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

September 8, 1989

NRC INFORMATION NOTICE NO. 89-65: POTENTIAL FOR STRESS CORROSION CRACKING IN STEAM GENERATOR TUBE PLUGS SUPPLIED BY BABCOCK AND WILCOX

Addressees:

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

Purpose:

The purpose of this information notice is to inform licensees of the status of primary water stress corrosion cracking (PWSCC) problems being experienced with steam generator tube plugs supplied by Babcock and Wilcox (B&W) and, in particular, to alert licensees to the results of recent inspections of B&W supplied plugs at McGuire Unit 2. PWSCC can potentially impair the integrity of the plugs, which serve as part of the reactor coolant system (RCS) boundary. 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 information notice do not constitute NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances:

This information notice applies to steam generator tube plugs of the "rolled," "ribbed," and "taper welded" designs supplied by B&W. The staff has previously issued generic correspondence on the subject of steam generator tube plugs supplied by Westinghouse, namely, NRC Information Notice 89-33, "Potential Failure of Westinghouse Steam Generator Tube Mechanical Plugs," and NRC Bulletin 89-01, "Failure of Westinghouse Steam Generator Tube Mechanical Plugs."

During a refueling outage inspection at McGuire Unit 2 in July 1989, eddy current inspections with a rotating pancake coil (RPC) probe revealed PWSCC indications in B&W rolled plugs fabricated from Inconel 600 heats W592-1, W945-1, and 2848-2. Such cracking had previously been identified at V. C. Summer, McGuire Unit 1, and Oconee Unit 1 for B&W rolled plugs supplied from heat W592-1. The indications at McGuire Unit 2 in plugs supplied from heats W945-1 and 2848-2 are the first reported PWSCC indications in B&W plugs involving heats other than W592-1.

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The susceptibility of B&W plugs to PWSCC was first reported to the staff by B&W letters dated September 6, 1988, and February 3, 1989. B&W provided additional details of this problem in a meeting with the NRC staff on April 21, 1989. At that time, known instances of cracking in B&W plugs were limited to rolled plugs fabricated from Inconel 600 heat W592-1. Investigation by B&W established that material from heat W592-1 exhibits a microstructure characterized by intragranular carbides with little intergranular carbide precipitation. B&W believes that this lack of intergranular carbide precipitation indicates that heat W592-1 is susceptible to PWSCC attack. B&W reported that it had also examined archived plugs from all other heats used to fabricate plugs (except heats NX2960 and 38131-14) and concluded that all the other heats exhibit the proper carbide distribution and therefore they should have adequate PWSCC resistance. Plug material from heats NX2960 and 38131-14 had not been characterized at the time of the April 21, 1989, meeting with the staff.

All cracks observed in the field in rolled plugs, as of April 21, 1989, were circumferentially oriented and were located at the "heel" (i.e., outermost) transition region, which is not part of the pressure boundary, rather than at the "toe" (i.e., innermost) transition region, which is part of the plug (and RCS) pressure boundary (See Figure 1). Because of their location, B&W does not believe that these heel transition cracks impair plug integrity.

B&W provided the NRC staff, in a letter dated June 12, 1989, its recommendations to utility customers. These recommendations included the inspection of rolled plugs, both hot-and cold-leg, from heat W592-1 as well as sample inspections of rolled plugs from other heats. B&W ribbed plugs cannot be inspected with eddy current testing. Previously in a letter to the NRC staff dated May 19, 1989, B&W concluded that the ribbed plug design was not subject to a plug top release failure mode because of relatively low stresses in the plug associated with its installation. Nevertheless in its letter of June 12, 1989, B&W recommended the removal and replacement of all ribbed plugs fabricated from heat W592-1 at the next scheduled refueling outage. Regarding B&W taper welded plugs, B&W believes that the design of these plugs is such that there is no mechanism for a gross failure (i.e., plug top release failure). B&W noted that taper welded plugs from heat W592-1 may crack in the future and recommended their removal at a convenient time unless some other course of action is developed to eliminate potential future concerns regarding the integrity of these plugs.

B&W also stated in its letter of June 12, 1989, that recent industry experience raises a concern that examination of material microstructures might not reveal all heats of material susceptible to PWSCC. Therefore, B&W is planning additional corrosion tests to (1) rank the relative resistance of the various microstructures of plug material to PWSCC, (2) establish the minimum expected service life of plugs already installed, and (3) determine if any other heat of plug material (besides W592-1) requires extensive examination or near-term removal. This corrosion test program is scheduled for completion by December 1989.

The following information concerning the recent eddy current inspections of the plugs at McGuire Unit 2 has been provided informally to the staff by the licensee and is therefore preliminary. The B&W plugs at McGuire Unit 2 were

supplied from three heats: W592-1, W945-1, and 2848-2. All rolled plugs installed on the hot-leg side and a sample of plugs installed on the cold-leg side were inspected at McGuire Unit 2. Regarding plugs from heat W592-1, 30 on the hot-leg side were identified to have eddy current indications. These indications involved only plugs installed on or before March 1986. No indications were found in plugs from heat W592-1 that were installed after March 1986. As a conservative measure, the licensee replaced all hot-leg plugs from heat W592-1 installed on or before March 1986 regardless of whether these plugs exhibited eddy current indications.

Regarding plugs from the heats other than W592-1, 16 plugs on the hot-leg side fabricated from heat W945-1 and 3 on the hot-leg side fabricated from heat 2848-2 exhibited eddy current indications and were replaced. The plugs with indications that were fabricated from heat W945-1 were installed in March 1986. No indications were found in plugs from this heat that were installed after March 1986. Plugs from heat 2848-2, including those with indications, were installed in June 1988.

No indications were found in rolled plugs located on the cold-leg side.

With the exception of three plugs, all indications found during the recent McGuire Unit 2 inspections of the rolled plugs were located at the heel transition region. Examination of a sample of these plugs after they were removed from the field confirmed the presence of circumferential cracks at the heel transition region. Three plugs (from heat W592-1) found during field eddy current testing to contain indications at the heel transition region were also found to contain indications at the toe transition region. However, preliminary findings from examinations after the plugs were removed indicate that these indications at the toe transition region are not associated with cracks. It is the staff's understanding that the source of these indications is still under investigation..

Two ribbed plugs from heat W592-1 were replaced (with rolled plugs) since they could not be inspected by eddy current testing. Examination of these ribbed plugs after they were removed (plus four ribbed plugs removed earlier from McGuire Unit 1) did not reveal any cracks. No ribbed or taper welded plugs are currently in service at McGuire Unit 2.

Discussion:

Although known instances of cracking in B&W rolled plugs have been limited to the heel transition region (which is not part of the pressure boundary), such cracks may be a precursor to eventual cracks at the toe transition region (which is part of the pressure boundary). Therefore, eddy current inspections to identify heel as well as any toe transition cracks are important for ensuring the continued integrity of the B&W rolled plugs. Furthermore, until additional evidence becomes available from corrosion tests and/or experience, all Inconel 600 heats used for plugs should be considered potentially susceptible to PWSCC.

Although B&W plugs of the ribbed and taper welded design may have less potential for developing PWSCC over the short term compared with rolled plugs because of differences in design and stress level, it is important that licensees consider how the integrity of these plugs is to be ensured over the short and long term.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, 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) 492-0945

Attachments:
1. Figure 1: Rolled Plug
2. List of Recently Issued NRC Information Notices

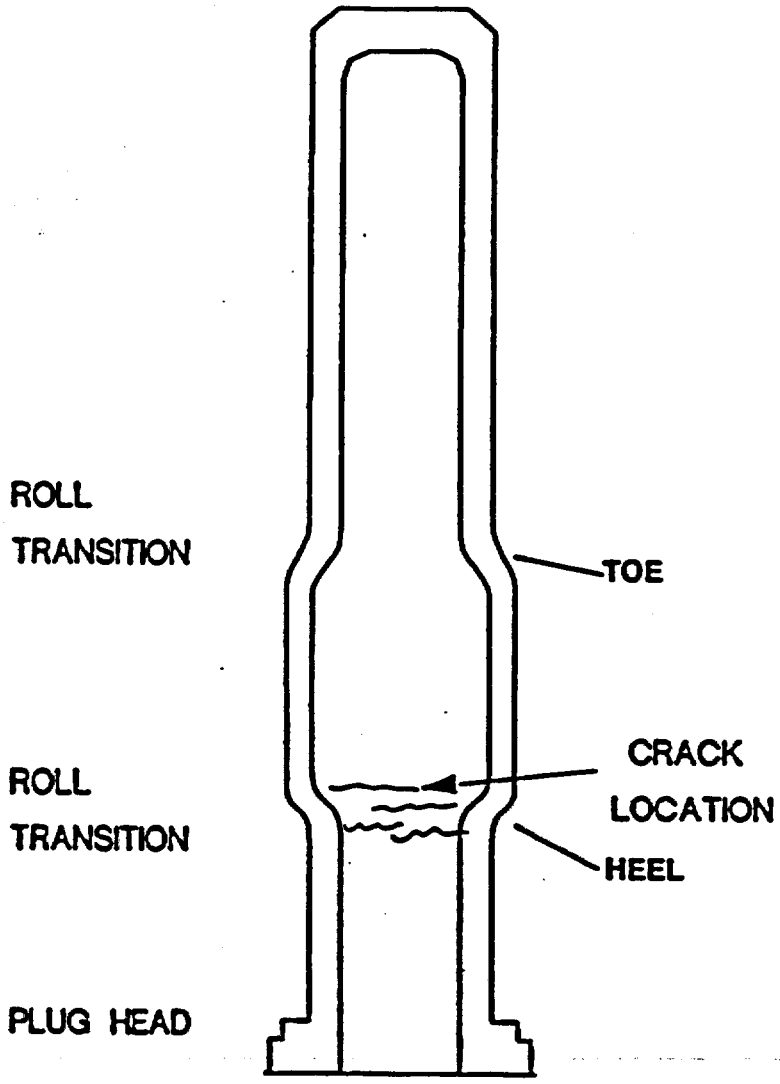

FIGURE 1. ROLLED PLUG

LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
89-64	Electrical Bus Bar Failures	9/7/89	All holders of OLs or CPs for nuclear power reactors.
89-63	Possible Submergence of Electrical Circuits Located Above the Flood Level Because of Water Intrusion and Lack of Drainage	9/5/89	All holders of OLs or CPs for nuclear power reactors.
89-62	Malfunction of Borg-Warner Pressure Seal Bonnet Check Valves Caused By Vertical Misalignment of Disk	8/31/89	All holders of OLs or CPs for nuclear power reactors.
89-61	Failure of Borg-Warner Gate Valves to Close Against Differential Pressure	8/30/89	All holders of OLs or CPs for nuclear power reactors.
88-48, Supp. 2	Licensee Report of Defective Refurbished Valves	8/22/89	All holders of OLs or CPs for nuclear power reactors.
89-60	Maintenance of Teletherapy Units.	8/18/89	All NRC Medical Teletherapy Licensees.
89-59	Suppliers of Potentially Misrepresented Fasteners	8/16/89	All holders of OLs or CPs for nuclear power reactors.
89-58	Disablement of Turbine-Driven Auxiliary Feedwater Pump Due to Closure of One of the Parallel Steam Supply Valves	8/3/89	All holders of OLs or CPs for PWRs.
89-57	Unqualified Electrical Splices in Vendor-Supplied Environmentally Qualified Equipment	7/26/89	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit

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1. Figure 1: Rolled Plug
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*See previous concurrences

*DEST:EMCB	*DEST:EMCB	*DEST:EMCB	*DEST:EAD
EMurphy:tys	KWichman	CYCheng	JERichardson
08/24/89	08/24/89	08/24/89	08/29/89

*NRR/OGCB	NRR/DOEA
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9/1/89	9/15/89

OFFICIAL RECORD COPY 5520 document name: MURPHY-2

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This IN has been reviewed and commented on by Tech Editor (M. Majac) 8/28/89
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EMurphy:tys	KWichman	CYCheng	JERichardson
8/24/89	8/24/89	8/24/89	8/29/89
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