UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
OFFICE OF NEW REACTORS
WASHINGTON, DC 20555-0001

March 23, 2016

# NRC REGULATORY ISSUE SUMMARY 2016-02
# DESIGN BASIS ISSUES RELATED TO TUBE-TO-TUBESHEET JOINTS IN PRESSURIZED-WATER REACTOR STEAM GENERATORS

## ADDRESSEES

All holders of an operating license or construction permit for a nuclear power reactor under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," except those that have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

All holders of and applicants for a power reactor combined license, standard design approval, or manufacturing license under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants." All applicants for a standard design certification, including such applicants after initial issuance of a design certification rule.

## INTENT

The U.S. Nuclear Regulatory Commission (NRC) is issuing this regulatory issue summary (RIS) to clarify the design requirements for tube-to-tubesheet welds in pressurized-water reactor steam generators and that changes to the tube-to-tubesheet joint design basis should be evaluated in accordance with 10 CFR 50.59, "Changes, tests, and experiments." Tube-to-tubesheet welds designed in accordance with the American Society of Mechanical Engineers *Boiler and Pressure Vessel Code* (ASME Code) as pressure boundary (structural) welds must follow the requirements of NB-3000, "Design," in Section III, "Rules for Construction of Nuclear Facility Components." For pressure boundary welds, conformance with ASME Code, Section III, NB-4350, "Special Qualification Requirements for Tube-to-Tubesheet Welds," and NB-5274, "Tube-to-Tubesheet Welded Joints," is not sufficient. This RIS requires no action or written response on the part of an addressee.

## BACKGROUND INFORMATION

On October 30, 2014, a licensee determined[1] that the tube-to-tubesheet welds for their replacement steam generators were characterized as seal welds, not as pressure boundary (structural) welds. AREVA designed and manufactured these replacement steam generators, which were installed in 2007. AREVA evaluated and qualified the tube radial expansion against the tubesheet bore to serve as the tube-to-tubesheet joint pressure boundary by demonstrating

[1] St. Lucie Plant - NRC Integrated Inspection Report 05000335/2014005 and 05000389/2014005, January 30, 2015, Available at Agencywide Documents Access and Management System (ADAMS) Accession No. ML15030A323

that the friction between the tube and tubesheet was sufficient to resist axial loads in the tube. The ASME Code, Section III, does not contain design limits that apply specifically to an expansion joint.

The tube-to-tubesheet welds in the original steam generators were designed to the requirements of NB-3000; thus, they were originally qualified as structural welds, taking no credit for the ability of tube expansion against the tubesheet bore to resist axial loads in the tube. The licensee determined that evaluations performed in support of the steam generator replacement project in accordance with 10 CFR 50.59 did not specifically identify and address this change to the design basis because the change to the joint design basis was not included in the design technical report reviewed by the licensee. The licensee has placed this issue into its corrective action program.

There are five units (Saint Lucie Plant, Unit 2; Salem Nuclear Generating Station, Unit 2; Prairie Island Nuclear Generating Plant, Units 1 and 2; and Callaway Plant) with replacement recirculating steam generators designed by AREVA that are potentially affected by this issue. The licensees for these five units are aware of this issue, as confirmed by the NRC through discussions with the industry.

On February 12, 2015, the Electric Power Research Institute (EPRI) Steam Generator Task Force (SGTF) met with the NRC staff to discuss various steam generator topics, including tube-to-tubesheet welds. In addition to the issue discussed above, an EPRI representative reported[2] that there is a difference in interpretation among steam generator designers/manufacturers for those units that consider the tube-to-tubesheet welds to be pressure boundary (structural) welds. The difference in interpretation is whether the welds must be analyzed in accordance with ASME Code, Section III, NB-3000. The alternative interpretation was that if the tube-to-tubesheet weld satisfied the requirements of NB-4350 and NB-5274, then all ASME design requirements for tube-to-tubesheet welds in a Class 1 component were satisfied.

On August 19, 2015, the EPRI SGTF met with the NRC and reported[3] that the EPRI SGTF sent an inquiry to the ASME Code Section III Standards Committee to determine whether this alternative interpretation was correct. In response to the inquiry, the ASME Standards Committee concluded[4] that the alternative interpretation was not correct, and that tube-to-tubesheet welds that are serving a pressure boundary function must meet the requirements of NB-3000, in addition to NB-4350 and NB-5274.

This latter issue (i.e., tube-to-tubesheet welds intended to be pressure boundary (structural) welds, but not designed to NB-3000) affects 13 of 15 units with replacement steam generators supplied by Babcock & Wilcox Canada. The tube-to-tubesheet welds at these 13 units were either not evaluated, or were only partially evaluated, to the requirements of NB-3000. The 13 units are:

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[2] February 12, 2015, Summary of Category 2 Public Meeting with the Steam Generator Task Force to Discuss Steam Generator Issues, Available at ADAMS Accession No. ML15068A400

[3] NRC/EPRI Steam Generator Task Force Meeting - August 19, 2015, Available at ADAMS Accession No. ML15231A575

[4] ASME BPVC, Section III, Division 1, Article NB-3000 (1983 Edition through 2013 Edition) – May 15, 2015, Available at ADAMS Accession No. ML15243A060

- Braidwood Station, Unit 1
- Byron Station Unit 1
- Calvert Cliffs Nuclear Power Plant, Units 1 and 2
- Catawba Nuclear Station, Unit 1
- Donald C. Cook Nuclear Power Plant, Unit 1
- McGuire Nuclear Station, Units 1 and 2
- Oconee Nuclear Station, Units 1, 2, and 3
- R.E. Ginna Nuclear Power Plant
- St. Lucie Plant, Unit 1

The tube-to-tubesheet welds for the remaining 2 of 15 units (Millstone Power Station, Unit 2, and Davis-Besse Nuclear Power Station, Unit 1) were previously fully evaluated to the requirements of NB-3000 at the request of the respective licensees. The licensees for these 13 units are aware of this issue, as confirmed by the NRC through communication with the industry.

**SUMMARY OF ISSUE**

This RIS addresses regulatory compliance issues related to the tube-to-tubesheet joint for both replacement and new steam generators. These regulatory compliance issues relate to the requirements of the ASME Code, Section III; the regulations of 10 CFR Part 50.55a, "Codes and standards;" 10 CFR 50.59, "Changes, tests, and experiments;" and 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," Criterion III, "Design Control". The NRC staff determined that five units with AREVA replacement recirculating steam generators have a tubesheet joint that relies on the tube radial expansion against the tubesheet to function as the tube-to-tubesheet joint pressure boundary. At least one of those five units (i.e., St. Lucie Plant, Unit 2) had original steam generators with tubesheet joints that relied on the tube-to-tubesheet welds to function as the pressure boundary and did not include this change to the design basis in the 10 CFR 50.59 evaluation for the replacement steam generators. The NRC staff further determined that 13 units with replacement steam generators designed by B&W Canada may have tube-to-tubesheet welds that were intended to be pressure boundary (structural) welds but were either not evaluated, or were only partially evaluated, to the requirements of ASME Code, Section III, NB-3000. The NRC staff concluded that these tube-to-tubesheet joint issues have limited risk significance because redundant load paths (i.e., the tube-to-tubesheet weld and the expansion joint) in the tube-to-tubesheet joint resist axial loads in the tubes. The NRC staff recommends that affected licensees ensure compliance with regulatory requirements, as clarified in this RIS for replacement and new steam generators. The licensees for all affected units are aware of this issue.

**BACKFITTING AND ISSUE FINALITY**

This RIS requires no action or written response. This RIS does not present any new or changed NRC position or interpretation with respect to ASME Code, NB-3000, "Design," in Section III, "Rules for Construction of Nuclear Facility Components," ASME Code, Section III, NB-4350, "Special Qualification Requirements for Tube-to-Tubesheet Welds," or NB-5274, "Tube-to-Tubesheet Welded Joints." Consequently, the staff did not perform a backfit analysis.

## *FEDERAL REGISTER* NOTIFICATION

A notice of opportunity for public comment on this RIS was not published in the Federal Register because it is informational and pertains to a staff position that does not represent a departure from current regulatory requirements and practice.

## CONGRESSIONAL REVIEW ACT

This RIS is not a rule as defined in the Congressional Review Act (5 U.S.C. §§ 801-808).

## PAPERWORK REDUCTION ACT STATEMENT

This RIS does not contain any new or amended information collection requirements subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 et seq.). Existing collection requirements under 10 CFR Part 50 were approved by the Office of Management and Budget, control number 3150-0011.

## Public Protection Notification

The NRC may not conduct or sponsor, and a person is not required to respond to, an information collection unless the requesting document displays a currently valid OMB control number.

**CONTACT**

Please direct any questions about this matter to the technical contact listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

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