

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555

November 14, 1990

NRC BULLETIN NO. 89-01, SUPPLEMENT 1: FAILURE OF WESTINGHOUSE STEAM GENERATOR
TUBE MECHANICAL PLUGS

Addressees:

All holders of operating licenses or construction permits for pressurized-water reactors (PWRs).

Purpose:

This bulletin supplement is intended to inform addressees of recent problems involving steam generator (SG) tube mechanical plugs supplied by Westinghouse Electric Corporation. This supplement updates information provided in Bulletin 89-01, "Failure of Westinghouse Steam Generator Tube Mechanical Plugs." It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this bulletin supplement do not constitute NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances:

NRC Bulletin 89-01 requested that licensees repair and/or replace mechanical plugs supplied by Westinghouse. This request applied only to plugs fabricated from Inconel 600 heats NX-3279, NX-3513, NX-3962, and NX-4523 (i.e., "bulletin heats") on the basis of field experience and laboratory studies indicating that plugs from these heats are highly susceptible to primary water stress corrosion cracking (PWSCC). Such cracking led to a gross plug failure at the North Anna Power Station, Unit 1, resulting in a 75-gallon-per-minute primary-to-secondary leak. The bulletin requested that the subject repairs and/or replacements be accomplished according to a schedule consistent with an algorithm developed by Westinghouse (Reference 1, Revision 1), using the most conservative corrosion rate data from the field (observed at Millstone Unit 2 for a plug fabricated from heat NX-3513) as a benchmark.

After the NRC issued Bulletin 89-01, Westinghouse issued Revision 3 of Reference 1 providing complete listings of plug lifetimes categorized by plant, date of installation, and heat number. The listed lifetimes of plugs fabricated from the bulletin heats were consistent with the approach requested in the bulletin. Revision 3 of Reference 1 also included a complete listing of lifetimes for plugs fabricated from all non-bulletin Inconel 600 heats. These lifetimes were estimated using the approach used for plugs from the bulletin heats, adjusted upward by heat-specific "performance factors" to reflect the

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comparative time-to-cracking performance of each non-bulletin heat with heat NX-3513 during Westinghouse corrosion tests.

The staff has received reports of two instances of PWSCC affecting non-bulletin heats of Inconel 600 during the summer and fall of 1990. At the Sequoyah Nuclear Power Plant, Unit 1, five plugs fabricated from heat NX-5222 were removed from the field to evaluate the performance of these plugs in the laboratory. One of these five plugs was found to exhibit a circumferential crack above the expander. This crack consisted of two small cracks with a total length of approximately 15 degrees around the tube circumference and a maximum depth of penetration of 0.009 inch. One of the remaining four plugs was found to exhibit axial cracks below the expander. These five plugs had accumulated only 21 percent of the calculated plug lifetime, as given in Revision 3 of Reference 1.

At North Anna Unit 2, 15 plugs fabricated from heat NX-6323(HR) were inspected using a Westinghouse eddy current test technique. Nine of these plugs were located on the hot-leg side, five of which exhibited evidence of minor leakage. Eight of the nine hot-leg plugs exhibited indications of axial and/or circumferential cracking above the expander. One of the plugs, which was removed from the field and examined, was found to contain a crack that extended 360 degrees around the plug circumference. The crack varied in depth between 74 percent and 99 percent of the plug wall thickness. No indications were found in the six cold-leg plugs that were inspected. The accumulated service time on these plugs was less than 20 percent of the calculated lifetime, as given in Revision 3 of Reference 1.

Discussion:

Westinghouse has reassessed its lifetime estimates for mechanical plugs fabricated from non-bulletin heats of Inconel 600 in light of the recent field information from Sequoyah Unit 1 and North Anna Unit 2. Westinghouse plans to issue the results of this reassessment by mid-November 1990. This reassessment will include new lifetime estimates for all plugs fabricated from non-bulletin heats. Based on an October 11, 1990, meeting with Westinghouse, the staff expects that the new lifetime estimates will be substantially lower than those given in Revision 3 of Reference 1 for plugs fabricated from the non-bulletin heats.

This bulletin supplement requires no specific action or written response. If you have any questions about the information in this supplement, please contact the technical contact listed below or the appropriate NRR project manager.


Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical Contact: E. Murphy, NRR
(301) 492-0710

References:

1. Westinghouse Reports WCAP-12244 (proprietary version) and WCAP-12245 (non-proprietary version), "Steam Generator Tube Plug Integrity Summary Report"; Revision 1, April 1989; Revision 3, November 1989.

Attachment:

1. List of Recently Issued NRC Bulletins

LIST OF RECENTLY ISSUED
NRC BULLETINS

Attachment 1
NRCB 89-01, Supplement 1
November 14, 1990
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Bulletin No.	Subject	Date of Issuance	Issued to
90-02	Loss of Thermal Margin Caused by Channel Box Bow	3/20/90	All holders of OLS or CPs for BWRs.
90-01	Loss of Fill-Oil in Transmitters Manufactured by Rosemount	3/9/90	All holders of OLS or CPs for nuclear power reactors.
89-03	Potential Loss of Required Shutdown Margin During Refueling Operations	11/21/89	All holders of OLS or CPs for PWRs.
88-10, Supplement 1	Nonconforming Molded-Case Circuit Breakers	8/3/89	All holders of OLS or CPs for nuclear power reactors.
89-02	Stress Corrosion Cracking of High-Hardness Type 410 Stainless Steel Internal Preloaded Bolting in Anchor Darling Model S350W Swing Check Valves or Valves of Similar Design	7/19/89	All holders of OLS or CPs for nuclear power reactors.
89-01	Failure of Westinghouse Steam Generator Tube Mechanical Plugs	5/15/89	All holders of OLS or CPs for PWRs.
88-08, Supplement 3	Thermal Stresses in Piping Connected to Reactor Coolant Systems	4/11/89	All holders of OLS or CPs for light-water-cooled nuclear power reactors.
88-07, Supplement 1	Power Oscillations in Boiling Water Reactors	12/30/88	All holders of OLS or CPs for BWRs.
88-11	Pressurizer Surge Line Thermal Stratification	12/20/88	All holders of OLS or CPs for PWRs.
88-10	Nonconforming Molded-Case Circuit Breakers	11/22/88	All holders of OLS or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit

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Original Signed by
Charles E. Rossi

Charles E. Rossi, Director
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1. List of Recently Issued NRC Bulletins

Final draft discussed with E. Murphy and J. Richardson on 11/7/90. Final draft was also discussed with D. Allison who discussed it with D. Ross concerning need for CRG-R review and appropriateness of a bulletin supplement (11/7/90)
C E Rossi

*See Previous Concurrence

EMCB:DET
*EMurphy:adl
10/30/90

EMCB:DET
*KWichman
10/31/90

EMCB:DET
*CYCheng
10/31/90

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*JRichardson
10/31/90

Tech Editor
*BCalure
10/30/90

OGC:DOEA
*CBerlinger
11/02/90

DOEA
Crossi
11/8/90

Official Document Name: NRCB 89-01, Supp. 1

The recent findings at Sequoyah Unit 1 and North Anna Unit 2 underscore the importance of performing periodic surveillance of SG tube plugs as part of the global approach to ensuring continued integrity of the SG tube plugs and thus integrity of the reactor coolant system boundary. The eddy current test surveillance used at North Anna Unit 1 appears to be a particularly attractive method for performing this surveillance because it enables the licensee to inspect large numbers of plugs without removing the plugs from service.

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1. Westinghouse Reports WCAP-12244 (proprietary version) and WCAP-12245 (non-proprietary version), "Steam Generator Tube Plug Integrity Summary Report"; Revision 1, April 1989, NRC Accession Nos. 8904250229 and 8905030163; Revision 3, November 1989, NRC Accession Nos. 9002220656 and 9002220645.

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Attachment:

1. List of Recently Issued NRC Information Notices

Distribution

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*See Previous Concurrence

EMCB:DET
EMurphy:ad1
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Official Document Name: Steam Generator-Murphy

The recent findings at Sequoyah Unit 1 and North Anna Unit 2 underscore the importance of performing periodic surveillance of SG tube plugs as part of the global approach to ensuring continued integrity of the SG tube plugs and thus integrity of the reactor coolant system boundary. The eddy current test surveillance used at North Anna Unit 1 appears to be a particularly attractive method for performing this surveillance because it enables the licensee to inspect large numbers of plugs, without removing the plugs from service.

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