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W3F1-2017-0039

May 12, 2017

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

SUBJECT: Responses to Request for Additional Information Set 17 Regarding the License Renewal Application for Waterford Steam Electric Station, Unit 3 (Waterford 3)
Docket No. 50-382
License No. NPF-38

REFERENCES:

1. Entergy letter W3F1-2016-0012 "License Renewal Application, Waterford Steam Electric Station, Unit 3" dated March 23, 2016.
2. NRC letter to Entergy "Requests for Additional Information for the Review of the Waterford Steam Electric Station, Unit 3, License Renewal Application – Set 17" dated April 17, 2017.
3. Entergy letter W3F1-2017-0002 "Responses to Request for Additional Information Sets 8 and 9 Regarding the License Renewal Application for Waterford Steam Electric Station, Unit 3"

Dear Sir or Madam:

By letter dated March 23, 2016, Entergy Operations, Inc. (Entergy) submitted a license renewal application (Reference 1).

In letter dated April 17, 2017 (Reference 2), the NRC staff made a Request for Additional Information (RAI) Set 17 needed to complete its review. Enclosure 1 provides the responses to RAI Set 17.

Additionally, this letter is notification that an editorial correction is being made to the B.1.13 table provided in the response to RAI 1.13-3d(a) as shown on page 10 of Enclosure 2 in Reference 3 . The heading of the second column is corrected to "Enhancement".

There are no new regulatory commitments contained in this submittal. If you require additional information, please contact the Regulatory Assurance Manager, John Jarrell, at 504-739-6685.

I declare under penalty of perjury that the foregoing is true and correct. Executed on May 12, 2017.

Sincerely,

MRC/AJH

Enclosures: 1. Set 17 RAI Responses – Waterford 3 License Renewal Application

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Enclosure 1 to

W3F1-2017-0039

Set 17 RAI Responses

Waterford 3 License Renewal Application

RAI 4.3.3-2a

Background:
By letter dated October 12, 2016, the staff issued RAI 4.3.3-2, requesting the applicant to provide additional information on its methodology to identify and evaluate plant-specific locations for environmentally-assisted fatigue (EAF). By letter dated December 12, 2016, the applicant responded to RAI 4.3.3-2 stating that its methodology will be based on EPRI Report 1024995, "Environmentally Assisted Fatigue Screening, Process and Technical Basis for Identifying EAF Limiting Locations." The applicant stated that this screening process will determine the "sentinel" locations that will bound and appropriately represent each thermal zone.

Per 10 CFR 54.29(a)(1), the staff needs reasonable assurance that the effects of aging will be managed for the period of extended operation. In addition, per SRP-LR Section 4.3.2.1.3, the applicant should address the effects of the coolant environment on component fatigue life. One acceptable approach (which the applicant is using) is to assess the impact on a sample of critical components. This sample should include, as a minimum, those selected in NUREG/CR 6260. Applicants should also consider adding additional plant specific component locations if the locations might be more limiting than those in NUREG/CR-6260.

The applicant has not provided reasonable assurance that their methodology will successfully and appropriately identify plant-specific component locations that may be more limiting than those identified in NUREG/CR 6260.

Issue:

As of April 2016, EPRI Technical Report 1024995 has not been submitted to the NRC for review and approval and, therefore, has not been endorsed by the NRC. The applicant did not define a plant-specific methodology and criteria to select the most limiting locations for EAF. The licensee has not demonstrated that a plant-specific screening methodology has been developed in a manner that conservatively evaluates EAF effects, with the same degree of analytical rigor for all locations, to identify the bounding locations.

For the step in the methodology that computes the estimated EAF value (U_{en}*), the applicant stated that it will calculate U_{en}* using a fatigue correction factor (F_{en}) that is the average of the Fen determined for the strain rate of the predominant thermal transient and the maximum Fen determined by the minimum strain rate. The term predominant thermal transient is not defined, nor how the predominant thermal transient will be determined for each component. Further, the applicant does not provide a basis for why the resulting U_{en}* is a conservative value that can be used to compare the locations in an appropriate manner. Also, within each thermal zone, the applicant stated that "the CUF values are determined on a common basis (i.e., unbundled transients) so that valid rankings can be achieved." The staff is unclear what specific parameters will be used. The staff needs additional information to determine if the components will be assessed similarly.

For the step in the methodology that examines the relative rankings and selects the sentinel locations, the staff also needs additional information to determine if the applicant selection of sentinel locations within a thermal zone is conservative and appropriate. The applicant did not define the specific selection criteria in its "further study" to determine the sentinel locations. Also, the staff is unclear on the term, "close-coupled," in terms of determining the number of sentinel locations within a thermal zone.

The applicant also did not clarify if material type is one of the criteria when selecting sentinel locations (i.e., a sentinel location of one material can bound a location of a different material within a thermal zone). The staff noted that the U_{en}* of different materials may respond differently when the EAF is being refined in the future. The staff noted that refinement of the U_{en}* value sentinel location of one material may not correspond to an equivalent reduction of the U_{en}* value of a bounded location of a different material. The applicant did not justify that the refinement of the higher U_{en}* of one material would ensure the reduction of U_{en}* values for another material within the same transient section.

<u>Request:</u>

1. Confirm if components in different thermal zones will be compared to each other. If they will be or can be, describe the methodology that will be used to make the comparison, including any assumptions, and provide a technical justification that the comparison can be made in an appropriate manner.

2. For the step in the methodology that compares locations within a thermal zone:
   a. Define the term, "predominant thermal transient," and how it will be determined for each component.
   b. Justify that calculating the U_{en}* using an average F_{en} is conservative and appropriate.
   c. In addition to use of unbundled transients, define other relevant parameters that will be used to ensure that the CUF values can be determined on a common basis (i.e., amount of rigor, use of the same ASME code fatigue curves).
   d. Justify that the parameters used above will provide a conservative and appropriate comparison between locations within the same thermal zone.

3. For the step in the methodology that selects sentinel locations:
   a. Define the term, "close-coupled," and how it will be applied in determining the number of sentinel locations within a thermal zone.
   b. Provide the selection criteria that will be applied to each thermal zone to select the sentinel locations.
   c. If material type is not a selection criterion (i.e., a sentinel location of one material can bound a location of a different material within a thermal zone), justify that the refinement of the U_{en}* value of a sentinel location of one material would ensure the reduction of the U_{en}* of a bounded location of a different material.

Waterford 3 Response

1. The WF3 environmentally assisted fatigue evaluation will not compare components in different thermal zones in order to eliminate components from consideration as sentinel locations.

2a. Predominant thermal transient is the thermal transient with the largest impact on fatigue usage. The WF3 environmentally assisted fatigue evaluation will not use an average F_{en} based on the strain rate of the predominant thermal transient. (See Part b.)

2b. The WF3 environmentally assisted fatigue evaluation will not screen locations using a fatigue correction factor (F_{en}) that is the average of the F_{en} determined for the strain rate of the predominant thermal transient and the maximum F_{en} determined by the minimum strain rate. The F_{en} used for screening will be computed based on realistic fluid dissolved oxygen levels, worst case (minimum) metal strain rate, worst case (maximum) sulfur in the metal and maximum metal service temperature. This method will produce conservative U_{en}* values appropriate for ranking.

2c. The evaluation will ensure that the CUF values can be compared on a common basis. Parameters considered include ASME Section III, NB-3200 vs. NB-3600 analyses, the degree of transient grouping and whether the same ASME Code fatigue curves are used. If a refined finite element analysis (such as elastic-plastic analysis) is used at a location to determine the CUF, that location will not be screened out based on a low CUF value when comparing to locations not using that level of refinement. Comparisons will be on a common stress evaluation basis; that is using values obtained from the same type analysis (such as, linear elastic).

2d. Since all components had CUF values, by using maximum F_{en} values for realistic oxygen levels, comparing like materials to each other and evaluating analyses to ensure a common analytical basis of comparison, the evaluation will provide a conservative and appropriate comparison between locations within the same thermal zone.

3a. The close–coupled term indicates that the numerical U_{en} values are close together in magnitude. See the response to Part b for the specific criteria.

3b. For each material type in a thermal zone, the location with the highest U_{en}* (estimated U_{en}) is selected for consideration as a sentinel location. The location with the second highest U_{en}* is also selected if the second highest U_{en}* value is greater than 50% of the highest. If the third-highest U_{en}* value is within 25% of the highest U_{en}* value within a thermal zone, then the top three locations in the thermal zone are selected. Also, all NUREG/CR 6260 locations are retained as sentinel locations.

3c. Material type will be a selection criterion. The WF3 environmentally assisted fatigue evaluation will not use a U_{en} for one material to bound the U_{en} for a location of a different material.

LRA Appendices A.1.11 and B.1.11 are amended as shown. Additions are underlined.

LRA Sections and Tables Affected

Section A.1.11

The Fatigue Monitoring Program will be enhanced as follows.

Revise Fatigue Monitoring Program procedures to monitor and track additional critical thermal and pressure transients for components that have been identified to have a fatigue TLAA.

Develop a set of fatigue usage calculations that consider the effects of the reactor water environment for a set of sample reactor coolant system components. This sample shall 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 shall be determined using the formulae recommended in NUREG-1801, X.M1**.** <u>The methodology for determining limiting locations will be based on EPRI report 1024995 "Environmentally Assisted Fatigue Screening, Process and Technical Basis for Identifying EAF Limiting Locations" with the following modifications.</u>

- <u>Components in one thermal zone will not be used to bound components in different thermal zones.</u>
- <u>Comparisons between components will use a fatigue correction factor (F_{en}) calculated with realistic dissolved oxygen values, worst case (minimum) metal strain rate, worst case (maximum) sulfur in the metal and maximum metal service temperature.</u>
- <u>A U_{en} for one material will not be used to bound the U_{en} for a location of a different material.</u>

<u>Analysts will ensure that comparisons to determine limiting locations will compare usage values that are determined with comparable methods. For example, a component with a low fatigue usage value determined with a refined analysis may be more limiting than a component with a higher CUF determined with a simplified analysis.</u>

<u>An environmentally assisted fatigue analysis using NUREG/CR-6909 will not use average temperature for complex transients. For simple transients that use average temperature, when the minimum temperature is below the threshold temperature, the maximum and threshold temperature will be used to calculate the average temperature.</u>

Enhancements will be implemented prior to the period of extended operation.

Section B.1.11

1. Scope of Program	Develop a set of fatigue usage calculations that consider the effects of the reactor water environment for a set of sample reactor coolant system components. This sample shall 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 shall be determined using the formulae listed in LRA Section 4.3.3. The methodology <u>for determining limiting locations</u> will be based on EPRI report 1024995 "Environmentally Assisted Fatigue Screening, Process and Technical Basis for Identifying EAF Limiting Locations" <u>with the following modifications.</u> • <u>Components in one thermal zone will not be used to bound components in different thermal zones.</u> • <u>Comparisons between components will use a fatigue correction factor (F_{en}) calculated with realistic dissolved oxygen values, worst case (minimum) metal strain rate, worst case (maximum) sulfur in the metal and maximum metal service temperature.</u> • <u>A U_{en} for one material will not be used to bound the U_{en} for a location of a different material.</u> <u>Analysts will ensure that comparisons to determine limiting locations will compare usage values that are determined with comparable methods. For example, a component with a low fatigue usage value determined with a refined analysis may be more limiting than a component with a higher CUF determined with a simplified analysis.</u> An environmentally assisted fatigue analysis using NUREG/CR-6909 will not use average temperature for complex transients. For simple transients that use average temperature, when the minimum temperature is below the threshold temperature, the maximum and threshold temperature will be used to calculate the average temperature.