Steam Generator Task Force / NRC

Technical Meeting

October 7, 2021

Agenda for Open Meeting

1:00	Introductions	All Participants
1:10	Opening Remarks	NRC and Industry
1:15	Standard Agenda Items	
	Summary of Recently Published EPRI Reports	
	Status of Industry Guidelines	
	Interim Guidance	
	NEI 03-08 Deviations	
	Recent Operating Experience	

Agenda for Open Meeting (cont)

2:15	Industry Adoption of TSTF-577 Enhanced Probe Inspections	Industry
2:25	Dents/Dings Definitions	NRC / Industry
2:35	NUREG 2191	NRC / Industry
2:45	Address Public Questions/Comments	NRC

Summary of Recently Published EPRI Reports

Brent Capell / Jim Benson, EPRI

EPRI Developed Process for Sharing Information with the NRC

- EPRI Staff should follow (in order) the methods when asked to share EPRI published products with the NRC.

1. Reading Room – Share the product with the NRC as Read Only (Preferred option)
2. Order Center Distribution – Share public material
3. Order Center Distribution – Share the proprietary product only, affidavit is required
4. Order Center Distribution – Share the Proprietary product **and** a Non-proprietary version, affidavit is required
    - When this method is used, the proprietary version goes to the NRC Project Manager and EPRI provides a redacted non-proprietary version (*containing only the product cover page and abstract*) to be placed in ADAMS for public viewing.

Hydrazine Alternatives for the PWR Secondary Side System: Carbohydrazide for Operational Use and SG Layup with No Oxygen Scavenger (3002020980), July 2021

- Hydrazine is a known carcinogen and EPRI is investigating alternatives
- This report discusses the following two different alternatives to the use of hydrazine:
  - Carbohydrazide use in the secondary system during power operations
  - Elevated pH with no oxygen scavenger during wet layup of steam generators
- Use considerations discussed in report include: procurement and handling issues, modeling and control issues, system compatibility, decomposition, corrosion, and interaction with other treatment chemicals.
- The results will be incorporated in the next revision of EPRI Secondary Water Chemistry Guidelines
  - Hydrazine alternatives are currently allowed with utility qualification

Several Documents Published Regarding Primary to Secondary Leak

- SGMP Primary-to-Secondary Leak Guidelines, Rev 5 (3002018267), December 2020
  - This was provided to the NRC staff
- Estimating Probability of Burst at In Situ Pressure Test Conditions as a Function of Measured Primary-to-Secondary Leakage (3002018269) December 2020
  - Not for integrity assessments, only provides relative risk discussion
- Primary-to-Secondary Leak Playbook (3002018271) December 2020
  - Address topics outside Primary to Secondary Leak Guidelines such as very low leakage (<5 gpd) or outage planning
- Use of Fluorine-18 for Primary-to-Secondary Leak Rate Measurement (3002018662) November 2020
  - Use is not required, only an alternative
- Primary-to-Secondary Leak Detection Limits for a Condenser Off Gas Rad Monitor System (3002019973) November 2020
  - Discussions to help utilities demonstrate condenser off gas monitor compliance to requirements

Simulation Model for Eddy Current SG Inspection – Model Validation (3002013010) December 2020

- The objective of this project is to develop a software tool that is capable of accurately simulating signals representing SG eddy current inspection data from various SG tube geometries, eddy current coil configurations, and tube degradation mechanisms.
- This report presents the formulation of the computational model and the results of a simulation software tool, including a comparison of simulated eddy current data with acquired data.
  - Describes features of the user interface
- The model was shown to be capable of predicting the signals generated by commercial SG eddy current probes for various tube flaws.

Two Reports Were Published to Provide Technical Bases for Longer Inspection Intervals for Alloy 600TT Tubing

- Both reports were subject of 2020 NRC audit
  - NRC's comments were incorporated
- Extended Inspection Interval Analyses for Axial ODSCC at TSP Intersections on High Residual Stress Tubes for SGs with Alloy 600TT Tubing (3002019984) November 2020
- Feasibility Study for Multi-cycle 600TT Operational Assessments (3002018258) November 2020

Status of Industry Guidelines
Helen Cothron / Brent Capell / Rich Guill, EPRI

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		Rev 5 in Endorsement Process
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 and 2021		Revision in progress
PWR SG Primary-to-Secondary Leakage Guidelines	5	3002018267	Dec 2020	12/22/2021	None	2024	

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		2023	Reviewed in 2021, decided not to start a revision
Secondary Water Chemistry Guidelines	8	3002010645	Sept 2017	6/27/2018	Published in 2019 and 2020	2023	Reviewed in 2021, decided not to start a revision

No active deviations

Interim Guidance Secondary Water Chemistry Guidelines

- IG issued in February 2020 in letter SGMP-20-03
- IG allows use of alternate measurement method for dispersant concentration to verify concentration does not exceed allowed value
- Instead of direct dispersant measurement, plants can develop correlation between steam generator blowdown cation conductivity and dispersant concentration
- Allowed method simplifies plant operation
- Conductivity provides adequate understanding of dispersant concentration

Interim Guidance Examination Guidelines

- In support of TSTF 577, Interim Guidance SGMP-21-02 was published in September 2021 to address two issues:
  - The expectation to analyze 100% of all acquired data
  - Provide guidance for using single-pass automated data analysis for the Alloy 600TT fleet when employing enhanced probes (e.g., array or MRPC)
    - Reduces the labor burden needed to analyze full-length array data

Interim Guidance

- **Discussion:**
  - Section 6.3.3 (Data Analysis Process) lacked clear guidance pertaining to the industry and regulatory expectation that 100% of all acquired eddy current data be analyzed in accordance with the Examination Guidelines
    - This was revised to a “shall” requirement, and that all acquired data required by Technical Specifications and the Degradation Assessment is analyzed

- **Discussion:**
  - Section 6.3.3.2 excluded the ability of tubing alloys that had experienced service-induced cracking from employing a multiple algorithm single integrated automated analysis process, it became necessary to allow the application of the process for those plant(s) electing to utilize enhanced probes allowed by TSTF-577
    - Provides a defense in depth using multiple techniques (array/bobbin or MRPC/bobbin) employing multiple algorithms for each technique

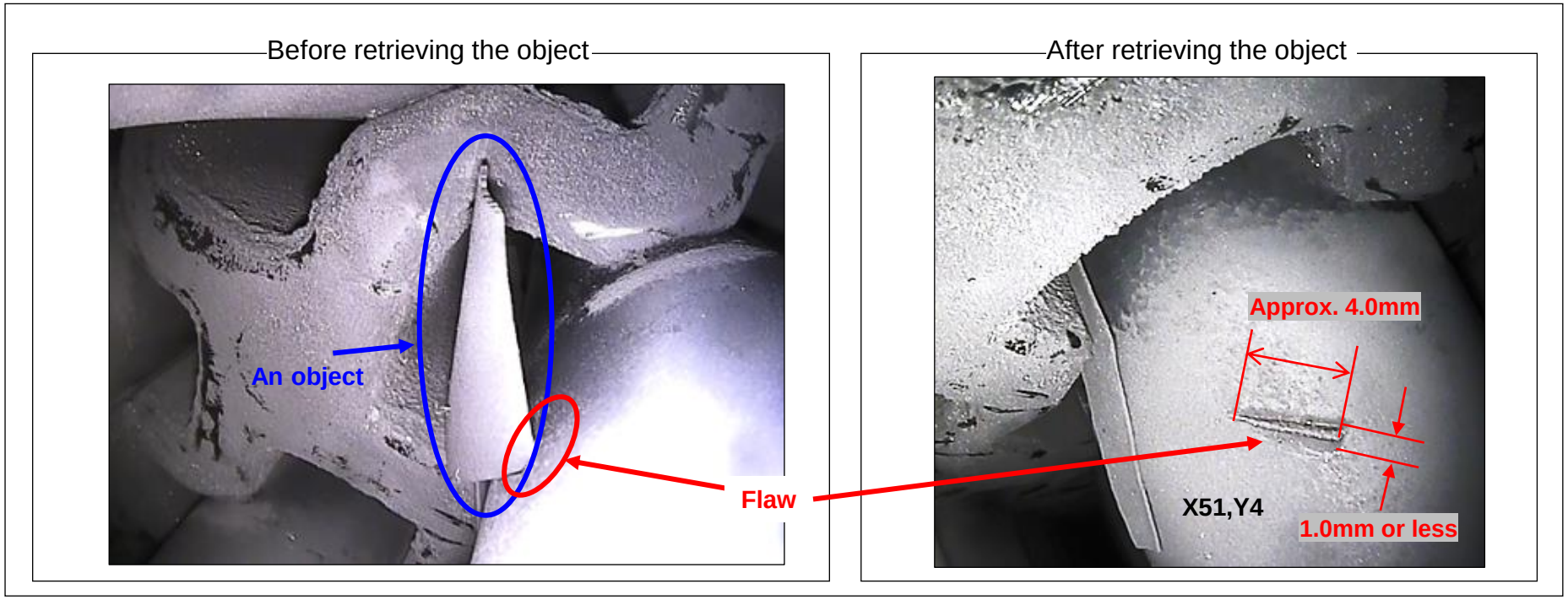
Recent Operating Experience
Jim Benson / Brent Capell, EPRI

International SG Operating Experience

- Plant Details
  - Commercial operation began in mid-1980s
  - 600 TT SG tubes
  - No chemical cleaning performed to date
- Eddy current testing identified indications on 4 tubes
  - One tube in SG-A and three tubes in SG-C, suspected to be wear initiating on the tube OD
    - All 4 indications were adjacent to 3rd TSP
    - SG-A tube flaw depth by ECT: 33%TW
    - SG-C tube flaw depth by ECT: 25%TW, 32%TW, 36%TW

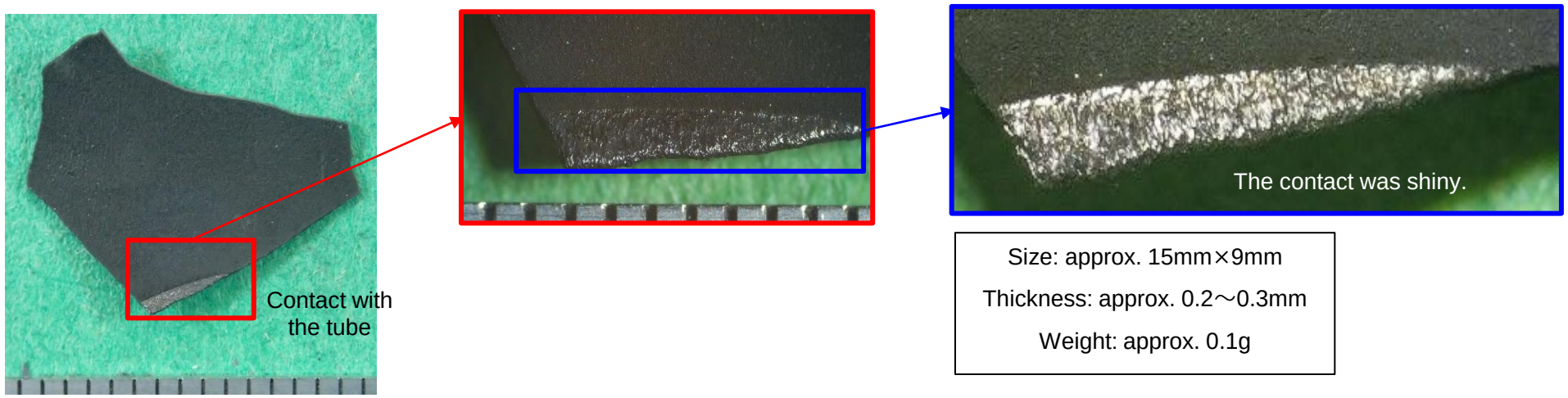
Event Description

- The affected SG tubes were visually inspected using a compact camera applied from the secondary side
  - Wear on the tube OD was observed.
  - Wear scar lengths ranged from 2 to 7 mm (0.08” to 0.28”)



Analytical Results of the Retrieved Object

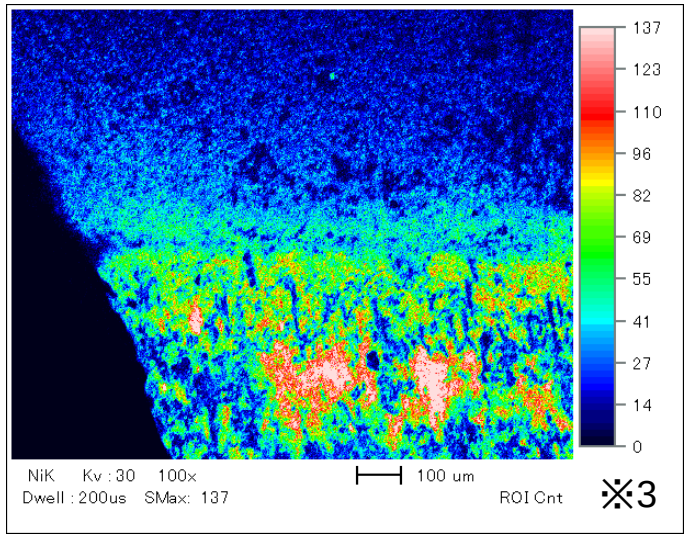
- An object was identified near the location of the eddy current indications on the affected tube in SG-A
  - The object was retrieved
  - A shiny area of the object was evidence of the object-to-tube contact location
  - Radius measurement of the object revealed that the object had a curved shape closely matching the curvature of the tube OD



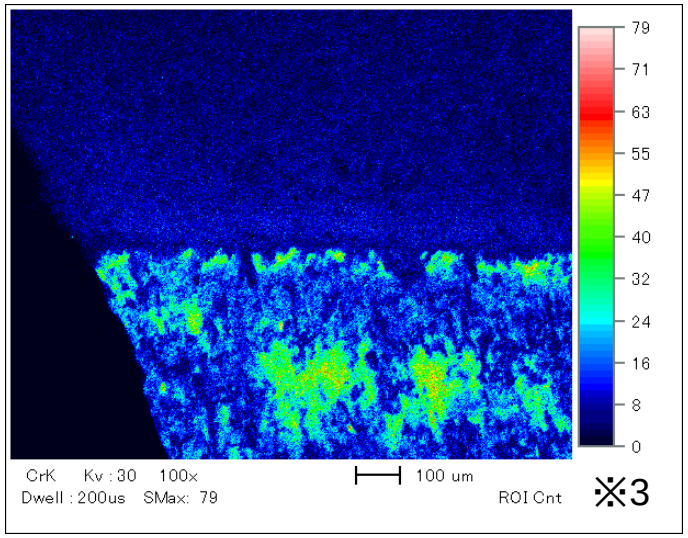
Analytical Results of the Retrieved Object

- Chemical composition analysis was performed on the object from SG-A
  - The main constituent was ferric oxide (i.e., magnetite), the object was suspected to be tube scale
  - Chemical composition analysis of the contact surface (corner) detected **nickel and chromium** components, which constitute the base metals of the tube.

【Ni】



【Cr】



Investigation of Scale Properties

- Tube deposit scales were retrieved from above the 1st and 2nd TSP inside SG-C for analysis.
  - Similar to SG-A, the SG-C scales had traces of contact and detected **nickel and chromium**.
- All cases of SG tube wear are suspected to have been caused by OD deposit tube scale that spalled off the tube

Summary

- One international PWR identified hard, dense scale that had spalled off the SG tubes and apparently resulted in tube wear
- The SGMP has been communicating with the utility and has informed SGMP member utilities of the operating experience
- Through continued discussions with the utility, EPRI hopes to learn additional details of the mechanism leading to dense scale formation and tube wear so that other utilities can consider if it could be a potential mechanism at their plants
- The SGMP is also considering performing research to improve our knowledge of the wear mechanism and its relevance to the industry

International Operating Experience

- One international PHWR identified significant flow accelerated corrosion of the primary moisture separators
- 10 pieces of material from the separators were identified on the top of the tubesheet in one steam generator
- The Cr content of one of the pieces retrieved was measured at 0.035% wt%
  - In spec for A569 carbon steel but not resistant to flow accelerated corrosion
- This operating experience has been reviewed by the SGMP

Industry Adoption of TSTF-577
Lee Friant, Exelon

Industry Adoption of TSTF-577

- Status of TSTF-577 LARs based on recent informal survey
  - 29 units/17 plants/10 utilities have already submitted
  - 4 units/3 plants/3 utilities have plans to submit this year
  - 18 units/11 plants/7 utilities have plans to submit in 2022
  - The remainder will be later than 2022 or will not submit
- Some of the 600TT fleet are planning or considering inspecting full length with advanced probes

Dents/Dings Definition
Bill Cullen, EPRI

Definition of Dents and Dings

- Definition from the Examination Guidelines and the Integrity Assessment Guidelines
  - Dent
    - A local reduction (plastic deformation) in the tube diameter due to corrosion products from carbon steel.
  - Ding
    - A local reduction (plastic deformation) in the tube diameter caused by manufacturing, support plate shifting, vibration, or other mechanical means.
- For inspection purposes, the technique and analysis methods are driven by the location of the deformation
  - Eddy current detects the reduction in the tubing diameter

NUREG 2191
Lee Friant, Exelon

NUREG 2191

- In NUREG 2191, Section XI.M19 STEAM GENERATORS, Under paragraph 3, Parameters Monitored or Inspected, and in Table X1-01, FSAR Supplemental Summaries for GALL-SLR Report Chapter XI Aging Management Programs, the following requirement does not align with TSTF-577 primary side inspection frequencies and doesn't exclude material that are not susceptible to SCC

  > "In summary, the NEI 97-06 program provides guidance on parameters to be monitored or inspected except for steam generator divider plate assemblies, tube-to-tubesheet welds, heads (channel or lower/upper heads), and tubesheets. For these latter components, visual inspections are performed at least every 72 effective full power months or every third refueling outage, whichever results in more frequent inspections. These inspections of the steam generator head interior surfaces including the divider plate are intended to identify signs that cracking or loss of material may be occurring (e.g., through identification of rust stains)."

Supplement to NUREG 1801 – LR-ISG-2016

- For plants that applied for license renewal after this interim staff guidance, the same requirement that visual inspections are performed at least every 72 effective full power months or every third refueling outage, whichever results in more frequent inspections
- The interim staff guidance is specific to steam generators with susceptible materials
- Industry thinks the best way to handle this is with interim staff guidance

Acronyms

- GALL – Generic aging lessons learned
- IG – Interim guidance
- ISG – Interim staff guidance
- LARs – License amendment requests
- MRPC – Motorized rotating pancake coil
- NEI – Nuclear Energy Institute
- NUREG – NRC Publication (Nuclear Regulatory)
- OD – Outer diameter
- ODSCC – Outside diameter stress corrosion cracking
- PHWR – Pressurized heavy water reactor
- PWR – Pressurized water reactor

Acronyms

- SCC – Stress corrosion cracking
- SG – Steam generator
- SGMP – Steam Generator Management Program
- SLR – Subsequent license renewal
- TSP – Tube support plate
- TSTF – Technical Specification Task Force
- TT – Thermally treated
- TW – Through wall

NRC Address Public Questions/Comments