional system controls for opposite division.	Monticello [6] SAMA 39	Reduced risk from fires that require control room evacuation.	Retain	This SAMA is to upgrade the alternate shutdown panels to include additional equipment for the opposite division at GGNS. The ASDS panel is designed to use division 1 safety and support systems to safely shutdown the plant. It will also include installation of additional transfer and isolation switches (SAMA 205).	Reduce Fire Risk
214	Add a bus cross-tie circuit breaker to Bus 1B2 to reduce the impact of fires in the 480-V AC switchgear room.	Oyster Creek [5] SAMA 125B	Reduced fire risk.	#1 - N/A	This is an Oyster Creek-specific SAMA, not applicable to GGNS.	Reduce Fire Risk
215	Relocation of relief valve cables, circuitry, and components, as well as other modifications, to ensure one train of core spray remains unaffected by fire.	Oyster Creek [5] 125C	Eliminated dominant contributors to fire risk.	#1 - N/A	This is an Oyster Creek-specific SAMA, not applicable to GGNS.	Reduce Fire Risk

Table 1 Phase I SAMA Analysis

216	Revise procedures to allow use of a fire pumper truck to pressurize the fire water system, increasing availability of the fire water system.	Cooper [33] SAMA 64	Reduced fire risk.	#3 - Already installed	See SAMA 212.	Reduce Fire Risk
217	Increase fire pump house building integrity to withstand higher winds so that the fire system would be capable of withstanding a severe weather event.	Oyster Creek [5] SAMA 134	Increased availability of fire water during severe weather.	#1 - N/A	The IPEEE showed the risk from high winds at GGNS is minor and did not identify any vulnerability related to the location of the fire pumps.	High Winds, External Floods, and Other
218	Install digital large break LOCA protection system.	NEI 05-01 [1]	Reduced probability of a large break LOCA (a leak before break).	Retain	GGNS has no leak detection system utilizing digital technology to integrate the various existing leakage detection schemes.	Other Improvements
219	Enhance procedures to mitigate large break LOCA.	NEI 05-01 [1]	Reduced consequences of a large break LOCA	#3 - Already installed	GGNS' EOPs/SAMGs provide numerous ways of flooding the RPV and flooding/spraying primary containment.	Other Improvements

Table 1 Phase I SAMA Analysis						
220	Install computer aided instrumentation system to assist the operator in assessing post-accident plant status.	NEI 05-01 [1]	Improved prevention of core melt sequences by making operator actions more reliable.	#3 - Already installed	The GGNS Safety Parameter Display System (SPDS) is a computer system that aids the operator in assessing plant status post-accident. Many of the parameters displayed are based on inputs from multiple, diverse indications, and the SPDS system displays the results.	Other Improvements
221	Improve maintenance procedures.	NEI 05-01 [1]	Improved prevention of core melt sequences by increasing reliability of important equipment.	#3 - Already installed	GGNS has implemented a Predictive Maintenance Program to improve plant safety, equipment availability and reliability through early detection and analysis of equipment problems.	Other Improvements
222	Increase training and operating experience feedback to improve operator response.	NEI 05-01 [1]	Improved likelihood of success of operator actions taken in response to abnormal conditions.	#3 - Already installed	A "flexible" portion of the requalification training is "designed to correct performance or knowledge weaknesses identified during plant Scrams or other events, from incident reports, licensee event reports, Operations Analysis group recommendations, industry operating events, significant plant modifications and procedure changes, etc."	Other Improvements

Table 1 Phase I SAMA Analysis

223	Develop procedures for transportation and nearby facility accidents.	NEI 05-01 [1]	Reduced consequences of transportation and nearby facility accidents.	#1 - N/A	GGNS addressed the hazard due to transportation and nearby facility accidents in the IPEEE submittal. The assessment concluded that no vulnerabilities exist due to transportation or nearby facility accidents.	Other Improvements
224	Increase operator training on the systems and operator actions determined to be important from the PRA.	Oyster Creek [5] SAMA 127	Increase the chance of recovery on systems that are important from a PRA standpoint.	#3 - Already installed	EN-TQ-114 states that the PRA model is one of the inputs used to define the curriculum.	Other improvements
225	Implement GRA (trip and shutdown risk modeling) into plant activities, decreasing the probability of trips/shutdown.	Cooper [33] SAMA 75	Decreases the probability of trip/shutdown risk	Retain	GGNS does not have a generation risk assessment (GRA) model.	Other Improvements
226	The Loss of Offsite Power Off-Normal Event Procedure will be revised to allow for the Level 2 signal to be bypassed in the event that that the Division 3 diesel generator must be cross-tied to Divisions 1 or 2.	IPE [9] Sec 6 (6.2.1)	Increased availability of on-site AC power leading to increased availability of ECCS injection.	#3 - Already installed	The Loss of AC Power Off-Normal Event Procedure has been revised to allow for the level 2 signal to be bypassed in the event that the Division 3 diesel generator must be cross-tied to divisions 1 or 2.	Core cooling systems

Table 1 Phase I SAMA Analysis						
227	Improve secondary containment isolation to allow the capability of bypassing the isolation signals and re-opening the valves.	IPE [9] Sec 6 (6.2.2)	Improved availability of PSW and Instrument Air such that the main condenser, condensate, and feedwater systems would not be lost. CRD would also not be degraded due to a loss of the preferred cooling source of the CCW heat exchangers.	#3 - Already installed	The PSW isolation valves in the Auxiliary Building penetrations (P44-F1I6, P44-FI17,P44-FII8, P44-FII9, P44-FI20, P44-FI2I, P44-FI22 and P44-FI23) can be reopened by manual override after a LOCA to reestablish PSW cooling to the CCW Heat Exchangers, Computer Room Coolers, Plant Chillers, Steam Tunnel Coolers, and Drywell Coolers. This should be done only if offsite power is available and after it has been determined that the release of radioactive fission products will not result. 05-S-01-EP-1 contains guidance to restore instrument air to containment loads by defeating containment isolation interlocks and opening the valves.	Other Improvements
228	Implement procedural changes to allow for bypass of the RCIC turbine trip due to main steam tunnel high temperature when PSW is unavailable and no steam line break has occurred.	IPE [9] Sec 6 (6.2.3)	Increased RCIC availability when main steam tunnel high temperature exists.	#1 - N/A	Provided there is no leak in the main steam tunnel, failure of main steam cooling will not result in a main steam tunnel temperature of 185 deg or greater. Therefore, it will not result in an initiation of the main steam tunnel high temperature isolation logic.	Core cooling systems

Table 1 Phase I SAMA Analysis

229	Increase the training emphasis and provide additional control room indication on the operational status of the SSW pump house ventilation system. This will allow operators to manually open the pump house dampers which can provide adequate ventilation such that pump failures would not occur.	IPE [9] Sec 6 (6.2.4)	Increased availability of the SSW pump house ventilation system.	Retain	In accordance with GDC 13, damper status is indicated in the main control room. In addition, there is a high temperature alarm in the main control room. Alarm 04-1-02-1H13-P870 provides an alarm, but the actions could be expanded to accomplish a more robust mitigation of this condition.	Heating, Ventilation, and air conditioning
230	Increase operator training for alternating operation of the low pressure ECCS pumps (LPCI and LPCS) for loss of SSW scenarios.	IPE[9] Sec 6 (6.2.5)	Increased time available for recovery actions for low pressure ECCS when a loss of SSW occurs.	Retain	No specific operator training is in place to address this condition.	Core cooling systems
231	Revise the containment flooding portion of the Emergency Procedures to remove or modify the step requiring MSIV venting.	IPE [9] Sec 6 (6.2.6)	Limit one of the major contributors to the source term released.	#3 - Already installed	GGNS contributed this IPE insight to the BWR Owners Group Severe Accident Subcommittee. GGNS has already implemented the current severe accident guidelines on RPV venting.	Containment Phenomena
232	Install a backup power supply to the hydrogen igniters.	IPE [9] Sec 6 (6.3.1)	Hydrogen Igniter Operability During Station Blackout.	#3 - Already Installed	See SAMA 162.	Containment Phenomena

Table 1 Phase I SAMA Analysis						
233	Install an additional method of removing heat from the containment.	IPE [9] Sec 6 (6.3.2)	Increased decay heat removal capability	Retain	GGNS utilizes the Containment Spray and RHR Suppression Pool Cooling for post-accident containment heat removal. Containment venting is also available to ensure pressure stays below design limits should the other systems fail to reduce containment pressure.	Containment Phenomena
234	Install a backup water supply and pumping capability that is independent of normal and emergency AC power.	IPE [9] Sec 6 (6.3.3)	Alternate Water Supply for Containment Spray/Vessel Injection	Retain	GGNS has a High Pressure Core Spray system, which is powered from an independent (division 3) power supply; however, a backup supply will be investigated per the IPE recommendations.	Core cooling systems
235	Extend the battery depletion time for the relief valves.	IPE [9] Sec 6 (6.3.4)	Enhanced Reactor Pressure Vessel Depressurization System Reliability	#2 - Similar item is addressed under other proposed SAMAs	ADS and Non-ADS relief valves are all dependent on DC power and Instrument Air. Extended DC power to the relief valves will allow longer operation during a loss of DC Battery Chargers. Similar to SAMAs 1, 3, and 27.	AC and DC power
236	Implement the latest revision of the BWR Owners Group EPGs.	IPE [9] Sec 6 (6.3.5)	Improved likelihood of success of operator actions taken in response to abnormal conditions.	#3 - Already Installed	GGNS currently utilizes Revision 2 of the BWROG emergency procedure guidelines (EPGs).	Other Improvements

Table 1 Phase I SAMA Analysis

237	Increase maintenance on drainage structures. Maintenance should include cleaning of culverts, concrete repair and removal of vegetation/debris which could obstruct flow.	IPEEE Summary Report [34] (Pg. 117)	Prevent deterioration of site conditions.	#3 - Already installed	GGNS has increased the maintenance on drainage structures.	Flooding
238	Plant procedures 05-1-02-VI-1 and 05-1-02-VI-2 currently require plant staff to insure that plant doors are closed during severe weather and in the event of plant flooding (Implicitly including former unit 2 doors). Revise one or both of these procedures to explicitly include at-grade former unit 2 doors.	IPEEE Summary Report [34] (Pg. 117)	Reduce leakage from flooding through an open door.	#3 - Already installed	GGNS has revised the plant flood mitigation procedure (Off-normal Event Procedure No. 05-1-02-VI-1).	Flooding
239	Revise procedures to periodically inspect roof drains and overflows to ensure they are not blocked.	IPEEE Summary Report [34] (Pg. 117)	Reduce the consequences of a flood.	#3 - Already installed	GGNS has created an inspection procedure for roof drains, roof drainage system, and roof overflows.	Flooding

Table 1 Phase I SAMA Analysis

240	Remove the wooden foot bridge crossing the northwest ditch near its upstream end.	IPEEE Summary Report [34] (Pg. 117)	Improve site drainage/external flood protection.	#1 - N/A	The IPEEE showed the risk from external flooding at GGNS is minor thus this potential modification is assumed to not be cost beneficial which follows the same assumption in the SER. NRC Inspectors verified that the plant grade is 132.5 feet above mean seal level and that the maximum expected flood height from the Mississippi River is about 103 feet above mean sea level. Therefore, floodwaters from the Mississippi River are not expected to impact the plant.	Flooding

Table 1 Phase I SAMA Analysis						
241	Remove the 15" corrugated metal pipe located in the small auxiliary ditch parallel to the northwest ditch (at the same approximate location as the duct bank crossing the northwest ditch). Re-grade the area to provide a gradual transition between the yard upstream, and the auxiliary ditch.	IPEEE Summary Report [34] (Pg. 117)	Improve site drainage/external flood protection.	#1 - N/A	The IPEEE showed the risk from external flooding at GGNS is minor thus this potential modification is assumed to not be cost beneficial which follows the same assumption in the SER. NRC Inspectors verified that the plant grade is 132.5 feet above mean seal level and that the maximum expected flood height from the Mississippi River is about 103 feet above mean sea level. Therefore, floodwaters from the Mississippi River are not expected to impact the plant.	Flooding

Table 1 Phase I SAMA Analysis						
242	Re-hang the security fence gates west of the control building to insure that approximately 5" of gap exists between the gate and the road.	IPEEE Summary Report [34] (Pg. 117)	Improve site drainage/external flood protection.	#1 - N/A	The IPEEE showed the risk from external flooding at GGNS is minor thus this potential modification is assumed to not be cost beneficial which follows the same assumption in the SER. NRC Inspectors verified that the plant grade is 132.5 feet above mean seal level and that the maximum expected flood height from the Mississippi River is about 103 feet above mean sea level. Therefore, floodwaters from the Mississippi River are not expected to impact the plant.	Flooding

Table 1 Phase I SAMA Analysis						
243	Grade down and remove the access road, the raised berm parallel to the access road, and curbs adjacent to the access road as necessary where they cross Culvert No.1, such that elevations above the culvert do not exceed 132.7 ft. above sea level.	IPEEE Summary Report [34] (Pg. 118)	Improve site drainage/external flood protection.	#1 - N/A	The IPEEE showed the risk from external flooding at GGNS is minor thus this potential modification is assumed to not be cost beneficial which follows the same assumption in the SER. NRC Inspectors verified that the plant grade is 132.5 feet above mean seal level and that the maximum expected flood height from the Mississippi River is about 103 feet above mean sea level. Therefore, floodwaters from the Mississippi River are not expected to impact the plant.	Flooding

Table 1 Phase I SAMA Analysis						
244	Replace the C8x11.5 channel forming the flood barrier across the SSW A equipment hatch opening with another member having a minimum depth of approximately 13".	IPEEE Summary Report [34] (Pg. 118)	Improve site drainage/external flood protection.	#1 - N/A	The IPEEE showed the risk from external flooding at GGNS is minor thus this potential modification is assumed to not be cost beneficial which follows the same assumption in the SER. NRC Inspectors verified that the plant grade is 132.5 feet above mean seal level and that the maximum expected flood height from the Mississippi River is about 103 feet above mean sea level. Therefore, floodwaters from the Mississippi River are not expected to impact the plant.	Flooding
245	Modify the piping systems to account for the grouted condition for the penetration of the Standby service water (SSW) piping in the Control Building.	IPEEE Summary Report [34] (Pg. 119)	Reduce vulnerability to a seismic event.	#3 - Already installed	The grout was removed and the pipe support at the penetration was modified to coincide with the design basis piping analysis assumption.	Reduce Seismic Risk
246	Implement a better method to control seismic housekeeping issues.	GNRI2001-0034 NRC SER [20]	Reduce vulnerability to a seismic event.	#3 - Already installed	A new standard (GGNS-08-17) was issued to address seismic housekeeping issues, e.g., securing "S" hooks on lighting fixtures and installing missing clips and screws.	Reduce Seismic Risk

Table 1 Phase I SAMA Analysis

247	Upgrade thermo-lag to ensure hourly fire endurance rating.	NUREG 1742_Vol_2 [8]	Reduced fire risk.	#3 - Already installed	The thermo-lag barriers at GGNS have been improved.	Reduce Fire Risk
248	Add a bypass around the SSW inlet and outlet isolation valves for the RHR heat exchangers.	GGNS PRA Model	Decrease the probability of failing the RHR HX due to a failed or plugged isolation valve.	Retain	GGNS has RHR heat exchangers that can be failed due to a single SSW inlet or outlet valve.	Cooling Water
249	Add a redundant RCIC lube oil cooling path.	GGNS PRA Model	Improve the reliability of RCIC.	Retain	The GGNS model shows RCIC lube oil cooling valves to be risk significant. Since this cooling path is just part of a much larger RCIC supercomponent, an evaluation should be performed to determine if this is the best reliability improvement for RCIC.	Core Cooling Systems

Attachment 3 to

GNRO-2012/00072

Release Mode Frequencies for Analysis Cases

Release Mode Frequencies for Analysis Cases

Analysis Cases	Release Modes												
	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/E	LL/I	LL/L	CDF
MAXBENEFIT	1.05E-07	1.23E-08	8.73E-08	3.49E-07	1.73E-07	2.71E-07	4.04E-09	3.34E-08	1.32E-07	2.00E-09	2.11E-09	6.83E-09	2.05E-06
1. DC Power	4.92E-08	8.48E-09	8.58E-08	2.67E-07	1.69E-07	2.61E-07	4.04E-09	3.29E-08	1.85E-08	1.98E-09	2.11E-09	6.81E-09	1.77E-06
2. Improve Charger Reliability	1.02E-07	1.23E-08	8.25E-08	3.43E-07	1.72E-07	2.60E-07	4.04E-09	3.34E-08	1.31E-07	1.98E-09	2.11E-09	6.83E-09	2.02E-06
3. Add DC System Cross-ties	9.37E-08	1.22E-08	5.02E-08	3.33E-07	1.66E-07	2.04E-07	4.04E-09	3.29E-08	1.30E-07	1.99E-09	2.11E-09	6.75E-09	1.90E-06
4. Increase Availability of On-Site AC Power	4.79E-08	8.02E-09	8.04E-08	2.62E-07	1.67E-07	2.21E-07	4.04E-09	3.00E-08	1.74E-08	1.98E-09	2.08E-09	6.47E-09	1.69E-06
5. Improve AC Power	4.71E-08	8.00E-09	7.90E-08	2.39E-07	1.67E-07	1.97E-07	4.02E-09	2.99E-08	1.71E-08	1.98E-09	2.08E-09	6.45E-09	1.63E-06
6. Reduce Loss of Off-Site Power During Severe Weather	9.31E-08	1.14E-08	8.69E-08	3.31E-07	1.72E-07	2.68E-07	4.04E-09	3.33E-08	1.08E-07	1.99E-09	2.11E-09	6.81E-09	1.99E-06
7. Provide Backup EDG Cooling	9.41E-08	1.13E-08	9.84E-08	3.23E-07	1.75E-07	2.78E-07	4.04E-09	3.26E-08	1.03E-07	1.99E-09	2.11E-09	6.79E-09	2.01E-06
8. Increase EDG Reliability	9.67E-08	1.17E-08	8.55E-08	3.24E-07	1.73E-07	2.57E-07	4.04E-09	3.23E-08	1.21E-07	2.00E-09	2.09E-09	6.63E-09	1.98E-06
9. Improve DG Reliability	1.04E-07	1.22E-08	8.73E-08	3.48E-07	1.73E-07	2.71E-07	4.04E-09	3.34E-08	1.29E-07	2.00E-09	2.11E-09	6.83E-09	2.05E-06
10. Reduce Plant-Centered Loss of Off-Site Power	6.95E-08	9.83E-09	8.62E-08	2.96E-07	1.70E-07	2.64E-07	4.04E-09	3.30E-08	6.22E-08	1.98E-09	2.11E-09	6.80E-09	1.86E-06
11. Redundant Power to Torus Hard Pipe Vent (THPV) Valves	1.05E-07	1.23E-08	8.62E-08	3.49E-07	1.73E-07	2.50E-07	4.04E-09	3.34E-08	1.31E-07	2.00E-09	2.11E-09	6.81E-09	2.03E-06
12. High Pressure Injection System	6.18E-08	5.34E-09	1.21E-09	2.69E-07	5.90E-08	6.66E-09	3.94E-09	5.48E-10	3.47E-10	4.44E-10	0.00E+00	2.05E-11	4.55E-07
13. Extend RCIC Operation	1.05E-07	1.23E-08	8.73E-08	3.49E-07	1.73E-07	2.50E-07	4.04E-09	3.34E-08	1.32E-07	2.00E-09	2.11E-09	6.83E-09	2.03E-06
14. Improve ADS System	8.79E-08	1.21E-08	8.35E-08	3.10E-07	1.73E-07	1.67E-07	4.03E-09	2.69E-09	1.15E-07	5.61E-10	6.24E-11	3.31E-10	1.11E-06
15. Improve ADS Signals	1.03E-07	1.11E-08	8.81E-08	3.43E-07	1.65E-07	2.63E-07	4.39E-09	5.60E-10	1.14E-07	1.77E-09	0.00E+00	6.57E-09	1.62E-06
16. Low Pressure Injection System	8.81E-08	6.84E-09	9.78E-09	3.27E-07	6.86E-08	1.26E-07	4.33E-09	3.95E-08	2.14E-08	2.54E-09	2.65E-09	8.70E-09	1.58E-06
17. ECCS Low Pressure Interlock	1.05E-07	1.23E-08	8.73E-08	3.49E-07	1.73E-07	2.50E-07	4.04E-09	3.34E-08	1.32E-07	2.00E-09	2.11E-09	6.83E-09	2.03E-06

Release Mode Frequencies for Analysis Cases

Analysis Cases	Release Modes												
	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/E	LL/I	LL/L	CDF
18. RHR Heat Exchangers	1.02E-07	6.35E-09	7.97E-08	2.09E-07	4.72E-08	2.07E-07	3.86E-09	3.14E-08	1.33E-07	1.94E-09	2.03E-09	6.51E-09	1.67E-06
19. Emergency Service Water System Reliability	1.03E-07	1.10E-08	8.68E-08	3.23E-07	1.50E-07	2.65E-07	3.99E-09	3.32E-08	1.28E-07	1.98E-09	2.10E-09	6.80E-09	1.98E-06
20. Main Feedwater System Reliability	7.94E-08	1.22E-08	1.84E-08	3.18E-07	1.63E-07	1.64E-07	4.18E-09	2.80E-08	1.29E-07	2.23E-09	1.84E-09	6.23E-09	1.65E-06
21. Increase Availability of Room Cooling	9.34E-08	1.16E-08	5.87E-08	3.27E-07	1.57E-07	1.52E-07	4.03E-09	2.36E-08	1.26E-07	1.57E-09	1.50E-09	4.84E-09	1.58E-06
22.Increase Availability of the DG System Through HVAC Improvements	7.12E-08	9.63E-09	8.72E-08	3.15E-07	1.71E-07	2.43E-07	4.04E-09	3.33E-08	5.39E-08	1.99E-09	2.11E-09	6.82E-09	1.86E-06
23. Increased Reliability of HPCI And RCIC Room Cooling	1.05E-07	1.23E-08	8.73E-08	3.49E-07	1.73E-07	2.50E-07	4.04E-09	3.34E-08	1.32E-07	2.00E-09	2.11E-09	6.83E-09	2.03E-06
24. Increase Reliability of Instrument Air	1.01E-07	1.12E-08	7.96E-08	2.31E-07	1.63E-07	2.04E-07	4.01E-09	2.23E-08	1.26E-07	1.87E-09	1.46E-09	4.74E-09	1.75E-06
25. Backup Nitrogen to SRV	1.04E-07	1.13E-08	8.55E-08	3.46E-07	1.65E-07	2.50E-07	4.02E-09	3.13E-08	1.30E-07	1.89E-09	2.05E-09	6.54E-09	1.94E-06
26. Improve Availability of SRVs and MSIVs	8.79E-08	1.21E-08	8.35E-08	3.08E-07	1.73E-07	1.67E-07	4.03E-09	2.68E-09	1.15E-07	5.49E-10	6.24E-11	3.31E-10	1.10E-06
27. Improve Suppression Pool Cooling	1.02E-07	6.35E-09	7.97E-08	2.09E-07	4.72E-08	2.07E-07	3.86E-09	3.14E-08	1.33E-07	1.94E-09	2.03E-09	6.51E-09	1.67E-06
28. Increase Availability of Containment Heat Removal	8.89E-08	5.84E-09	5.34E-08	1.45E-07	2.93E-08	1.73E-07	3.85E-09	3.22E-08	1.32E-07	1.84E-09	2.11E-09	6.82E-09	1.51E-06
29. Decay Heat Removal Capability – Drywell Spray	8.89E-08	5.84E-09	5.34E-08	1.45E-07	2.93E-08	1.73E-07	3.85E-09	3.22E-08	1.32E-07	1.84E-09	2.11E-09	6.82E-09	1.51E-06
30. Increase Availability of the CST	9.99E-08	7.25E-09	7.72E-08	3.39E-07	1.01E-07	2.23E-07	3.96E-09	2.95E-08	1.29E-07	1.86E-09	1.83E-09	5.95E-09	1.82E-06
31. Filtered Vent to Increase Heat Removal Capacity For Non-ATWS Events	1.05E-07	1.23E-08	8.73E-08	3.49E-07	1.73E-07	2.71E-07	4.04E-09	3.34E-08	1.32E-07	2.00E-09	2.11E-09	6.83E-09	2.05E-06
32. Reduce Hydrogen Ignition	6.00E-08	1.17E-08	1.60E-08	2.79E-07	1.59E-07	2.32E-07	3.98E-09	3.35E-08	1.13E-07	1.87E-09	2.11E-09	6.27E-09	1.72E-06

Release Mode Frequencies for Analysis Cases

Analysis Cases	Release Modes												
	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/E	LL/I	LL/L	CDF
33. Controlled Containment Venting	1.05E-07	1.23E-08	8.73E-08	3.12E-07	1.72E-07	2.50E-07	4.04E-09	3.34E-08	1.32E-07	2.00E-09	2.11E-09	6.83E-09	1.99E-06
34. ISLOCA	1.05E-07	1.23E-08	8.73E-08	3.49E-07	1.73E-07	2.71E-07	4.04E-09	3.34E-08	1.32E-07	2.00E-09	2.11E-09	6.83E-09	2.05E-06
35. MSIV Design	1.05E-07	1.23E-08	8.73E-08	3.49E-07	1.73E-07	2.50E-07	4.04E-09	3.34E-08	1.32E-07	2.00E-09	2.11E-09	6.83E-09	2.03E-06
36. SLC System	1.05E-07	1.23E-08	8.73E-08	3.49E-07	1.73E-07	2.50E-07	2.32E-09	3.34E-08	1.32E-07	1.83E-09	2.11E-09	6.83E-09	2.03E-06
37. SRV Reseat	1.03E-07	1.16E-08	8.61E-08	3.33E-07	1.58E-07	2.67E-07	4.04E-09	3.34E-08	1.30E-07	1.98E-09	2.11E-09	6.83E-09	1.99E-06
38. Add Fire Suppression [(1)]	-	-	-	-	-	-	-	-	-	-	-	-	-
39. Reduce Risk from Fires that Require Control Room Evacuation[(1)]	-	-	-	-	-	-	-	-	-	-	-	-	-
40. Large Break LOCA	1.05E-07	6.24E-09	8.73E-08	3.47E-07	5.99E-08	2.70E-07	3.86E-09	3.34E-08	1.32E-07	1.94E-09	2.11E-09	6.83E-09	1.91E-06
41. Trip/Shutdown Risk	9.97E-08	1.20E-08	7.84E-08	3.22E-07	1.69E-07	2.44E-07	3.65E-09	3.00E-08	1.29E-07	1.75E-09	1.89E-09	6.10E-09	1.89E-06
42. Increase Availability of SSW Pump House Ventilation System	1.05E-07	1.22E-08	8.45E-08	3.48E-07	1.73E-07	2.49E-07	4.04E-09	3.30E-08	1.31E-07	2.00E-09	2.10E-09	6.78E-09	2.02E-06
43. Increase Recovery Time of ECCS Upon Loss of SSW	1.05E-07	1.21E-08	8.09E-08	3.48E-07	1.65E-07	2.12E-07	4.04E-09	3.34E-08	1.31E-07	2.00E-09	2.11E-09	6.83E-09	1.97E-06
44. Additional Containment Heat Removal	8.89E-08	5.84E-09	4.91E-08	1.45E-07	2.88E-08	1.59E-07	3.85E-09	3.13E-08	1.32E-07	1.84E-09	2.03E-09	6.50E-09	1.49E-06
45. Improve RHR Heat Exchanger Availability	1.04E-07	1.06E-08	8.73E-08	3.17E-07	1.41E-07	2.71E-07	3.98E-09	3.34E-08	1.32E-07	1.98E-09	2.11E-09	6.83E-09	1.98E-06
46. Improve RCIC Lube Oil Cooling	9.81E-08	1.23E-08	8.70E-08	3.41E-07	1.73E-07	2.67E-07	4.04E-09	3.27E-08	1.20E-07	1.86E-09	2.11E-09	6.76E-09	1.95E-06

(1) These analysis cases only impact external events and have been evaluated as explained in response to RAI 3.c