UNITED STATES
NUCLEAR REGULATORY COMMISSION
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May 19, 2020

Mr. Rod L. Penfield
Site Vice President
Energy Harbor Nuclear Corp.
Beaver Valley Power Station
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SUBJECT: SUMMARY OF APRIL 22, 2020, TELECONFERENCE WITH ENERGY HARBOR NUCLEAR CORP. REGARDING SPRING 2020 STEAM GENERATOR INSPECTIONS AT BEAVER VALLEY POWER STATION, UNIT 2 (EPID L-2020-LRO-0006)

Dear Mr. Penfield:

On April 22, 2020, a teleconference was held between the U.S. Nuclear Regulatory Commission (NRC) and representatives of Energy Harbor Nuclear Corp. (the licensee) regarding the ongoing steam generator inspection activities at the Beaver Valley Power Station, Unit 2. The list of participants is provided as Enclosure 1. The teleconference summary is provided as Enclosure 2. The list of questions discussed is provided as Enclosure 3.

Based on the information provided by the licensee, the NRC staff did not identify any issues that warranted immediate follow-up action. However, the NRC staff asked to be notified if any unusual conditions were detected during the remainder of the outage.

Please direct any inquiries to me at (301) 415-2328 or Jennifer.Tobin@nrc.gov.

Sincerely,

/RA/

Jennifer C. Tobin, Project Manager
Plant Licensing Branch I
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-412

Enclosures:
1. List of Participants
2. Teleconference Summary
3. Steam Generator Tube Inspection Discussion Points

cc: Listserv

LIST OF PARTICIPANTS

APRIL 22, 2020, TELECONFERENCE WITH

ENERGY HARBOR NUCLEAR CORP.

BEAVER VALLEY POWER STATION, UNIT 2

SPRING 2020 STEAM GENERATOR INSPECTIONS

Name	**Participant**
Greg Makar	U.S. Nuclear Regulatory Commission (NRC)
Paul Klein	NRC
Andrew Johnson	NRC
Steven Bloom	NRC
Jennifer Tobin	NRC
Elise Burkett	NRC
Phil Lashley (Licensing)	Energy Harbor Nuclear Corp. (Energy Harbor)
Brian Prinkey (Beaver Valley Engineering)	Energy Harbor
Ken McMullen (Beaver Valley Engineering)	Energy Harbor
Gary Alberti (Beaver Valley Engineering)	Energy Harbor
Tim Saibena (Beaver Valley Engineering)	Energy Harbor
Jay Smith	Westinghouse

SUMMARY OF TELECONFERENCE

WITH ENERGY HARBOR NUCLEAR CORP.

BEAVER VALLEY POWER STATION, UNIT 2

SPRING 2020 STEAM GENERATOR TUBE INSPECTIONS

DOCKET NO. 50-412

On April 22, 2020, the staff of the Corrosion and Steam Generator Branch (NCSG) of the Division of New and Renewed Licenses, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission (NRC) participated in a conference call with Energy Harbor Nuclear Corp. (the licensee) regarding the ongoing steam generator (SG) tube inspection activities at Beaver Valley Power Station, Unit 2 (Beaver Valley Unit 2), during Refueling Outage 21. The licensee provided additional inspection details prior to the conference call and that information is in Enclosure 3.

Beaver Valley Unit 2 is a three-loop plant with Westinghouse Model 51M SGs. Each SG contains 3,376 mill-annealed alloy 600 tubes with a nominal outside diameter of 0.875 inches and a nominal wall thickness of 0.050 inches. The tubes are supported by carbon steel tube support plates and alloy 600 anti-vibration bars. The tubes were roll expanded for the full depth of the tubesheet. The entire length of tube interior within the tubesheet was shot-peened on both the hot-leg and cold-leg side of the SG prior to operation. In addition, the U-bend region of the small radius tubes was in-situ stress-relieved prior to operation.

In addition to the depth-based tube repair criteria, the licensee is also authorized to apply the Generic Letter 95-05 voltage-based tube repair criteria for predominantly axially-oriented outside diameter stress corrosion cracking (ODSCC) at the tube support plate elevations (Agencywide Documents Access and Management System (ADAMS) Accession No. ML031070113). In addition, the licensee is authorized to leave flaws within the tubesheet region in service, provided they satisfy the F* repair criterion (ADAMS Accession No. ML12143A445).

Additional information discussed during the conference call and not included in the information provided by the licensee is summarized below:

- At the time of the call, the SG tube inspections were nearly complete.

- The screening process for in-situ pressure testing was not complete at the time of the call, but no flaws had been identified that required in-situ pressure testing. One tube had been identified for in-situ pressure testing as a conservative evaluation approach. After the call, the NCSG staff was informed by the Region I inspector that, in total, three tubes were in-situ pressure-tested, and each tube satisfied the tube integrity criteria.

- The licensee explained that a Ghent probe was being used to supplement +Point probe inspections of the nickel band region of the lower joint of sleeves in the tubesheet region. A site-specific Ghent probe technique was qualified during previous outages and implemented for the first time in this inspection outage. In response to an NRC staff question, the licensee stated that no indications were detected in the tube sleeves.

- One indication of axial ODSCC had been detected in the portion of a tube within the flow distribution baffle region. The indication was not associated with a dent, and the location is not subject to the voltage-based alternate repair criteria.

- One indication of circumferential ODSCC had been detected in the free-span of a tube. The indication was in the hot leg at a ding between the second and third tube support plates.

- The licensee indicated that at the time of the call, there were approximately 84 tubes identified for repair by sleeving and 14 tubes identified for plugging.

- The inspections revealed three foreign objects in SG A and three in SG C, but no tube wear was associated with the objects.

- The licensee indicated that the nine tubes with plug-in-plug (PIP) repairs had been analyzed to remain in service.

The NRC staff did not identify any issues that required follow-up action at this time; however, the staff asked to be notified in the event that any unusual conditions were detected during the remainder of the outage.

BEAVER VALLEY POWER STATION, UNIT 2

STEAM GENERATOR TUBE INSPECTION DISCUSSION POINTS

FOR APRIL 22, 2020, TELECONFERENCE WITH ENERGY HARBOR NUCLEAR CORP.

The following discussion points were prepared to facilitate the conference call arranged with the licensee to discuss the results of the steam generator (SG) tube inspections to be conducted during the Beaver Valley Power Station, Unit 2, spring 2020 refueling outage. The conference call was scheduled to occur toward the end of the planned SG tube inspections, but before Unit 2 completed the inspections and repairs. The licensees' responses (below) were provided prior to the conference call (ADAMS Accession No. ML20140A335).

The following abbreviations were used in the responses provided by the licensee:

AVB − Anti-Vibration Bar
BLG − Bulge
BRT − Bottom Roll Transition
DA – Degradation Analysis
DNI – Dent/Ding with Possible Indication
DSI – Distorted Tube Support Plate Signal with Possible Indication
EPRI – Electric Power Research Institute
EXP – Expansion
FDB – Flow Distribution Baffle
FENOC – FirstEnergy Nuclear Operating Company
FOSAR – Foreign Object Search and Retrieval
FS – Free-Span
FSH – Free-Span Signal History
GL – Generic Letter
MBH – Manufacturing Burnish History
NSAL – Nuclear Safety Advisory Letter
ODSCC – Outside Diameter Stress Corrosion Cracking
PDA – Percent Degraded Area
PIP – Plug-in-Plug
PLP – Possible Loose Particles
PWSCC – Primary Water Stress Corrosion Cracking
SBH – Sleeve Bottom Hot
SG – Steam Generator
STH – Sleeve Top Hot
TEC – Tube End Cold
TSP – Tube Support Plate
TTS – Top of Tubesheet
TW – Through-Wall
V − Volts
Vvm – Vertical Max Voltage

1. **Discuss any trends in the amount of primary-to-secondary leakage observed during the recently completed cycle.**

RESPONSE: There was no primary to secondary leakage reported during the last operating cycle (Cycle 21).

2. **Discuss whether any secondary side pressure tests were performed during the outage and the associated results.**

   RESPONSE: There were no secondary pressure tests performed during the outage. [Subsequent to the call, three pressure tests were performed by the licensee, as discussed in Enclosure 2.]

3. **Discuss any exceptions taken to the industry guidelines.**

   RESPONSE: There were no exceptions taken to the industry guidelines.

4. **For each SG, provide a description of the inspections performed, including the areas examined and the probes used (e.g., dents/dings, sleeves, expansion-transition, U-bends with a rotating probe), the scope of the inspection (e.g., 100 percent of dents/dings greater than 5 V and a 20 percent sample between 2 V and 5 V), and the expansion criteria.**

   RESPONSE:

   Base Scope Programs:

   - 100 percent full length 0.720-inch bobbin inspection in Rows 5 and higher (non-sleeved tubes)
   - 0.720-inch bobbin inspection in Row 5 and higher in all sleeved tubes from TEC to STH
   - 100 percent 0.720-inch bobbin inspection in Rows 1 through 4 hot leg and cold leg straight legs (non-sleeved hot leg tubes)
   - 0.630-inch-wide groove bobbin in all sleeved tubes in Rows 2 through 4 from STH to 08H
   - 100 percent 0.700-inch bobbin inspection in Rows 3 and 4 U-bend from 08H to 07C
   - 100 percent hot leg TTS +POINT probe inspection from 6 inches above to 3 inches below TTS in non-sleeved tubes
   - 100 percent +POINT probe inspection of BLG and EXP bobbin reports in hot leg tubesheet below F* distance but above tubesheet neutral axis s
   - 100 percent +POINT probe inspection of cold leg BLG and EXP bobbin reports above the TTS
   - 100 percent 0.610 gimbaled +POINT probe full length from STH +3 to SBH -4 inches in sleeved tubes
   - 100 percent Ghent Version 2 probe of sleeve nickel band region in lower tubesheet sleeve joints
   - 100 percent Rows 1 and 2 small radius U-bend +POINT probe inspection in each SG using mid-range +POINT coil
   - 100 percent +POINT probe inspection at all dented (hot and cold leg) TSP intersections >5 V
   - 100 percent +POINT probe inspection of all TSP DSI/DNI signals >2 V
   - 100 percent +POINT probe inspection of all free-span dings (all reported voltages)

- 100 percent +POINT probe inspection of Rows 3 through 10 U-bends in SG-C (top TSP to top TSP)
- 100 percent +POINT probe inspection of hot leg dents >2 V but <5 V at 01H, 02H, 03H, and 04H
- 25 percent +POINT probe inspection of Rows 3 through 10 U-bends in SG-A and SG-B (top TSP to top TSP)
- 25 percent +POINT probe inspection of hot leg dents >2 V but <5 V at 05H, 06H, 07H, and 08H
- 20 percent inspection of the SG-A cold leg TTS region from +6 inches to -3 inches, including all SG-A cold leg crevice depths >0.5 inch
- +POINT probe inspection of hot leg and cold leg tubes that contain BRT >5 inches below the TTS

Special Interest Inspections:

- 100 percent inspection of bobbin special interest I-codes such as free-span differential signals meeting change criteria
- 100 percent inspection at TSP DSI signals >1 V (not required per GL 95-05)
- 100 percent inspection of <2 V DSI locations previously confirmed by the +POINT probe to contain axial ODSCC
- 100 percent inspection of all TSP residuals with bobbin phase angle ≤55 degrees and ≥1.25 V on the bobbin P1 mix channel
- 100 percent of DSI signals regardless of voltage size at TSP 01H/01C and TSP 02C/03C locations
- High frequency +POINT probe testing of Row 1 U-bends with noise values of 0.65 Vvm and greater
- High frequency +POINT probe confirmatory testing of all U-bend PWSCC indications reported with the mid-range +POINT coil
- 100 percent inspection of all dents at AVB sites (+/- 1 inch of AVB)
- 100 percent inspection of all newly reported signals at AVBs plus any atypical growth (>6 percent TW growth for Cycle 19) AVB wear indications
- 100 percent inspection of all free-span signals not resolved as MBH/FSH or without historical review
- 100 percent inspection of newly reported PLP signals (includes 2-tube box) plus locations adjacent to tubes plugged in prior outages for PLP interaction (2 tube box), plus one tube box around SG-A 01C PLP signals from 2R20
- 25 percent inspection of all bobbin TSP mix residuals >1.5 V but <2 V plus 100 percent of >2 V mix residuals. TSP mix residuals have bobbin phase angles >55 degrees
- +POINT probe inspection of tubes with newly identified foreign objects that have the potential to cause tube wear that are identified from secondary side visual inspections at the applicable elevation (includes 1 tube box)

Expansion Criteria:

Since the majority of the inspection programs are at 100 percent, there are no expansion requirements. If expansion of an inspection program is required, the expansion will follow the direction provided in the 2R21 DA.

Visual Inspections:

- Tube plug video inspection, including PIP repaired plugs and PIP tack welds
- Primary channel head visual inspections per NSAL-12-1, Revision 1, which includes:
  - Divider plate-to-channel head weld
  - Divider plate-to-stub runner weld
  - Tubesheet-to-channel head Z-seam area
  - Entire inside surface of the channel head bowl cladding
  - Targeted visual inspection of the potential cladding anomaly identified in 2R20
- SG secondary side FOSAR of annulus and tube lane with FOSAR of in-bundle PLP reports from eddy current testing

5. For each area examined (e.g., tube supports, dent/dings, sleeves, etc.), provide a summary of the number of indications identified to date for each degradation mode (e.g., number of circumferential PWSCC indications at the expansion transition). For the most significant indications in each area, provide an estimate of the severity of the indication (e.g., provide the voltage, depth, and length of the indication). In particular, address whether tube integrity (structural and accident-induced leakage integrity) was maintained during the previous operating cycle. In addition, discuss whether any location exhibited a degradation mode that had not previously been observed at this location at this unit (e.g., observed circumferential PWSCC at the expansion transition for the first time at this unit).

RESPONSE: Data as of 11:00 a.m. April 21, 2020.

	SG A		SG B		SG C		2R21 Total	
Degradation Mech.	**Ind.**	**Tubes**	**Ind.**	**Tubes**	**Ind.**	**Tubes**	**Ind.**	**Tubes**
AVB Wear	52	34	93	47	9	6	154	87
AVB Wear >=40% TW	0	0	0	0	0	0	0	0
FDB Wear	0	0	0	0	1	1	1	1
FS Volumetric at TTS	0	0	3	2	0	0	3	2
FS Volumetric at TSP	1	1	0	0	0	0	1	1
FS Volumetric in FS	0	0	0	0	1	1	1	1
TSP Axial ODSCC (GL 95-05)	368	306	463	380	359	298	1,190	984
TSP Axial ODSCC at 01H	0	0	1	1	0	0	1	1
TTS Circ ODSCC	47	47	19	19	19	19	85	85
TTS Axial ODSCC	1	1	1	1	0	0	2	2
TTS Mixed Mode ODSCC	0	0	0	0	0	0	0	0
FS Ding Axial ODSCC	0	0	0	0	0	0	0	0
FS Ding Circ ODSCC	0	0	0	0	0	0	0	0
FS Axial ODSCC	0	0	0	0	0	0	0	0

AVB Wear:

A total of 154 indications of AVB wear have been reported in 87 tubes in all three SGs, with the majority in SG A and SG B. Only nine indications in six tubes have been reported in SG C.

No indications have exceeded the technical specification 4 percent TW repair limit. The largest indications were measured at 37 percent TW. All AVB wear indications satisfy the condition monitoring limit of 62 percent TW.

FDB Wear:

One indication of FDB wear has been reported in SG C. The indication has not yet been depth-sized. This is a historical wear indication that measures 21 percent TW at the prior inspection.

Volumetric Indications:

There are five indications reported to date with volumetric indications in the free-span near TSPs and at or above the tubesheet. The indications have not yet been depth-sized. Four of the indications are historical in nature and have not shown growth since initial reporting. One indication is newly reported, but historical data reviews have shown to be small, and the indication has been present for several cycles with no change in signals character. The largest of these indications was 18 percent TW during the prior inspection.

Axial ODSCC Indications at TSPs (GL 95-05):

A total of 1,190 axial ODSCC indications are reported in all SGs. The NRC GL 95-05 voltage-based repair criteria is applicable to these indications. The maximum bobbin coil voltage measured in each SG is 1.61 volts. The GL 95-05 upper voltage repair limit is 4.60 V and any indication that confirms with the +POINT probe that exceeds 2.0 V. All indications are below the repair limits. The voltage distributions are bound by previous inspection results.

One axial ODSCC indication was found within a flow distribution baffle location, which is not encompassed by the GL 95-05 voltage-based arc. The indication had a maximum voltage of 0.18 V on the 300 kHz +POINT probe with a maximum depth of 50 percent TW using the EPRI Appendix I amplitude-based sizing technique. The measured length of the indication was 0.47 inch. The maximum voltage is less than the in-situ pressure test screening criteria 0.5 V, and no portion of the indication exceeds the second-tier voltage screen of 0.4 V over 0.6".

Axial and Circumferential ODSCC at Expansion Transitions:

A total of 85 circumferential ODSCC indications has been reported at the hot leg expansion transition region: 47 in SG A, 19 in SG B, and 19 in SG C. The +POINT probe 300 kHz voltages range from 0.05 V to 0.52 V. All but one are below the in-situ pressure test initial voltage screening criteria of 0.5 V. The flaw with the 0.52 V indication was depth-profiled and resulted in a PDA of 34.5, which is below the condition monitoring limit and in-situ criteria of 47 PDA. No other indications met the initial voltage screening criteria for proof and leakage in-situ testing.

The largest PDA from depth profiling of the 16 largest indications was 64.6 PDA, which exceeds the condition monitoring limit of 47 percent PDA. The voltage of this flaw was 0.27 V, which does not meet the initial in-situ screening criteria; however, this tube will be in-situ pressure-tested as a conservative measure.

The range of maximum depth measurements by phase analysis is 0 percent TW to 99 percent TW. It should be noted that phase-based depth assessment of small voltage signals can be inaccurate due to the expansion transition geometry and deposit influence. The indicated circumferential crack arc lengths range from 31 degrees to 309 degrees. A total of 2 axial ODSCC indications has been reported at the hot leg expansion transition region. The +POINT probe 300 kHz voltage was 0.13 V and 0.28 V. The in-situ pressure test voltage screening criteria is 0.5 V. The measured axial crack lengths range from 0.13 inch and 0.16 inch. The critical crack length for structural integrity is 0.4 inch for a 100 percent TW flaw over the entire length.

One indication of circumferential ODSCC at a free-span ding (21 V ding) has been detected by the +POINT probe during the 100 percent ding inspection program. Sizing and disposition of the indication are still in progress.

To date, there have been no indications of PWSCC of any type or axial ODSCC within the free-span and dings, which have been reported in prior outages.

6. Describe repair/plugging plans.

RESPONSE: As of 7:00 a.m. on April 22, 2020.

SG	Acquired	Complete	Potential Repairs
A	93.77%	92.98%	49
B	99.98%	99.46%	21
C	93.88%	93.41%	21
TOTAL	95.72%	95.11%	91

7. Describe in-situ pressure test and tube pull plans and results (as applicable and if available).

RESPONSE: One tube in SG A (R10 C26) will be in-situ pressure-tested. Several other tubes are being screened as possible candidates.

8. Discuss the following regarding loose parts:

- What inspections are performed to detect loose parts?

  RESPONSE: Primary side eddy current; secondary side visual inspections

- A description of any loose parts detected and their location within the SG (including the source or nature of the loose part, if known)

RESPONSE:

Three objects were observed in SG A secondary side tube bundle (TTS). No objects were observed in SG B secondary side tube bundle (TTS). Two objects were observed in SG C secondary side tube bundle (TTS).

- If the loose parts were removed from the SG

  RESPONSE: In SG A secondary side, two of the three pieces of foreign material observed were removed. One piece was a small wire bristle, and the other item was a piece of scale. The item that was not removed was a small wire bristle embedded in the hard sludge pile. Attempts to retrieve the wire bristle were unsuccessful. The wire bristle is fixed in place. No tube wall wear was associated with this part. The wire bristle will remain in the SG and monitored in future outages.

  No foreign material observed in SG B secondary side.

  In SG C secondary side, one of the three pieces of foreign material observed was removed. The removed piece was a sludge rock. Two pieces of hard scale were also observed in SG C. Attempts to retrieve the hard scale were unsuccessful. The two pieces are fixed in place. No tube wall wear was associated with either part. The hard scale will remain in the SG and be monitored in future outages.

- Indications of tube damage associated with the loose parts

  RESPONSE: No indications of tube damage have been associated with the loose parts that have been detected/observed in the secondary side of the SGs.

9. Discuss the scope and results of any secondary side inspection and maintenance activities (e.g., in-bundle visual inspections, feedring inspections, sludge lancing, assessing deposit loading, etc).

RESPONSE: No secondary side feedring inspections were scheduled during the 2R21 outage.

Secondary side visual inspections included the annulus, blown down lane, and selected in-bundle tube locations (selected by eddy current results). Generators look relatively clean. In-bundle inspections are described above.

SG A - ~30 pounds (lbs.) without filter weight
SG B - ~30 lbs. without filter weight
SG C - ~ 31.5 lbs. without filter weight

10. Discuss any unexpected or unusual results.

RESPONSE: None experienced to date.

11. Provide the schedule for SG-related activities during the remainder of the current outage.

RESPONSE: Close out inspection programs, in-situ pressure test in SG A, remediate tubes as required (plug or sleeve), install manway covers.

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