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Waterford 3

W3F1-2017-0026

April 11, 2017

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

SUBJECT: Responses to Request for Additional Information Set 15 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 15" dated March 14, 2017.
3. Entergy letter W3F1-2017-0006 "Responses to Request for Additional Information Set 12 Regarding the License Renewal Application for Waterford Steam Electric Station, Unit 3" dated February 23, 2017

Dear Sir or Madam:

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

In letter dated March 14, 2017 (Reference 2), the NRC staff made a Request for Additional Information (RAI) Set 15, needed to complete its review. Enclosure 1 provides the responses to the Set 15 RAIs. Enclosure 2 contains revised responses to RAIs B.1.1-3a and B.1.38-1 which supersede the responses previously presented in Reference 3.

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 April 11, 2017.

Sincerely,

MRC/AJH

Enclosures:
1. Set 15 RAI Response – Waterford 3 License Renewal Application
2. Revised Responses B.1.1-3a and B.1.38-1 – Waterford 3 License Renewal Application

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Enclosure 1 to

W3F1-2017-0026

Set 15 RAI Response

Waterford 3 License Renewal Application

RAI 4.2.3-1a

Background:

In its letter dated February 6, 2017, the applicant responded to RAI 4.2.3-1 that addressed the adequacy of updated initial RT_{NDT} values for reactor vessel beltline plates. In its response, the applicant identified specific paragraphs of ASME Section III, NB-2331 (i.e., paragraphs (a)(2), (a)(3) and (a)(4)) that were used to determine the initial RT_{NDT} values. The provisions in these paragraphs are summarized as follows:

- Paragraph (a)(2): T_{NDT} (nil-ductility transition temperature by drop weight tests) is the initial RT_{NDT} if each specimen of the Charpy impact (C_v) test exhibits at least 35 mils (0.89 mm) lateral expansion and absorbed energy not less than 50 ft-lb at a temperature not greater than T_{NDT} + 60°F.
- Paragraph (a)(3): When paragraph (a)(2) is not met, additional C_v tests are conducted in groups of three specimens to determine the temperature T_{Cv} at which they are met. In this case, the initial RT_{NDT} is the higher of T_{NDT} and T_{Cv} – 60°F.
- Paragraph (a)(4): When a C_v test has not been performed at T_{NDT} + 60°F or the C_v test at T_{NDT} + 60°F does not exhibit a minimum of 50 ft-lb and 35 mils lateral expansion, T_{Cv} may be determined from a full C_v impact curve developed from the minimum data points of all the C_v tests performed. In this case, the initial RT_{NDT} is the higher of T_{NDT} and T_{Cv} – 60°F.

The applicant indicated that the initial RT_{NDT} of lower shell plate M-1004-2 was determined in accordance with paragraph (a)(3) and that T_{Cv} of this material is 47°F. In addition, the applicant provided the T_{NDT} values of reactor vessel beltline plates as part of the response to demonstrate the adequacy of the initial RT_{NDT} values.

Issue:

The staff noted that Table 4 (page 124) of the following document referenced in the applicant's response does not identify 47°F as a C_v test temperature for lower shell plate M-1004-2. Therefore, it is not clear to the staff whether the applicant adequately identified the ASME Code provision that was used to determine the initial RT_{NDT} for that material.

- C-PENG-ER-004, Revision 0, Volume 1, October 1995, "The Reactor Vessel Group Evaluation Program Phase II Final Report for the Waterford 3 RPV Plates, Forging, Welds and Cladding"

In addition, the staff noted that T_{NDT} values of reactor vessel beltline plates provided in the applicant's response are not consistent with those described in FSAR Table 5.3-13 (i.e., T_{NDT} for plates M-1003-2, M-1003-3, M-1004-1, M-1004-2 and M-1004-3). For example, the FSAR table indicates that T_{NDT} of intermediate shell plate M-1003-2 is -50°F in contrast with -40°F that is identified as T_{NDT} of the material in the applicant's response.

Request:

1. Provide justification for why Table 4 of C-PENG-ER-004, Revision 0, Volume 1 does not identify 47°F as a C_v test temperature for reactor vessel plate M-1004-2 in contrast with the applicant's claim that the initial RT_{NDT} of the plate was determined in accordance with ASME Code Section III, NB-2331, paragraph (a)(3). As part of the response, explain how the applicant determined the T_{Cv} value of the M-1004-2 plate (i.e., 47°F).
2. Resolve the inconsistency regarding the T_{NDT} values of reactor vessel plates between the applicant's response and FSAR Table 5.3-13.

Waterford 3 Response

1. Table 4 of C-PENG-ER-004, Rev. 0, Volume 1 does not identify 47°F as a C_v test temperature because the material specimens were not tested at 47°F. The RT_{NDT} of plate M-1004-2 was determined using the following process.

   a) C-PENG-ER-004 identified that at the 40°F test temperature, the 50 ft-lb screening criterion of ASME Code Section III, NB-2331 paragraph (a)(2) was not satisfied.

   b) Both the 50 ft-lb and 35 mils screening criteria were satisfied at the 100°F test temperature.

   c) In order to avoid over-conservatism, paragraph (a)(4) of ASME Code Section III, NB-2331 was utilized. The curve-fit in accordance with (a)(4) showed that the T_{Cv} where both screening criteria were satisfied was 47°F.

   d) Since paragraph (a)(4) of the 1973 Summer Addenda to the Code does not include guidance on selecting an RT_{NDT} based on T_{Cv} and T_{NDT}, paragraph (a)(3) of the Code was used to determine the RT_{NDT} as the greater of T_{NDT} and T_{Cv} – 60°F.

   Thus, both paragraph (a)(3) and (a)(4) were used to establish the RT_{NDT} of plate M-1004-2, and to establish the RT_{NDT} of plates M-1003-1, M-1004-1, M-1002-1, and M-1002-2. Table 2 of the response to RAI 4.2.3-1 submitted in W3F1-2017-0004, dated February 6, 2017, is revised as follows.

Table 2 (revised from RAI 4.2.3-1 response)
Summary of Waterford Unit 3 Reactor Vessel Plate Initial RT_{NDT} Determination

Material Description	$RT_{NDT(U)}$ (°F)	T_{CV} (°F)	Charpy Limiting Parameter	T_{NDT} (°F)	Overall Limiting Parameter	ASME Section III, Subarticle NB-2331, Paragraph (a)(2), (a)(3) or (a)(4)
Intermediate Shell Plate M-1003-1	-25.1	34.9	Impact energy	-30	**T_{CV}[(a)]**	(a)(4)[(d)]
Intermediate Shell Plate M-1003-2	-20	40	N/A[(c)]	-40	**T_{CV}[(a)]**	(a)(3)
Intermediate Shell Plate M-1003-3	-20	40	N/A[(c)]	-30	**T_{CV}[(a)]**	(a)(3)
Lower Shell Plate M-1004-1	-37.6	22.4	Impact energy	-40	**T_{CV}[(a)]**	(a)(4)[(d)]
Lower Shell Plate M-1004-2	0	47.0	Impact energy	0	**T_{NDT}[(b)]**	(a)(4)[(d)]
Lower Shell Plate M-1004-3	-20	10	N/A[(c)]	-20	**T_{NDT}[(b)]**	(a)(2)
Upper Shell Plate M-1002-1	-15.4	44.6	Impact energy	-20	**T_{CV}[(a)]**	(a)(4)[(d)]
Upper Shell Plate M-1002-2	-1.4	58.6	Impact energy	-20	**T_{CV}[(a)]**	(a)(4)[(d)]
Upper Shell Plate M-1002-3	-20	40	N/A[(c)]	-20	**T_{NDT}[(b)]**	(a)(2)

<u>Notes for Table 2</u>

(a) $RT_{NDT(U)} = T_{CV} – 60°F$ (Charpy Limited)
(b) $RT_{NDT(U)} = T_{NDT}$ (Drop Weight Limited)
(c) Both the impact energy (ft-lb) and the lateral expansion (mils) exceeded the minimum values of 50 ft-lb and 35 mils, respectively, at the same tested temperature
(d) Paragraph (a)(3) used to select RT_{NDT} as the greater of T_{NDT} and T_{CV}-60°F

2. The T_{NDT} values of reactor vessel plates M-1003-2, M-1003-3, M-1004-1, M-1004-2, and M-1004-3 were updated in the response to RAI 4.2.3-1 submitted in W3F1-2017-0004, dated February 6, 2017. These values are based on the use of newly discovered drop weight test data from a combination of sources, including C-PENG-ER-004, TR-C-MCS-002 (the surveillance capsule material baseline report), and their source certified material testing reports (CMTRs). The previous values of T_{NDT} were based only on a portion of the drop weight test data. The newly discovered drop weight data have been incorporated into the UFSAR through the Waterford 3 licensing basis document change process. The updated values in Table 5.3-13 of the UFSAR match those in Table 2, Column 5 of the Waterford 3 response to RAI 4.2.3-1 submitted in W3F1-2017-0004, dated February 6, 2017. The values are identified in Table 2 (revised from RAI 4.2.3-1 response) above.

Enclosure 2 to

W3F1-2017-0026

Revised Responses B.1.1-3a and B.1.38-1

Waterford 3 License Renewal Application

RAI B.1.1-3a (Revised)

Background:

Section 54.21(a)(3) of Title 10 of the Code of Federal Regulations (10 CFR) requires applicants to demonstrate that the effects of aging for systems, structures, and components (SSCs) within the scope of license renewal and subject to an aging management review (AMR) pursuant to 10 CFR 54.21(a)(1) will be adequately managed so that intended function(s) will be maintained consistent with the current licensing basis (CLB) for the period of extended operation.

The "detection of aging effects" program element of GALL Report AMP XI.M18 recommends periodic visual inspections (at least once per refueling cycle) of closure bolting for signs of leakage to ensure the detection of age related degradation due to loss of material and loss of preload. Periodic inspection of pressure boundary components for signs of leakage ensures that age-related degradation of closure bolting is detected and corrected before component leakage becomes excessive. The staff noted that it is difficult to visually detect leakage of clear gaseous fluids and the GALL Report AMP XI.M18 does not provide specific guidance for the detection of leakage of clear gaseous fluids from a bolted connection. Therefore, by letter dated November 15, 2016, the staff issued RAI B.1.1-3 requesting that the applicant state how signs of leakage of clear gaseous fluids will be detected from bolted closures included in the Bolting Integrity Program in order to ensure the detection of loss of material and loss of preload before there is a loss of intended function. In its response to RAI B.1.1-3, provided by letter dated December 15, 2016, the applicant stated, in part, that:

> [e]ffectively, bolted closures on fluid-containing systems would represent a sample of the overall bolted closure population, including bolted closures in gas-filled systems. […] [P]ersonnel can identify leakage from bolted closures through visual and audible indications. Visual indications can include residue on nearby components and, in the case of steam systems, a visible plume or condensation in the area of the leak. Audible indications that could indicate a leak are the sounds of leaking gaseous contents escaping from the system. In addition, system engineers review operations logs, deficiency lists, and system parameters such as pressure, flow, and temperature which could indicate a system leak. Based on these activities and considerations, signs of leakage of clear gaseous fluids are detected from bolted closures included in the Bolting Integrity Program, and ensure that the detection of loss of material and loss of preload occur before there is a loss of intended function.

Issue:

The LRA states that the applicant's Bolting Integrity Program is consistent with GALL Report AMP XI.M18. The staff notes that the GALL Report AMP XI.M18 is not a sampling-based program and that the program relies on periodic inspections of all closure bolts within the scope of license renewal. From the applicant's statement that "fluid-containing systems would represent a sample of the overall bolted closure population, including bolted closures in gas-filled systems," it is not clear whether the applicant plans to use closure bolt degradation in fluid-filled systems as a leading indicator for degradation of closure bolting for gas-filled systems, and potentially not inspect all closure bolting as recommended by the GALL Report.

The staff notes that for systems with gaseous fluids such as air it is unlikely that a leakage could be identified through a visual inspection and that it is also unlikely that such leakage may leave residue on nearby components that would be identifiable by a visual inspection. The staff also notes that although identification of leakage is possible through audible indications this method may not be effective for systems in areas where there is a high level of noise and also due to common requirements for the use of ear protection in those areas. Furthermore it is not clear whether all systems with gaseous fluids are subject to a review of operations logs, deficiency lists, and parameters such as pressure, flow, and temperature which could indicate a system leak. Therefore for each system with air it is not clear what method or combination of methods applies and how such method(s) would be effective to identify air leakage and ensure the detection of loss of material and loss of preload before there is a loss of intended function.

Request:

1. State whether the inspections of closure bolts under the Bolting Integrity Program will include all closure bolts in-scope of the program or if only a sample will be inspected. If an exception is taken to the GALL Report AMP XI.M18 recommendation that all in-scope closure bolting be inspected for signs of leakage to indicate loss of material and loss of preload, provide the technical basis to demonstrate that the program will adequately ensure the detection of age related degradation before there is a loss of intended function.

2. List those systems in-scope of license renewal that contain gaseous fluids for which aging effects will be managed by the Bolting Integrity Program. For each of the systems listed state how signs of leakage of clear gaseous fluids will be detected on associated closure bolting in order to ensure the detection of age related degradation due to loss of material and loss of preload before there is a loss of intended function.

Waterford 3 Response

1. As stated in LRA Appendix B.1.1, the Bolting Integrity Program, with one exception, will be consistent with the program described in NUREG-1801, Section XI.M18, Bolting Integrity. The Bolting Integrity Program includes all closure bolts as described in the license renewal application (LRA).

   In addition to the visual inspections described in LRA Appendix B.1.1, the Bolting Integrity Program will be revised to include visual inspection of a representative sample of closure bolting (bolt heads, nuts, and threads) from components with an internal environment of a clear gas, such as air or nitrogen. A representative sample will be 20 percent of the population (for each material/environment combination) up to a maximum of 25 fasteners during each 10-year period of the period of extended operation. The inspections will be performed when the bolting is removed to the extent that the bolting threads and bolt heads are accessible for inspections that cannot be performed during visual inspection with the threaded fastener installed.

   The LRA is revised as shown. Additions are underlined.

A.1.1 Bolting Integrity Program

The Bolting Integrity Program will be enhanced as follows.

- <u>Revise Bolting Integrity Program documents to specify visual inspection of a representative sample of closure bolting (bolt heads, nuts, and threads) from components with an internal environment of a clear gas, such as air or nitrogen. A representative sample will be 20 percent of the population (for each material/environment combination) up to a maximum of 25 fasteners during each 10-year period of the period of extended operation. The inspections will be performed when the bolting is removed to the extent that the bolting threads and bolt heads are accessible for inspections that cannot be performed during visual inspection with the threaded fastener installed.</u>

B.1.1 Bolting Integrity

Enhancements

The following enhancements will be implemented prior to the period of extended operation.

Element Affected	Enhancement
<u>4. Detection of Aging Effects</u>	<u>Revise Bolting Integrity Program documents to specify visual inspection of a representative sample of closure bolting (bolt heads, nuts, and threads) from components with an internal environment of a clear gas, such as air or nitrogen. A representative sample will be 20 percent of the population (for each material/environment combination) up to a maximum of 25 fasteners during each 10-year period of the period of extended operation. The inspections will be performed when the bolting is removed to the extent that the bolting threads and bolt heads are accessible for inspections that cannot be performed during visual inspection with the threaded fastener installed.</u>

2. WF3 agrees that NUREG-1801 XI.M18 specifies only visual inspection for the detection of leakage of bolted connections, including bolted connections in systems with clear gaseous fluids. Consistent with NUREG-1801, Section XI.M18, the Waterford 3 Bolting Integrity Program includes periodic inspections and preventive measures that are based on the guidance of industry documents including NUREG-1339, EPRI NP-5769, and EPRI TR-104213.

   Proper joint preparation and make-up in accordance with industry standards is expected to preclude loss of preload. The review of WF3 OE did not identify instances in which non-Class 1 mechanical components became unable to perform license renewal intended functions due to loss of pressure boundary bolting preload.

   Nevertheless, the Bolting Integrity Program includes provisions to manage loss of preload, primarily in the form of preventive measures, which include material selection (e.g., use of materials with an actual yield strength of less than 150 kilo-pounds per square inch [ksi]), lubricant selection (e.g., restricting the use of molybdenum disulfide), applying the appropriate preload (torque), and checking for uniformity of gasket compression, where appropriate, to preclude loss of preload, loss of material, and cracking.

   In addition to preventive measures to preclude aging effects that could result in leakage, the program provides for identification of leakage from bolted closures included in the Bolting Integrity Program during periodic inspections conducted during system walkdowns. Other plant personnel may also identify leakage during routine maintenance and operational activities. During these inspections and during routine operational activities, personnel can identify leakage from bolted closures through visual and audible indications. Visual indications can include residue on nearby components and, in the case of steam systems, a visible plume or condensation in the area of the leak. Audible indications that could indicate a leak are the sounds of leaking gaseous contents escaping from the system. In addition, system engineers review operations logs, deficiency lists, and system parameters such as pressure, flow, and temperature that could indicate a system leak. Low compressed air or nitrogen pressure could indicate leakage through a bolted connection. Compressed air and nitrogen systems are monitored for pressure locally and in the main control room.

   Although leakage, if it occurs, may not be readily apparent from bolted closures serving some systems containing gaseous material, Waterford 3 operating experience demonstrates that the combination of preventive actions, visual inspections and observations during routine operational activities has been effective at managing the effects of aging on closure bolting. Specifically, the review of Waterford 3 operating experience found no instances in which loss of intended function of a non-Class 1 mechanical component was attributable to loss of pressure boundary bolting preload.

   As indicated by review of Waterford 3 operating experience, continuation of the activities specified in the Waterford 3 Bolting Integrity Program provides reasonable assurance that the effects of aging on bolted connections in air and gas systems will be adequately managed so that the pressure boundary intended function will be maintained consistent with the current licensing basis (CLB) for the period of extended operation.

The following systems with bolted connections identified in LRA tables have internal environments of air – indoor (int), air - outdoor (int), condensation (int), or gas (int) and credit the Bolting Integrity Program.

Table 3.2.2-1: Containment Spray System
Table 3.2.2-2: Safety Injection System
Table 3.2.2-3: Containment Penetrations
Table 3.3.2-1: Chemical and Volume Control System
Table 3.3.2-2: Chilled Water System
Table 3.3.2-3: Component Cooling and Auxiliary Component Cooling Water System
Table 3.3.2-4: Compressed Air System
Table 3.3.2-5: Containment Cooling HVAC System
Table 3.3.2-6: Control Room HVAC System
Table 3.3.2-7: Emergency Diesel Generator System
Table 3.3.2-8: Fire Protection – Water System
Table 3.3.2-9: Fire Protection RCP Oil Collection System
Table 3.3.2-11: Nitrogen System
Table 3.3.2-12: Miscellaneous HVAC Systems
Table 3.3.2-13: Auxiliary Diesel Generator System
Table 3.3.2-14: Plant Drains
Table 3.3.2-15-3: Annulus Negative Pressure System,
Nonsafety-Related Components Affecting Safety-Related Systems
Table 3.3.2-15-13: Containment Atmosphere Purge System,
Nonsafety-Related Components Affecting Safety-Related Systems
Table 3.3.2-15-14: Containment Atmosphere Release System,
Nonsafety-Related Components Affecting Safety-Related Systems
Table 3.3.2-15-18: Fuel Handling Building HVAC System,
Nonsafety-Related Components Affecting Safety-Related Systems
Table 3.3.2-15-20: Gaseous Waste Management System,
Nonsafety-Related Components Affecting Safety-Related Systems
Table 3.3.2-15-22: Leak Rate Testing System,
Nonsafety-Related Components Affecting Safety-Related Systems
Table 3.3.2-15-24: Nitrogen System,
Nonsafety-Related Components Affecting Safety-Related Systems
Table 3.3.2-15-28: Primary Sampling System,
Nonsafety-Related Components Affecting Safety-Related Systems
Table 3.3.2-15-29: Radiation Monitoring System,
Nonsafety-Related Components Affecting Safety-Related Systems
Table 3.3.2-15-30: Reactor Auxiliary Building HVAC System,
Nonsafety-Related Components Affecting Safety-Related Systems
Table 3.3.2-15-31: Reactor Cavity Cooling System,
Nonsafety-Related Components Affecting Safety-Related Systems
Table 3.3.2-15-33: Secondary Sampling System,
Nonsafety-Related Components Affecting Safety-Related Systems
Table 3.4.2-1: Condensate Makeup and Storage System
Table 3.4.2-5-6: Main Steam System,
Nonsafety-Related Components Affecting Safety-Related Systems

Many of these systems are in the scope of license renewal and subject to aging management review only for 10 CFR 54.4(a)(2), that is, for the potential of nonsafety-related components to adversely impact the ability of safety-related equipment to perform its safety functions. Leakage from gas-filled portions of these systems would not be a threat to safety-related systems or components. Those portions of systems would be subject to aging management review because they have a license renewal intended function of structural support.

RAI 1.38-1(Revised)

Background:

Section 54.21(a)(3) of 10 CFR requires the applicant to demonstrate that the effects of aging for structures and components will be adequately managed so that the intended function(s) will be maintained consistent with the current licensing basis for the period of extended operation. As described in SRP LR, an applicant may demonstrate compliance with 10 CFR 54.21(a)(3) by referencing the GALL Report and when evaluation of the matter in the GALL Report applies to the plant.

The "parameters monitored or inspected," and "detection of aging effects" program elements of GALL Report AMP XI.S6, "Structures Monitoring," recommends that high strength (actual measured yield strength greater than or equal to 150 ksi) structural bolts in sizes greater than 1 inch in diameter to be monitored for stress corrosion cracking (SCC). The GALL Report also recommends that visual inspections be supplemented with volumetric or surface examinations to detect cracking for this type of bolts.

LRA Section B.1.38, "Structures Monitoring," states that the Structures Monitoring Program is an existing program, with enhancements, that will be consistent with GALL Report AMP XI.S6. The staff notes that LRA Section B.1.38 does not provide an enhancement to the "parameters monitored or inspected," and/or "detection of aging effects" program elements to address the aging effects of SCC in high strength structural bolts. LRA Table 3.5.1, item 68, states, in part, that "since molybdenum disulfide thread lubricants are not used at WF3, for structural bolting applications, SCC of high strength structural bolting is not an aging effect requiring management at WF3."

During the AMP audit, the staff reviewed the applicant's "Aging Management Program Evaluation Report Civil/Structural" (AMPER), implementing procedures, plant structural specifications and drawings, and noted the following:

- The applicant excluded the use of supplemental examinations in high strength structural bolts and states, in part, that "since a thread lubricant containing molybdenum disulfide is not used at WF3, SCC of structural bolting in not plausible, inspections are not required to be supplemented with volumetric or surface examinations." (AMPER Section 3.4.2.b)
- Plant structural specification LOU 1564.723, "Structural Steel Seismic I & II," states, in part, that "field connections shall be friction type joints, assembled with 7/8" diameter high-strength bolts, unless otherwise noted on drawings…"
- Plant drawings notes, in general, stated that "field connections, unless noted, shall be ASTM A325 high strength bolted friction type connections…"
- Structural drawings reviewed by the staff indicates the use of several types of bolts (including A325 and A193 B7 types bolts), and bolts with diameter greater than 1 inch.

Issue:

It is not clear to the staff if "parameters monitored or inspected," and "detection of aging effects" program elements of the Structures Monitoring Program is consistent with the GALL Report recommendation because:

1. The applicant's Structures Monitoring Program does not provide sufficient justification for not managing the aging effects of SCC in high strength structural bolting, because the GALL Report does not credit the molybdenum disulfide thread lubricant as the only contributor to

the aging mechanism of SCC in high strength bolts.

2. It is not clear to the staff (1) whether high strength structural bolts greater than 1 inch in diameter are used or not in structural applications, or (2) how supplemental examinations are performed for these bolts because the plant's structural specifications and drawings do not preclude the use of high strength structural bolts with diameter greater than 1 inch when specified or noted as such in the drawing details.

Request:

1. State whether or not there are high-strength structural bolts (actual measured yield strength greater than or equal to 150 ksi) in sizes greater than 1 inch diameter used in structural applications. Note: consider actual bolts being specified in the plant's structural drawing details in addition to generic drawing notes.
2. If high-strength structural bolts (actual measured yield strength greater than or equal to 150 ksi) in sizes greater than 1 inch diameter are used in structural applications, state whether and how the recommendations for managing degradation of high-strength bolts described in the "parameters monitored or inspected," and "detection of aging effects" of the GALL Report AMP XI.S6 will be implemented for the Structures Monitoring Program. Otherwise, provide adequate technical justification for the exception taken to the GALL Report AMP recommendation.
3. Update the LRA and FSAR supplement, as appropriate, to be consistent with the response to the above requests.

Waterford 3 Response

1. WF3 has identified the following high-strength structural bolting with actual measured yield strength greater than or equal to 150 ksi in sizes greater than 1 inch diameter that is within the scope of the Structures Monitoring Program. The reactor coolant system (RCS) supports and stops, and safety injection tank (SIT) supports have A-540 threaded bolts/studs. These bolts/studs with minimum yield strength of 150 ksi are monitored in the Structures Monitoring Program by visual inspection.

   WF3 has determined through review of site documentation (specifications, drawing, certified material requests, etc.) that there are no other high-strength structural bolts with actual measured yield strength greater than or equal to 150 ksi in sizes greater than 1 inch diameter within the scope of the Structures Monitoring Program.

2. The "parameters monitored or inspected" program element of NUREG-1801 AMP XI.S6 indicates that high-strength structural bolts greater than 1 inch in diameter should be monitored for stress corrosion cracking (SCC). The "detection of aging effects" program element of NUREG-1801 AMP XI.S6 provides recommendations for managing cracking of high-strength bolts due to SCC. The following describes how Waterford 3 addresses the recommendations in the "detection of aging effects" program element of NUREG-1801 AMP XI.S6 regarding stress corrosion cracking of high-strength bolts.

   Line items that address cracking of high-strength bolting on RCS supports and stops and SIT supports within the scope of the Structures Monitoring Program will be added in LRA Table 3.5.2-1. The Structures Monitoring Program will include periodic visual examinations that confirm the absence of a corrosive environment that supports SCC for high-strength bolting greater than one-inch nominal diameter. These periodic visual examinations will monitor the surface condition of the bolting and adjacent structures. The acceptance criteria will be the absence of evidence of moisture, residue, foreign substances, or corrosion. Conditions identified during the periodic visual examinations that identify a potential corrosive environment that supports SCC will be entered into the corrective action program. Engineering will evaluate adverse conditions identified during the periodic visual examinations to determine if the bolting has been exposed to a corrosive environment with the potential to cause SCC. Supplemental visual examination or analysis of residue will be conducted if necessary to determine if there is a potential for SCC.

The extent to which the environmental indicators will be weighed in the engineering evaluation will be determined by the conditions that are observed during the initial visual examinations of the bolting locations and during any follow-up visual examination or analysis. Some of the listed environmental indicators may not be present, e.g., moisture. Some of the factors that are observed may have minimal impact on the outcome of the evaluation. Environmental indicators will be evaluated together to provide the most accurate characterization of the environment. If the engineering evaluation concludes that the bolting material had been subjected to an environment with the potential to cause SCC, then the affected bolts will be included in the population of bolting that will be sampled through volumetric examinations.

From the population of A-540 bolts where an environment conducive to SCC is identified, 20 percent (rounded up to the nearest whole number) of the population, up to a maximum of 25 bolts, will be subjected to volumetric examination to determine whether SCC is present. The results of the volumetric examinations will be evaluated under the corrective action program to determine if any other corrective actions are necessary.

NUREG-1801 AMP XI.S6 “detection of aging effects” program element recommends that visual inspection of high-strength bolting is supplemented with volumetric or surface examination to detect cracking. Justification for waiving volumetric and surface examination of WF3 high-strength bolting follows.

- Operating records indicate that lubricants containing molybdenum disulfide have never been used for this bolting. Procedural guidance also prohibits the use of this lubricant on structural bolting. The thread lubricant used for this bolting is N-5000, Anti-Seize lubricant which is a nickel/graphite based thread lubricant not containing molybdenum disulfide. Because the A-540 bolts are in a noncorrosive and low-temperature environment, stress corrosion cracking in these bolts is not expected. A-540 bolts are not prone to SCC. WF3 operating experience includes volumetric examinations of SA-540 reactor head closure studs. One hundred percent of the head closure bolting has been subject to volumetric examination under ASME Section XI, Subsection IWB and inspection results have not revealed cracking due to SCC.

- The A-540 bolts/studs associated with the SIT supports are inside the steel containment vessel (SCV) in an area outside the secondary shield walls that is dry and relatively cool. The A-540 bolts/studs associated with the RCS support and stops are part of the reactor coolant pump support components. This bolting is located inside the SCV and the components are not exposed to an aggressive environment (i.e., wet environment with high oxygen levels or lubricant containing molybdenum disulfide) conducive to SCC.

- The Boric Acid Corrosion Program provides for inspections during each refueling outage to identify borated water leakage and ensure that corrosion caused by leaking borated water does not lead to unacceptable degradation of the leakage source or adjacent structures or components. Inspections are also conducted inside containment prior to startup from each refueling outage to ensure no adverse conditions exist in the normal operating environment.

- The A-540 bolts used for these supports are carbon steel bolts, so SCC would be accompanied by surface corrosion that can be readily detected through visual examinations.

- The Structures Monitoring Program inspections, performed at least once every five years, and the Boric Acid Corrosion Program inspections, performed every refueling cycle, provide reasonable assurance that environmental conditions will be maintained that are not conducive to SCC.

Monitoring the environmental indicators and performing visual examinations under the Structures Monitoring Program every 5-year interval, as described above and in the proposed enhancement, will be effective in managing this aging effect. This conclusion is based upon (a) the bolting material is carbon steel, (b) plant design and procedures limit the potential for contamination, and (c) established plant programs and procedures include directions to identify leakage onto any component or structure. Therefore, a corrosive environment that supports SCC for ASTM A-540 bolts is not expected. The Structures Monitoring Program with enhancements will adequately manage cracking due to SCC by inspecting bolting and by identifying environments with the potential for SCC of ASTM A-540 bolts such that they can be corrected prior to a loss of function.

3. Consistent with the response to RAI B.1.16-1 and with the response above, LRA Table 3.5.1 items 3.5.1-68 and 3.5.1-69 discussion and related Table 2.4-1 and Appendix A and B are revised.

LRA revisions are as follows. Additions are underlined and deletions are lined through.

LRA Table 2.4-1:

Reactor Building
Components Subject to Aging Management Review

Component	**Intended Function**
Steel and Other Metals	
<u>High-strength bolting (RCP and SIT support)</u>	<u>Support for Criterion (a)(1) equipment</u>

LRA Table 3.5.1:

Structures and Component Supports

Item Number	Component	Aging Effect/ Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.5.1-68	High-strength structural bolting	Cracking due to stress corrosion cracking	ISI (IWF)	No	WF3 does not have high-strength structural bolts with actual measured yield strength greater than or equal to 150 ksi in sizes greater than 1 inch diameter within the scope of the WF3 Inservice Inspection-IWF Program. ~~NUREG-1801 item referencing this item defines the bolting susceptible to SCC as: high strength (actual measured yield strength greater than or equal to 150 kilo-pound per square inch [ksi] or greater than or equal to 1,034 MPa) for structural bolts greater than 1 inch (25 mm) in diameter. Per EPRI 1015078, a periodically wetted environment and the use of thread lubricant containing molybdenum disulfide must be present to initiate SCC in high yield-strength bolting. Since Molybdenum disulfide thread lubricants are not used at WF3, for structural bolting applications, SCC of high strength structural bolting is not an aging effect requiring management at WF3.~~
3.5.1-69	High-strength structural bolting	Cracking due to stress corrosion cracking	Structures Monitoring Program Note: ASTM A 325, F 1852, and ASTM A 490 bolts used in civil structures have not shown to be prone to SCC. SCC potential need not be evaluated for these bolts.	No	WF3 does not have high-strength bolts that are subject to sustained high tensile stress in a corrosive environment. As defined for bolting in this line item, ASTM A 325, F 1852, and ASTM A 490 bolts used in civil structures have not shown to be prone to SCC. However, WF3 has identified ASTM A-540 structural bolting with yield stress greater than or equal to 150 ksi. This bolting is not subject to high temperature and a corrosive environment. However, the Boric Acid Corrosion and Structures Monitoring Programs will be used to manage aging effects for this bolting. ~~WF3 procedures do not identify the use of high strength bolts ASTM A325 and A-490 for structural applications. Therefore, the listed aging effect is not applicable for WF3 high strength bolting.~~

LRA Table 3.5.2-1:

Reactor Building

Structure and/or Component or Commodity	Intended Function	Material	Environment	Aging Effect Requiring Management	Aging Management Program	NUREG-1801 Item	Table 1 Item	Notes
High-strength bolting (RCP and SIT supports)	SSR	Carbon steel	Air – indoor uncontrolled	Cracking	Boric Acid Corrosion Structures Monitoring	III.B.5.TP-300	3.5.1-69	E

A.1.38 Structures Monitoring Program

- Revise plant procedures to inspect the SIT and RCS supports with ASTM A-540 high-strength bolting greater than one-inch nominal diameter prior to the period of extended operation and at least once every 5 years thereafter. The periodic visual inspections are intended to detect whether a corrosive environment that supports SCC potential exists or has existed since the previous inspection.
    - Acceptance criteria for the inspections will be the absence of evidence of moisture, residue, foreign substances, or corrosion.

- Conditions that don't meet the acceptance criteria and thus indicate a potential corrosive environment that supports SCC will be entered into the corrective action program for evaluation.

- Revise plant procedures to include qualitative and quantitative acceptance criteria for A-540 bolts as follows:

    a) If moisture is present at or near a bolt or stud, factors considered in the evaluation include, but are not limited to:

    - The source of leakage or condensation that supplied the moisture.
    - The proximity of the moisture to the bolt or stud.
    - The probable or analyzed chemical characteristics of the moisture, including the presence of contaminants.
    - The visible or likely pathway, if any, that the liquid traversed to arrive at or near the bolt or stud.
    - The amount of any corrosion on or near the bolt or stud.
    - The material condition of the coatings on the bolt or stud, and associated support.
    - The characteristics of any corrosion on or near the bolt or stud.
    - The proximity to the bolt or stud of any nearby evidence of corrosion.
    - The material condition of accessible concrete or grout near the bolt or stud.

b) If there is evidence that moisture had been present at or near a bolt or stud, but no moisture is present at or near a bolt or stud, factors considered by engineering include, but will not be limited to:

- The probable sources of past leakage or condensation that could have supplied the moisture.
- The proximity to the bolt or stud to the evidence that moisture had been present.
- The probable or analyzed chemical characteristics of any moisture residue, including the presence of contaminants.
- The visible or likely pathway, if any, that the liquid may have traversed to arrive at or near the bolt or stud.
- The amount of any corrosion on or near the bolt or stud.
- The material condition of any coatings on the bolt or stud, and associated support.
- The characteristics of any corrosion on or near the bolt or stud.
- The proximity to the bolt or stud of any nearby evidence of corrosion.
- The material condition of concrete or grout near the bolt or stud.
- Should adverse conditions be identified during the examinations, engineering will determine if the bolting has been exposed to a corrosive environment with the potential to cause SCC. Bolts determined to have been exposed to a corrosive environment with the potential to cause SCC will be identified as within a population where SCC is a concern. A sample equal to 20 percent (rounded up to the nearest whole number) of the population, with a maximum sample size of 25 bolts, will be subject to volumetric examination. The selection of the samples will consider susceptibility to stress corrosion cracking (e.g., actual measured yield strength) and ALARA considerations.

B.1.38 Structures Monitoring Program

Enhancements

Element Affected	Enhancement
3. Parameters Monitored or inspected 4. Detection of Aging Effects	• Revise plant procedures to inspect the SIT and RCS supports with ASTM A-540 high-strength bolting greater than one-inch nominal diameter prior to the period of extended operation and at least once every 5 years thereafter. The periodic visual inspections are intended to detect whether a corrosive environment that supports SCC potential exists or has existed since the previous inspection. Acceptance criteria for the inspections will be the absence of evidence of moisture, residue, foreign substances, or corrosion. • Conditions that don't meet the acceptance criteria and thus indicate a potential corrosive environment that supports SCC will be entered into the corrective action program for evaluation.
6. Acceptance Criteria	Revise plant procedures to include qualitative and quantitative acceptance criteria for A-540 bolts as follows: 1) If moisture is present at or near a bolt or stud, factors considered by engineering include, but will not be limited to: • The source of leakage or condensation that supplied the moisture. • The proximity of the moisture to the bolt or stud. • The probable or analyzed chemical characteristics of the moisture, including the presence of contaminants. • The visible or likely pathway, if any, that the liquid traversed to arrive at or near the bolt or stud. • The amount of any corrosion on or near the bolt or stud. • The material condition of the coatings on the bolt or stud, and associated support. • The characteristics of any corrosion on or near the bolt or stud. • The proximity to the bolt or stud of any nearby evidence of corrosion. • The material condition of accessible concrete or grout near the bolt or stud.

Element Affected	**Enhancement**
Acceptance Criteria (cont'd)	2) If there is evidence that moisture had been present at or near a bolt or stud, but no moisture is present at or near a bolt or stud, factors considered by engineering include, but will not be limited to: • The probable sources of past leakage or condensation that could have supplied the moisture. • The proximity to the bolt or stud to the evidence that moisture had been present. • The probable or analyzed chemical characteristics of any moisture residue, including the presence of contaminants. • The visible or likely pathway, if any, that the liquid may have traversed to arrive at or near the bolt or stud. • The amount of any corrosion on or near the bolt or stud. • The material condition of any coatings on the bolt or stud, and associated support. • The characteristics of any corrosion on or near the bolt or stud. • The proximity to the bolt or stud of any nearby evidence of corrosion. • The material condition of concrete or grout near the bolt or stud. • Should adverse conditions be identified during the examinations, engineering will determine if the bolting has been exposed to a corrosive environment with the potential to cause SCC. Bolts determined to have been exposed to a corrosive environment with the potential to cause SCC will be identified as within a population where SCC is a concern. A sample equal to 20 percent (rounded up to the nearest whole number) of the population, with a maximum sample size of 25 bolts will be subject to volumetric examination. The selection of the samples will consider susceptibility to stress corrosion cracking (e.g., actual measured yield strength) and ALARA considerations.