Steam Generator Task Force/NRC Meeting

September 8, 2022

Open Meeting Agenda

1:00	Introductions	All Participants
1:10	Opening Remarks	NRC and Industry
1:15	Standard Agenda Items	Industry
	Recently Published EPRI Reports	
	Status of Industry Guidelines	
	Appendix N Ongoing Work	
	Interim Guidance	
	NEI 03-08 Deviations	
	Recent Operating Experience	
	ENSA Tube Samples Status	
	Transfer Function From +Point to Array Voltage	

Open Meeting Agenda

2:15	Steam Generator Tube Inspection Report Initial feedback on Appendix G Implementation	NRC
2:30	Address Public Comments/Questions	NRC
2:40	Adjourn Open Meeting	

Summary of Recently Published EPRI Reports
Helen Cothron

Steam Generator Performance and Reliability Database, 3002020907, May 2022

- Describes the development of the database, which will provide a single database for PWR plants to upload SG performance data for comparison to other plants as well as for research purposes.
- The report presents an initial structure including the types of information and a starting set of data covering ten plants which are currently included in a pre-release beta version available only to EPRI staff. Future versions of the SG-PAR will expand access to the database software.

Effect of Organic Acids on Steam Turbine Materials: Crack Growth Rate Testing, 3002020930, July 2022

- This is the second and final study of how the use of amines as pH control agents affect steam turbines
- This study measured crack growth rates of a sample of low-pressure turbine rotor steel, supplied by a turbine vendor, in a solution with acetate and formate concentrations calculated to bound, by at least an order of magnitude, the concentrations that could develop in PWR steam turbines
- The results showed that the presence of acetate and formate did not significantly increase the fatigue crack growth rate of the steel that was tested.
- This work, along with previous work, will be used to develop recommendations/guidance for consideration by the Secondary Water Chemistry Guidelines Committee.

Hydrazine Alternatives: DEHA Decomposition and Deaeration Kinetics, 3002023967, Aug 2022

- If Diethylhydroxylamine (DEHA) is to be used on the secondary side of PWRs, its reaction kinetics need to be well understood.
- This testing expanded the industry's understanding by establishing a rate law and determining reaction kinetic constants for DEHA's thermal decomposition and its reaction with oxygen.
- Utility personnel investigating the use of DEHA can use these results to determine the concentration of DEHA needed to reduce the concentration of oxygen along the feedwater (FW) train

Status of Industry Guidelines
Lee Friant

Guideline Title	Current Rev #	Report #	Last Pub Date	Implementation Date(s)	Interim Guidance	Review Date	Comment
SG Integrity Assessment Guidelines	5	3002020909	Dec 2021	1/20/23	None	2025	
EPRI SG In Situ Pressure Test Guidelines	5	3002007856	Nov 2016	8/31/17	None	2023	2022 review determined no need for revision. Information Letter sent to SGMP with additional data
PWR SG Examination Guidelines	8	3002007572	June 2016	8/31/17	Published 2019 and 2021		Revision in progress – Scheduled to be complete in 2024
PWR SG Primary-to-Secondary Leakage Guidelines	5	3002018267	Dec 2020	12/22/2021	None	2024	

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

There are no deviations to the NEI 03-08 requirements in these guidelines
No interim guidance issued since the last meeting

Appendix N "Noise Measurement and Monitoring"

- **Targeted Updates being Considered**
  - Additional prescriptive guidance pertaining to:
    - Filters (spike, median)
    - Measurements (average vs maximum) (Vpp vs Vmx for PWSCC)
    - Window and increment sizes at support structures/TTS
    - Outliers
    - Vendor software variance
    - Consistent guidance from industry tube integrity engineers
    - Evaluating the need for noise monitoring for Alloy 690 tubing

Recent Operating Experience
Bill Cullen

Topics

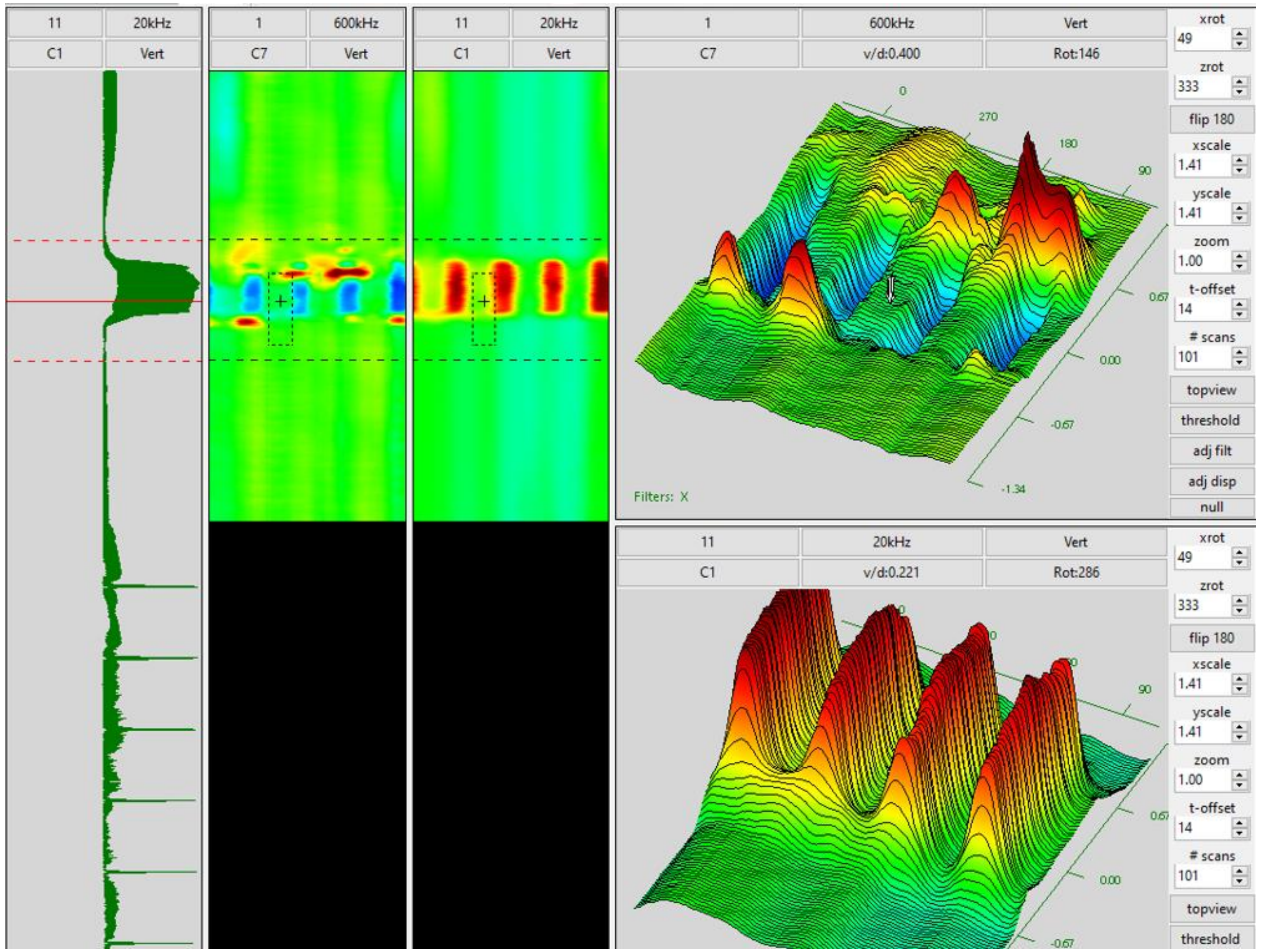
- Why does ODSCC form on freespan dings?
- Ding crack analysis primer – how can axial ODSCC in dings be mischaracterized as PWSCC?
- Recent U-bend ding crack experiences
- Judgments regarding SCC susceptibility in small radius A600TT bends

Axial ODSCC on Dings and Dents (SS TSPs)

- Freespan dings and dents at stainless steel quatrefoil TSPs are basically a large, localized noise component
- The +Pt phase angle of the noise is key to understanding how SCC signals will combine with this noise to form a resultant signal
- Recent EPRI work indicates that most of the freespan dings in A600TT plants are artifacts of the tube insertion process and interaction with the TSP
- Thus, freespan dings and dents will display similar ODSCC initiation rates as the residual stresses will be similar
- PWSCC at dings and dents is not likely to occur – an artifact of hysteresis from the forming of the ding/dent

Axial ODSCC on Dings and Dents (SS TSPs)

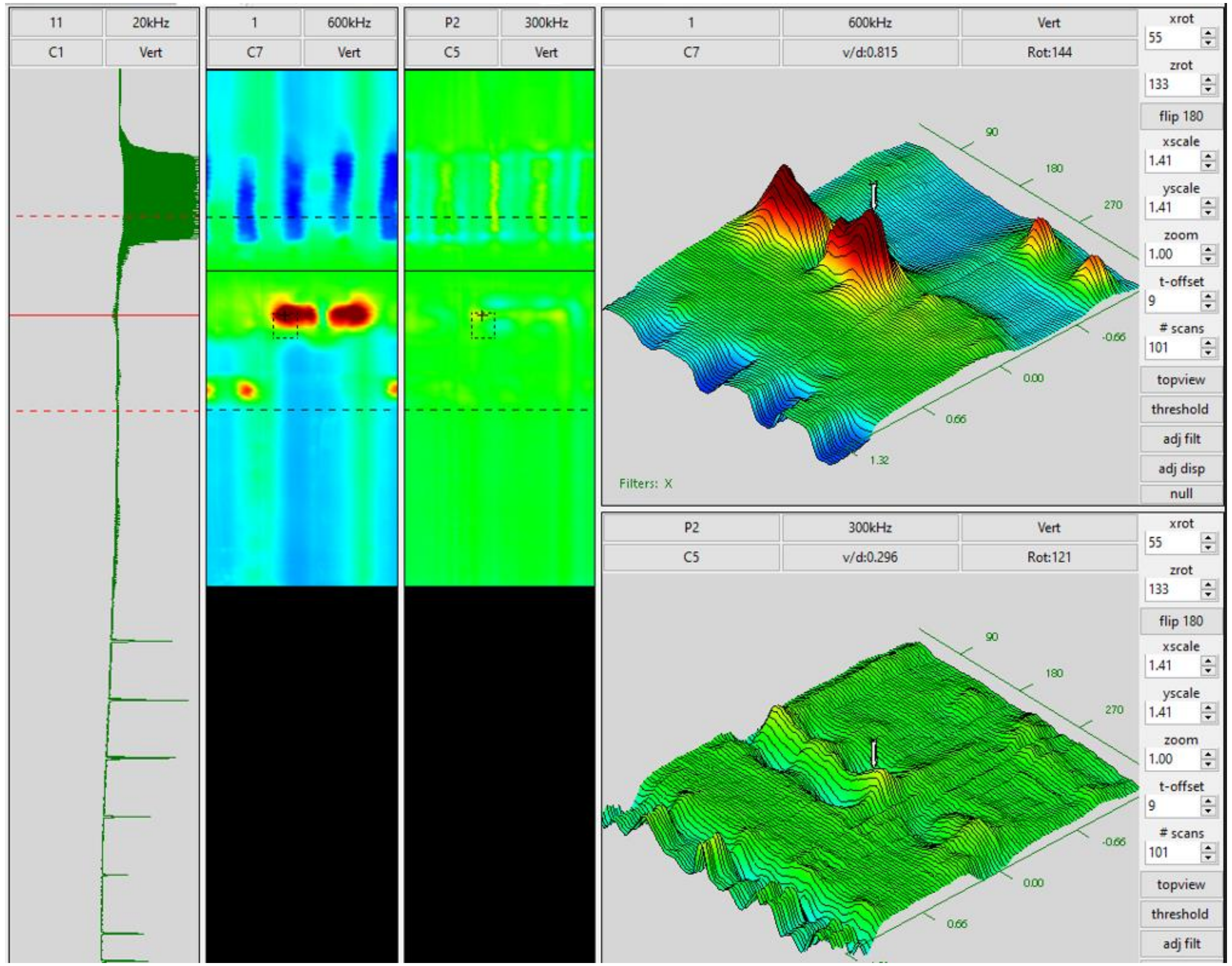
- Example of dents at quatrefoil TSP



Note the dents are aligned with TSP contact land

Axial ODSCC on Dings and Dents (SS TSPs)

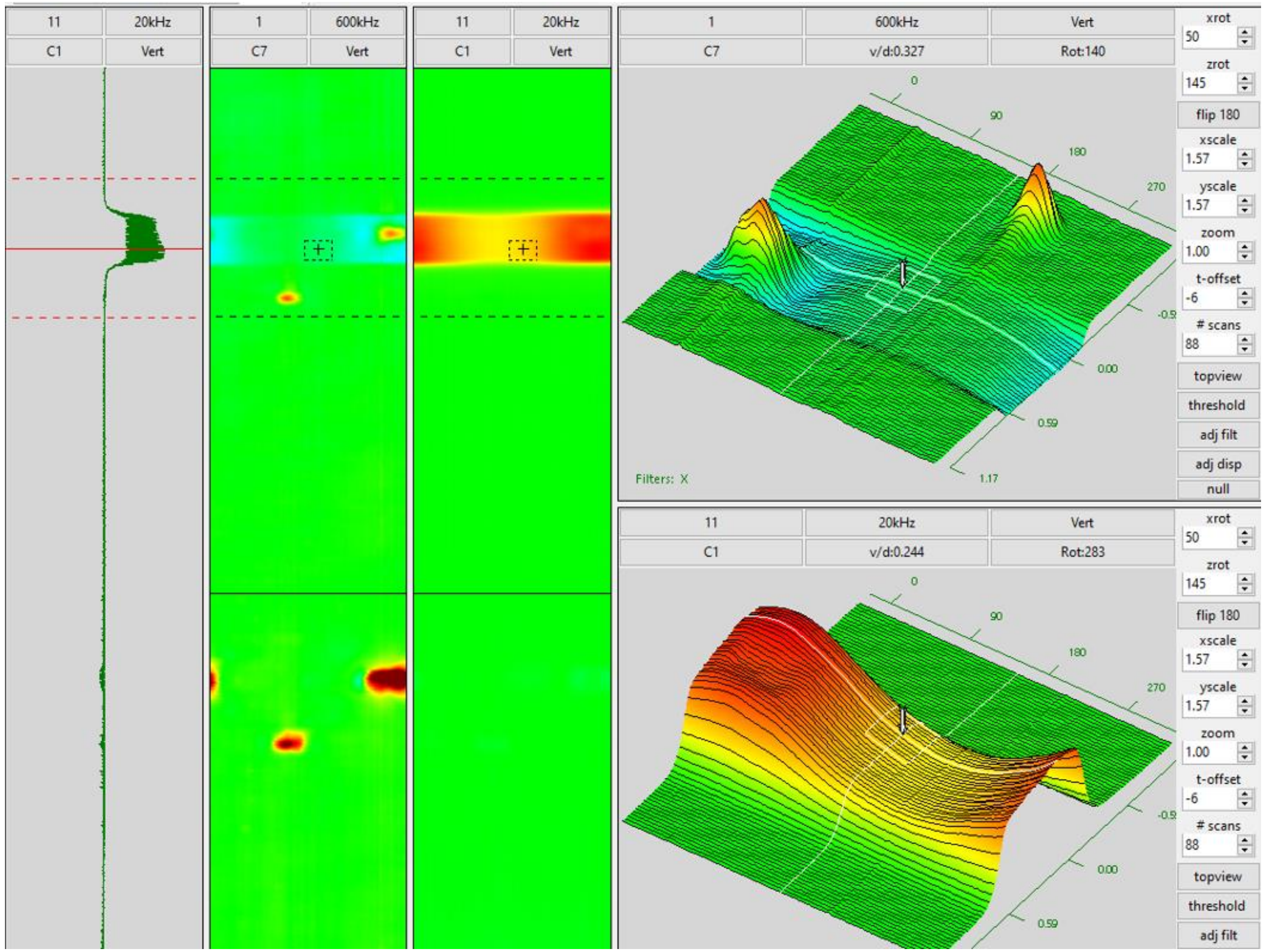
- Example of freespan dings (same plant)



Dings are aligned with the TSP contact lands with spacing coincident with TSP geometry

Axial ODSCC on Dings and Dents (SS TSPs)

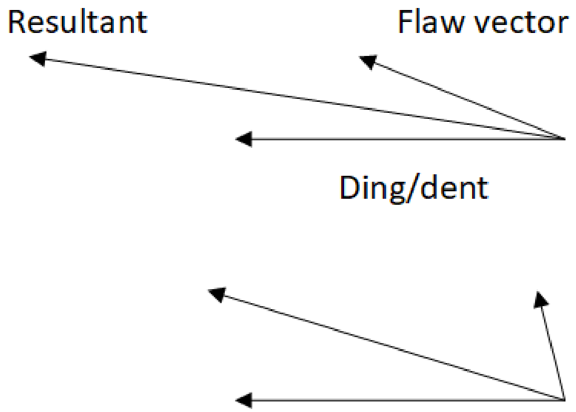
- Dents at FDB (drilled hole or octafoil design) can be generated from TSP interaction at a higher location during insertion
- Due to the tube/TSP engagement above, it is nearly impossible to get the required tube deflection at the FDB to introduce the dent during insertion
- This doesn't apply to all FDB dents, some may be due to misalignment of the FDB tube hole



Ding angular spacing and axial spacing consistent with TSP geometry

Axial ODSCC on Dings and Dents (SS TSPs)

- The +Pt residual signal resides at approximately 0 degrees phase
- Simple vector addition can be used to illustrate how an ODSCC signal when combined with the ding/dent residual can produce resultant signals in the ID plane
- For equal depth ODSCC, the larger the ding, more phase suppression and the smaller the ding, less phase suppression
- If PWSCC is present, the resultant amplitude should be significantly larger than the non-flawed residual; this is not observed on in situ flaws

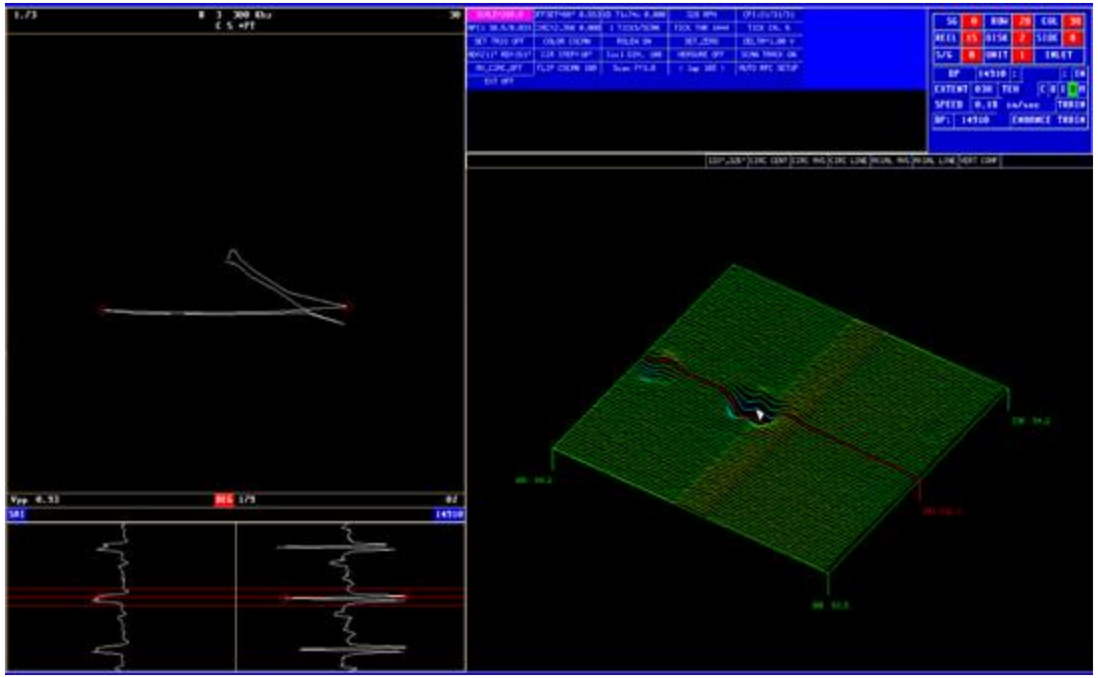


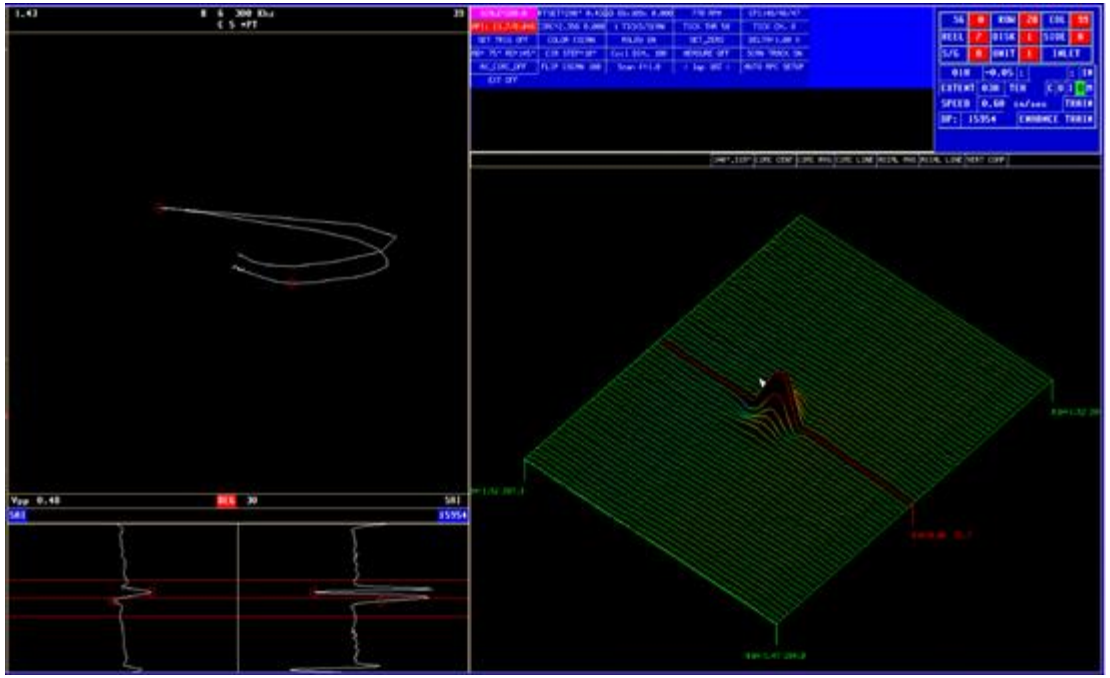
Note these are approximations, real ECT signals are rarely characterized by a linear vector

Top: 60%TW PWSCC on 1.5V ding. Bottom: 60%TW ODSCC on 1.5V ding

Doped Steam Axial ODSCC at Freespan Ding (ETSS 24013)

- Lab sample BOQ-28-02: 4.6V ding, 78%TW (DE), 0.23 inch long
- Pre-crack and post-crack +Pt graphics

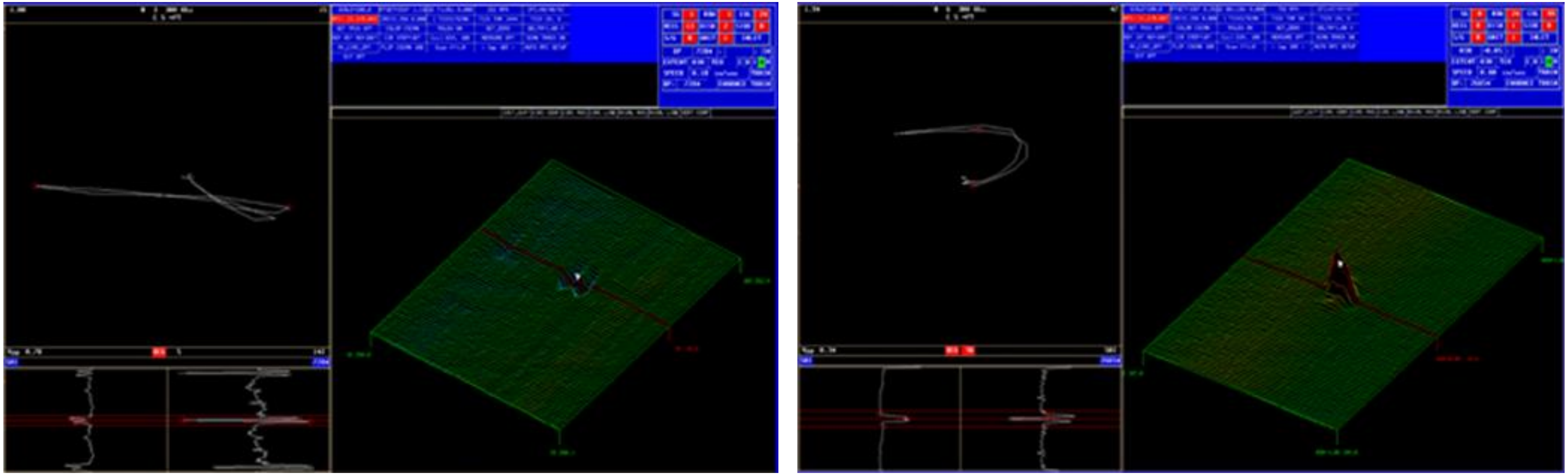




Post crack condition more resembles a PWSCC response. Nearly identical flaw parameters as the following example but larger ding, more phase suppression

Doped Steam Axial ODSCC at Freespan Ding (ETSS 24013)

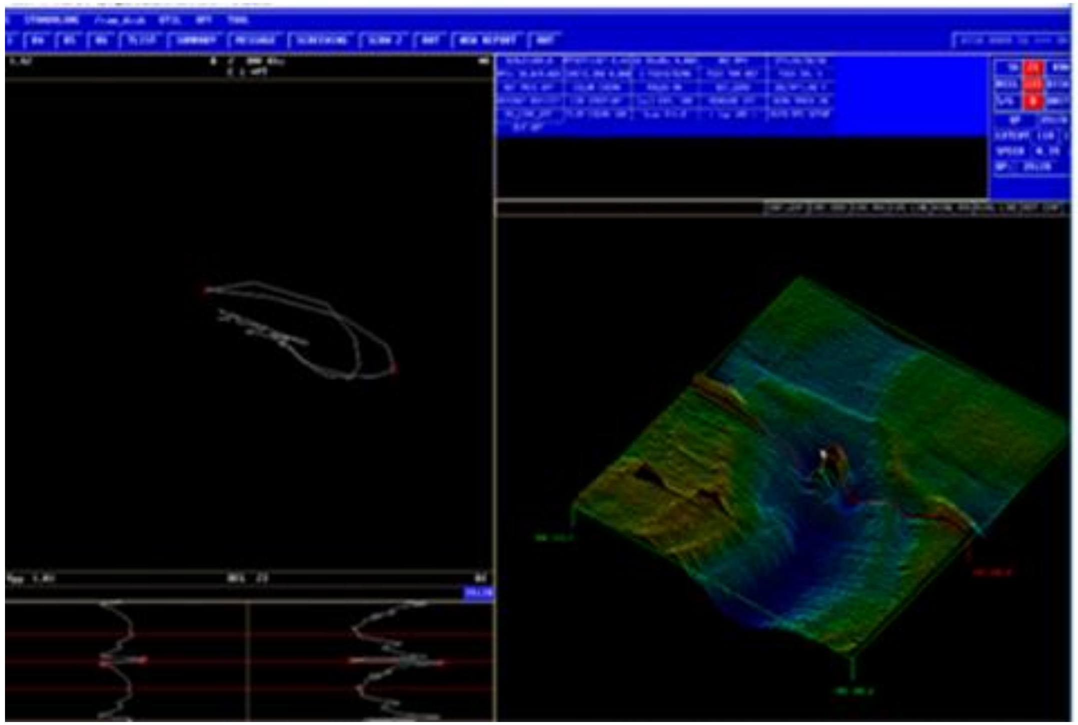
- Lab sample BOQ-24-01: 2.4V ding, 78%TW (DE), 0.25 inch long
- Pre-crack and post-crack +Pt graphic

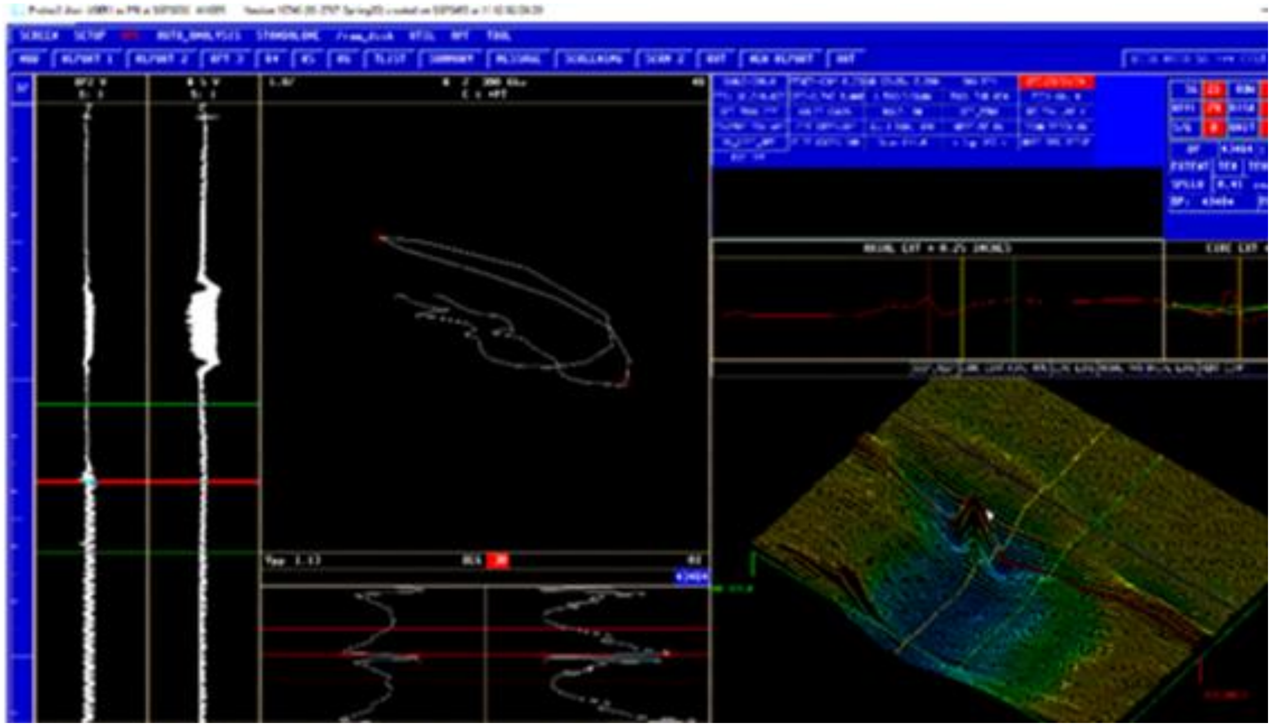


Note the phase suppression and unique Lissajous shape

Recent U-bend SCC Experience

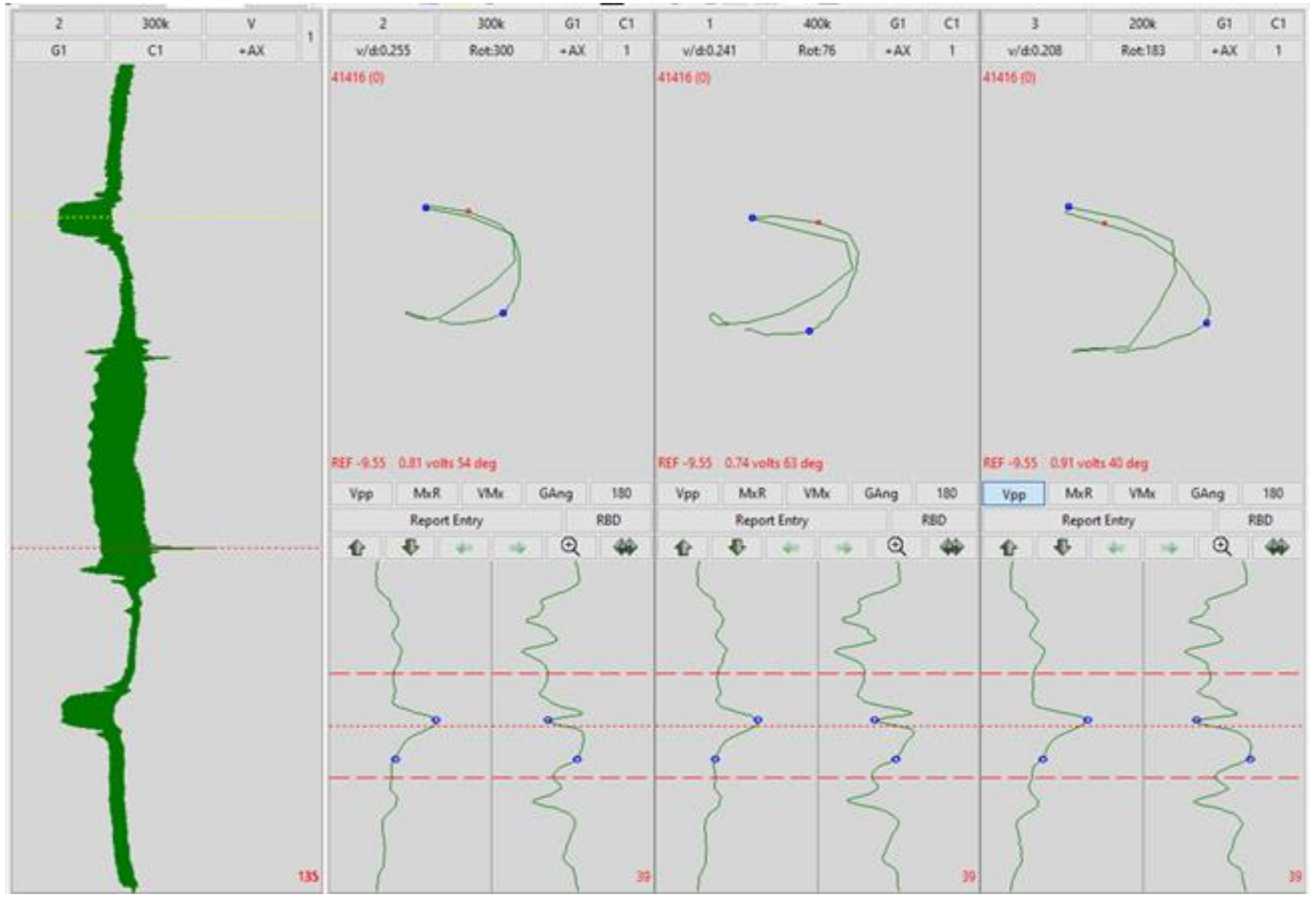
- Model D5 plant, Row 1 U-bend, axial ODSCC at 6 to 7V ding, on intrados, about 1 inch above bend tangent, in-line with TSP quatrefoil contact land
- Data Union simulation on left, plant signal on right





Recent U-bend SCC Experience

- Model 44F SG, Row 1 U-bend, axial ODSCC at ~4V ding, on intrados, about 1 inch above bend tangent, in-line with TSP contact land
- Smaller ding, lesser phase suppression
- Common factors for both plants: dings in U-bend, located on intrados, aligned with TSP contact land, located ~1 inch above bend tangent



Is PWSCC of an A600TT Small Radius U-bend Likely?

- A600TT has enhanced PWSCC resistance compared to A600MA
- The first 8 to 10 rows of U-bends (and some of straight length) received a post-bend stress relief designed to reduce residual stresses to near straight leg levels
  - This level does not support SCC initiation
- Therefore, SCC of a stress relieved U-bend without an additional stress riser is not a likely event
- Anecdotal historic information suggests that Row 1 and 2 tube insertion was problematic with cases of overinsertion resulting in the U-bend contacting the top TSP, creating the ding on intrados

Improved material + post bend stress relief = negligible SCC potential

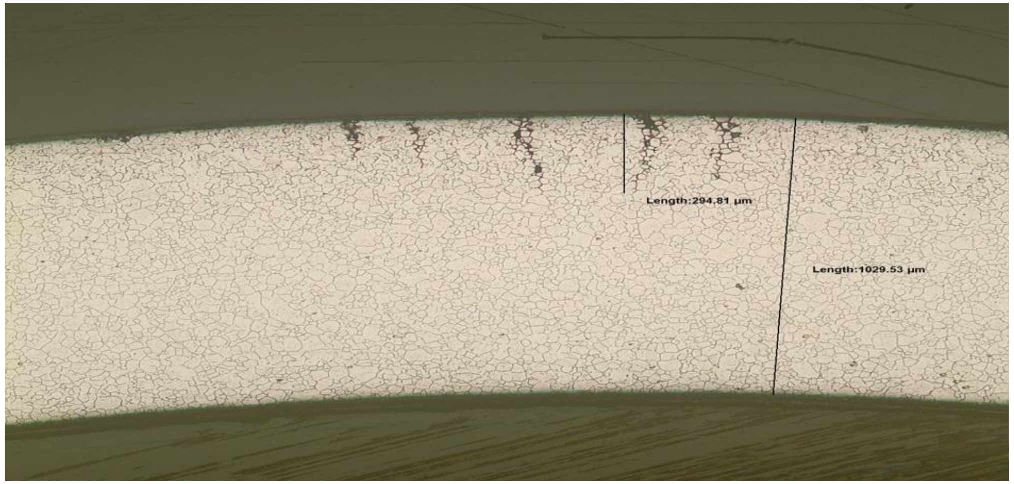
Historic A600TT U-bend “PWSCC” Experience

- In 2009, an axial PWSCC was reported on a Row 1 tube at a plant with A600TT tubing
- Given the recent U-bend experiences, EPRI has performed some preliminary investigations of this indication
- Suggests this is another example of axial ODSCC at a ding
  - About 1 inch above bend tangent, on intrados, large ding (9 to 10V)
  - Vector addition does not support the historical progression of the flaw parameters as PWSCC
  - Amplitude change and phase rotation are not large enough to support PWSCC as the mechanism
- Additional investigation is planned in early 2023

Questions?

ENSA Tube Samples Status
Rich Guill

Fabricate and Destructive Analysis of Samples



Need

- Realistic flaw samples are the most critical element of NDE development, documenting technique performance, and (site applicability) techniques for field use
- When pulled tubes do not provide an adequate number of realistic flaws, fabrication of laboratory-induced flaws remains the only alternative

SGMP Response

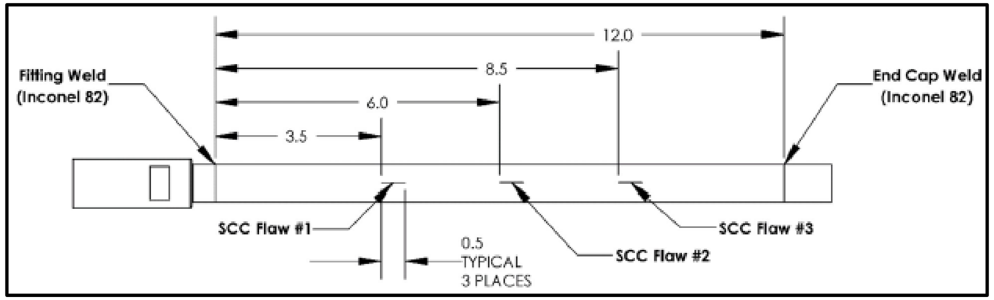
- This task addresses fabrication and destructive analysis of flaw samples for current and new generation steam generators

Status

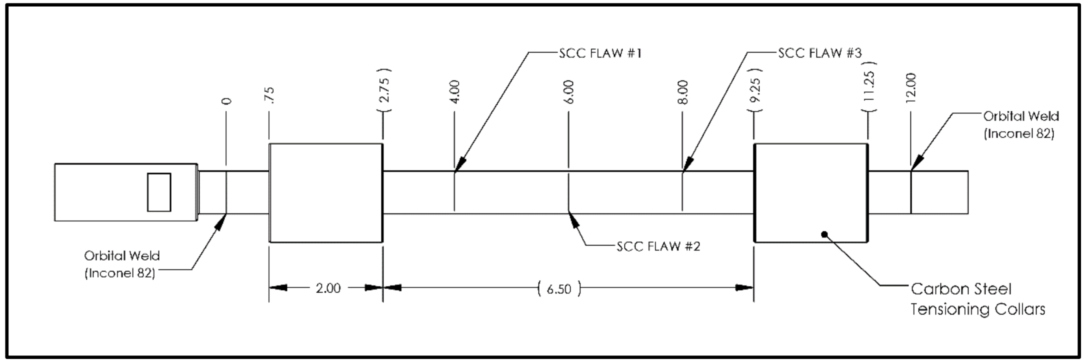
- Investigating crack fabrication methods
  - 2019 contract with Dominion Engineering and Pedro Veron (formally with ENSA)
    - Technology transfer
  - In December 2019 Dominion successful produced their first Axial ODSCC lab induced crack
    - 2020 and 2021 worked to refine the process and produce additional samples
      - Seven samples received and investigated (twenty-three cracks)
        - Fifteen usable cracks, seven Non-detectable cracks and four thru-wall cracks
    - 2022 Circumferential ODSCC flaw development

Dominion Engineering Equipment and Process

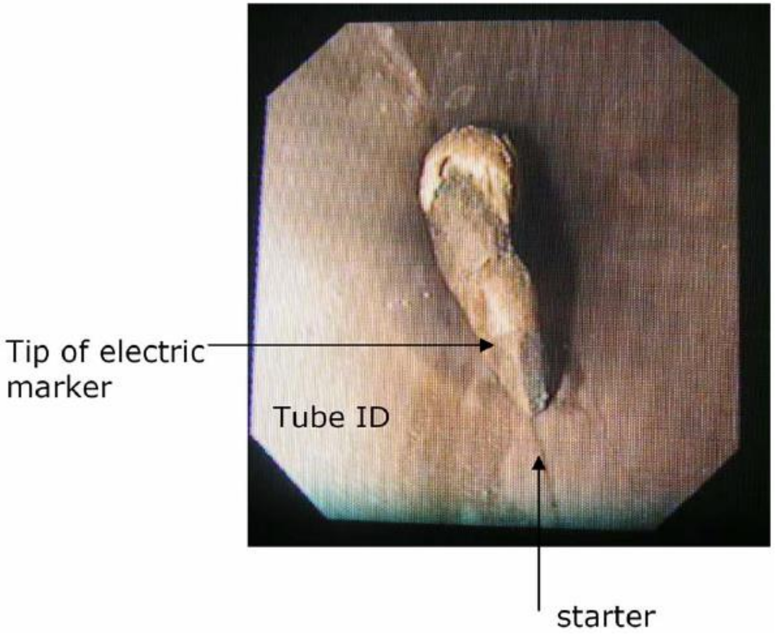
- Specimen Flaw Site Preparation
  - Tube specimens fabricated from 600MA steam generator tubes supplied by EPRI
  - Each tube specimen contains up to three flaw sites (either axial or circumferential), created using an arc engraver



Axial Flaw Site Diagram



Circumferential Flaw Site Diagram



Dominion Engineering Equipment and Process

- Tube Specimen Exposure Parameters
  - Testing performed in heated autoclave at elevated temperature and pressure
    - Results in supersaturated steam
    - Added salts are volatilized to create doped steam conducive to corrosion
  - Operating pressure chosen for volume on the opposite surface of the flaw is differentially pressurized to match the stress profile of the specific test goal

SCC Flaw Type & Location	Specimen Pressure	Specimen Environment	Vessel Pressure	Vessel Environment
OD Axial Flaw	Vessel Pressure +1450 ± 100 psia	Argon	1160 ± 100 psia	Doped Steam w/ H_2
ID Axial Flaw	1160 ± 100 psia	Doped Steam w/ H_2	Atmospheric Pressure	Argon
OD Circumferential Flaw	Vessel Pressure ± 100 psia	Argon	1160 ± 100 psia	Doped Steam w/ H_2

Crack Fabrication Results

Exposure Test	Specimen	Test Termination Condition	Test Duration	Flaw Location	Arc Engraver Voltage	Post-Test Optical Imaging	Post-Test Pressure Test	EPRI NDE	
								Voltage	Est. Crack Depth
2019 Test 1	5830-06-01	Test Duration Reached (60 days)	60 days	1	0.9	—		Not Detectable	
				2	1.0	—		0.09	19% - 59%
				3	1.1	—		0.1	26% - 62%
2020 Test 1	5830-06-02	Specimen Pressure Drop (45 days)	46 days	1	1.1	—	No Leak	0.05	14%-32%
				2	1.1	—	No Leak	0.3	40%-54%
				3	1.1	Multiple Cracks Observed	Leak Observed	4.3	thruwall
2020 Test 2	5849-07-01	Test Duration Reached (30 days)	30 days	1	1.1	Crack Observed		Not Detectable	
				2	1.1	—		Not Detectable	
				3	1.1	—		Not Detectable	
2020 Test 3	5849-07-02	Specimen Pressure Drop (47 days)	49 days	1	1.0	—	No Leak	0.08	15%-59%
				2	1.3	—	No Leak	0.15	26%-70%
				3	1.6	—	No Leak	0.11	26%-62%
2021 Test 1	5849-07-03	Specimen Pressure Drop (75 days)	83 days	1	1.1	—	No Leak	0.21	50%-70%
				2	1.1	Multiple Cracks Observed	Small Leak	2.11	thruwall
				3	1.1	Multiple Cracks Observed	Large Leak	2.02	thruwall
2021 Test 2	5887-04-01	Specimen Pressure Drop (141 days)	148 days	1	1.1	—	No Leak	Not Detectable	
				2	1.1	—	No Leak	0.07	ND
				3	1.1	Crack Observed	Large leak	0.97	80%-100%
2021 Test 3	5887-06-01	Specimen Pressure Drop (27 days)	32 days	1 (off axis)	1.1	Off axis crack	Leak Observed	1.89	thruwall
				2	1.1	—	No Leak	0.32	40%-60%
				3	1.1	—	No Leak	0.42	41%-79%
				Extra (4)	—	—	No Leak	0.29	40%-54%
				Extra (5)	—	—	No Leak	0.17	35%-70%
2021 Test 4	5887-09-01	Specimen Pressure Drop (82 days)	89 days	1	1.1	—	No Leak	Not Detectable	
				2	1.1	Crack Observed	No Leak	0.53	65%-85%
				3	1.1	Crack Observed	Leak Observed	1.09	80%-100%

Next Step – Destructive Analysis **(Priority list has been established)**

Destructive Analysis Process

- The cracks produced by ENSA or Dominion Engineering are destructively analyzed by a fully accredited metallurgical lab
  - Crack evaluation process:
    - Photographed
    - Wet fluorescent dye penetrant testing performed
    - Each crack is destructive analyzed by step-grinding in 0.020-inch (20 mils) increments
    - Cracks are mounted in thermal setting compound, then machined and polished for metallographic examination
      - Samples are given a light electrolytic 5% Nital etch and slightly repolished to reveal the full extent of cracking
    - The maximum depth of each flaw and number of penetrations at the same flaw position is measured and recorded at each step-grind increment
      - The full tube wall thickness is measured at multiple step grinds to obtain the actual wall thickness and used for %TW calculations

Samples That Will Be Destructively Analyzed to Support MAPOD Calculations - Lab Cracks Available

MTI has finalized destructive Analysis of 18 Axial PWSCC Samples, ETSS updates will begin ASAP

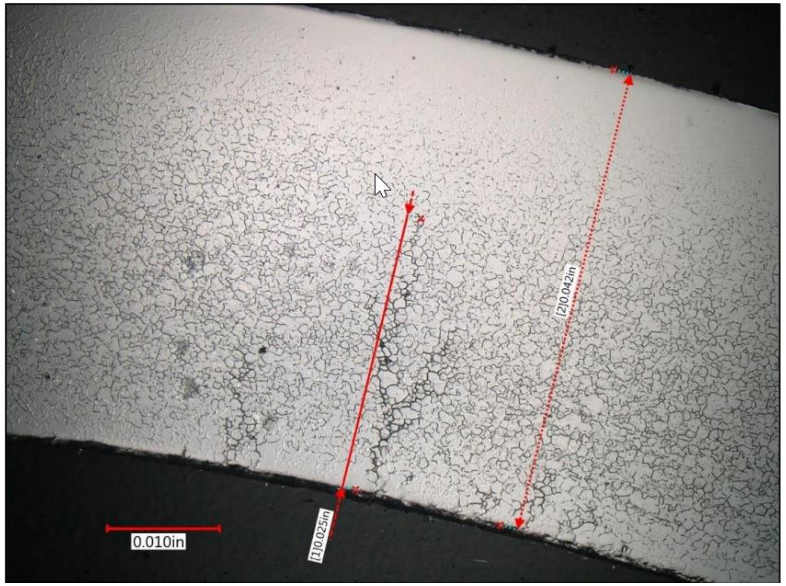
Circ ODSCC D.E. is in progress, over 30 cracks will be analyzed

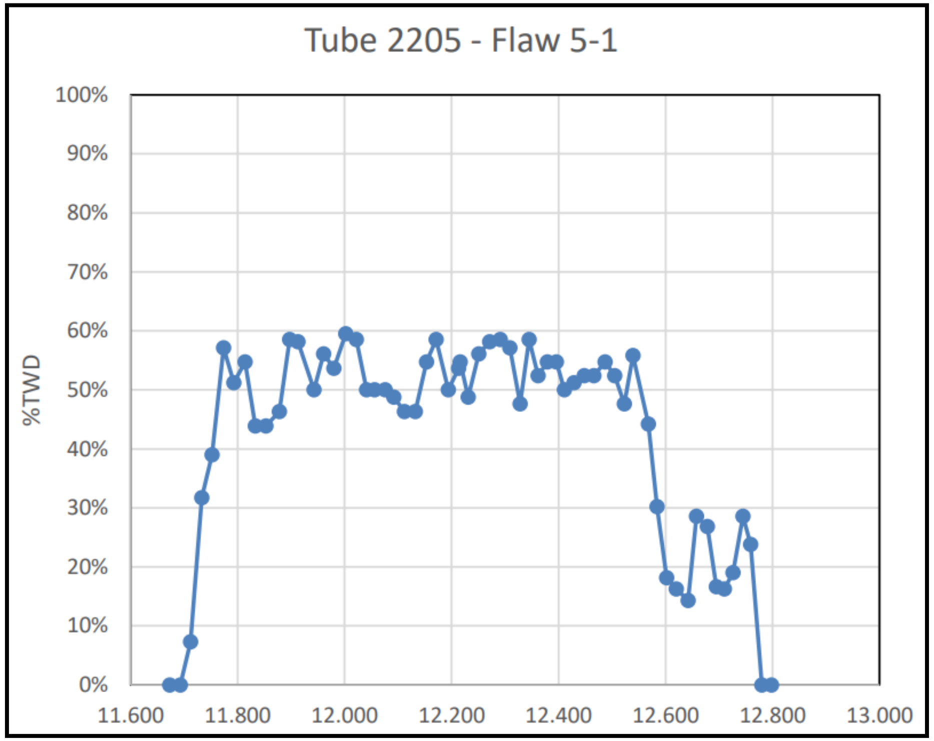
18 Axial PWSCC Samples Will Be Added to Existing ETSS in Support of MAPOD Calculations

Tube - Crack No.	Circ Position	Met Max %TW	Met Max %TW Loc	GRIND NO.	PHOTO NO.
2205-3	10-30°	49%	7.17	2205-3A-G2	K211
2205-4	0°	54%	9.48	2205-4-G30	K2827
2205-5-1	5-45°	60%	12.00	2205-5A-G29	K2773
2205-5-2	90°	33%	13.92	2205-5C-G28	K2727
2205-5-3	130-160°	32%	13.31	2205-5B-G38	K3180
2205-6-1	60-80°	74%	14.97	2205-6A-G0	K48
2205-6-2	120-140°	43%	15.47	2205-6B-G26	K2624
2205-6-3	140°	30%	14.78	2205-6A-G10	K1055
2205-7-1	20-80°	83%	17.39 & 18.03	2205-7A-G13 2205-7B-G21	K1437 K2331
2205-7-2	110°	45%	17.33	2205-7A-G16	K1866
2205-7-3	120°	51%	18.26	2205-7B-G33	K3049
2505-1	10°	90%	0.77	2505-1A-G7	K761
2505-2	15°	75%	4.11	2505-2B-G0	K10
2505-3	310°	63%	6.50	2505-3B-G41	K3235
2605-1	5°	83%	2.62	2606-1A-G22	K2405
2605-2	310°	63%	8.10	2605-2A-G6	K668
2705-1	5°	77%	12.66	2705-1A-G8	K882
2705-2	10°	58%	15.31	2705-2-G29	K2815

Tube 2205 – Axial PWSCC Flaw 5-1

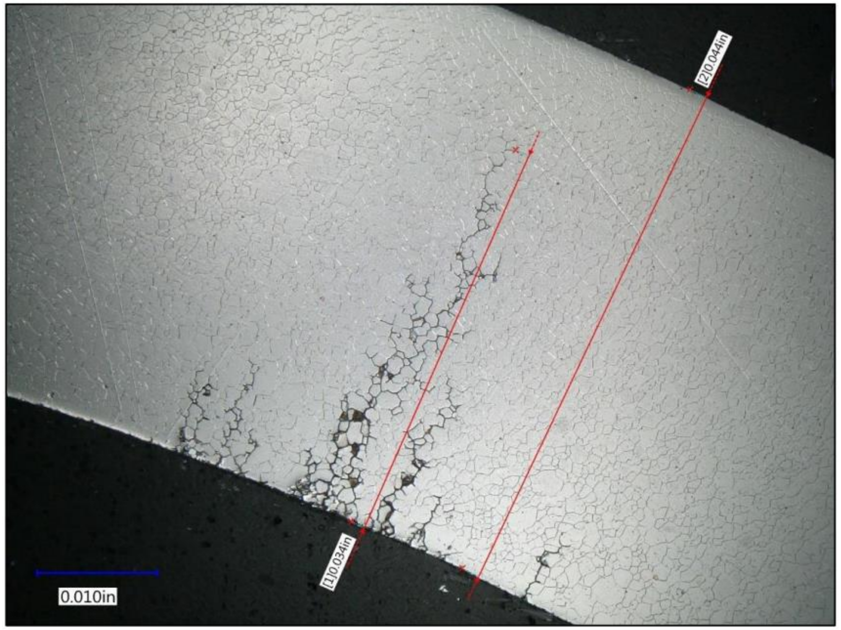
Final Mount Height	Wall Thickness	Depth	% Through Wall	Distance From Marked End
0.485	-	0	0%	11.673
0.505	-	0	0%	11.693
0.524	41	3	7%	11.712
0.545	41	13	32%	11.733
0.564	41	16	39%	11.752
0.586	42	24	57%	11.774
0.605	41	21	51%	11.793
0.626	42	23	55%	11.814
0.645	41	18	44%	11.833
0.665	41	18	44%	11.853
0.690	41	19	46%	11.878
0.709	41	24	59%	11.897
0.725	43	25	58%	11.913
0.755	42	21	50%	11.943
0.773	41	23	56%	11.961
0.792	41	22	54%	11.980
0.814	42	25	**60%**	12.002
0.834	41	24	59%	12.022
0.853	42	21	50%	12.041
0.868	42	21	50%	12.056
0.888	42	21	50%	12.076
0.904	41	20	49%	12.092
0.924	41	19	46%	12.112
0.944	41	19	46%	12.132
0.965	42	23	55%	12.153
0.983	41	24	59%	12.171
1.006	42	21	50%	12.194
1.025	41	22	54%	12.213
1.043	41	20	49%	12.231
1.063	41	23	56%	12.251
1.083	43	25	58%	12.271
1.103	41	24	59%	12.291
1.121	42	24	57%	12.309
1.140	42	20	48%	12.328
1.157	41	24	59%	12.345
1.174	42	22	52%	12.362
1.191	42	23	55%	12.379
1.208	42	23	55%	12.396
1.223	42	21	50%	12.411
1.241	41	21	51%	12.429
1.260	42	22	52%	12.448
1.278	42	22	52%	12.466
1.299	42	23	55%	12.487
1.317	42	22	52%	12.505
1.335	42	20	48%	12.523
1.351	43	24	56%	12.539
1.250	43	19	44%	12.568
1.234	43	13	30%	12.584
1.216	44	8	18%	12.602
1.198	43	7	16%	12.620
1.176	42	6	14%	12.642
1.160	42	12	29%	12.658
1.140	41	11	27%	12.678
1.123	42	7	17%	12.695
1.108	43	7	16%	12.710
1.092	42	8	19%	12.726
1.073	42	12	29%	12.745
1.059	42	10	24%	12.759
1.038	-	0	0%	12.780
1.020	-	0	0%	12.798

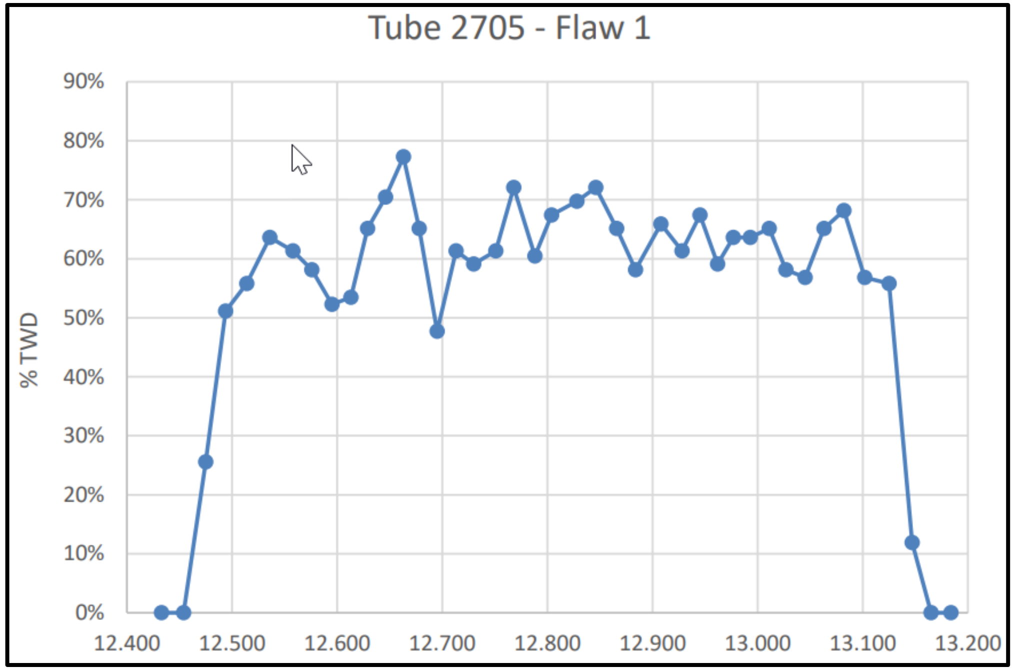




Tube 2705 – Axial PWSCC Flaw 1

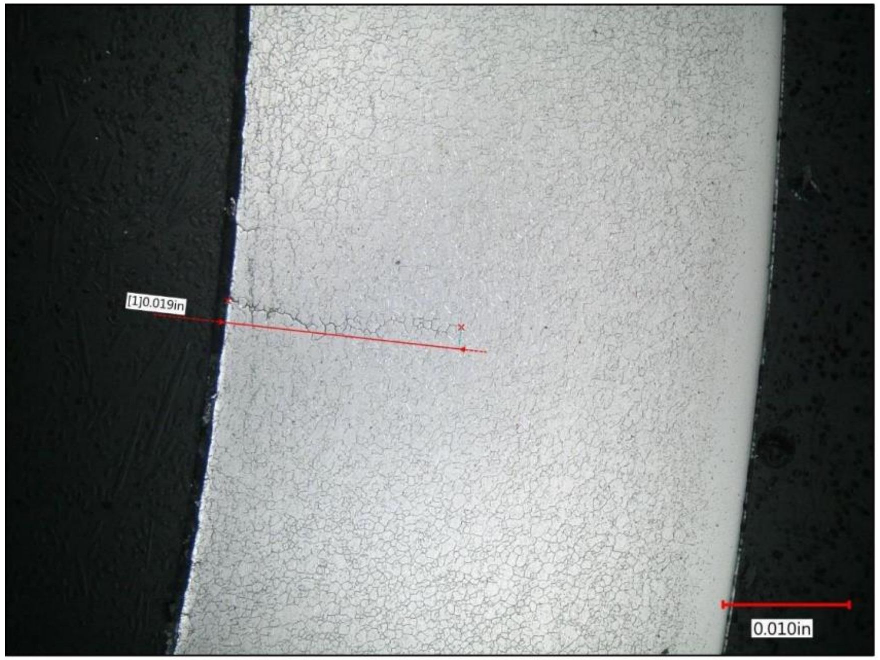
Final Mount Height	Wall Thickness mils	Depth mils	% Through Wall	Distance From Marked End
0.763	-	0	0%	12.433
0.784	-	0	0%	12.454
0.805	43	11	26%	12.475
0.824	43	22	51%	12.494
0.844	43	24	56%	12.514
0.866	44	28	64%	12.536
0.888	44	27	61%	12.558
0.906	43	25	58%	12.576
0.925	44	23	52%	12.595
0.943	43	23	53%	12.613
0.959	43	28	65%	12.629
0.976	44	31	70%	12.646
0.993	44	34	**77%**	12.663
1.008	43	28	65%	12.678
1.025	44	21	48%	12.695
1.043	44	27	61%	12.713
1.060	44	26	59%	12.730
1.081	44	27	61%	12.751
1.098	43	31	72%	12.768
1.118	43	26	60%	12.788
1.134	43	29	67%	12.804
1.154	43	30	70%	12.828
1.136	43	31	72%	12.846
1.116	43	28	65%	12.866
1.098	43	25	58%	12.884
1.074	44	29	66%	12.908
1.054	44	27	61%	12.928
1.037	43	29	67%	12.945
1.020	44	26	59%	12.962
1.005	44	28	64%	12.977
0.989	44	28	64%	12.993
0.971	43	28	65%	13.011
0.955	43	25	58%	13.027
0.937	44	25	57%	13.045
0.919	43	28	65%	13.063
0.900	44	30	68%	13.082
0.880	44	25	57%	13.102
0.857	43	24	56%	13.125
0.835	42	5	12%	13.147
0.817	-	0	0%	13.165
0.798	-	0	0%	13.184

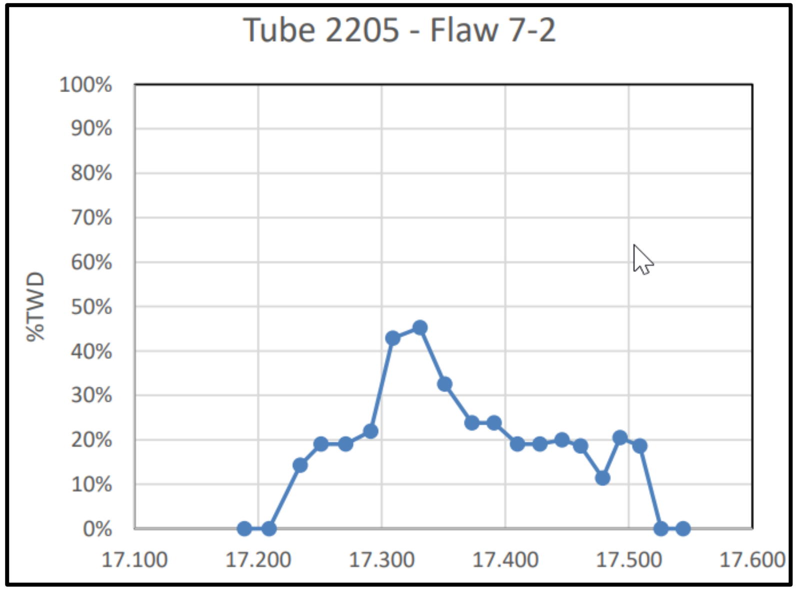




Tube 2205 – Axial PWSCC Flaw 7-2

Final Mount Height	Wall Thickness	Depth	% Through Wall	Distance From Marked End
0.740	-	0	0%	17.189
0.760	-	0	0%	17.209
0.785	42	6	14%	17.234
0.802	42	8	19%	17.251
0.822	42	8	19%	17.271
0.842	41	9	22%	17.291
0.860	42	18	43%	17.309
0.882	42	19	**45%**	17.331
0.902	43	14	33%	17.351
0.924	42	10	24%	17.373
0.942	42	10	24%	17.391
0.961	42	8	19%	17.410
0.979	42	8	19%	17.428
0.997	45	9	20%	17.446
1.012	43	8	19%	17.461
1.030	44	5	11%	17.479
1.044	44	9	20%	17.493
1.060	43	8	19%	17.509
1.077	-	0	0%	17.526
1.095	-	0	0%	17.544





Crack Samples Well Traveled in 2019

AUGUST 2019

Sun	Mon	Tue	Wed	Thu	Fri	Sat
28	29	30	31	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22 Core Star (EPRI)	23	24
25	26	27	28	29	30	31

SEPTEMBER 2019

Sun	Mon	Tue	Wed	Thu	Fri	Sat
1	2	3	4	5	6	7
8	9 Framatome (VA)	10	11	12	13	14
15	16 EDF/Zetec (WA)	17	18	19	20	21
22	23	24 Tecnatom (EPRI)	25	26	27	28
29	30 Tecnatom	1	2	3	4	5

OCTOBER 2019

Sun	Mon	Tue	Wed	Thu	Fri	Sat
29	30	1 Kinectrics (Toronto, CA)	2	3	4	5
6	7 SGndt (Quebec, CA)	8	9	10	11	12
13	14 NEL (EPRI)	15	16	17	18	19
20	21 Argonne (IL)	22	23	24	25	26
27	28	29	30	31 MTI	1	2

- March 2022 received Axial PWSCC MET report from MTI
- MET report sent out to all vendors that participated in data acquisition

EPRI

Transfer Function from +Point to Array Voltage
Bill Cullen

+Point to Array Probe Transfer Function

Problem Statement: Array Probe eddy current qualifications are based solely on laboratory generated flaws and may not provide for a broad spectrum of qualification samples

- +Point ETSSs are primarily comprised of pulled tube specimens
- Lab generated flaws, especially sodium-tetrathionate produced flaws, may not have consistent amplitude vs depth response as pulled tube flaws; this directly affects the array probe A-hat function (flaw amplitude vs depth regression) and thus, POD simulations
- A concept for a transfer function was developed in 2017 using flaws found in both the +Point and array probe ETSSs
- In 2020, additional work was completed using a new concept for the transfer function (only ODSCC investigated)
- In 2021, EPRI published the function technical report (3002022466)
- This transfer function was peer reviewed in August
- PWSCC mechanisms will be investigated in 2023

+Point to Array Probe Transfer Function

The new methodology is a *<u>generalized assessment</u>* of probe amplitude performance for known mechanical flaws (axial and circ EDM notches) is used

- The generalized comparison eliminates the issue of lab produced flaw compatibility with pulled tube data
- +Point and array probe data was collected for all A600TT tubing sizes
- Benchmarking of predicted (using the transfer function) vs measured array probe amplitudes for those flaws with both +Pt and array inspection data is excellent

Benchmarking is the key comparison point and validates the transfer function

+Point to Array Probe Transfer Function

The methodology is extremely simple

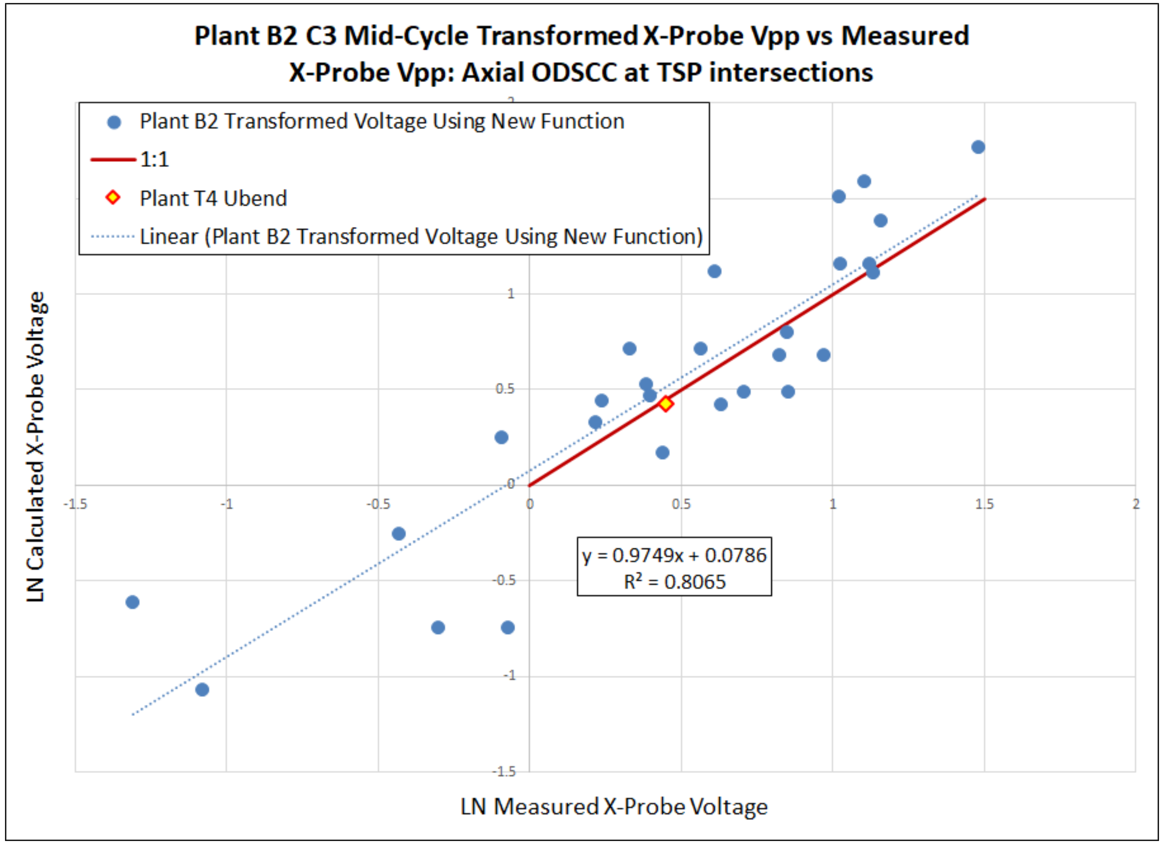
1. Develop a linear regression of array probe signal amplitude on +Point signal amplitude for generalized probe performance; this is the transfer function
2. Test (benchmark) the transfer function against empirical plant data and evaluate the results
3. Assesses compatibility of lab-produced flaws, not for development of the transfer function but for inclusion in A-hat data set based on amplitude versus depth comparison of pulled tube and lab-produced flaws
4. Generate new array probe A-hat functions for axial and circumferential ODSCC
5. Develop example POD curves using example noise data sets and assess the reasonability of these curves

- New array probe ETSSs can then be developed for degradation mechanisms for which there is no current ETSS, such as axial ODSCC at expansion transitions and axial ODSCC in dings/dents and for improvement to existing PODs by application of a more appropriate A-hat
- PWSCC mechanism transfer function to be developed in 2023

+Point to Array Probe Transfer Function Benchmarking

Axial ODSCC Benchmarking

- Excellent agreement between predicted and measured array amplitudes
- Non-dented TSP and freespan locations, i.e., low noise locations

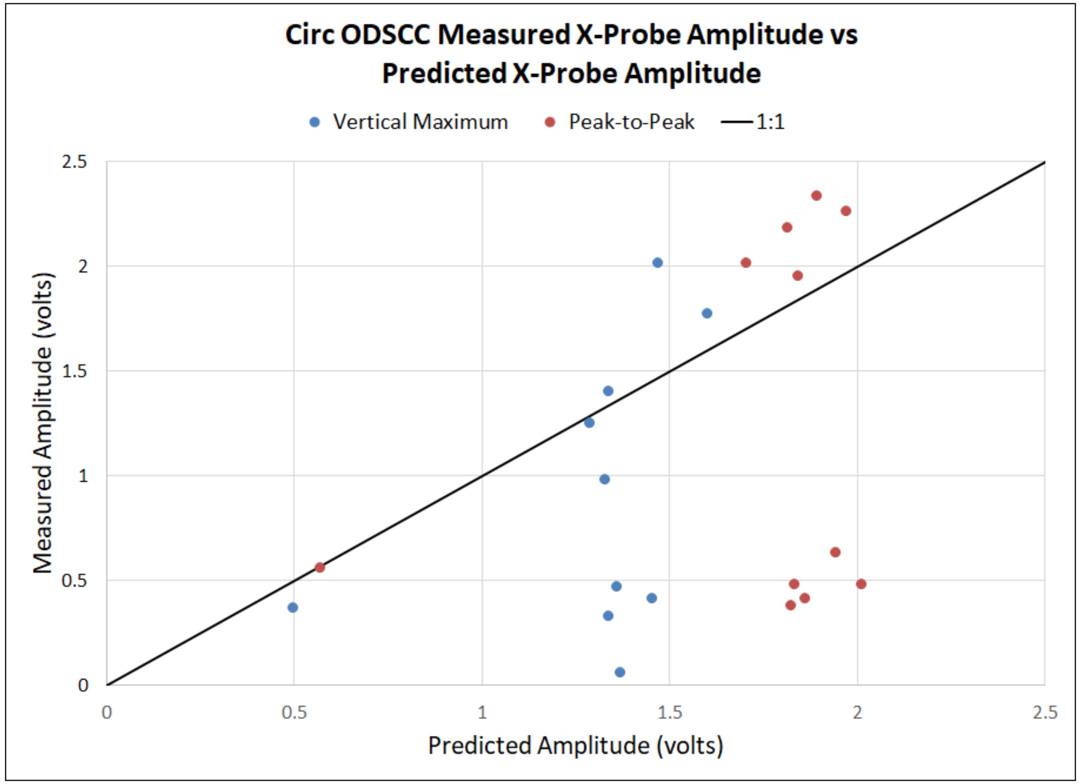


Field indication from spring 2022 falls essentially on the 1:1 line

+Point to Array Probe Transfer Function Benchmarking

Circumferential ODSCC Benchmarking

- Two distinct performances are observed; either the prediction matches the measurement, or the measurement is well less than prediction
- EPRI has associated this performance with noise characteristics between difference elevations within the expansion transition
- EPRI is addressing array probe noise monitoring protocol with Revision 9 of the Examination Guidelines
- Preliminary MAPOD modeling shows very good benchmarking for the recommended window height and noise measurement technique



This is simply a signal-to-noise issue and research is promising

ODSCC A-hat Functions

- The axial ODSCC array probe A-hat is based entirely on pulled tube flaws using transformed array voltages from +Pt voltages
  - Flaws from ETSS I28431 and ETSS I28432 are combined
  - Flaw voltages from these ETSSs are used to perform the transform
- The circ ODSCC array probe A-hat is based primarily on pulled tube data using transformed array voltages from +Pt voltages
  - Lab cracks which reside within upper and lower 95% prediction bound of depth on amplitude for pulled tubes are included; only influences the PDA dataset
  - The circ ODSCC voltages are based on an expert review of all available pulled tube data, confirmed by the engineer and another QDA
  - Since the A-hat is based on *these* voltages, the EPRI array probe A-hat cannot be combined with other data sets

Conclusions

- The new methodology is uses mainly pulled tube data for the A-hat dataset
- The array probe A-hat functions are very similar for axial and circumferential ODSCC, thus, for similar noise conditions, the POD curves for both mechanisms will be similar
- The array probe A-hat functions for PWSCC are expected to be similar to those for ODSCC since the array probe gives similar amplitude response for ID and OD notches
- The array probe functioning and analysis are different than +Point, this requires differing mindsets when evaluating data for these two probes
- This (transfer function) concept should be able to be applied to any two combinations of probes, provided the input data is collected for consistent flaws
- Future developed POD curves should examine plant empirical detection performance, a recommendation in Rev 5 of the IAGL
- For low noise conditions the benchmarking of the transfer function is excellent; for high noise conditions, the performance can be recreated using MAPOD

+Point to Array Probe Transfer Function

Questions?

NRC Items of Interest

NRC Address Public Comments/Questions

EPRI 50th

ANNIVERSARY