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GNRO-2012/00030

May 3, 2012

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

SUBJECT: Response to Request for Additional Information (RAI)
Grand Gulf Nuclear Station, Unit 1
Docket No. 50-416
License No. NPF-29

REFERENCE: Nuclear Regulatory Commission Letter, "Request for Additional Information for the Review of the Grand Gulf Nuclear Station, License Renewal Application," dated April 4, 2012 (TAC NO. ME7493, GNRI-2012/00076)

Dear Sir or Madam:

Entergy Operations, Inc is providing, in the Attachment, the response to the referenced Request for Additional Information (RAI).

This letter does not contain any 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 3rd day of May, 2012.

Sincerely,

MP/jas

Attachment: Response to Request for Additional Information (RAI)

cc: (see next page)

cc: with Attachment

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Attachment to

GNRO-2012/00030

Response to Request for Additional Information (RAI)

The format for the RAI responses below is as follows. The Request for additional information (RAI) is listed in its entirety as received from the Nuclear Regulatory Commission (NRC) with a background, issue and request subparts. This is followed by the Grand Gulf Nuclear Station (GGNS) RAI response to the individual question.

RAI B.1.19-1

Background
During its audit, the staff reviewed the applicant's program basis document and implementing procedure for the Fatigue Monitoring Program and noted that the program relies on tracking the number of critical thermal and pressure transients to ensure that fatigue usage remains within allowable limits. However, the applicant's implementing procedure discusses a periodic update methodology for manual counting of accrued cycles, determining all relevant plant cycles and computing cumulative usage factors (CUFs). In addition, the implementing procedure discusses partial cycle counting and partial cycle determination (for hydrotests and thermal cycles).

Issue
The Fatigue Monitoring Program uses several different methods for managing cumulative fatigue damage that are not described in License Renewal Application (LRA) Sections B.1.19 and A.1.19 or the applicant's program basis document. Therefore, the details of how the program manages cumulative fatigue damage, including environmental effects when applicable, are not clear. The program's reliance on manual cycle counting, automatic cycle counting, cycle-based fatigue usage updates and partial cycle-based fatigue updates and how they relate to a specific component or fatigue evaluation was not clearly identified. It is also not clear how the different methods work together to ensure that cumulative fatigue damage is managed and the allowable limit is not exceeded (e.g. actual cycles < assumed cycles, CUF < 1.0, CUF < 0.1, $CUF_{en} < 1.0$).

Request

a. Describe all of the different methods that are used to manage cumulative fatigue damage with the Fatigue Monitoring Program. Describe any additional methods that are currently planned to be used by the Fatigue Monitoring Program during the period of extended operation to manage cumulative fatigue damage.

b. If a particular method is used for certain components or fatigue evaluations (e.g., design basis, environmentally-assisted, high-energy line break) specifically identify the components/fatigue evaluations that each method relies on. In addition, justify that the particular method is capable of ensuring the analyses remains valid or the allowable limit is not exceeded prior to taking corrective actions.

c. If these monitoring methods are used or will be used in combination with each other; describe how they work together to ensure that cumulative fatigue damage is managed and the allowable limit is not exceeded.

d. Revise the applicable LRA sections, as necessary, (Appendices A and B) to incorporate the details of the different monitoring methods and how the Fatigue Monitoring Program manages cumulative fatigue damage (this includes the use of the FatiguePro software). If any of the monitoring methods is not a part of the existing program, provide an appropriate enhancement to the program.

RAI B.1.19-1 RESPONSE:

a. The methods that are used to manage cumulative fatigue damage include cycle counting, cycle-based fatigue monitoring, and stress-based fatigue monitoring.

<u>Cycle Counting</u>

At GGNS, plant data such as reactor pressure, feedwater temperature, jet pump flow rate, and generator output, are monitored and saved in computer files for evaluation during periodic cycle tracking updates. During these updates, the numbers of those transients shown in License Renewal Application (LRA) Table 4.3-1 that occurred are determined and logged. Although the fatigue monitoring system collects information that would allow for the logging of partial cycles, this option is not used at GGNS and only full cycles are logged in the periodic cycle tracking updates. The numbers of cycles that have occurred are compared to limits corresponding to the allowable values used in associated fatigue analyses.

<u>Cycle-based Fatigue Monitoring</u>

Cycle-based fatigue monitoring counts the cycles that have occurred and computes a usage factor for a given location based on the usage attributable to each individual transient cycle. The use of cycle-based fatigue allows a conservative determination of the usage (CUF) that has occurred at a specific location based on the actual number of transients that have occurred assuming that the usage that is associated with each of these transients is the fatigue usage for the design transient severity. This is a determination of the actual fatigue usage in contrast to cycle counting, which simply demonstrates that the fatigue analysis remains valid. Events that are more severe than the design transients have been evaluated, and the resulting fatigue usage has been included in the cumulative fatigue usage at affected locations. During the periodic cycle tracking updates, the cumulative fatigue usage at cycle-based fatigue locations is projected through the end of the period of extended operation (60 years) to ensure corrective action is initiated prior to exceeding an allowable usage value.

<u>Stress-based Fatigue Monitoring</u>

Stress-based fatigue monitoring is used where more refined fatigue estimates are necessary because of the more severe thermal duty experienced by specific components. The stress-based fatigue approach utilizes computer-based analyses and actual plant data to calculate the actual stress that occurs during each transient and the associated fatigue usage. The calculated CUF is projected through the end of the period of extended operation (60 years) to ensure corrective action is initiated prior to exceeding an allowable usage factor. Additional information regarding stress-based fatigue, including consideration of environmentally assisted fatigue, is available in Electric Power Research Institute (EPRI) report 1022876 "Methodology for Fatigue Monitoring of Class 1 Nuclear Components in a Reactor Water Environment."

There are no additional methods planned for the period of extended operation.

b. The counting of cycles is relied on for determination of the approach to the cycle limits and for the determination of cycle-based fatigue usage, and is adequate to ensure fatigue usage is acceptable for most locations. If cycle counting alone does not demonstrate that an analysis will remain valid, then cycle-based fatigue monitoring or stress-based fatigue monitoring is used. Specific types of analyses, such as environmentally assisted fatigue analyses or high-energy line break analyses, do not exclusively use one particular method of fatigue monitoring. For locations that utilize stress-based fatigue monitoring, cycle counting is not relied on and the actual cumulative usage factor is calculated as the plant undergoes operating transients. Stress-based fatigue monitoring is used for the feedwater nozzle, the high pressure core spray nozzle, and the feedwater weldolets. Cycle counting ensures that applicable analyses remain valid by confirming the actual accrued cycles do not exceed the numbers of cycles assumed in the analyses. Cycle-based fatigue monitoring and stress-based fatigue monitoring determine a CUF based on actual transients incurred and project that value to the end of the Period of Extended Operation (PEO) to assure the CUF remains below the allowable limit of 1.0.

c. The direct counting of cycles is the simplest approach to ensure evaluation of fatigue cycles and provides an indication of when transient cycles are approaching their originally analyzed numbers. By itself, transient cycle counting does not give a direct indication of the actual fatigue usage for a location, but ensures that analysis assumptions regarding numbers of transient cycles remain valid. The cycle-based fatigue approach also uses cycle counts and determines specific usage factors based on transients experienced. The stress-based fatigue approach is only used for the feedwater nozzle, the high pressure core spray nozzle, and the feedwater weldolets and utilizes the actual plant conditions that were present (not actual cycle counts) to determine the stress and fatigue. Thus, the approaches are used together to ensure that cumulative fatigue damage is managed and the allowable limit is not exceeded.

d. Additional description has been added to Appendices A and B for the different monitoring methods and how the Fatigue Monitoring Program manages cumulative fatigue damage.

Appendix A and B are revised as shown below with underline for additions and strikethrough for deletions.

A.1.19 Fatigue Monitoring Program

The Fatigue Monitoring Program ensures that fatigue usage remains within allowable limits by (a) tracking the number of critical thermal and pressure transients for selected components, (b) verifying that the severity of monitored transients are bounded by the design transient definitions for which they are classified, and (c) assessing the impact of the reactor coolant environment on a set of sample critical components.

Transient cycle logging and fatigue monitoring software are used together to ensure cumulative usage factors do not exceed design limits. The Fatigue Monitoring Program utilizes both fatigue monitoring software and manual cycle counting techniques. In addition to providing cycle counting information, the fatigue monitoring software determines cycle-based fatigue and stress-based fatigue based on actual transients incurred. Cycle-based fatigue monitoring utilizes cycle counts that have occurred and design basis fatigue calculations to calculate usage for a specific location and make projections of future fatigue usage. Stress-based fatigue monitoring calculates stress and fatigue based on actual stress loadings. The combination of cycle counting, cycle-based fatigue monitoring and stress-based fatigue monitoring ensures that cumulative usage factors will be maintained within allowable limits.

The Fatigue Monitoring Program will be enhanced as follows.

- A review of the GGNS high energy line break analyses and the corresponding tracking of associated cumulative usage factors will be performed to ensure that the GGNS program adequately manages fatigue usage for these locations.

- Fatigue usage calculations that consider the effects of the reactor water environment will be developed for a set of sample reactor coolant system components. This sample set will include the locations identified in Nuclear Regulatory Commission (NRC) Regulatory Guide (NUREG)/CR-6260 and additional plant-specific component locations in the reactor coolant pressure boundary if they are found to be more limiting than those considered in NUREG/CR-6260. F_{en} factors will be determined using the formulae sets listed in Section A.2.2.3. If necessary following this analysis, revised cycle limits will be incorporated into the Fatigue Monitoring Program documentation.

- Program guidance documents will be revised to provide updates of the fatigue usage calculations on an as-needed basis if an allowable cycle limit is approached, or in a case where a transient definition has been changed, unanticipated new thermal events are discovered, or the geometry of components has been modified.

Enhancements will be implemented at least two years prior to entering the period of extended operation.

B.1.19 FATIGUE MONITORING

Program Description

The Fatigue Monitoring Program is an existing program that ensures that fatigue usage remains within allowable limits by (a) tracking the number of critical thermal and pressure transients for selected components, (b) verifying that the severity of monitored transients are bounded by the design transient definitions for which they are classified, and (c) assessing the impact of the reactor coolant environment on a set of sample critical components.

Transient cycle logging and fatigue monitoring software are used together to ensure cumulative usage factors do not exceed design limits. The Fatigue Monitoring Program utilizes both fatigue monitoring software and manual cycle counting techniques. In addition to providing cycle counting information, the fatigue monitoring software determines cycle-based fatigue and stress-based fatigue based on actual transients incurred. Cycle-based fatigue monitoring utilizes cycle counts that have occurred and design basis fatigue calculations to calculate usage for a specific location and make projections of future fatigue usage. Stress-based fatigue monitoring calculates stress and fatigue based on actual stress loadings. The combination of cycle counting, cycle-based fatigue monitoring and stress-based fatigue monitoring ensures that cumulative usage factors will be maintained within allowable limits.

NUREG-1801 Consistency

The Fatigue Monitoring Program, with enhancements, is consistent with the program described in NUREG-1801, Section X.M1, Fatigue Monitoring, with one exception.

Exceptions to NUREG-1801

The Fatigue Monitoring Program is consistent with the program described in NUREG-1801, Section X.M1, Fatigue Monitoring, with the following exception.

Elements Affected	Exception
7. Corrective Actions	NUREG-1801 recommends use of a design code limit for cumulative usage factors (CUFs). GGNS applies a more stringent design limit of 0.1 CUFs at high energy line break (HELB) locations. Also, GGNS includes an additional corrective action to evaluate the HELB analysis to address a HELB exclusion location with a CUF that increases to greater than 0.1.[1]

Exception Note:
1. The use of a 0.1 limit for CUF at HELB locations is consistent with the criteria stated in UFSAR Section 3.6A.2. Evaluation of the HELB analysis is an additional valid corrective action to address HELB exclusion locations with a CUF that increases to greater than 0.1.

Enhancement

The following enhancements will be implemented at least two years prior to entering the period of extended operation.

Elements Affected	Enhancement
1. Scope of Program	A review of the GGNS high energy line break analyses and the corresponding tracking of associated cumulative usage factors will be performed to ensure that the GGNS program adequately manages fatigue usage for these locations.
1. Scope of Program	Fatigue usage calculations that consider the effects of the reactor water environment will be developed for a set of sample reactor coolant system components. This sample set will include the locations identified in NUREG/CR-6260 and additional plant-specific component locations in the reactor coolant pressure boundary if they are found to be more limiting than those considered in NUREG/CR-6260. F_{en} factors will be determined using the formulae sets listed in Section 4.3.3. If necessary following this analysis, revised cycle limits will be incorporated into the Fatigue Monitoring Program documentation
4. Detection of Aging Effects	The GGNS program will be enhanced to revise program documents to provide updates of the fatigue usage calculations on an as-needed basis if an allowable cycle limit is approached, or in a case where a transient definition has been changed, unanticipated new thermal events are discovered, or the geometry of components has been modified.

RAI B.1.19-2

Background
The "parameters inspected/monitored" program element of Generic Aging Lessons Learned (GALL) Report AMP X.M1, "Fatigue Monitoring," states that more detailed monitoring of local pressure and thermal conditions may be performed to allow the actual fatigue usage for the specified critical locations to be calculated. LRA Section B.1.19 states, in part, that the Fatigue Monitoring Program ensures that fatigue usage remains within allowable limits by tracking the number of critical thermal and pressure transients for selected components. In addition, LRA Section 4.3.1.1 states that stress-based fatigue (SBF) monitoring on the feedwater nozzle, the high pressure core spray nozzle, and the feedwater weldolets is being used. LRA Section 4.3.1.2 states the feedwater nozzle fatigue due to plant transients and the rapid cycling fatigue were reanalyzed for EPU operating conditions and will also be reanalyzed to consider the effects of reactor water environment on fatigue.

Issue
Since the Fatigue Monitoring Program relies on tracking the number of transients for selected components to ensure that fatigue usage remains within allowable limits, it is not clear how SBF monitoring is currently incorporated and how it will be used to manage fatigue for the feedwater nozzle, since it will be reanalyzed to consider the effects of reactor water environment.

As discussed in Regulatory Issue Summary (RIS) 2008-30 "Fatigue Analysis of Nuclear Power Plant Components," there were concerns with a methodology that has been used to perform fatigue calculations and as input for on-line fatigue monitoring programs by license renewal applicants or licensees in the current operating term. Specifically, the concern involves an input in which only one value of stress is used for the evaluation of the actual plant transients and that this simplification of the analysis requires a great deal of judgment by the analyst to ensure that the simplification still provides a conservative result.

Request
a. Since SBF will be used in the reanalysis of the feedwater nozzle to consider the effects of reactor water environment on fatigue, describe and justify any actions that have been or will be taken for the period of extended operation to address the concerns described in RIS 2008-30, related to the use of one value of stress to perform fatigue calculations and as input for on-line fatigue monitoring programs, for any reanalysis that will use SBF.
b. Since SBF monitoring is currently used for the feedwater nozzle, the high pressure core spray nozzle, and the feedwater weldolets, describe and justify the actions that have been taken to ensure that the potential non-conservative methods described in RIS 2008-30 have not challenged the ability to maintain the allowable limit

RAI B.1.19-2 RESPONSE:

a. As stated in GGNS LRA Section B.1.19, environmentally assisted fatigue (EAF) analyses will be completed prior to the period of extended operation. As indicated in LRA Section 4.3.3, this includes applying the appropriate environmentally assisted fatigue correction factors (F_{en}) to valid CUFs determined using an NRC-approved version of the American Society of Mechanical Engineers (ASME) code or NRC-approved alternative (e.g., NRC-approved code case). Any reanalysis to address the effects of the reactor coolant environment will use all six stress components for varying principal stress. The issues discussed in Regulatory Issue Summary (RIS) 2008-30 are being addressed in the GGNS corrective action program as a current licensing basis issue under 10CFR50. As part of the corrective actions, Entergy will upgrade the SBF monitoring software to analyze fatigue using all six stress components. Thus, during the period of extended operation, any locations that use the SBF method for the analysis of fatigue will use all six stress components.

b. There are no indications that the single stress value determined by analysts for use in SBF monitoring was not conservative for GGNS analyses. In addition, industry experience with the evaluation of RIS 2008-30 indicates that potential non-conservatisms in the analysis of these locations are not expected to result in significant changes to the extent that the calculated fatigue usage would be unacceptable. This was also indicated in RIS 2008-30 where the confirmatory analysis of the sole location that was considered non-conservative still demonstrated acceptable fatigue usage. Thus, no immediate actions were found to have been needed to ensure that the allowable limit is maintained.

   The numbers of cycles that GGNS has experienced are much less than the total numbers of transients that were postulated in the analysis of the components that use SBF monitoring. This provides additional assurance that the fatigue usage at these locations remains acceptable.

   Prior to the period of extended operation, the SBF monitoring software will be upgraded to use all six stress components. This will provide further confirmation that cumulative usage factors determined through SBF monitoring remain within allowable limits.

RAI B.1.19-3

Background
The "monitoring and trending" program element of GALL Report AMP X.M1 states that trending is assessed to ensure that the fatigue usage factor remains below the design limit during the period of extended operation.

During its audit, the staff reviewed the implementing procedure for the Fatigue Monitoring Program and noted that it relies on manual cycle counting, cycle-based fatigue usage updates and partial cycle-based fatigue updates. In addition, the staff noted that the applicant uses automatic cycle counting and stress-based fatigue monitoring during the review of the on-site documentation. Furthermore, the staff reviewed the implementing procedures for the Fatigue Monitoring Program, which state that the FatiguePro software computes fatigue usage for critical reactor pressure vessel, piping and piping penetration components.

Issue
During its audit, the staff noted that implementing procedure only provides direction to generate a condition report that is based on the projected cumulative fatigue usage factor for a component. Since the Fatigue Monitoring Program relies on several different methods of monitoring, it is not clear whether the program includes or will include appropriate trending of the appropriate parameters (e.g. cycles, CUF, CUF_{en}) based on the method of monitoring.

The staff noted that FatiguePro is currently being used and appears that it will continue to be used during the period of extended operation; therefore, it is not clear to the staff why the Updated Final Safety Analysis Report (UFSAR) Supplement update does not contain the details of using FatiguePro to manage cumulative fatigue damage.

Request

a. For each method used, or that will be used, by Fatigue Monitoring Program, describe and justify the parameter that is or will be trended to ensure that cumulative fatigue damage of metal components caused by anticipated cyclic strains in the material is managed. Discuss the associated action limits for each method of monitoring and justify that there is sufficient margin to ensure that the design limits will not be exceeded. If an enhancement is needed as a result of this RAI, provide the appropriate revisions to the applicable LRA sections (Appendices A and B).
b. Provide the appropriate revisions to the applicable LRA sections (Appendices A and B) to describe the purpose and use of the FatiguePro software for managing cumulative fatigue damage.

RAI B.1.19-3 RESPONSE:

a. As described in LRA Section B.1.19 and the response to RAI B.1.19-1 above, the GGNS Fatigue Monitoring Program trends the number of critical transients that have occurred and verifies that the severity of accrued transients are bounded by the design transient definitions. The program manages cumulative fatigue damage by tracking accrued transients against calculation assumptions and by calculating and trending cumulative usage factors using cycle-based fatigue monitoring and stress-based fatigue monitoring.

Following the incorporation of the enhancements identified in LRA section B.1.19 Fatigue Monitoring, the following parameters will be monitored or trended to ensure that the aging effects of cumulative fatigue damage on metal components is managed.

- For the cycle-counting approach, the actual number of specific cycles that have occurred will be trended. In counting specific transient cycles, action will be taken prior to the number of any individual transient exceeding the limit established in the analysis. Sufficient margin remains in that the numbers of all transients used in the analysis must be at the limits for the actual CUF to equal the calculated CUF. The timing of possible corrective actions will depend on the historic rate of transient occurrence, the time remaining in the license term, scheduled outage dates, and the specific correction action planned.
- For the cycle-based and stress-based fatigue monitoring approaches, the parameter tracked is the cumulative usage factor that is based on transients that have occurred. For the determination of cycle-based and stress-based fatigue cumulative usage factors, action will be taken when the cumulative usage factor is projected to exceed the allowable within the next six years. The allowable is identified as a CUF< 0.1 for piping designated to be in the no-break zone for high-energy line break analyses and a CUF < 1.0 for other locations in accordance with ASME code requirements.

These limits provide ample time so that repair, replacement, reevaluation or other corrective action can be completed before the limit is reached. If a limit is reached, the condition will be entered into the corrective action program for evaluation.

b. As described in the response to RAI B.1.19-1 above, revisions have been made to LRA sections A.1.19 and B.1.19 that describe the use of the fatigue management software for managing cumulative fatigue damage.

RAI B.1.19-4

Background
The "corrective actions" program element of GALL Report AMP X.M1 recommends specific corrective actions if the acceptance criteria are exceeded, in addition to the requirements of 10 CFR Part 50, Appendix B. Specifically, it states acceptable corrective actions include repair of the component, replacement of the component, and a more rigorous analysis of the component to demonstrate that the design code limit will not be exceeded during the period of extended operation. In addition, it recommends program scope expansion to include consideration of other locations with the highest expected cumulative usage factors when considering environmental effects.

The applicant claimed, in its program basis document for the Fatigue Monitoring Program, that the "corrective actions" program element is consistent of GALL Report AMP X.M1.

LRA Section B.1.19 states that the sample set of locations that will address the effects of reactor water environment will include the locations identified in NUREG/CR-6260 and additional plant-specific component locations in the reactor coolant pressure boundary if they are found to be more limiting than those considered in NUREG/CR-6260.

Issue
During its audit, the staff reviewed the "corrective actions" program element in the applicant's program basis document and noted the applicant applies the requirements of 10 CFR Part 50 Appendix B to its program through the Corrective Actions Program. However, the specific recommendations from GALL Report X.M1 for corrective actions that include repair, replacement and reanalysis of the component and scope expansion were not included in the program basis document or Fatigue Monitoring Program.

Since the applicant will be enhancing its program prior to the period of extended operation as described above, it is not clear whether the "corrective actions" program element of the applicant's program will ensure that if any changes/modifications occur in the future that the limiting locations will have been addressed for the effects of reactor water environment.

Request
Justify the claim of consistency with the "corrective actions" program element of GALL Report AMP X.M1, considering the recommendations for corrective actions to include repair, replacement and reanalysis of the component and scope expansion to include other locations when considering environmental effects were not included.

Confirm that the enhanced Fatigue Monitoring Program will continually ensure that the locations managed for effects of reactor water environment will remain limiting for the plant-specific configuration if any plant changes or modifications occur in the future. Alternatively, justify that the program can adequately address the effects of reactor water environment on fatigue life.

RAI B.1.19-4 RESPONSE

As indicated in the program basis document, Entergy applies the requirements of 10 CFR Part 50, Appendix B to the Fatigue Monitoring Program through the corrective action program. This is consistent with NUREG-1801, X.M1 corrective actions, which states, "The program provides for corrective actions to prevent the usage factor from exceeding the design code limit during the period of extended operation" and that "...the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions." This does not contradict the NUREG-1801, X.M1 acceptance criteria statement that "Acceptable corrective actions include repair of the component, replacement of the component, and a more rigorous analysis of the component to demonstrate that the design code limit will not be exceeded during the period of extended operation." Not specifically listing these acceptable corrective actions was not intended to eliminate them from consideration during evaluation of a condition that fails to meet the acceptance criteria. In fact, repair, replacement and reevaluation are common corrective actions assigned under the corrective action program for many identified conditions. Evaluation under the corrective action program is expected to consider scope expansion to include other locations with the highest expected cumulative usage factors when considering environmental effects. For example, if the program acceptance criteria are not met due to experiencing a higher number of a specific transient than assumed, then the evaluation is expected to consider the impact on the fatigue analyses of other locations that are affected by the same specific transient.

As identified in an enhancement to the Fatigue Monitoring Program in LRA Section B.1.19, two years prior to the period of extended operation the environmental assisted fatigue analyses will be completed. Any additional cycle limits determined necessary to support those analyses will be added to the Fatigue Monitoring Program. The modification process governed by Entergy's modification procedures is relied upon to identify the appropriate design requirements for analysis of metal fatigue associated with plant changes or modifications. Additional cycle limits, if any, that must be monitored to support new design analyses will be added to the Fatigue Monitoring Program. Thus, the program will adequately address the effects of reactor water environment on fatigue life.

RAI B.1.19-5

Background
The "operating experience" program element of GALL Report AMP X.M1 recommends that the program review industry experience relevant to fatigue cracking. The staff noted that RIS 2011-14, "Metal Fatigue Analysis Performed By Computer Software," was issued on December 29, 2011. This RIS is associated with the implementation of computer software packages used to demonstrate the ability of nuclear power plant components to withstand the cyclic loads associated with plant transient operations. During its audit, the staff reviewed the implementing procedures for the Fatigue Monitoring Program, which state that the FatiguePro fatigue monitoring software computes fatigue usage for critical reactor pressure vessel, piping and piping penetration components.

Issue
RIS 2011-14 describes concerns regarding the implementation of computer software packages used to demonstrate the ability of nuclear power plant components to withstand the cyclic loads associated with plant transient operations. Specifically, using computer software to compute cumulative usage factors may involve analyst intervention that relies on engineering judgment, which, without control and documentation, could produce results that are not predictable, repeatable, nor conservative.

During its audit, the staff noted that the applicant uses the computer software, FatiguePro, which performs automatic cycle counting and stress-based fatigue monitoring to manage cumulative fatigue damage of certain components. It is not clear, if the data collected by FatiguePro is reviewed and modified prior to the determination of cumulative fatigue usage for a component or of an accrued transient cycle.

Request
a. Describe and justify any actions that have been or will be taken to address the concerns described in RIS 2011-14, related to the use of computer software to demonstrate the ability of components to withstand cyclic loads associated with transients and the documentation of analyst's engineering judgment and intervention.
b. Describe the activities that are performed to the information/data that is collected by FatiguePro prior to determining the cumulative fatigue usage for a component or an accrued transient cycle. Further justify if the concerns described in RIS-2011-14, related to documentation of the analyst's engineering judgment and intervention, have been addressed for the current use or will be addressed for the future use of FatiguePro.

RAI B.1.19-5 RESPONSE:

a. The GGNS Fatigue Monitoring Program is being upgraded under the corrective action program to use monitoring software that analyzes fatigue using all six stress components for locations that utilize stress-based fatigue monitoring. This will include consideration of RIS 2011-14. Entergy procedures specify that the basis for engineering judgment must be documented in the body of the calculation.
b. No such activities are performed. The GGNS fatigue monitoring program does not perform NB-3600 analysis so this identified concern is not relevant. The GGNS fatigue monitoring program does not allow stress peak and valley times to be modified so this identified concern is not relevant. As identified in response "a", when the upgraded version of the fatigue monitoring program is utilized, this enhanced version will include consideration of RIS 2011-14.

RAI B.1.19-6

Background
The "parameters monitored/inspected" program element of GALL Report AMP X.M1 states the program monitors all plant design transients that cause cyclic strains, which are significant contributors to the fatigue usage factor. The implementing procedure for the Fatigue Monitoring Program provides the definition of a "counted cycle" and states that for the definition of "specific system/component cycles, the component stress report should be reviewed." The applicant's procedure continues to describe the basic reactor cycles that contribute significantly to fatigue usage of Class 1 pressure boundary components and is counted in accordance with the procedure.

LRA Section 4.3.1 states that the Fatigue Monitoring Program will ensure that the accrued numbers of cycles of all design transients will remain below the numbers of cycles evaluated in the fatigue analyses.

Issue
It is not clear to the staff, whether the "specific system/component cycles" that are referenced in the applicant's implementing procedures are or will be monitored and tracked by the Fatigue Monitoring Program.

The staff noted that there are several locations which contain information related design transients and associated design limits:

- UFSAR Section 3.9.1.1 provides the design transient for specific components.
- UFSAR Table 3.9-1 provides the design transients for the reactor pressure vessel assembly and internals.
- Technical Specification Section 5.5.5 states that the cyclic and transient occurrences identified on UFSAR Table 3.9-35 are tracked to ensure that the reactor vessel is maintained within the design limits. UFSAR Table 3.9-35 also provides limits for four design transients.
- LRA Table 4.3-1 provides a list of design transients with the associated projected and analyzed transient cycles

The staff noted that the number of assumed number of cycles for the same design transient is different, in some instances, between the aforementioned sections for different components.

Request
a. Confirm that the transient cycles that will be monitored and tracked by the Fatigue Monitoring Program include all transients used in the determination of cumulative usage factors in ASME Class 1 fatigue evaluations and high-energy line break evaluations and will be used in environmentally-assisted fatigue evaluations.
b. If there are any transients used in these calculations that will not be monitored and tracked by the Fatigue Monitoring Program, justify why it is not necessary to monitor these design transients.
c. Confirm that the most limiting cycle limit for a particular design transient, that was or will be used in any fatigue analysis, will be monitored and tracked to assure that action is taken prior to any applicable fatigue analysis becoming invalid. If different cycle limits

are applicable to specific design transients or components, describe and justify how the Fatigue Monitoring Program will "assure that action is taken if the actual cycles approach their analyzed numbers" and the applicable fatigue analysis will not be invalid.

B.1.19-6 RESPONSE:

a. The transient cycles that will be monitored and tracked by the Fatigue Monitoring Program include the necessary transients used in the determination of cumulative usage factors in ASME Class 1 fatigue evaluations and high-energy line break evaluations and the transients that will be used in environmentally-assisted fatigue evaluations. Since Entergy has not yet completed the environmentally assisted fatigue (EAF) analysis, it is not yet known if a reduction in allowable cycles may be required by the EAF reanalysis. If a reduction in the allowable cycles is necessary following the environmentally assisted fatigue analysis, the associated cycle limits will be revised accordingly.

b. The design cyclic transients for Class 1 components are defined by applicable design specifications for each component. The design specifications establish the set of transients that are used in the design of the components and are included as part of each component stress report. The overall set of plant design transients may be augmented by component specific design transients to adequately bound the cycles expected at a specific location. The process used for calculating fatigue usage uses the set of design transients that are specified and determines which of these design transients would cause load pairs that result in significant fatigue based on the ASME fatigue curves.

   The transients identified in the GGNS calculations that are not tracked but may contribute to fatigue usage are listed below along with an explanation for why tracking is not required.

   General Class 1 Transients

Transient Description	**Cycles Specified**	**Explanation why tracking is not required**
Daily Reduction of 75% Power	10,000	GGNS is a base loaded plant that does not perform these power reductions. The numbers postulated and used in the analyses are far more than required to bound the actual plant operation, so this transient need not be tracked.
Weekly Reduction of 50% Power	2,000	GGNS is a base loaded plant that does not perform these power reductions. The numbers postulated and used in the analyses are far more than required to bound the actual plant operation, so this transient need not be tracked
Control Rod Patterns Change	400	This transient is a reduction of power. The total number of power reductions used in the analyses is far more than what is required to bound the actual plant operation, so this transient need not be tracked.

Location Specific Transients

Transient Description	Explanation why tracking is not required
CRD Return Nozzle Hydraulic System Return Nozzle	This nozzle was capped
Head Cooling Spray Nozzle	Head cooling spray is not utilized at GGNS
Core differential pressure and standby liquid control nozzle	Standby liquid control (SLC) injection path changed such that this nozzle is not used for SLC injection.

c. The most limiting cycle limit for a particular design transient that was or will be used in any fatigue analysis will be monitored and tracked to assure that action is taken prior to any applicable fatigue analysis being invalid. Following the incorporation of the program enhancements identified in LRA Section B.1.19, the program will provide for updates of the fatigue usage calculations if an allowable cycle limit is approached and ensure the fatigue analysis does not become invalid. If different cycle limits for the same transient apply to different components, the Fatigue Monitoring Program will use the lowest value for the limit for the specific transient.

RAI B.1.19-7

Background
LRA Section B.1.19 provides an enhancement to the "detection of aging effects" program element, which states the program will be enhanced to revise program documents to provide updates of the fatigue usage calculations on an as-needed basis if an allowable cycle limit is approached, or in a case where a transient definition has been changed, unanticipated new thermal events are discovered, or the geometry of components has been modified.

The "detection of aging effects" program element of GALL Report AMP X.M1 states the program provides for updates of the fatigue usage calculations on an as-needed basis if an allowable cycle limit is approached, or in a case where a transient definition has been changed, unanticipated new thermal events are discovered, or the geometry of components have been modified.

Issue
During its audit, the staff reviewed the applicant's implementing procedures for the Fatigue Monitoring Program and noted that the relation between the different monitoring methods (e.g. cycle counting, cycle-based fatigue and stressed based fatigue) is not apparent. Therefore, it is not clear to the staff what aspects of the program and procedures will be revised to account for this enhancement.

In addition, the enhancement is specific about updates to calculations when an allowable cycle limit is approached; however, since the program relies on different monitoring methods, it is also not clear if and when updates to calculations will be required for other parameters (e.g. actual cycles < assumed cycles, CUF < 1.0, CUF < 0.1, CUF_{en} < 1.0) that are monitored.

Request
Provide a description of how the implementing procedures for the Fatigue Monitoring Program will be revised to implement this enhancement, considering that the program relies on several monitoring methods (i.e. manual and automatic cycle counting, cycle-based and partial cycle-based fatigue monitoring and stress-based fatigue monitoring).

RAI B.1.19-7 RESPONSE:

The enhancement will ensure the implementing procedure is consistent with the GALL program element. The procedure will provide for updates of the fatigue usage calculations on an as-needed basis if an allowable cycle limit is approached, or in a case where a transient definition has been changed, unanticipated new thermal events are discovered, or the geometry of components has been modified.

The GGNS Fatigue Monitoring Program manages cumulative fatigue damage by counting cycles, by the calculation of cycle-based fatigue cumulative usage factors, and by the calculation of stress-based fatigue cumulative usage factors. To address allowable cycle limits, following incorporation of the enhancements identified in LRA section B.1.19 Fatigue Monitoring, implementing procedures will provide for updates of the fatigue usage calculations as follows.

- For specific cycle logging (including partial cycle counting if it is utilized in the future), update of the fatigue analysis will be done prior to the number of any individual transient exceeding the limit analyzed for in the analysis.

- For the determination of cycle-based and stress-based fatigue cumulative usage factors, action will be taken when the cumulative usage factor is projected to exceed the allowable within the next six years. The allowable limit is identified as a CUF<0.1 for locations designated to be part of a no-break zone for high-energy line break analyses and a CUF <1.0 (in accordance with ASME code) for other locations.

These limits provide ample time for repair, replacement, reevaluation or other corrective action before the limit is reached. If a limit is reached, the condition will be entered into the corrective action program for evaluation.