



Watts Bar Nuclear Plant (WBN)
Pre-Application Meeting for Proposed License Amendment Request
(LAR) Regarding Change to the WBN Unit 2
Technical Specifications (TS) 3.4.17, “Steam Generator Tube Integrity”
and 5.7.2.12 “Steam Generator Program”

June 11, 2019

Agenda

- Opening Remarks (R. Wells)
- WBN Unit 2 Steam Generator (SG) Design (J. Mayo)
- WBN Unit 2 SG Program (J. Mayo)
- WBN Unit 2 SG Operating and Maintenance Strategy (J. Mayo)
- Basis to Install Alloy 800 Non-Nickel Banded Leak-Limiting Sleeves (J. Smith)
- Operating Experience (J. Smith)
- Regulatory Precedent (R. Wells)
- Schedule for Submittal (R. Wells)
- Closing Remarks (R. Wells)

Opening Remarks

- WBN Unit 2 is scheduled to perform the next steam generator (SG) tube inspections during the Fall 2020 outage (U2R3)
- This LAR proposes changes to WBN Unit 2 TS 3.4.17 “Steam Generator Tube Integrity,” and TS 5.7.2.12, “Steam Generator Program,” to permit the repair of steam generator tubes due to potential degradation using Alloy 800 non-nickel banded leak-limiting sleeves
- Two leak-limiting Alloy 800 sleeve designs are proposed for use in repairing SG tubes: a transition zone (TZ) sleeve, and a tube support sleeve
- Currently, only nickel banded tube sleeves are licensed domestically to address top of the tubesheet cracks

Opening Remarks (cont)

- Elimination of the nickel band from the lower joint of the TZ sleeve is proposed to address concerns related to eddy current inspection of the parent tube wall adjacent to the sleeve nickel band
- Nondestructive eddy current examination methods have been demonstrated to be effective in accordance with the requirements of the Electric Power Research Institute (EPRI) SG Examination Guidelines for the TZ and tube support sleeve

WBN Unit 2 SG Design

- WBN Unit 2 commenced commercial operation in October 2016
 - Westinghouse NSSS – 4-loop design
 - Westinghouse Model D3 SGs
 - > Alloy 600 low temperature mill annealed tubes
 - > Proactive measures implemented prior to commercial operation to mitigate Primary Water Stress Corrosion Cracking (PWSCC) susceptibility include:
 - » Row 1 and 2 U-bend in situ stress relieving
 - » Tubesheet rotopeening
 - > Zinc Addition Program implemented

WBN Unit 2 Steam Generator Program

- WBN Unit 2 Technical Specification (TS) 5.7.2.12 requires that a SG Program be established and implemented to ensure SG tube integrity is maintained
- SG tube integrity is maintained by meeting the NEI 97-06, Steam Generator Program Guidelines, Rev. 3 performance criteria for structural integrity, accident-induced leakage, and operational leakage
- The SG Program establishes additional provisions for SG tube plugging or repair criteria, SG tube inspections, and SG tube repair methods

WBN Unit 2 Steam Generator Operating and Maintenance Strategy

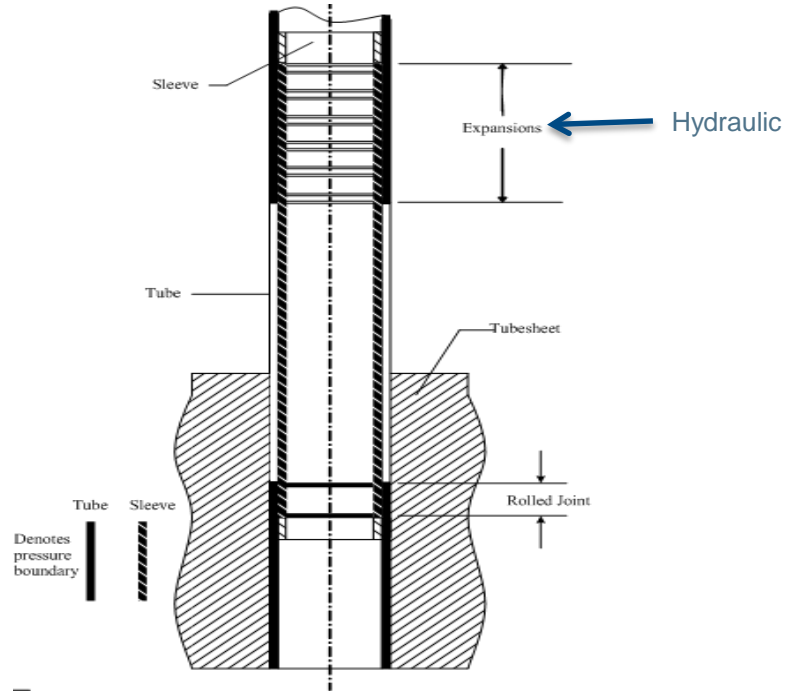
- SG replacement tentatively projected for WBN U2R5 (Fall 2023)
- LAR is needed to have the option to sleeve tubes (if needed) for U2R3 (Fall 2020)

Basis to Install Alloy 800 Non-Nickel Banded Leak-Limiting Sleeves

- Sleeve design description
- Qualification testing and structural analysis
- Improved inspection capabilities
- Overall conclusions

Basis to Install Alloy 800 Non-Nickel Banded Leak-Limiting Sleeves

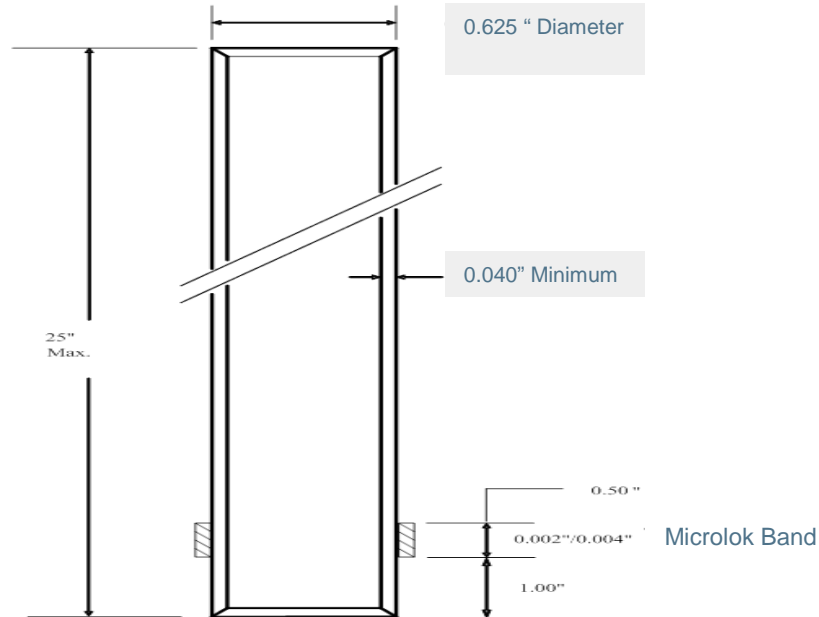
- Alloy 800 Non-Nickel Banded Leak-Limiting TZ Sleeve Design Description



Basis to Install Alloy 800 Non-Nickel Banded Leak-Limiting Sleeves

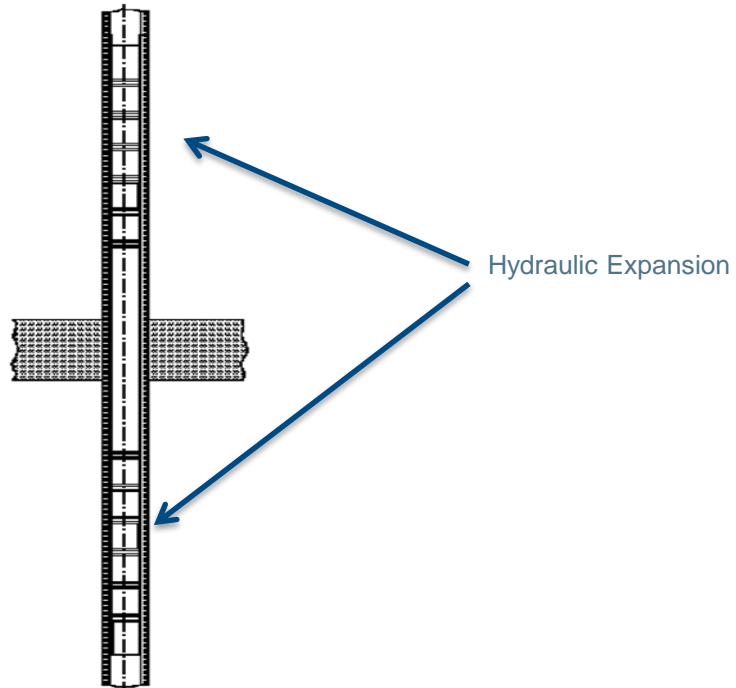
- Alloy 800 Non-Nickel Banded Leak-Limiting TZ Sleeve Design Description

The thermally sprayed nickel alloy band, (microlok) results in a rough surface which enhances the strength of the rolled mechanical joint.



Basis to Install Alloy 800 Non-Nickel Banded Leak-Limiting Sleeves

- Alloy 800 Leak-Limiting Tube Support Sleeve Design Description



Basis to Install Alloy 800 Non-Nickel Banded Leak-Limiting Sleeves

- Alloy 800 non-nickel band leak-limiting sleeve design description
 - > Roll expanded joints are robust
 - » Used in numerous power generator and other applications (SG tube plugs, sleeves, etc) because of their inherent characteristics
 - » Provide the most load bearing capability and best leakage restriction performance compared to other expansion techniques
 - » F* and L* Alternate Repair Criteria (ARC) address roll expanded joints
 - Typical F* length ~ 1 inch from the top of tubesheet (TTS), 1.64 inch at WBN Unit 2
 - Shorter F* lengths can be used based on tubesheet elevation; consistent with sleeve roll joint elevation
 - > Limited or no potential of degradation of parent tube adjacent to TZ lower joint
 - » Rotopeening greatly improves PWSCC resistance
 - » Finite Element Analysis (FEA) modeling shows parent tube residual stresses are compressive

Basis to Install Alloy 800 Non-Nickel Banded Leak-Limiting Sleeves

- Previous qualification testing, corrosion testing, and structural analyses for nickel banded sleeve applies to non-nickel banded sleeve
 - Previous mechanical load tests which included axial load, pressure, collapse and load cycling were performed on sleeve tube assemblies without the nickel band
 - Previous leak tests were also performed for various temperatures and pressures under normal operating and main steam line break conditions without the nickel band
 - Structural analyses of the sleeve-tube assembly do not model the presence of the nickel band
- NEI 97-06 structural and leakage performance criteria are demonstrated

Basis to Install Alloy 800 Non-Nickel Banded Leak-Limiting Sleeves

- Improved sleeve inspection capability over nickel banded TZ sleeve
 - The proposed TS amendment will include a requirement to perform an inspection of the parent tube in the area of the TZ and tube support sleeve expansion joints
 - > Sleeve installation will only proceed if these regions are free of service-induced indications
 - With the elimination of the nickel band from the lower joint of the TZ sleeve, for both the TZ and tube support sleeves, nondestructive examination methods have been demonstrated to be in compliance with EPRI SG Tube Examination Guidelines
 - Tubes found by inservice inspection that contain a flaw in a sleeve or sleeve to tube joint shall be plugged

Basis to Install Alloy 800 Non-Nickel Banded Leak-Limiting Sleeves

- Overall Conclusions
 - Roll expanded lower joint for the TZ sleeve is robust; upper joint is same hydraulic expansions which have been approved for nickel banded sleeves
 - Parent tube residual stresses are compressive post sleeve rolling - one of the elements necessary for SCC initiation is eliminated
 - NEI 97-06, Rev. 3 SG tube integrity performance criteria are met
 - The non-nickel banded TZ sleeve is qualified to Appendix H of the EPRI SG Tube Examination Guidelines
 - TVA will conservatively plug any tube with a flaw within TZ and tube support sleeves

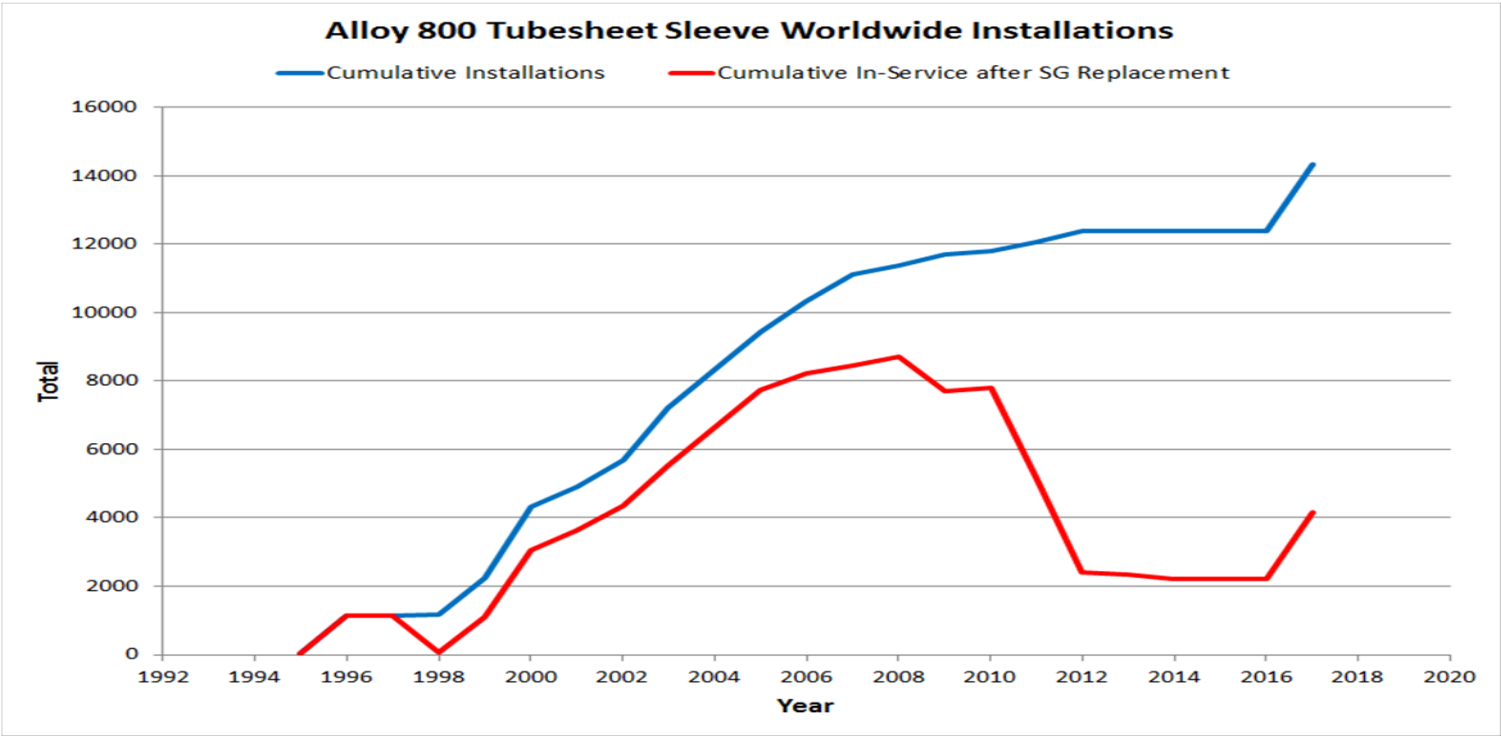
Operating Experience

- Alloy 800 Sleeve/Tube Operating Experience
 - More than 14,000 leak-limiting Alloy 800 TZ sleeves without the nickel band have been installed worldwide with no reported parent tube/sleeve degradation
 - Approximately 12,000 tube support sleeves have been installed with no reported parent tube/sleeve degradation
 - Hundreds of SG tubes that contain leak-limiting Alloy 800 PLUSS (plug replacing sleeve which also stabilizes) sleeves installed have been in operation in international plants for over 12 effective full power years (EFPY) with no reports of sleeve/parent tube wall degradation
 - Besides leak-limiting Alloy 800 sleeves, Alloy 800 tubing has been used in SG tube design in international plants with excellent results based on experience in over 200,000 tubes in service
 - > In-service inspection (ISI) data from Spanish RSGs with Alloy 800 tubing identified outer diameter (OD) circumferential cracking (~2009 timeframe)
 - » Associated with denting at TTS resulting from poor chemistry control
 - » Chemical cleaning applied to remove hardened deposits – no stress corrosion cracking (SCC) reports long term
 - > One German unit reported axial ODSKC in tubesheet (one tube)
 - » No additional reports since initial identification

Operating Experience

- An extensive history of Westinghouse Hybrid Expansion Joint (HEJ) and Laser Welded Sleeve (LWS) installations further supports the conclusion that degradation of the parent tube adjacent to the roll expansion at the lower joint is not anticipated
 - No reports of parent tube SCC in the sleeve roll joint region for any Westinghouse sleeve design

Operating Experience



Regulatory Precedent

- Prior to SG replacement the NRC issued Amendment No. 44 for WBN Unit 1 allowing the use of leak-limiting Alloy 800 sleeves to repair defective SG tubes as an alternative to plugging a tube (ML032300143)
 - Only difference in 2003 is the TZ sleeve had a nickel band at the lower joint in addition to a thermally sprayed nickel band (microlok band)
 - Previous WCAP-15918, Revision 0, submitted in 2003, is primarily being revised to reflect changes in sleeve design description, sleeve operating experience, and eddy current inspection capability, with the removal of the nickel band in the lower joint of the TZ sleeve.
 - TZ sleeve (with nickel band) and tube support sleeve approved in 2003 for installation
- Nickel band TZ and tube support sleeve (no nickel band) approved in 2019 at Beaver Valley Unit 2 (ML18348B206)
 - Non-Nickel band sleeve TZ and tube support sleeve to be installed at WBN Unit 2

Regulatory Precedent

- As noted in the Beaver Valley Unit 2 NRC SE, “The PLUS sleeves are identical to the Alloy 800 leak-limiting sleeves at Beaver Valley, Unit 2, except that there is no nickel band on the PLUS sleeves. The NRC staff found this information to be valuable because this international operating experience bounds the number of effective full power years that the Beaver Valley, Unit 2, sleeves will have at the end of the proposed sleeving extension.”

Schedule for Submittal

- 6/11/19 - Pre-application meeting with the NRC
- Late August 2019 Pre-submittal meeting with NRC
- 9/30/19 - Submit LAR to NRC
- Request NRC approval within one year to support WBN U2R3 outage in Fall of 2020 to support next inspection

Closing Remarks

- Proposed WBN Unit 2 TS changes are needed to address anticipated SG tube degradation.
- These changes are needed to support the WBN Unit 2 Cycle 3 Fall 2020 outage.
- SG tube integrity in accordance with NEI 97-06, Rev. 3 criteria is maintained with the installation of non-nickel banded TZ and tube support leak-limiting Alloy 800 sleeves for the repair of defective SG tubes at WBN Unit 2.

