



ELECTRIC POWER
RESEARCH INSTITUTE

SGTF/NRC Technical Meeting

October 28, 2020



Agenda

- Summary of Recently Issued SGMP Technical Reports
- Status of Industry Guidelines
- NEI 03-08 Deviations
- Interim Guidance
- Recent Operating Experience
- Lessons Learned From Lookback on Alloy 600TT Eddy Current Data
- Status of In-Plane Fluid Elastic Instability Project
- Status of AVB Mapping and Fatigue Analysis
- 180-Day Reporting Template

Summary of Recently Issued SGMP Technical Reports

Jim Benson, EPRI

PWR Heavy Water Reactor Secondary Side Filming

Product Application: Technical Assessment Program

Development Candidate Status and Recommended Compatibility Testing (3002015894) Sept 2019

- Building on EPRI's 2016 scoping study, this report represents the next stage in a series of technical assessments expected to culminate in a monitored plant demonstration of filming product addition in a nuclear unit.
- The report develops a detailed technical assessment program covering the important aspects of filming product use in the secondary systems of PWRs and pressurized heavy water reactors
- This document identifies the important technical issues, candidate assessment methods, and recommended minimum requirements supporting routine filming product use in fourteen technical areas.

Steam Generator Foreign Object Wear Estimation Model: Model Validation (3002015956) Dec 2019

- The objective of the work in this report is to test and validate a recent phenomenological model for estimating FO-induced tube wear in the TTS region of steam
- The model has been validated using FO-induced tube wear data obtained from a large number of plants with both triangular and square geometry tube arrays.
- The wear model provided a reasonably conservative estimate of FO wear times for nearly all cases analyzed.
- The model was shown to reproduce the wear-time trends observed for different FOs and different flow conditions.
- A comparison was also made between the phenomenological model and current EPRI prioritization

Considerations for Implementing Single-Pass Automated Data Analysis for Steam Generator Eddy Current Inspections (3002015984) Dec 2019

- Identifies the fundamentals of the steam generator eddy current automated data analysis process and provides a vocabulary of terms typically used.
- Technical solutions to address challenges posed by automated analysis—and, particularly by single-pass automated analysis—are identified and assessed.
- Processes prone to common mode failures when shared between redundant techniques, and the means to prevent these failures, are identified.
- The importance of identifying “significant” and “must detect” indications is recognized, along with the possible reasons for these indications not being reported.
- Data and conditions that may be challenging for the automated systems are discussed. Examples of eddy current signals and tube conditions that present different types and levels of challenges are provided, along with some solutions that may be implemented to mitigate challenges.
- Practical guidance and instructions are provided in the form of a list of tasks that can be performed in the preparation and implementation phases of the auto analysis system configuration process.

Steam Generator Thermal Performance Modelling Using Effectiveness Methods (3002015985) Dec 2019

- The objective of this work is to develop relationships to characterize thermal performance of recirculating U-tube steam generators and once-through steam generators using concepts of thermal effectiveness, which are extended from those of conventional single-phase heat exchangers.
- Parametric surveys are performed by using the newly developed relationships to show how the thermal effectiveness of UTSGs varies with different operating conditions or heat-transfer areas.
- The effects of various design features are also described to show how heat-transfer area changes to achieve the same operating conditions and thermal performance.
- An alternate method to calculate global fouling factors is developed, instead of the traditional methodology which is based on an approximate log-mean temperature difference that necessarily introduces uncertainty.
- Example calculations are performed using results of the parametric survey to show how limitations of the traditional global fouling factor methodology may be overcome using the alternate calculation method.

White Paper : Derivation of Equations for Primary-to-Secondary Leak Rate Measurements: A Supplement to the Primary-to-Secondary Leak Guidelines Chapter 5 (3002018663) June 2020

- All pressurized water reactors (PWRs) are required to monitor for Primary-to-Secondary Leakage and be able to measure leakage if detected.
- The primary method to measure all leakage is to determine the amount of a radioactive component in the secondary side and determine a leak rate based on corresponding activity in the primary side.
- This White Paper describes the derivation of simplified equations for leakage rates based on the relationship between the primary and secondary measured activity and other operational parameters of importance.
- The equations derived in this White Paper are presented in Chapter 5 of the Primary-to-Secondary Leak Guidelines for use by plants during operation.
- This White Paper is meant to document the derivations showing the effect of various simplifying assumptions as well as a resource for plant-specific evaluations in the case that one or more simplifying assumption has been challenged.

Online Polyacrylic Acid Dispersant Addition in PWRs: Investigation of Effects on Steam Generator Tube Deposits (3002018425) August 2020

- This report represents a continuation of research exploring the efficacy of polyacrylic acid (PAA) dispersant addition to pressurized water reactor (PWR) secondary systems in reducing the rate of deposit accumulation and heat-transfer fouling within steam generators (SGs).
- It builds on and extends technical analyses documented in EPRI's dispersant application sourcebook, report 1025317 (2012), and a follow-up field evaluations study, report 3002005416 (2015).

SGMP Guideline Status

Steve Brown, Entergy, SGMP Chair

SGMP Guidelines

Guideline Title	Current Rev #	Report #	Last Pub Date	Implementation Date(s)	Interim Guidance	Review Date	Comment
SG Integrity Assessment Guidelines	4	3002007571	June 2016	8/31/17	None	2020	Technical work on a revision will begin in 2020
EPRI SG In Situ Pressure Test Guidelines	5	3002007856	Nov 2016	8/31/17	None	2021	This review will consider tests completed since the last revision
PWR SG Examination Guidelines	8	3002007572	June 2016	8/31/17	Published 2019	2020	
PWR SG Primary-to-Secondary Leakage Guidelines	4	1022832	Sept 2011	4/11/2012 7/11/2012	None	2015	Planned publish date 2020

SGMP Guidelines

Guideline Title	Current Rev #	Report #	Last Pub Date	Implementation Date(s)	Interim Guidance	Review Date	Comments
Primary Water Chemistry Guidelines	7	3002000505	April 2014	1/28/2015		2021	Reviewed in 2019, but decided not to start a revision
Secondary Water Chemistry Guidelines	8	3002010645	Sept 2017	6/27/2018	Published in 2020	2021	

There are no active deviations to SGMP NEI 03-08 Guideline Requirements

Steam Generator Integrity Assessment Guidelines

Revision

- This guideline revision began this year with a scope review
- Scope in Review:
 - Review all NRC feedback comments on the guideline document
 - May result in additional guidance or justification
 - Review all recommendations to ensure they should not be changed to requirements
 - Add a section on in plane fluid elastic instability
 - Ensure guidance for accident-induced leakage performance criteria is clear and includes all aspects of the NRC's Regulatory Information Summary
 - Provide additional guidance for performing fully probabilistic assessments
 - Results of audit of feasibility studies for TSTF-577

Steam Generator Integrity Assessment Guidelines

Revision

- Scope in Review:
 - Include guidance for plants operating flexibly
 - Provide clarification on noise monitoring
 - Review Section 10, Secondary Side Maintenance
 - Potential new guidance for secondary side inspections and cleaning given longer primary side inspection intervals
 - Consider guidance for new plants

SGMP Letter for Examination Guidelines

- SGMP Letter has been drafted to highlight recent events at two A600TT plants
 - Indications of axial stress corrosion cracking
- Discussion later

Recent Operating Experience

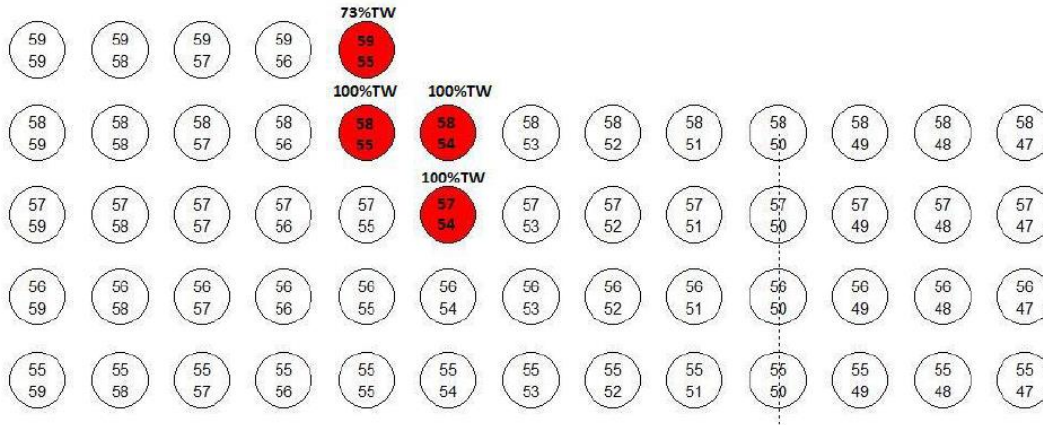
Lee Friant, Exelon, SGTf Chair

Primary-to-Secondary Leakage 600TT SG from Foreign Object

S/G 14
HOT
PRIMARY FACE

GROUP
LPW Indications

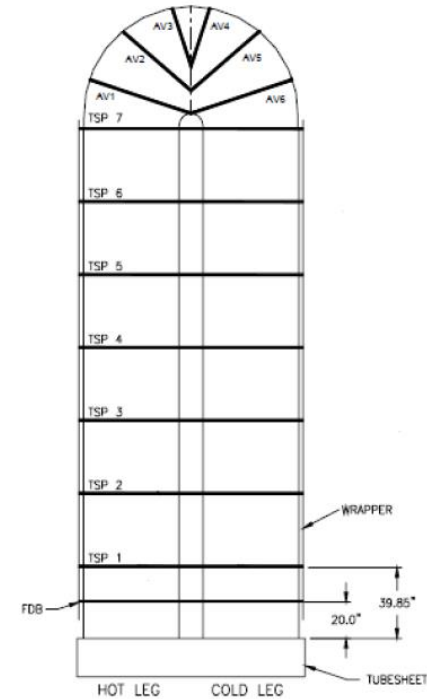
TUBES
4



SG	Tube Row-Col	Location	Sizing ETSS (Note 1)	1MCO27 %TW RPC	RPC Axial Length (inches)	RPC Circ Extent (Degrees)	Status
14	57-54	FBH +0.59	27904.1	100	0.32	98.3	Stabilized/Plugged
14	58-54	FBH +0.57	27901.1	100	0.38	94.9	Stabilized/Plugged
14	58-55	FBH +0.54	27901.1	100	0.40	94.9	Stabilized/Plugged
14	59-55	FBH +0.62	27904.1	73	0.24	73.3	Stabilized/Plugged

Notes:

- The ETSS identified for sizing was based off a review of all ECT and visual results of the tubes after the loose part was removed.

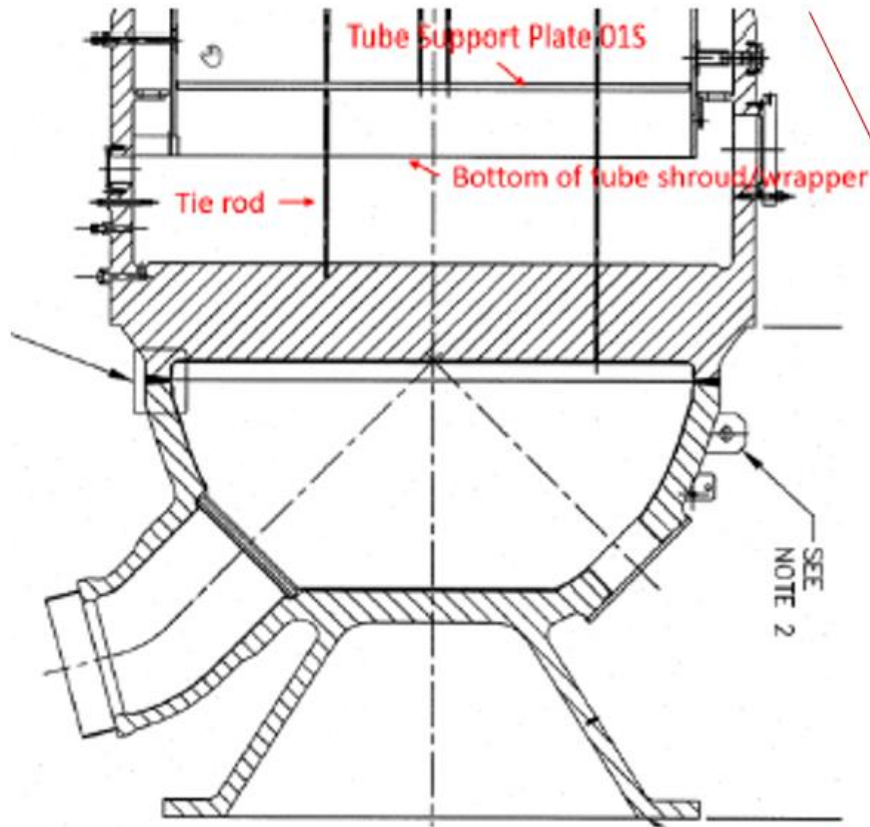


Note: FDB – Flow Distribution Baffle Plate (FBH is HL side)

Plant safely shut down, identified the tubes with wear, took the tubes out of service with plugging, and performed 100% inspection. The three tubes with 100% TW indications were in situ pressure tested. Only tube R57-C54 had any measured leakage. All indications met performance criteria

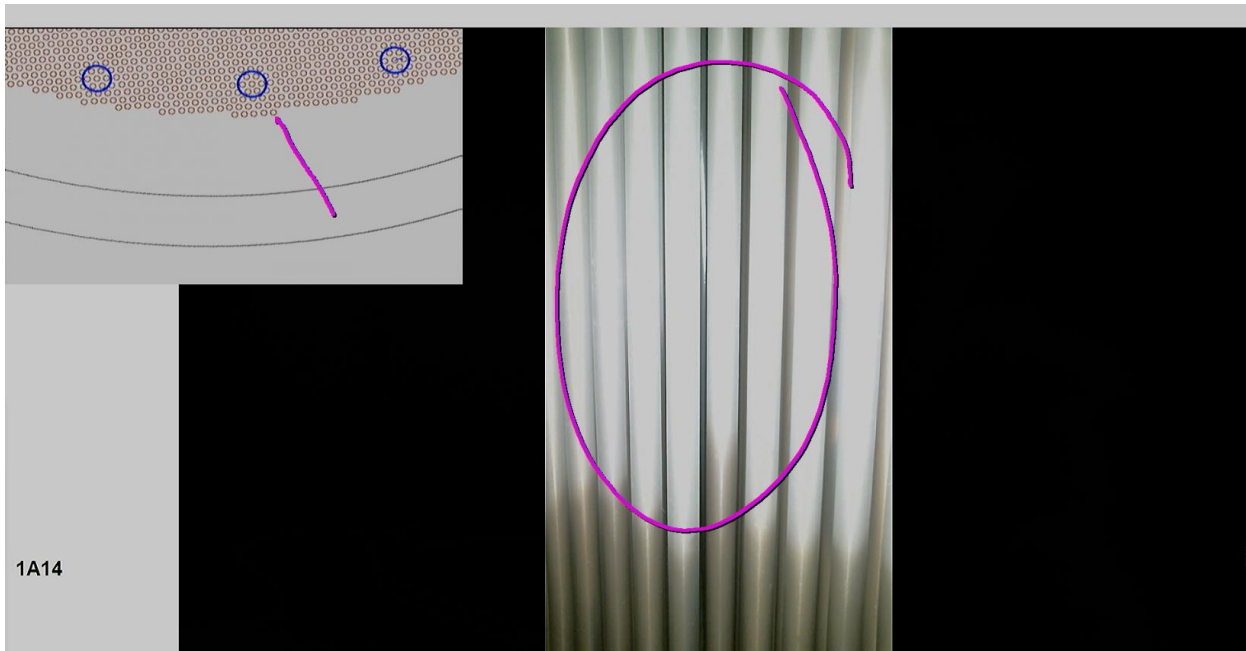
Tie Rod Bowing in Once Through Steam Generator

Tie Rod Location Schematic



- Proximity indications identified during bobbin exam
- Tubes tested with array
- No tube wear identified

Tie Rod Bowing in Once Through Steam Generator



- Visually confirmed
- Most likely cause is the tube support plate interaction with other SG structures caused compressive stresses (buckling) on tie rods during cooldown
- Root cause evaluation ongoing
- Plugged 143 tubes that would be in contact at normal operating temperature
- Operating interval limited to 1 fuel cycle

Lessons Learned from Lookback Data

Lessons Learned from Lookback Data

- To obtain growth data for Alloy 600TT operational assessments for feasibility studies, look back analysis was performed on all Alloy 600TT eddy current data
- Many of the crack-like indications had discernable signals in the past data, some with very little change
 - None of these signals represented challenges to tube integrity
- Actions are being taken by the industry to identify these types of signals earlier
- The industry views this as a training issue rather than a probe detection issue

SGMP Letter Regarding Determining Change in Historical Eddy Current Signals

- SGMP letter drafted
 - Intent of historical reviews in the Examination Guidelines
 - Will assist utilities and analysts recognize and appropriately disposition complex signals in relationship to changes in historical data
 - With emphasize when historical reviews are required, the source of the data utilized to perform these reviews should pertain to the plants PSI, first ISI, or first ISI recorded on optical disk and the use of only the immediately preceding inspections' data is not recommended
 - Recommend the use of new software tools, using eddy current historical data compare systems when performing historical indication reviews
 - Utilities should also take advantage of the enhanced probe technologies that are available (e.g., array probes, rotating probes) when dispositioning complex signals

SGMP Letter Regarding Determining Change in Historical Eddy Current Signals

- Additional training on complex signals
 - SGMP posted current and historical eddy current data from Alloy 600TT to epriq.com
 - This data can be incorporated to augment and strengthen site-specific performances demonstrations (SSPDs), helping analysts recognize complex signals in relationship to changes from historical data
- Case study re-analysis of one Alloy 600TT plant data using a historical data compare software
 - Most of the indications were discernable using the historical data compare software
- SGMP will revise ETSS 10013 and 24013 to include a flow chart giving guidance on reviewing dent signals based on “phase” analysis opposed to “voltage”
 - ETSS 10013 = Bobbin, ODS/CC in Dented TSPs Less Than or Equal to 5 Volts
 - ETSS 24013 = Bobbin, ODS/CC in Freespan Dings Less Than or Equal to 5 Volts
 - Some utilities have a 2.0 volt dent criteria pertaining to supplemental testing
 - The letter will have recommendations for all dent voltages

SGMP Letter Regarding Determining Change in Historical Eddy Current Signals

- The issue of dent/crack combination which creates a complex signal that can be misinterpreted or mischaracterized during outages can be resolved
 - With additional analyst training, implementation of the revised detection flowcharts, and implementation of current probe and software technologies could significantly improve the overall detection capabilities, thus avoiding an inspection transient or the potential for performance criteria challenging indications to be reported at future inspections

Status of In Plane Fluid Elastic Instability

Helen Cothron, EPRI

Status of In Plane Fluid Elastic Instability Project

- Director of Engineering, Nuclear Regulatory Commission issued a letter to SGMP's Executive Sponsor August 13, 2014
 - Noted that the events at San Onofre raise issues that could affect operating steam generators
 - Requested the industry to discuss specific actions planned or taken to address in plane fluid elastic instability
- SGMP conducted tests to better understand the phenomenon and documented the results in two SGMP technical reports
- SGMP followed research being conducted world-wide
- With this information, SGMP, along with an expert panel developed a survey to determine the susceptibility of the US operating fleet

Survey Results

- Feedback from this survey indicated that utilities did not have all the information requested and some of it was proprietary to their steam generator design organization
- SGMP started a project in 2019 and requested US NSSS steam generator design organizations to complete the survey for their fleet
- This work was completed in 2020 and letters have been sent to US SGMP members
- No operating plant in the US is susceptible to in plane fluid elastic instability
- SGMP participated on an ASME Subcommittee that developed language for Section III, Appendix N to make designers aware of this operating experience
 - This should ensure future designs include protection from this phenomenon
- The industry considers this issue closed

Update on AVB Mapping and Fatigue Analysis

Helen Cothron, EPRI

Anti-Vibration Bar Mapping and Fatigue Analyses

- Westinghouse published NSAL 12-7, “Insufficient Insertion of Anti Vibration Bars in Alloy 600TT Steam Generators with Quatrefoil Tube Support Plates”
 - Concluded that it is judged that the worst-case consequence of this issue does not result in a Substantial Safety Hazard
- SGMP conducted research to provide generic fatigue analysis that could be used for site-specific work
 - Model F work completed in 2013
 - Model D5 technical work was completed in 2014
 - Model 44F and 51F work was completed in 2015
- Plants with susceptible SGs were investigating the insertion depths of AVBs
 - They needed generic work to be completed prior to the site-specific analysis
- The last time we reported on this issue there were two plants that needed to do the mapping
 - These two have since completed the work

180-Day Reporting Template See Word Document

Public / NRC Comments

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