Entergy

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Stephen J. Bethay
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April 20, 2007

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

SUBJECT: Entergy Nuclear Operations, Inc.
Pilgrim Nuclear Power Station
Docket No. 50-293
License No. DPR-35

Response to NRC Request for Additional Information Related Repair of the Core Shroud Stabilizer Assemblies (TAC NO. MD4918)

REFERENCES:

1. Entergy Letter No. 2.07.016, Request for Authorization Under the Provision of 10 CFR 50.55a(a)(3)(1) for Modification of the Core Shroud Stabilizer Assemblies, dated March 22, 2007
2. Entergy Letter No. 2.07.035, Pilgrim Repair of the Core Shroud Stabilizer Assemblies- Torsion Arm Clamp Stress Evaluation Report, dated April 10, 2007

LETTER NUMBER: 2.07.039

Dear Sir or Madam:

This letter provides Entergy's response to NRC Request for Additional Information related to the repair of the core shroud stabilizer assemblies discussed in References 1 and 2.

The attachment to this letter provides additional information concerning the referenced submittals requested during discussions with the NRC staff. This submittal, along with References 1 and 2 submittals, contain the basis for concluding that the modification provides an acceptable level of quality and safety.

There are no regulatory commitments made in this submittal.

A001

NRC authorization to use this proposed alternative is requested by April 27, 2007, to support the scheduled startup of Pilgrim following RFO-16.

If you have any questions or require additional information, please contact Mr. Bryan Ford, Licensing Manager, at (508) 830-8403.

Sincerely,

Stephen J. Bethay

SJB/dl
Attachment

1. Entergy Response to NRC Request for Additional Information Related to Repair of Pilgrim Core Shroud Stabilizer Assemblies (TAC No. MD4918) (12 pages)

cc: Mr. James S. Kim, Project Manager
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ATTACHMENT 1

Entergy Response to NRC Request for Additional Information
Related to Repair of Pilgrim Core Shroud Stabilizer Assemblies (TAC No. MD4918)

By letter dated March 22, 2007, Entergy Nuclear Operations, submitted a request for authorization under the provisions of Title 10 of the Code of Federal Regulations 50.55a(a)(3)(I) for modification of the core shroud stabilizer assemblies (tie rods) for the Pilgrim Nuclear Power Station (PNPS). The licensee proposes to replace tie rod upper support with a modified upper support design capable of operation through the end of renewed operating license term. The staff has reviewed the information the licensee provided that supports the proposed request and requires information from the licensee related to the following issues to complete its review.

RAI 1

The request references the BWRVIP-84 report, "BWR Vessel Internals Project, Guidelines for Selection and Use of Materials for Repairs to BWR Internals," which addresses requirements for materials that are used in the reactor vessel internal (RVI) components. In a letter dated September 6, 2005, the staff issued a safety evaluation (SE) for this report with conditions related to additional surface preparation of the cold worked materials used in RVI components. The staff requests that the licensee include a statement in its current proposal that it will comply with all the staff's conditions that are addressed in the staff's final SE including the conditions identified below.

(A) Surface preparation of the cold worked austenitic stainless steel reactor vessel internal (RVI) components---Section 3.5.2 of the staff's safety evaluation.
(B) Surface preparation of the cold worked Alloy X-750 RVI components---
Section 3.6.2 of the staff's safety evaluation.
(C) Electrical Discharge Machining (EDM) of Alloy X-750 RVI components---
Section 3.6.3 of the staff's safety evaluation.

Response

The modification hardware complies with the revised version of BWRVIP-84, as described in the response to the final SE (Reference 1). Items (A), (B) and (C) are addressed as follows:

(A) This item is not applicable to the Pilgrim hardware. All 300 series stainless steel components are solution annealed subsequent to the machining operation. No further cold work mitigation is necessary.
(B) Consistent with Section 3.6.2 of the Staff's safety evaluation, the surface finish requirements for Alloy X-750 components described in Paragraph B8.9 of BWRVIP-84 have been applied to the replacement hardware.
(C) Consistent with Section 3.6.3 of the Staff's safety evaluation, EDM surfaces of Alloy X-750 have demonstrated to be acceptable for BWR service by examination of qualification samples. This examination includes metallographic cross sections to confirm that the surfaces do not contain detrimental surface features (e.g., microfissures).

Reference

1. Letter from William Eaton (BWRVIP) to Matthew Mitchell (NRC), "Project 704: BWRVIP Response to NRC Safety Evaluation of BWRVIP-84," BWRVIP Letter 2006-500, dated December 5, 2006.

RAI-2

By letter dated January 16, 1995, the licensee submitted a proposal to install four stabilizer assemblies and core plate wedges for the core shroud at Pilgrim, and in a letter dated May 12, 1995, the staff approved this repair. The Event Analysis section of Enclosure 1 to the January 16, 1995 letter included the following load case definitions which were used to evaluate stress analyses of the core shroud upper support assembly.

(1) Normal Operation
(2) Upset # 1
(3) Upset # 2
(4) Emergency # 1
(5) Emergency # 2
(6) Emergency # 3
(7) Faulted # 1
(8) Faulted # 2
(9) Faulted # 3

In the current proposal, dated March 22, 2007, the GE Report GE-NE-0000-0061-6306-R4-P indicates analyses representing one emergency condition and one faulted condition were performed. Provide an explanation for not using three emergency and three faulted conditions (used in original modification in 1995) for developing stress analyses for the current modification. Explain why the stress analyses used in the current modification are bounding.

Response

The evaluation took into account all the load combinations as in the original design basis report (GENE 771-79-1194, Supplement A to Rev 2), for each service level. The original normal and upset condition load combinations (load cases 1, 2, and 3 above) were used for the replacement upper support design. While there are three Emergency condition load combinations and two Faulted condition load combinations, the bounding (largest) Emergency and Faulted condition load were considered in the replacement upper support stress analysis.

The design basis for the Pilgrim tie rod design defined Emergency 1, 2, and 3, and Faulted 1 and 2 load combinations.

In the emergency condition, the Emergency-2 combination (based on Main Steam Line Break LOCA) was bounding compared to Emergency-1 (based on Seismic) and Emergency-3 (based on Recirculation Suction Line Break LOCA).

In the faulted condition, the Faulted-1 combination (based on Main Steam Line Break LOCA load plus Seismic) was bounding compared to Faulted –2 combination (based on Recirculation Suction Line Break LOCA plus Seismic).

RAI-3

Section 5.3.1 of GE-NE-0000-0061-6180-R2-P indicates the bearing interface of the horizontal arm of the upper support was modeled using contact elements with a particular coefficient of friction value. Describe the impact of lower or higher values of coefficient of friction on the total stress (Pm + Pb + Q + F) due to sustained normal operation and whether different values of coefficient of friction could cause the total stress to exceed the IGSCC allowable limit in BWRVIP-84. How was the coefficient of friction used in the GE-NE-0000-0061-6180-R2-P determined?

Response

The GE Report quoted in the RAI (GE-NE-0000-0061-6180-R2-P) is for the NMP1 Replacement Upper Support; however, both NMP1 and Pilgrim Replacement Upper Support Stress Analysis (Pilgrim Report GE-NE-000-0061-6304-R4-P) used a friction factor of 0.3 between the bearing interface of the horizontal arm of the upper support and the shroud flange, which is a typical value for such applications, and is also consistent with GE standard design specification for Core Support Structures. This valve is within the range used for wetted steel in engineering references. However, a sensitivity study was performed to assess the effect of different friction coefficient values on the upper support stress. The friction coefficients of 0.2, 0.3, and 0.4 were used in the sensitivity analyses. The results of these analyses showed that stress increased with increased friction coefficients, the change in the Pm+Pb+Q+F stress in the upper support due to the above friction coefficients is negligible (< 1%) and, as a result, the design is insensitive to the friction coefficient used. Hence, resistance of the upper support to IGSCC is not impacted.

RAI 4

Section 7.1 of Attachment 1 to the licensee's March 22, 2007, letter indicates that the BWRVIP issued letters dated March 29, 2006, and April 3, 2006, requiring plants with core shroud tie rod repairs to inspect their repairs at their next scheduled refueling outage. These letters indicated that inspections should include all the same or similar locations where the indications were observed and that consideration should also be given to other locations in the tie rod repair using X-750 material that may experience high-sustained stresses. The licensee indicates that a review of all of the tie rod assembly X-750 components in the primary vertical and horizontal load paths has been performed. Based on this review, there are no other high stress X-750 locations, with the exception of the torsion arm bolt, that require inspections as addressed in the BWRVIP letters dated March 29, 2006, and April 3, 2006.

a) What is the proposed frequency of inspection for the torsion arm bolt and what type of inspection will be performed to ensure that the torsional arm bolt has not had IGSCC?

Response:

A repair (torsion arm clamp) will be implemented in conjunction with stabilizer support replacement that retains the torsion arm function by securing the torsion arms in their slots in the upper spring as well capturing the torsion arm bolt to prevent the bolts from becoming loose should the bolts fail. Therefore, no further inspection of the torsion bolt is required.

RAI-5

Section 7.2.2 of Attachment 1 to the March 22, 2007, letter indicates that the licensee will work with General Electric and the BWRVIP to establish the appropriate reinspection criteria for X-750 components. Provide a plan and schedule for determining which X-750 components need to be reinspected to verify that they are not susceptible to IGSCC.

Response

The high stress Alloy X-750 components will be inspected during the current refueling outage, consistent with the vendor (GE) and BWRVIP recommendations. The modification to the repair hardware results in the stresses in the shroud repair assembly being acceptable from an IGSCC perspective for a 40-year design life and no augmented inspections are planned at this time.

Pilgrim is committed to follow BWRVIP guidelines and supports BWRVIP activities in this area.

RAI-6

In the staff's safety evaluation dated May 12, 1995, for installation of the four sets of stabilizer assemblies and core plate wedges, the staff indicated that the reinspection plan should include the (4) gusset plate welds and the core shroud H11 weld because the integrity of these welds is essential to maintaining tie rod preload. The Regulatory Commitments in Attachment 2 to the March 22, 2007, letter does not include inspection of the gusset plate welds and core shroud H11 weld. The staff requests that the licensee

(a) either include the gusset plate and H11 welds in the reinspection plan or explain why reinspection is not necessary.

Response

The following figures provide a cross section of the core shroud and the tie rod inspection points. As shown, the H11 weld is between the vessel and core support plate. The gusset plates are being inspected by EVT-1 methods during the current refueling outage. The inspection plan includes the locations necessary for assuring the structural integrity of the repair hardware. Future inspections will be performed consistent with the BWRVIP recommendations provided in BWRVIP-38 and BWRVIP-76-A.

EXAMINATION OF GUSSETS AND GUSSET WELDS

Pilgrim has an installed (4) tie-rod system for the core shroud pre-emptive repair in the RPV. The main load path from the lower section of the tie-rods to the RPV wall is through corresponding gusset plates and connecting welds at 45°, 135°, 225° and 315°. These gussets have been inspected as follows:

Gusset Location	RFO11 (1997)	RFO12 (1999)	RFO16 (2007) (1)
45°		x	x
135°		x	x
225°		x	x
315°	x		x

Notes: (1) Examinations are in progress as part of equipment replacement.

Examination frequency complies with BWRVIP-38 guidelines. No relevant indications noted on these examinations.

In addition, Pilgrim has inspected 100% of the shroud support weld (top surface of H11) to the RPV wall in RFO15 with no relevant indications noted.

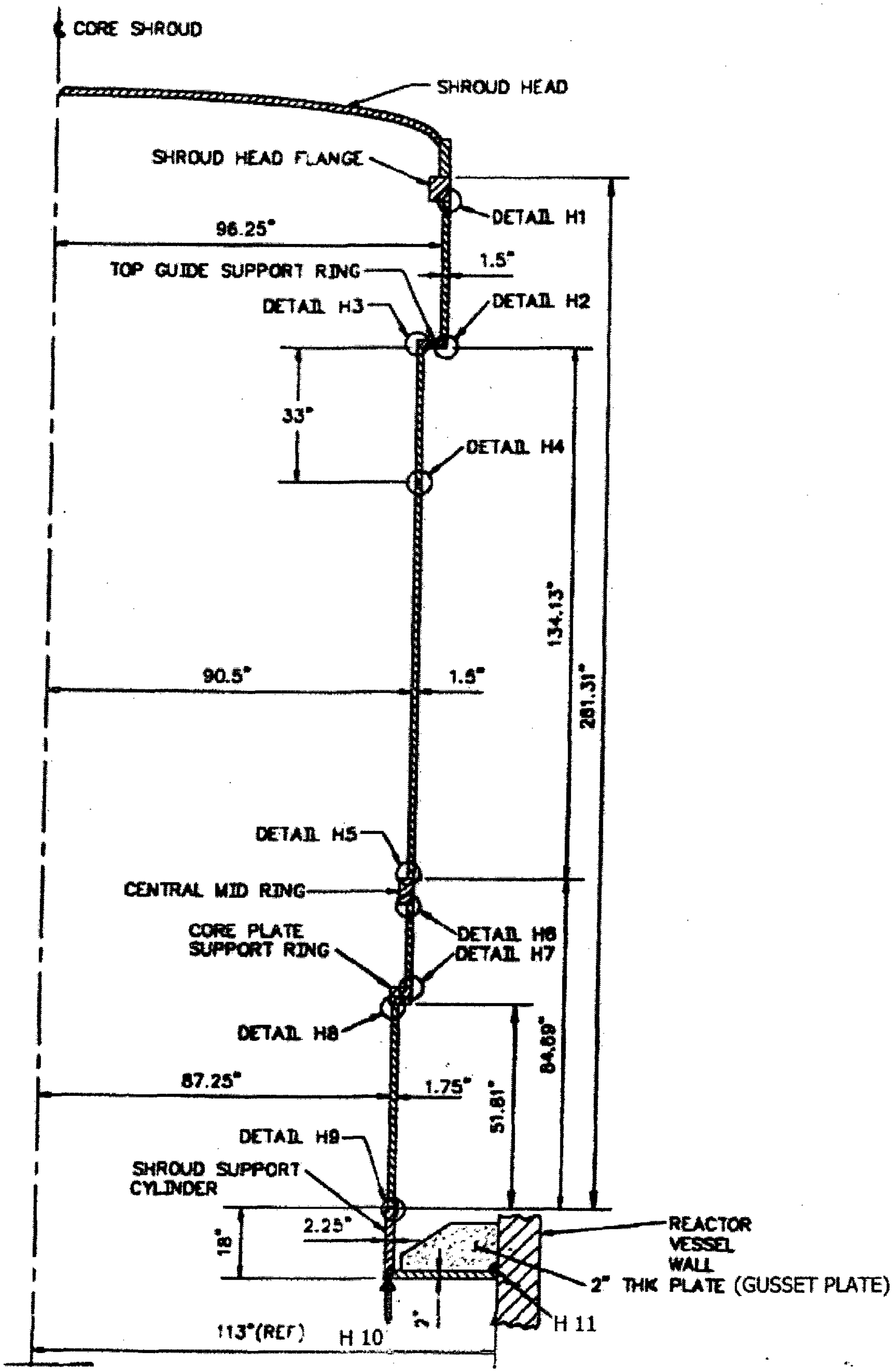
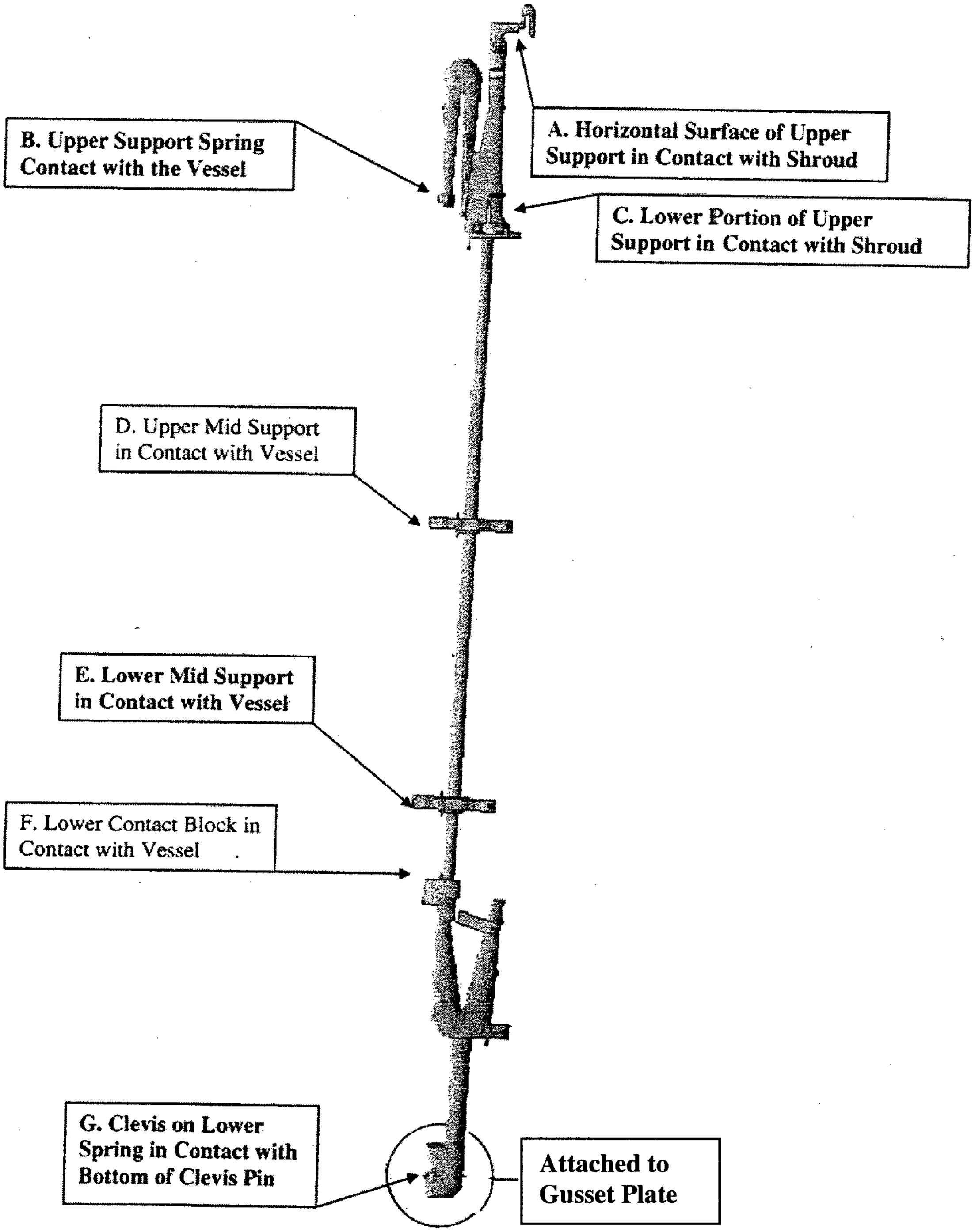


Figure B-12.1 – PNPS Shroud Cross-section

FIGURE 4: TIE ROD ASSEMBLY INSPECTION POINTS



RAI-7

Attachment 1 to the March 22, 2007 letter indicates that finite element analyses that were used to evaluate the modified upper support assembly components were performed using the ANSYS computer program. Section 4.1.1.2 of the attachment indicates that the ANSYS program is qualified for use on safety related components.

Identify analyses that the users have performed to qualify the ANSYS computer code for use on safety related components and identify staff safety evaluations that approved the use of this code to perform finite element analyses to determine the total stress on safety related components.

Response

GE has used ANSYS for several RPV internals evaluations (e.g., Clinton Power Station Unit 1 – Core Shroud Repair, Docket No. 50-461). Details of the qualification of the ANSYS program for use in safety related applications is provided below in the format provided by USNRC to conform to 10CFR Part 50.

Engineering Computer Program	**ANSYS**	
Author	ANSYS, Inc. 275 Technology Drive Canonsburg, PA 15317	
Source	ANSYS, Inc.	
Dated Version	ANSYS V9.0 and v10.0	
Facility	Work Stations at Sunol Location	
In the 3 columns below, check all Seismic Category 1 components to which your component applies.		
☒ Shroud ☒ Shroud support ☒ Core plate ☐ Top guide	☐ In-core stabilizers ☐ In-core guide tubes ☐ CRD Housing	☐ SLC Internal Piping ☐ Orificed fuel supports ☐ Control rod guide tubes
Extent and Limitations of the Application	The extent and limitation of ANSYS is determined by the verification cases that are performed to qualify ANSYS as a Level 2 ECP – meaning that ANSYS is an Approved Production Program that is verified and documented for design applications or for all technical activities used in developing design related information.	
The method used to demonstrate the computer program's applicability and validity.	ANSYS applicability and validity is demonstrated by running a series of verification cases (over 200) that exercise the elements and options used in the finite	

	element code. The verification cases provided by ANSYS, Inc. are extracted from textbooks in which classical or theoretical solutions are published or can readily be obtained by simple hand calculations.
Does the computer program calculate stress?	☒ Yes ☐ No If yes, please answer the questions below.
Is the computer program used to calculate stresses for service level D, faulted service limits?	☒ Yes ☐ No
IF, yes for service level D, is Appendix F requirements designed within computer program?	☐ Yes ☒ No
IF, yes for service level D, is the program used for inelastic analysis?	☒ Yes ☐ No
Is the computer program used for calculating stress and cumulative usage factors for class 1, 2 or 3 components?	☒ Yes ☐ No If yes, what environmental effects on the fatigue curves are considered? Environmental effects are considered outside ANSYS.

RAI-8 (a)

Attachment 1 to the April 10, 2007 letter provides a structural analysis of a clamp on each of the upper support spring torsion arm bolt.

a) If the torsion arm fails as a result of IGSCC, will the torsion arm clamp have sufficient load carrying capability to ensure that the core shroud stabilizer assembly maintains its intended function? Were the analyses performed in Attachment 1 to the April 10, 2007 letter and Attachments 3 and 4 to the March 22, 2007 letter assuming the torsion arm bolt had failed and was not capable of performing its intended function? If they were not performed assuming the torsion arm bolt had failed, what is the impact of the torsional arm bolt failure on the analyses in Attachment 1 to the April 10, 2007 letter and Attachments 3 and 4 to the March 22, 2007 letter?

Response

The design of the torsion arm clamp is to secure the torsion arms in the slot; thus, maintaining the function of the torsion arms, and to prevent them from becoming loose parts should the torsion arm bolt fail. The primary restraint to torsion arm rotation comes from the close fit between the torsion arm key and its mating slot in the upper spring. The torsion arm clamp retains the torsion arm tab/key in its mating slot. Therefore, the design function of the torsion arm is maintained.

The March 22, 2007 letter discussed the scenario assuming that the torsion arm bolt fails and the torsion arm loses its function (prior to the torsion arm clamp installation). That assessment considered the maximum rotation that would occur if the torsion arm were to become non-functional. The effect of this rotation was assessed quantitatively and determined that there is no safety concern from a structural integrity point of view. A failure of the torsion arm bolt has no impact on the sustained loading; therefore, IGSCC resistance of the clamp is not affected by the failure of a torsion arm bolt.

Considering the above discussion the following is the answer to the specific questions:

1. If the torsion arm fails as a result of IGSCC, will the torsion arm clamp have sufficient load carrying capability to ensure that the core shroud stabilizer assembly maintains its intended function? The torsion arm bolt is the high stress component of concern, not the torsion arm itself. Should the torsion arm bolt fail, the torsion arm clamp will maintain the function of the torsion arm and the rotation of the upper stabilizer will be limited to within original design limits. Therefore, if the torsion arm bolt fails the core shroud stabilizer assembly will maintain its intended function.
2. Were the analyses performed in Attachment 1 to the April 10, 2007 letter and Attachments 3 and 4 to the March 22, 2007 letter assuming the torsion arm bolt had failed and was not capable of performing its intended function? Yes.

RAI-8 (b)

Describe the inspection program to verify that the torsion arm clamp materials are not susceptible to IGSCC and irradiation assisted stress corrosion cracking (IASCC).

Response

The torsion arm clamp was fabricated from two materials: Type XM-19 and Alloy X-750. The Type XM-19 material was procured and fabricated in accordance with BWRVIP-84 requirements, and is, therefore considered resistant to IGSCC in the BWR environment. The Alloy X-750 components were likewise procured and fabricated in accordance with BWRVIP-84 requirements. In addition, the stresses in the Alloy X-750 component were evaluated to be less than 70% of the yield strength at 550°F, and therefore the component was assessed to have adequate IGSCC resistance. It should be noted that the 70% IGSCC acceptance criteria is more conservative than the 80% criteria currently specified in BWRVIP-84. Therefore, no augmented inspections of the torsion arm clamp are necessary to address IGSCC.

For this location, the fluence is below the IASCC threshold; therefore IASCC is not a concern for the torsion arm clamp.

Surface preparation of these components is discussed in response to RAI 1.