

General Information or Other (PAR)

Event # 42573

Rep Org: GENERAL ELECTRIC COMPANY	Notification Date / Time: 05/12/2006 22:36 (EDT)
Supplier: GENERAL ELECTRIC COMPANY	Event Date / Time: 04/24/2006 (EDT)
	Last Modification: 05/12/2006
Region: 1	Docket #:
City: WILMINGTON	Agreement State: Yes
County:	License #:
State: NC	
NRC Notified by: JASON POST	Notifications: ANTHONY DIMITRIADIS R1
HQ Ops Officer: MIKE RIPLEY	JAMES MOORMAN R2
Emergency Class: NON EMERGENCY	RICHARD SKOKOWSKI R3
10 CFR Section:	OMID TABATABAI-EMAIL NRR
21.21 UNSPECIFIED PARAGRAPH	JACK FOSTER (EMAIL) NRR

PART 21 NOTIFICATION - BWR CORE SHROUD TIE ROD UPPER SUPPORT CRACKING

"Summary:

GE Energy, Nuclear (GE) has provided core shroud repairs using tie rods to the US BWR plants identified in Attachment 1 [of the Part 21 notification]. Recently it was discovered during an in-vessel visual inspection (IVVI) that tie rod upper supports at Hatch Unit 1 experienced cracking. The apparent root cause is Intergranular Stress Corrosion Cracking (IGSCC) in the Alloy X-750 tie rod upper support material. Alloy X-750 material is susceptible to IGSCC if subjected to sustained, large peak stress conditions. GE opened an internal evaluation to determine if the potential IGSCC in the X-750 tie rod structural components of other BWR shroud repairs designed by GE could be a reportable condition under 10CFR21.

GE used the criterion provided in the BWR Vessels & Internals Project (BWRVIP-84) for the IGSCC susceptibility assessment of the X-750 components in the tie rod vertical load path. GE has concluded that it is not a reportable condition for the plants that were found to be within or not significantly exceed the BWRVIP-84 criterion. These US plants are identified as 'NR' in Attachment 2 [of the Part 21 notification]. GE determined that two US plants exceed the BWRVIP-84 criterion for the upper supports (in addition to the Hatch Unit 1 as-found condition). GE has not completed the evaluation for these plants to assess if a substantial safety hazard (SSH) exists. These plants have been provided a 60-Day Interim Report Notification under §21.21(a)(2) and are identified as '60-Day' in Attachment 2 [of the Part 21 notification].

"Safety Basis:

Cracking in the tie rod components made of X-750 may render the tie rod ineffective in maintaining core shroud configuration integrity during postulated accident conditions. Loss of core shroud integrity could impact the ability to maintain adequate core cooling for postulated design basis accident conditions. This condition would be reportable under 10 CFR 21 as a substantial safety hazard.

IE19

General Information or Other (PAR)

Event # 42573

"Corrective Action:

The corrective action which has been, is being, or will be taken; the name of the individual or organization responsible for the action; and the length of time that has been or will be taken to complete the action (note, these are actions specifically associated with the identified deviation or failure to comply):

1. A preliminary cause evaluation has been performed. The apparent cause of the cracking is Intergranular Stress Corrosion Cracking (IGSCC). A material sample is being shipped to the GE Vallecitos Nuclear Center for examination to confirm the apparent cause. GE will report the results of the examination by August 21, 2006.
2. The issue has been communicated to the industry through the BWR Owners' Group and the Electric Power Research Institute (EPRI)/BWR Vessel and Internals Project (BWRVIP). The NRC was informed in a NRC management meeting with EPRI and the BWRVIP Executive Oversight Committee at the NRC offices, Rockville, on March 15, 2006.
3. GE has completed an evaluation of the susceptibility to IGSCC using the BWRVIP-84 criterion. Determination of whether any possible cracking could lead to a substantial safety hazard (i.e., loss of core shroud configuration integrity during a design basis accident condition) depends upon many factors, including the actual extent of cracking in the repair components. Until inspections are completed, the actual extent of cracking is not known. GE is developing a model to predict the postulated extent of tie rod upper support cracking for tie rods with upper supports made of Alloy X-750. For upper supports that exceed the BWRVIP-84 criteria significantly, the model will be used to postulate the extent of cracking. This prediction will be used to determine if a substantial safety hazard could exist. GE will report the results of the evaluation by October 9, 2006.
4. The original design basis stress reports will be reviewed to assess the available margin in the primary membrane + bending stress intensities of the upper supports with respect to ASME code allowable values. Where reasonable margin exists in the original design basis code evaluation (an existing margin of approximately 25 % will be considered as reasonable margin), the existing margin is deemed adequate to offset any engineering assumptions or judgments used in the original analysis. Where the original margin is less than 25%, further review will be performed (including finite element analysis, if necessary) to confirm that the upper support remains qualified. This review will be completed by October 9, 2006."

Affected US Plants per Attachment 2 of the Part 21 notification: Clinton, Nine Mile Point 1, Pilgrim, Dresden 2 & 3, Quad Cities 1 & 2, Hatch 1 & 2.



GE Energy

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Safety Evaluation Program Manager

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May 12, 2006
MFN 06-133

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

**Subject: Part 21 60-Day Interim Report Notification:
Core Shroud Repair Tie Rod Upper Support Cracking**

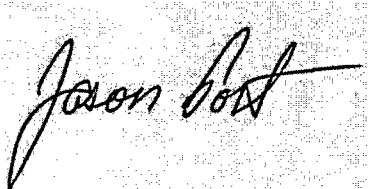
**Reference: NRC Event Notification Report 42372 (Retracted), Degraded Condition of
Shroud Tie Rods, NRC Event Notification Report for April 24, 2006**

This letter provides information concerning an evaluation being performed by GE Energy, Nuclear (GE) regarding the cracking discovered in the Hatch Unit 1 core shroud repair tie rod upper supports. The condition, the impact on other plants with tie rod repairs by GE, and the recommended actions were presented to NRC management in a meeting with the BWR Vessel & Internals Project (BWRVIP) Executive Oversight Committee at the NRC Rockville, MD offices on March 15, 2006. As identified herein, GE has concluded that this is not a reportable condition for Hatch Unit 1 and for several other US plants that have core shroud repairs designed by GE. GE has not completed the evaluation for two other US plants (Pilgrim and NMP-1), resulting in this 60-Day Interim Report Notification. GE will complete the evaluation and inform the NRC of the results by October 9, 2006. In the interim, the tie rod upper support parameters at Hatch Unit 1 are bounding for the conditions at Pilgrim and NMP-1 and the recommendations made by the BWRVIP to inspect the tie rods at the next scheduled refueling outage are endorsed by GE.

A description of the evaluation performed by GE is provided in Attachment 1. A list of the affected US plants is provided in Attachment 2. The information required for a 60-Day Interim Report Notification per §21.21(a)(2) is provided in Attachment 3. The commitment for follow-on actions are provided in Attachment 3, item (vii).

If you have any questions, please call me at (910) 675-6608.

Sincerely,

A handwritten signature in black ink that reads "Jason Post". The signature is written in a cursive style with a horizontal line extending from the end of the name.

Jason. S. Post
Safety Evaluation Program Manager

Attachments:

1. Description of Evaluation
2. US Plants With GE Core Shroud Repair
3. 60-Day Interim Report Notification Information per §21.21(a)(2)

cc: S. B. Alexander (NRC-NRR/DISP/PSIM) Mail Stop 6 F2
M. C. Hincharik (NRR/DPR/PSPB) Mail Stop O-7D11
C. V. Hodge (NRC-NRR/DIPM/IROB) Mail Stop 12 H2
M. E. Harding (GE)
J. F. Harrison (GE)
J. F. Klapproth (GE)
A. Lingenfelter (GE)
L. M. Quintana (GE)
K. K. Sedney (GE)
G. B. Stramback (GE)
R. J. Marcoot (GE)
PRC File
DRF No. 0000-0054-1184

Attachment 1 -Description of Evaluation

Summary:

GE Energy, Nuclear (GE) has provided core shroud repairs using tie rods to the US BWR plants identified in Attachment 1. Recently it was discovered during an in-vessel visual inspection (IVVI) that tie rod upper supports at Hatch Unit 1 experienced cracking. The apparent root cause is Intergranular Stress Corrosion Cracking (IGSCC) in the Alloy X-750 tie rod upper support material. Alloy X-750 material is susceptible to IGSCC if subjected to sustained, large peak stress conditions. GE opened an internal evaluation to determine if the potential IGSCC in the X-750 tie rod structural components of other BWR shroud repairs designed by GE could be a reportable condition under 10CFR21.

GE used the criterion provided in the BWR Vessels & Internals Project (BWRVIP-84) for the IGSCC susceptibility assessment of the X-750 components in the tie rod vertical load path. GE has concluded that it is not a reportable condition for the plants that were found to be within or not significantly exceed the BWRVIP-84 criterion. These US plants are identified as "NR" in Attachment 2. GE determined that two US plants exceed the BWRVIP-84 criterion for the upper supports (in addition to the Hatch Unit 1 as-found condition). GE has not completed the evaluation for these plants to assess if a substantial safety hazard (SSH) exists. These plants have been provided a 60-Day Interim Report Notification under §21.21(a)(2) and are identified as "60-Day" in Attachment 2.

Background

During the H1R22 IVVI examination of Hatch 1 shroud tie rod upper support, cracks were observed in one of the upper support brackets, each at the 135° and 225° tie rod locations. The cracking occurred at the 90° corner of the horizontal and vertical legs of the upper support. These upper supports were made of X-750 material. The most likely cause for the cracking is IGSCC due to large peak stress in the X-750 material as a result of sustained loading during operation. The Hatch 1 condition, apparent cause, and recommended action have been communicated to the BWR industry and the NRC by the EPRI and BWRVIP.

Evaluation

There are nine US BWRs operating with a GE-designed shroud repair. All of these plants were assessed for IGSCC susceptibility of the X-750 components in the tie rod vertical load path using the BWRVIP-84 criterion to preclude IGSCC. Tie rods upper supports made of X-750 material were modeled using the ANSYS computer program in sufficient detail to capture the peak stress effects. The BWRVIP-84 criterion limits the maximum sustained stress during operation in the X-750 material to 80% of yield strength to preclude IGSCC, where

Maximum stress = Primary membrane and bending, secondary stress, and peak stress
 $= P_m + P_b + Q + F$

Accordingly, the maximum stress in the upper support during sustained, normal operation was compared against the BWRVIP-84 criterion of 80% of yield stress to determine susceptibility. Where available and beneficial to demonstrate that the BWRVIP-84 criterion is met, the yield strength of the upper support material was based on the certified material test report (CMTR). The results of the upper support assessment are summarized in Table 1. The IGSCC criterion for the Hatch 1 upper supports that experienced cracking is also included.

The other major components made of X-750 material in the tie rod vertical load path were also assessed based on the stresses documented in the original design basis reports of the repairs. Depending on the location of interest, stress concentration factors were applied as appropriate, and the resulting maximum sustained stress in the normal operating condition was compared to the BWRVIP-84 criterion. All other major X-750 components in the tie rod vertical load path were found to be within the BWRVIP-84 criterion.

Safety Basis

Cracking in the tie rod components made of X-750 may render the tie rod ineffective in maintaining core shroud configuration integrity during postulated accident conditions. Loss of core shroud integrity could impact the ability to maintain adequate core cooling for postulated design basis accident conditions. This condition would be reportable under 10 CFR 21 as a substantial safety hazard.

Table 1. Upper Support Comparison to BWRVIP-84 IGSCC Criterion

Plant	Value of Maximum Sustained Stress in Upper Support Compared to BWRVIP-84 Criterion (%)	Conclusion
Hatch 1 (original design ¹)	Exceeds by ~149%	Upper support evaluated based on known extent of cracking
NMP-1	Exceeds by ~124%	Upper support evaluation not complete
Pilgrim	Exceeds by ~82%	
Quad Cities 1/2	Exceeds by ~1%	Upper support acceptable based on being within or slightly exceeding the BWRVIP-84 criterion ²
Hatch 1 (replacement design ²)	Under by ~7%	
Hatch 2	Under by ~14%	
Dresden 2/3	Under by ~14%	
Clinton	N/A - Upper support is not X-750	Upper support material not susceptible to IGSCC

Table 1 Notes:

1. Hatch 1 started up based on recategorizing the shroud as an Unrepaired Category C shroud using the results of shroud horizontal weld UT exams evaluated in accordance with BWRVIP-76.
2. The upper support at the 135° location was replaced. The replacement support incorporated an elliptical stress relief radius to mitigate the peak stress effects.

Conclusion

The GE evaluation concluded the following:

- a. The conclusions for the upper support brackets are provided in Table 1 above. All other X-750 components in the tie rod vertical load path for the plants with GE designed tie rod repairs are within the BWRVIP-94 criterion for IGSCC susceptibility.
- b. It is not a reportable condition for the as found Hatch 1 condition based on the known extent of tie rod upper support cracking.
- c. It is not a reportable condition for Clinton since the X-750 material is not used for the tie rod upper support brackets.
- d. It is not a reportable condition for plants that have margin to the BWRVIP-84 IGSCC criteria for the tie rod upper support brackets (or which exceed the criteria by a very small amount). These plants are Hatch 2, Quad Cities 1/2, and Dresden 2/3.
- e. GE has not completed the evaluation for plants that exceed the BWRVIP-84 IGSCC criterion for the upper support brackets. These plants are NMP-1, and Pilgrim.

Corrective/Preventive Actions

Refer to Attachment 3, Item (vii) for corrective actions.

Attachment 2 - US Plants With GE Core Shroud Repair

<u>NR¹</u>	<u>60-Day²</u>	<u>Utility</u>	<u>Plant</u>
X		AmerGen Energy Co.	Clinton
		AmerGen Energy Co.	Oyster Creek
		Carolina Power & Light Co.	Brunswick 1
		Carolina Power & Light Co.	Brunswick 2
	X	Constellation Nuclear	Nine Mile Point 1
		Constellation Nuclear.	Nine Mile Point 2
		Detroit Edison Co.	Fermi 2
		Dominion Generation	Millstone 1 ³
		Energy Northwest	Columbia
		Entergy Nuclear Northeast	FitzPatrick
	X	Entergy Nuclear Northeast	Pilgrim
		Entergy Nuclear Northeast	Vermont Yankee
		Entergy Operations, Inc.	Grand Gulf
		Entergy Operations, Inc.	River Bend
X		Exelon Generation Co.	Dresden 2
X		Exelon Generation Co.	Dresden 3
		Exelon Generation Co.	LaSalle 1
		Exelon Generation Co.	LaSalle 2
		Exelon Generation Co.	Limerick 1
		Exelon Generation Co.	Limerick 2
		Exelon Generation Co.	Peach Bottom 2
		Exelon Generation Co.	Peach Bottom 3
X		Exelon Generation Co.	Quad Cities 1
X		Exelon Generation Co.	Quad Cities 2
		FirstEnergy Nuclear Operating Co.	Perry 1
		Nebraska Public Power District	Cooper
		Nuclear Management Co.	Duane Arnold
		Nuclear Management Co.	Monticello
		PPL Susquehanna LLC.	Susquehanna 1
		PPL Susquehanna LLC	Susquehanna 2
		PSEG Nuclear	Hope Creek
X		Southern Nuclear Operating Co.	Hatch 1
X		Southern Nuclear Operating Co.	Hatch 2
		Tennessee Valley Authority	Browns Ferry 1 ⁴
		Tennessee Valley Authority	Browns Ferry 2
		Tennessee Valley Authority	Browns Ferry 3

- Notes:
1. NR = Not Reportable
 2. 60-Day = 60-Day Interim Report Notification
 3. Plant has been shutdown.
 4. Plant is in an extended shutdown

Attachment 3 – 60-Day Interim Report Notification Information per §21.21(a)(2)

- (i) Name and address of the individual providing the information:
J. S. Post, Safety Evaluation Program Manager, GE Energy - Nuclear, 3901 Castle Hayne Road, Wilmington, NC 28401
- (ii) Identification of the facility, the activity, or the basic component supplied for such facility or such activity within the United States that contains a deviation or failure to comply:
Core shroud repairs by GE using a tie rod design with components made of Alloy X-750 stainless steel.
- (iii) Identification of the firm constructing the facility or supplying the basic component which contains a deviation or failure to comply:
Provided by GE Energy – Nuclear, Wilmington, NC.
- (iv) Nature of the defect or safety hazard which could be created by such a deviation or failure to comply:
Cracking in the tie rod components made of X-750 may render the tie rod ineffective in maintaining core shroud configuration integrity during postulated accident conditions. Loss of core shroud integrity could impact the ability to maintain adequate core cooling for postulated design basis accident conditions.
- (v) The date on which the information of such a deviation or failure to comply was obtained:
Cracking was discovered in a Hatch 1 tie rod upper support during the refueling outage in-vessel visual inspection, February 2006. This was initiated as a potential reportable condition evaluation in the GE Part 21 compliant program on March 13, 2006.
- (vi) In the case of a basic component which contains a deviation or failure to comply, the locations of all such components in use or being supplied:
The US plants with GE shroud tie rod repairs are identified in Attachment 2.
- (vii) The corrective action which has been, is being, or will be taken; the name of the individual or organization responsible for the action; and the length of time that has been or will be taken to complete the action (note, these are actions specifically associated with the identified deviation or failure to comply):
 1. A preliminary cause evaluation has been performed. The apparent cause of the cracking is Intergranular Stress Corrosion Cracking (IGSCC). A material sample is being shipped to the GE Vallecitos Nuclear Center for examination to confirm the apparent cause. GE will report the results of the examination by August 21, 2006.
 2. The issue has been communicated to the industry through the BWR Owners' Group and the Electric Power Research Institute (EPRI)/BWR Vessel and Internals Project (BWRVIP). The NRC was informed in a NRC management meeting with

EPRI and the BWRVIP Executive Oversight Committee at the NRC offices, Rockville, on March 15, 2006.

3. GE has completed an evaluation of the susceptibility to IGSCC using the BWRVIP-84 criterion. Determination of whether any possible cracking could lead to a substantial safety hazard (i.e., loss of core shroud configuration integrity during a design basis accident condition) depends upon many factors, including the actual extent of cracking in the repair components. Until inspections are completed, the actual extent of cracking is not known. GE is developing a model to predict the postulated extent of tie rod upper support cracking for tie rods with upper supports made of Alloy X-750. For upper supports that exceed the BWRVIP-84 criteria significantly, the model will be used to postulate the extent of cracking. This prediction will be used to determine if a substantial safety hazard could exist. GE will report the results of the evaluation by October 9, 2006.
 4. The original design basis stress reports will be reviewed to assess the available margin in the primary membrane + bending stress intensities of the upper supports with respect to ASME code allowable values. Where reasonable margin exists in the original design basis code evaluation (an existing margin of ~25 % will be considered as reasonable margin), the existing margin is deemed adequate to offset any engineering assumptions or judgments used in the original analysis. Where the original margin is less than 25%, further review will be performed (including finite element analysis, if necessary) to confirm that the upper support remains qualified. This review will be completed by October 9, 2006.
- (viii) Any advice related to the deviation or failure to comply about the facility, activity, or basic component that has been, is being given to purchasers or licensees:

Inspect the tie rods at the next scheduled refuel outage per the BWRVIP recommendations:

All plants with core shroud repairs using tie rods should inspect their tie rods at their next scheduled refueling outage. This should include inspections in the same or similar locations where the Hatch 1 indications were observed. Consideration should also be given to other locations in the tie rod using Alloy X-750 that may experience high sustained loads, thus increasing the possibility of IGSCC (see BWRVIP-84, Section B.3.1 for additional information).