IP-2 MEMORANDUM

Date: 9/15/03

From: D. Curt Ingram

To: Administrative Services (Document Control)

Subject: Calculation No. FMX-00323 Revision 01

Calculation Title: Indian Point Unit 2 Condition Monitoring and Operational Assessment RFO-15 SG-SGDA-02-45 September, 2003 Westinghouse Electric Company

QA Classification: ☒ **A** ☐ **FP** ☐ **MET** ☐ **NON-CLASS**

IP-2 Calculation Database Information

Calculation Status: ☐ **Preliminary** ☒ **As Built** ☐ **Pending** ☐ **Superseded** ☐ **Voided**

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Jeffrey Goldstein / Jeff Goldstein 9/15/03

Responsible Engineering Supervisor (Print/Sign/Date)

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Title: IP2 CMOA RFO-15 SG-SGDA-02-45 September 2003 Westinghouse

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MESSAGE: Review the subject vendor document to identify impacted procedures, licensing basis documents (e.g. Technical Specifications, FSAR), design basis documents (e.g. drawings, calculations, analyses, DBDs), programs (e.g. EQ, Fire Protection, Appendix R, ISI/IST, PRA, MOVs, AOVs, etc.) and other configuration assets (e.g. databases, equipment lists, vendor manuals), which must be updated because of the vendor document. Also, provide the name of the individual who will be responsible for the update. Sign and return the form to the originator. Upon acceptance of the vendor document the RE will assign a tracking number.

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CALCULATION COVER PAGE

☒IP-2 ☐IP-3 ☐JAF ☐PNPS

Calculation No. FMX-00323	Revision 01	Sheet 1 of 46
Title: Indian Point Unit 2 Condition Monitoring and Operational Assessment RFO-15 SG-SGDA-02-45 September, 2003 Westinghouse Electric Company		☒ QR ☐ NQR
Discipline: Engineering Programs		Design Basis Calculation? ☐ Yes ☒ No

This calculation supercedes/voids calculation: NA

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☒ No software used
☐ Software used and filed separately (Include Computer Run Summary Sheet)
☐ Software used and filed with this calculation

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(Attached additional pages if necessary)

Print / Sign

REV #	STATUS (Prel. Pend, A, V, S)	PREPARER	REVIEWER/DESIGN VERIFIER	OTHER REVIEWER/ DESIGN VERIFIER	APPROVER	DATE
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00	Original Issue	NA
01	A conservative BOC indication of 20% was assumed in section VI.B.1	CR-IP2-2003-05542

CALCULATION SUMMARY PAGE

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Calculation No. FMX-00323

Revision No. 01

CALCULATION OBJECTIVE: This report provides a summary of the Indian Point 2 steam generator tube integrity condition determined in the year 2002 refueling outage RFO 15 by NDE inspection and a projection by analysis of the tube integrity until the next planned steam generator inspection.

CONCLUSIONS: All indications in this inspection were below the calculated integrity limits and therefore met integrity requirements without further testing. Based on the inspection results, all four SGs were found in compliance with CM requirements provided in Ref 1 and 2. OA for an assumed operation duration of 4.0 EFPY for Cycle 16 and 17 confirms that the SG tube structural and leakage integrity will be maintained until the next planned SG inspection.

ASSUMPTIONS: Calculated integrity limits, including consideration for appropriate uncertainties, burst and leak analytical correlations, material properties, and NDE technique and analyst uncertainties were provided in the degradation assessment report (Reference 5).

DESIGN INPUT DOCUMENTS: N/A

AFFECTED DOCUMENTS: N/A

METHODOLOGY: The inspection at RFO 15 is at the end of the first fuel cycle after replacement, therefore all four steam generators were inspected in the current inspection. A Condition Monitoring assessment was performed, on a defect specific basis, by demonstrating compliance with integrity criteria through comparison of RFO 15 NDE measurements with calculated burst and leakage integrity limits.

Indian Point Unit 2

Condition Monitoring
and
Operational Assessment

RFO-15

SG-SGDA-02-45, REV.1

SAP: 111175

September, 2003

Westinghouse Electric Company

Authors Names	Signature / Date	For Pages
D.J. Ayres	David A. Ayres 9/5/2003	All
Verifier's Name	Signature / Date	For Pages
P. R. Nelson	Peter Nelson 9/5/03	All
Manager Name	Signature / Date	
R. J. Sterdis	RJ [signature] 9/5/03.	

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5 ☐ FOR INFORMATION

Acceptance does not constitute approval of design details, calculations, analysis, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual negotiations.

Responsible Engineer: D Curt Ingram (Print Name) D Curt Ingram (Signature) 9/15/03 (Date)

EXECUTIVE SUMMARY

This report provides a summary of the Indian Point 2 steam generator tube integrity condition, determined in the year 2002 refueling outage (RFO 15) by NDE inspection, and a projection by analysis of the tube integrity until the next planned steam generator inspection. The next inspection is planned for RFO 17 in 2006, which is at the completion of two fuel cycles. All of the activities reported in this report have been conducted in accordance with NEI 97-06 Revision 1 (Reference 1) and associated guidelines (References 2 and 3).

The RFO 15 inspection occurred at the end of the first fuel cycle after the original steam generators were replaced, therefore all four steam generators were inspected. A Condition Monitoring assessment was performed, on a defect specific basis, by demonstrating compliance with integrity criteria through a comparison of RFO 15 NDE measurements with calculated burst and leakage integrity limits. Calculated integrity limits, including consideration for appropriate uncertainties, burst and leak analytical correlations, material properties, and NDE technique and analyst uncertainties were provided in the RFO 15 degradation assessment report (Reference 5). All indications in this inspection were below the calculated integrity limits and therefore met integrity requirements without further testing. Based on the inspection results, all four steam generators were found in compliance with Condition Monitoring requirements provided in Reference 1 and 2.

An Operational Assessment for an assumed operation duration of 4.0 EFPY for Cycle 16 and 17 confirms that the steam generator tube structural and leakage integrity will be maintained until the next planned steam generator inspection.

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I. INTRODUCTION

A steam generator tube integrity condition monitoring assessment and an operational assessment have been completed for the Indian Point Unit 2 (IP2) refueling outage RFO 15 and Operating Cycles 16 and 17, respectively. The assessments have been conducted to meet the requirements and intent of NEI 97-06 Revision 1 and EPRI guideline documents (References 1 - 3).

This report provides:

- a summary of the inspection findings;
- the defect specific condition monitoring assessment of the tube structural and leakage integrity at the end of Cycle 15; and
- the operational assessment of the tube structural and leakage integrity for Cycles 16 and 17 for all steam generators.

These assessments are based on the RFO 15 inspection results. The inspection scope, as planned and expanded, is summarized in Appendix A.

The results of the steam generator tube inspection and secondary side inspection are summarized in Section II of this report. A list of tube indications detected by the primary side NDE is provided in Appendix B. The final official inspection results are provided in a separate Westinghouse report on the NDE inspection, Reference 4. The results of the secondary side search for loose parts are summarized in Section III. A detailed list of objects retrieved from the SGs and of objects remaining in the SGs is provided in Appendix C

A condition monitoring assessment was performed, on a defect specific basis, by demonstrating compliance with integrity criteria through comparison of reported NDE measurements with calculated pressure or leakage integrity limits as appropriate for the flaw indication type. The indication size calls by NDE were compared to defect-specific burst and leakage criteria specified in the degradation assessment (Reference 5). All indications were below the calculated integrity limits. Based on RFO 15 inspection results, all steam generators were determined to be in compliance with condition monitoring integrity guidelines as provided by Reference 1. The details of the defect specific condition monitoring assessment are provided in Section IV of this report.

In order to assure that the integrity criteria will continue to be satisfied, all 13 tubes that had AVB wear and the 3 tubes with volumetric indications were plugged. This is a very conservative treatment since no indication depth exceeded 20% of the tube wall thickness.

An operational assessment was performed on a defect specific basis considering the indications detected and the tube repairs performed during RFO 15. The assessment analysis was performed in accordance with the requirements of Reference 1 and the supporting EPRI guidelines (References 2-3). The results of the assessment confirm that the steam generator tube structural and leakage integrity will be maintained until the next scheduled inspection at the end of operation cycle 17, which will be after two fuel cycles of 24 months each. The details of the operational assessment analysis are provided in Section VI of this report.

This report has been independently reviewed under the requirements of the Westinghouse Nuclear Services Policies and Procedures Manual, Revision 15, October 1, 2002.

II. NDE SUMMARY

Appendix A contains the steam generator tube NDE inspection summary plan for RFO 15 and the scope expansions performed.

Appendix B contains the NDE indications found in RFO 15. Wear indications at AVBs were observed in all four steam generators. A total of thirteen tubes had indications of AVB wear. All wear indications were less than or equal to 20% through-wall (%TW). Although loose parts on the secondary side were identified in all four steam generators, no loose part wear was found by eddy current examination. There were 3 freespan volumetric indications detected. These indications were also less than 20% through-wall. Bobbin probe examination of the wear indications measured 20% through-wall depth, but plus point examination showed that the wear was double sided, indicating that the 20% through-wall wear was the sum of shallower wear on two sides. Therefore the through-wall extent at any location was less than 20% through-wall, and wear projections based on the 20% through-wall value are conservative.

Table II-1 – RFO 15 NDE Summary of Tubes with Indications

	Steam Generator 21		Steam Generator 22		Steam Generator 23		Steam Generator 24	
Defect Type	Number of tubes with indications	Maximum Depth, % through-wall	Number of tubes with indications	Maximum Depth, % through-wall	Number of tubes with indications	Maximum Depth, % through-wall	Number of tubes with indications	Maximum Depth, % through-wall
AVB Wear	6	20%	1	10%	2	20%	4	16%
Loose Part Wear	0		0		0		0	
Volumetric Indications	2	18%	0		1	19%	0	
Total Number of Tubes with Indications	8		1		3		4	

Data quality was assured by the site specific qualification of Reference 9. Data on ECT noise was obtained for all ECT techniques used and compared to the corresponding data from the preservice inspection and the EPRI ETSS database in Appendix E. The noise levels measured indicate that the detection capabilities of the inspection techniques are consistent with the detection capabilities defined in the corresponding EPRI ETSS.

III. LOOSE PARTS ASSESSMENT

Loose parts were detected in all four steam generators. The larger objects were removed, but many small objects were not retrieved. The list of objects identified and if they were retrieved is provided in Tables C1 through C4 in Appendix C. No tubes were repaired or degraded due to the presence of loose parts. The following is paraphrased from Reference 7.

During the current Fall 2002 (2R15) outage at Indian Point Unit 2, various loose objects were observed during FOSAR of the tubesheet region of the steam generators. Many of the small wires and sludge rocks in the bundle were left due to size, time and personnel exposure to retrieve. Tables C1 through C4 contain a full listing of all of the objects found during the visual inspection of the steam generators with an indication if the object was removed. The objects that remain inside the S/G can be classified into three general types of objects as indicated below:

Object Type 1 - Sludge rocks/sludge pebbles – Diameters ranging from 1/8 to 3/4 inch.
Object Type 2 - Small wires/bristles - ~ 1/64 inch diameter with maximum length of 1.5 inches
Object Type 3 - Metallic mass, oval shaped- ~1/2 inch x 1/4 inch

The purpose of Reference 7 is to document calculations performed to determine the effects of leaving these objects in the steam generators. These calculations have been performed specifically for the most limiting of each type of object, however the results of this limiting calculation would conservatively envelope the less limiting objects. The amount of time required for these objects to wear a tube down to a minimum, yet still acceptable, tube wall thickness has been determined. The minimum acceptable tube wall thickness is the same as the structural repair limit or tube plugging limit of 40% depth or 60% remaining.

The analysis has been completed assuming that objects are located at the tube that exhibits the limiting amplitudes of vibration and cross flow fluid velocity, and that this tube has existing 20% through wall degradation. The evaluation also assumes that the objects rests upon a sludge pile approximately 6 inches deep (at this elevation, tube vibration amplitudes are larger than those at the top of the tubesheet). This is very conservative because the actual sludge pile is less than 1/4 inch deep. Additional conservative assumptions are made in that the object will remain in the same location (once tube wear begins), and that only the tubes will experience wear. With respect to the steam generator operating conditions, the effects of the 1.4% power uprate have also been considered.

As indicated above the analysis has been performed assuming that a small degree of undetected wear (20% depth which is very conservative for the limit of detection) has occurred on the limiting tube. The assumption of essentially no tube degradation has been verified via eddy current inspection of the steam generators.

The evaluation shows that the time required for the limiting sludge rock type object to wear a tube down to 40% through wall (assuming 20% initial tube wear) is greater than 2 operating cycles.

The evaluation shows that the time required for the limiting wire bristle type object to wear a tube down to 40% through wall (assuming 20% initial tube wear) is greater than 2 operating cycles.

The evaluation shows that the time required for the metallic mass rock-like mass, object type 3, to wear a tube down to 40% through wall (assuming 20% initial tube wear) is greater than 2 operating cycles.

An analysis has also been performed to determine the effect on the tubes should the material begin to migrate and repeatedly contact the tubes (impacting only analysis). A conservative analysis was performed assuming that the maximum possible weight of the largest loose object is less than 0.1 lbs. This weight conservatively bounds the weight of any of the known objects remaining inside the S/Gs. The analysis has determined that the energy that the postulated loose object would impart on a tube during repeated collisions is sufficiently low that significant deformation of the tubes due to impacting only is not expected.

In summary, the analysis has determined that continued S/G operation with the objects known to be present in the secondary side as described in Tables 1 through 4 will not adversely affect the steam generator for the next two 24 month operating cycles. At the end of this period of time, FOSAR should be performed to attempt to remove these objects from the steam generators if they are still in the same location in the steam generators, or eddy current testing should be performed to detect the presence of wear.

IV. CONDITION MONITORING

A. Defect Specific Approach

A defect specific approach based on EPRI Steam Generator Tube Integrity Report (Reference 2) was used to determine steam generator tube integrity. Consistent with the approach identified in the pre-outage degradation assessment report (Reference 5), an assessment based on NDE depth was used for wear degradation forms detected. The degradation assessment provided information for addressing a number of potential degradation types. The information provided in this report is focused on the degradation types actually detected in the RFO 15 inspection.

B. AVB Wear

AVB wear was detected in all four steam generators. The location and indication depth are shown in Tables IV-1 through IV-4.

Table IV-1 – Wear in SG 21

Tube	Row	Col	Volts	Depth, %TW	Location (Distance from center of AVB in inches)	
1	44	43	0.31	9	AV3	-0.08"
			0.33	10	AV4	-0.03"
2	45	45	0.51	17	AV1	0
			0.64	20	AV2	-0.03"
			0.64	20	AV3	+0.11"
			0.36	14	AV4	-0.08"
3	38	47	0.32	13	AV2	+0.11"
			0.46	16	AV3	0
4	45	47	0.37	14	AV1	0
			0.53	18	AV2	0
5	28	50	0.21	10	AV3	0
			0.38	14	AV4	0
6	28	79	0.28	12	AV3	-0.34"

Table IV-2 – Wear in SG 22

Tube	Row	Col	Volts	Depth, %TW	Location (Distance from center of AVB in inches)	
1	39	37	0.25	10	AV3	+0.03"

Table IV-3 – Wear in SG 23

Tube	Row	Col	Volts	Depth, %TW	Location (Distance from center of AVB in inches)	
1	41	46	0.22	12	AV1	0
			0.37	17	AV2	0
			0.49	20	AV3	-0.2"
			0.37	17	AV4	0
2	41	61	0.3	13	AV3	-0.11"

Table IV-4 – Wear in SG 24

Tube	Row	Col	Volts	Depth, %TW	Location (Distance from center of AVB in inches)	
1	41	41	0.39	14	AV2	0.11"
			0.43	15	AV3	-0.05"
			0.49	16	AV4	-0.03"
2	34	51	0.33	12	AV2	0.14"
3	36	64	0.28	11	AV3	-0.03"
			0.32	12	AV4	-0.06"
4	36	66	0.28	11	AV1	0.06"

The deepest wear indication is 20% of the tube wall thickness, which is well below the 63% condition monitoring limit developed in the degradation assessment. The plus point determination that the deepest indications were two-sided wear adds additional conservatism. Therefore all AVB wear indications meet the condition monitoring structural integrity and leakage criteria.

C. Loose Parts Wear

Although loose parts were found as discussed in Section III, no tube degradation due to the loose parts was found. Therefore there is no challenge to the tube integrity and leakage criteria due to loose parts.

D. Volumetric Indications

Three freespan volumetric indications were detected and are summarized in Tables IV-5 and IV-6.

Table IV-5 – Volumetric Indications in SG 21

Tube	Row	Col	Volts	Depth, %TW	Location (inches)	
1	16	28	0.09	18	5H	+5.63"
2	21	56	0.09	18	TSH	+18.13"

Table IV-6 – Volumetric Indication in SG 23

Tube	Row	Col	Volts	Depth, %TW	Location (inches)	
1	27	33	0.12	19	5H	+37.98"

All three volumetric indications are well below the condition monitoring limits for structural and leakage integrity established in the degradation assessment. Experience with other plants has shown that tubes with Alloy 600 TT material have a tendency to develop freespan indications during the first cycle of operation. At IP2 many signals were detected by bobbin that did not exist in the preservice inspection. All of these indications were tested with plus point and only three were reported as volumetric indications by plus point. There is no basis for suspecting that these indications are due to a corrosive mechanism. It is presumed that these volumetric indications were caused by a transient loose part, or perhaps were deep buff marks that became indications after the sustained heating of the operation cycle.

V. TUBE REPAIRS

All thirteen tubes with AVB wear indications were plugged even though the wear depth was significantly below the plugging limit. It is recommended that the tubes with wear indications at all four AVB supports (SG 21 R45 C45 and SG 23 R41 C46) be stabilized. This stabilization does not need to be accomplished for at least two operational cycles as discussed in Reference 8, which is presented in Appendix D. Wear projection analyses are required to provide a more quantitative assessment of the latest time to install the cable dampener in the two tubes at issue.

All three tubes with freespan volumetric indications were plugged even though the indication depth was significantly below the plugging limit.

VI. OPERATIONAL ASSESSMENT

A. Operational Assessment Overview

The operational assessment of the steam generators requires the consideration of growth of degradation to assess if the structural and leak integrity of the Indian Point 2 steam generators will be maintained during the next operation cycles. The only observed degradation with potential growth is the AVB wear. Operating condition changes for a potential power uprate of 1.4% would have negligible impact on degradation since AVB wear is not temperature dependent, and flow changes should be minimal. Since the tubes with wear indications were plugged, and the wear rate is expected to show a significant decrease with operating time, it is reasonable to expect that the Indian Point 2 steam generator tube structural and leakage integrity requirements will be maintained through the next two operating cycles.

The Operational Assessment process of evaluating the condition of the steam generator tubes during the next cycles of operation requires that the steam generator tubes meet specified performance criteria that provide reasonable assurance of adequate tube structural and leakage integrity at the end of the next inspection interval.

The operational assessment consists of four parts:

1. the size of the largest flaws of each type that are present at the beginning of the next operating cycle.
2. the estimation of the size of the largest flaws that will be present at the end of the next inspection interval.
3. the demonstration that the largest flaw of each type will meet the structural integrity criterion at the next inspection.
4. the demonstration that at the end of the next inspection interval the total leakage at MSLB conditions will meet the leakage criterion.

This Operational Assessment of the IP2 steam generators is based on the inspection results summarized in Section II of this report and provided in Appendix B. This assessment has been conducted in accordance with the requirements of NEI 97-06 Rev.1 and EPRI Tube Integrity Assessment Guidelines (References 1 and 2). This report provides a demonstration based on the NDE data acquired that the structural and leakage criteria will be maintained in all steam generators throughout the estimated 4.0 effective full power years of Cycles 16 and 17.

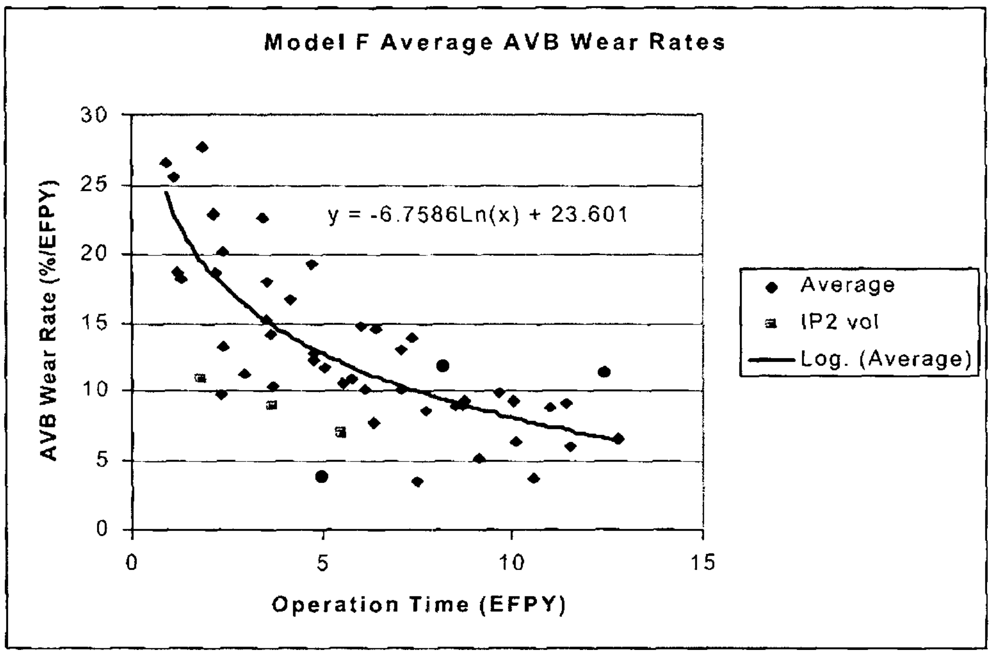
B. Indication Specific Operational Assessment

1. <u>AVB Wear</u>

The Tube Integrity Guidelines (Reference 2) suggest using the largest flaw left in service or the depth of flaw with a fraction detected < 95% from the appropriate ETSS. All tubes exhibiting AVB Wear were plugged. The fraction detected for flaws in the 0% to 19% depth range in the ETSS 96004.1 is 100% with the minimum flaw depth in the 0% to 19% depth population given in the ETSS as 4%. Therefore a 4% depth could be used as the assumed beginning of cycle (BOC) indication. A conservative estimate of the maximum depth of wear scar left in service would be the maximum depth detected. The maximum wear detected was 20% (Tables IV-1-4) through-wall in one cycle. If the same rate would continue to occur in a tube with an initial depth of 20%, then the depth could be as large as 20% + 20% x 2 = 60% through-wall at the end of the next two cycles which would be below the condition monitoring limit of 63% (which includes consideration of NDE uncertainties). Therefore either tube integrity guideline option satisfies the operational assessment requirement.

Wear rates, however, are known to decrease with time as shown in Figure VI-1 (a similar figure was presented in Reference 10). Therefore the assumption of constant growth leads to a very conservative degradation prediction. In addition as discussed previously, the plus point showed that the wear was two sided, providing additional conservatism to the projection of through-wall wear.

Figure VI-1



In the Figure legend, "Average" means the average growth rate for a particular model F plant at the given operation time. The value of the model F plant growth rates may not be representative of IP2 growth rates, but the trends with operating time are expected to be similar because the AVB design and materials are similar. The "IP2 Vol" points on the Figure show the prediction of wear rate for IP2 starting at the maximum measured value of 20% through-wall in the first cycle, and continuing in time as a constant volume wear rate. Both the model F data and the assumption of constant volume wear rate indicate a significant reduction in growth rate with operating time. The similarity of the slope of the curve fitted to the model F data and the slope of the "IP2 Vol" points shows that the constant volume wear rate is a reasonable explanation for the observed reduction of wear rate with increasing operation time. This reduction of the growth rate with operating time provides additional assurance of the acceptability of operation until the next planned steam generator inspection. Appendix D addresses the issue of the potential for continued wear after plugging and the need to stabilize the tubes at a future time.

2. Loose Parts Wear

No wear was detected due to loose parts. The location of all possible loose part signals were reviewed from the secondary side on tape, or re-looked to verify no foreign object was on the tube. If no object was present the cause of the signal is likely to be sludge. If an object was observed it was removed if possible or left if it was unable to be retrieved. The wear that could result from the loose parts that were identified and remain in the steam generators was evaluated in Section III. The result of that evaluation is that wear conservatively predicted will not reach the plugging limit for more than 2 cycles of operation. Therefore the operational assessment integrity criteria will be satisfied for at least the next two cycles of operation.

3. Volumetric Indications

The tubes with freespan volumetric indications detected were plugged. Tubes with Alloy 600 TT material have a tendency to develop freespan indications during the first cycle of operation. At IP2 many signals were detected by bobbin that did not exist in the pre-service inspection. All of these indications were tested with plus point and only three were reported as volumetric indications by plus point. There is no basis for suspecting that these indications are due to a corrosive mechanism. It is presumed that these volumetric indications were caused by a transient loose part, or perhaps were deep buff marks which became indications after the sustained heating of the operation cycle.

4. Potential Degradation

Potential degradation modes described in the Degradation Assessment, Reference 5, were not detected and are not anticipated to develop during the next operating cycles. Therefore those degradation modes are not expected to impact the integrity of the steam generators.

VII. CM/OA RESULTS AND CONCLUSIONS

A condition monitoring assessment for the 2002 refueling outage and an operational assessment have been completed.

A total of 16 tubes with volumetric indications were detected by NDE including:

1. 13 tubes with Wear at AVBs
2. 3 tubes with Volumetric Freespan Indications

All indications had measured depths well below their respective structural and leakage condition monitoring limit. Therefore all detected indications were determined to meet the performance criteria recommended in NEI 97-06, Revision 1. The Indian Point 2 Condition Monitoring for RFO 15 complies with the guidance of NEI 97-06, Revision 1, and demonstrates that the structural and leakage criteria for all steam generators are satisfied.

The operational assessment demonstrated that there is reasonable assurance that the two observed degradation modes will not lead to a predicted flaw of any type that would equal or exceed its respective structural or leakage limit at the end of the next two operation cycles. The Indian Point 2 Operational Assessment for all four steam generators complies with the guidance of NEI 97-06, Revision 1, and demonstrates that the Indian Point 2 Steam Generators are expected to continue to meet the leakage and structural integrity performance criteria for the duration of Cycles 16 and 17.

VIII. REFERENCES

1. NEI 97-06, Rev.1, "Steam Generator Program Guidelines," January, 2001.
2. EPRI Report TR-107621, Rev. 1, "Steam Generator Integrity Assessment Guidelines: Revision 1," March 2000.
3. EPRI Report TR-107569-V1R5, "PWR SG Examination Guidelines: Revision 5," September 1997.
4. Westinghouse Report, "Indian Point 2 RFO15 Fall 2002 RSG Eddy Current Dataroom Summary," Rev. 0, 11/20/02.
5. Westinghouse Report SG-SGDA-02-29, Rev.0, "Steam Generator Degradation Assessment for Indian Point Unit 2 RFO 15," September 2002.
6. Westinghouse Field Service Report, Indian Point 2 RSG Pre-Service Inspection, Summer 2000.
7. Westinghouse Letter, LTR-SGDA-02-369, Revision 1, "Evaluation of Foreign Objects in the Steam Generators at Indian Point Unit 2 During 2R15," November 22, 2002.
8. Westinghouse Letter, LTR-SGDA-02-372, Revision 1, "Stabilization Recommendations to Address Indian Point Unit 2 AVB Wear Identified During RFO15," November 15, 2002.
9. Westinghouse Report, MRS-TRC-1291, Rev. 0, "Use of Appendix H Qualified Techniques at Indian Point Fall 2002," September 19, 2002.
10. "Extended Inspection Intervals", by H. Lagally and R. Lieder, EPRI Steam Generator NDE Conference, July 2001.

APPENDIX A

RFO 15 NDE Inspection Plan

The planned scope for the IP2 RFO 15 outage was as follows:

- 100% bobbin in all 4 S/G's except U-bend portion of Row 1 and 2
- 100% Row 1 and 2 U-bend plus point RPC in all 4 S/G's
- 20% H/L TTS ±3 inches plus point RPC
- 100% H/L TTS periphery ±3 inches plus point RPC
- 20% H/L DNRs plus point RPC
- 40% Dings > 5 volts plus point RPC (consistent with ALARA & Schedule)
- 100% of bobbin "I codes"
- 4 selected tubes from PSI for plus point RPC (Reference 6):
  SG 21: R28C50 VOL at TSC - 1.81
  SG 24: R22C80 VOL at 4C + 32.42
  SG 21: R9C89 IDV at 6H - 2.21
  SG 23: R2C33 IDV at TSH - 2.28

RFO 15 NDE Inspection Completed Scope

The completed scope for the IP2 RFO 15 outage was as follows (Detailed description is available in Reference 10):

- 100% bobbin in all 4 S/G's except U-bend portion of Row 1 and 2
- 100% Row 1 and 2 U-bend plus point RPC in all 4 S/G's
- 20% H/L TTS ±3 inches plus point RPC (26 – 27% when including periphery)
- 100% H/L TTS periphery ±3 inches plus point RPC
- 100% H/L DNRs plus point RPC (Total of 9)
- 100% Dings > 5 volts plus point RPC (Total of 21)
- 991 special Interest (included 1074 bobbin I codes)
  - The IDV's from the PSI were selected because this code is not used in present guidelines and they were signals of interest for tracking purposes. All ended up as either NDF or reported as TRA (trackable anomalies).
- 51 TTS plus point RPC to bound Possible Loose Parts (PLP)
- 100% C/L TTS periphery ±3 inches plus point RPC (In order to perform a more complete search for loose parts)

APPENDIX B – NDE Indication Results Table

Table B-1 – Indication Results for SG 21

Row	Col	Volts	Ind.	Depth, %TW	Location	Distance, Inches	Probe Type	Comments
16	28	0.2	NQI		5H	5.9	Bobbin	RESULT OF HISTORY REVIEW
16	28	0.09	VOL		5H	5.66	Plus Point	
16	28	0.09	PCT	18	5H	5.63	Plus Point	TUBE PREVENTIVE PLUGGED BASED ON +POINT VOLUMETRIC RESPONSE
44	43	0.31	PCT	9	AV3	-0.08	Bobbin	RESULT OF RESOLUTION PROCESS
44	43	0.33	PCT	10	AV4	-0.03	Bobbin	RESULT OF RESOLUTION PROCESS
44	43							TUBE PREVENTIVE PLUGGED DUE TO AVB WEAR
44	43	0.22	PLP		TSH	0.42	Plus Point	RESULT OF RESOLUTION PROCESS
45	43	0.27	PLP		TSH	0.21	Plus Point	
44	44	0.35	PLP		TSH	0.04	Plus Point	RESULT OF RESOLUTION PROCESS
45	45	0.76	VOL		AV3	-0.02	Plus Point	RESULT OF RESOLUTION PROCESS
45	45	0.77	VOL		AV3	0	Plus Point	RESULT OF RESOLUTION PROCESS
45	45	0.81	VOL		AV4	-0.01	Plus Point	RESULT OF RESOLUTION PROCESS
45	45	0.31	VOL		AV4	0	Plus Point	RESULT OF RESOLUTION PROCESS
45	45	0.51	PCT	17	AV1	0	Bobbin	
45	45	0.64	PCT	20	AV2	-0.03	Bobbin	TUBE PREVENTIVE PLUGGED DUE TO AVB WEAR
45	45	0.64	PCT	20	AV3	0.11	Bobbin	
45	45	0.36	PCT	14	AV4	-0.08	Bobbin	
45	45	0.42	VOL		AV1	0	Plus Point	
45	45	0.41	VOL		AV1	0.07	Plus Point	
45	45	0.28	VOL		AV2	-0.02	Plus Point	
45	45	0.32	VOL		AV2	0.03	Plus Point	
1	47	0.3	PLP		TSH	0.05	Plus Point	
38	47	0.32	PCT	13	AV2	0.11	Bobbin	
38	47	0.46	PCT	16	AV3	0	Bobbin	TUBE PREVENTIVE PLUGGED DUE TO AVB WEAR
45	47	0.37	PCT	14	AV1	0	Bobbin	
45	47	0.53	PCT	18	AV2	0	Bobbin	RESULT OF RESOLUTION PROCESS
45	47							TUBE PREVENTIVE PLUGGED DUE TO AVB WEAR
28	50	0.21	PCT	10	AV3	0	Bobbin	RESULT OF HISTORY REVIEW
28	50	0.38	PCT	14	AV4	0	Bobbin	RESULT OF RESOLUTION PROCESS
28	50							TUBE PREVENTIVE PLUGGED DUE TO AVB WEAR
21	56	0.53	NQI		TSH	18.39	Bobbin	RESULT OF HISTORY REVIEW
21	56	0.1	VOL		TSH	18.13	Plus Point	
21	56	0.09	PCT	18	TSH	18.13	Plus Point	TUBE PREVENTIVE PLUGGED BASED ON +POINT VOLUMETRIC RESPONSE
42	59	0.33	PLP		TSH	0.07	Plus Point	RESULT OF RESOLUTION PROCESS
42	60	0.36	PLP		TSH	0.27	Plus Point	RESULT OF RESOLUTION PROCESS
28	79	0.28	PCT	12	AV3	-0.34	Bobbin	RESULT OF RESOLUTION PROCESS
28	79							TUBE PREVENTIVE PLUGGED DUE TO AVB WEAR

Table B-2 – Indication Results for SG 22

Row	Col	Volts	Ind.	Depth,%TW	Location	Distance, Inch	Probe type	Comments
39	37	0.25	PCT	10	AV3	0.03	Bobbin	RESULT OF RESOLUTION PROCESS
39	37							TUBE PREVENTIVE PLUGGED DUE TO AVB WEAR
1	46	0.28	PLP		TSC	0.2	Plus Point	

Table B-3 – Indication Results for SG 23

Row	Col	Volts	Ind.	Depth,%TW	Location	Distance, Inches	Probe type	Comments
27	33	0.13	NQI		5H	37.98	Bobbin	RESULT OF HISTORY REVIEW
27	33	0.12	VOL		5H	37.89	Plus Point	TUBE PREVENTIVE PLUGGED BASED ON +POINT VOLUMETRIC RESPONSE
27	33	0.12	PCT	19	5H	37.98	Plus Point	RESULT OF HISTORY REVIEW
41	46	0.27	VOL		AV3	0	Plus Point	RESULT OF RESOLUTION PROCESS
41	46	0.22	VOL		AV3	0.08	Plus Point	RESULT OF RESOLUTION PROCESS
41	46	0.42	VOL		AV4	0	Plus Point	RESULT OF RESOLUTION PROCESS
41	46	0.22	PCT	12	AV1	0	Bobbin	RESULT OF RESOLUTION PROCESS
41	46	0.37	PCT	17	AV2	0	Bobbin	RESULT OF RESOLUTION PROCESS
41	46	0.49	PCT	20	AV3	-0.2	Bobbin	RESULT OF RESOLUTION PROCESS
41	46							TUBE PREVENTIVE PLUGGED DUE TO AVB WEAR
41	46	0.37	PCT	17	AV4	0	Bobbin	RESULT OF RESOLUTION PROCESS
1	47	0.12	PLP		TSC	0.12	Plus Point	RESULT OF RESOLUTION PROCESS
41	61	0.3	PCT	13	AV3	-0.11	Bobbin	TUBE PREVENTIVE PLUGGED DUE TO AVB WEAR

Table B-4 – Indication Results for SG 24

Row	Col	Volts	Ind.	Depth,%TW	Location	Distance, Inches	Probe type	Comments
41	41	0.39	PCT	14	AV2	0.11	Bobbin	
41	41	0.43	PCT	15	AV3	-0.05	Bobbin	
41	41	0.49	PCT	16	AV4	-0.03	Bobbin	TUBE PREVENTIVE PLUGGED DUE TO AVB WEAR
34	51	0.33	PCT	12	AV2	0.14	Bobbin	TUBE PREVENTIVE PLUGGED DUE TO AVB WEAR
36	64	0.28	PCT	11	AV3	-0.03	Bobbin	RESULT OF RESOLUTION PROCESS
36	64	0.32	PCT	12	AV4	-0.06	Bobbin	RESULT OF RESOLUTION PROCESS
36	64							TUBE PREVENTIVE PLUGGED DUE TO AVB WEAR
36	66	0.28	PCT	11	AV1	0.06	Bobbin	RESULT OF RESOLUTION PROCESS
36	66							TUBE PREVENTIVE PLUGGED DUE TO AVB WEAR

APPENDIX C
Loose Part Inventory

Table C-1 – Objects Found in S/G 21

Item #	LOCATION	DESCRIPTION	DIMENSIONS	RETRIEVED YES / NO
1	CL R30C25	Wire Bristle	3/8" L X 1/64" Dia.	No
2	CL R28C30	Wire Bristle	1/4" L X 1/64" Dia.	No
3	CL R43C40	Sludge Rock	1/4" X 1/4"	No
4	CL R43C40	Sludge Rock	1/4" X 1/4"	No
5	CL R42C40	Wire Bristle	3/8" L X 1/64" Dia.	No
6	CL R41C40	Assorted Wire Bristle	1/8" to 3/8" L X 1/64" Dia.	No
7	**CL R45C43**	**Weld Slag**	**1/4" W X 3/16" H X 1" L**	**YES**
8	CL R40C43	Wire Bristle	1/16" W X 1/64" Thick X 1/4" L	No
9	CL R40C43	Wire Bristle	3/8" L X 1/64" Dia.	No
10	CL R38C43	Assorted Wire Bristle	1/8" to 3/8" L X 1/64" Dia.	No
11	CL R36C43	Wire Bristle	3/8" L X 1/64" Dia.	No
12	CL R34C43	Wire Bristle	3/8" L X 1/64" Dia.	No
13	CL R32C43	Wire Bristle	1/4" L X 1/64" Dia.	No
14	HL R27C20	Wire Bristle	1/4" L X 1/64" Dia.	No
15	HL R43C35	Wire Bristle	3/16" L X 1/64" Dia.	No
16	HL R41C40	Assorted Wire Bristle	1/8" to 3/8" L X 1/64" Dia.	No
17	HL R31C40	Wire Bristle	1/4" L X 1/64" Dia.	No
18	HL R40C43	Wire Bristle	1/4" L X 1/64" Dia.	No
19	HL R40C43	Sludge Rock	1/8" X 1/8"	No
20	HL R38C43	Wire Bristle	1/4" L X 1/64" Dia.	No
21	HL R38C43	Sludge Rock	1/8" X 1/8"	No
22	HL R37C43	Wire Bristle	3/8" L X 1/64" Dia	No
23	HL R35C43	Wire Bristle	3/8" L X 1/64" Dia	No
24	HL R10C43	Assorted Wire Bristle	1/8" to 3/8" L X 1/64" Dia.	No
25	HL R10C43	Assorted Wire Bristle	1/8" to 3/8" L X 1/64" Dia.	No
26	CL R34C62	Wire Bristle	1/4" L X 1/64" Dia.	No
27	CL R33C62	Wire Bristle	1/4" L X 1/64" Dia.	No
28	CL R32C62	Wire Bristle	1/4" L X 1/64" Dia.	No
29	CL R28C62	Wire Bristle	1/8" L X 1/64" Dia.	No
30	CL R43C57	Sludge Rock	1/8" X 1/8"	No
31	CL R40C57	Wire Bristle	1/4" L X 1/64" Dia.	No

Table C-1 (Continued) – Objects Found in S/G 21

Item #	LOCATION	DESCRIPTION	DIMENSIONS	RETRIEVED YES / NO
32	CL R34C57	Wire Bristle	1/4" L X 1/64" Dia.	No
33	CL R31C57	Wire Bristle	1/4" L X 1/64" Dia.	No
34	CL R30C57	Wire Bristle	1/4" L X 1/64" Dia.	No
35	CL R23C57	Wire Bristle	1/4" L X 1/64" Dia.	No
36	CL R18C57	Wire Bristle	1/8" L X 1/64" Dia.	No
37	CL R37C52	Wire Bristle	1/8" L X 1/64" Dia.	No
38	CL R27C52	Wire Bristle	1/8" L X 1/64" Dia.	No
39	HL R14C87	Wire Bristle	1/8" L X 1/64" Dia.	No
40	HL R41C62	Assorted Wire Bristle	1/8" to 3/8" L X 1/64" Dia.	No
41	HL R40C62	Assorted Wire Bristle	1/8" to 3/8" L X 1/64" Dia.	No
42	HL R39C62	Assorted Wire Bristle	1/8" to 3/8" L X 1/64" Dia.	No
43	HL R43C57	Assorted Wire Bristle	1/8" to 3/8" L X 1/64" Dia.	No
44	HL R42C57	Assorted Wire Bristle	1/8" to 3/8" L X 1/64" Dia.	No
45	HL R40C57	Assorted Wire Bristle	1/8" to 3/8" L X 1/64" Dia.	No
46	HL R41C56	Wire Bristle	3/8" L X 1/64" Dia	No
47	HL R37C56	Wire Bristle	1/8" L X 1/64" Dia.	No
48	HL R32C56	Wire Bristle	1/8" L X 1/64" Dia.	No
49	HL R41C54	Wire Bristle	3/8" L X 1/64" Dia	No
50	HL R37C54	Wire Bristle	3/8" L X 1/64" Dia	No
51	HL R42 C59/60	Metallic Mass Rock-Like, Oval Shape	1/2" x 1/4"	No

Table C-2 – Objects Found in S/G 22

Item #	LOCATION	DESCRIPTION	DIMENSIONS	RETRIEVED YES / NO
1	**HL R29C15**	**Flexitalic Gasket**	**2"L X 3/16"**	**YES**
2	HL R19C15	Wire Bristle	3/8"L X 1/64"	No
3	HL R23C20	Wire Curl	1/4" high X 1/64"	No
4	HL R20C20	Wire Bristle	3/8"L X 1/64"	No
5	HL R32C25	Wire Bristle	1/2"L X 1/64"	No
6	HL R27C25	Wire Bristle	3/8"L X 1/64"	No
7	HL R40C30	Wire Bristle Pile	3/8"L X 1/64"	No
8	HL R38C30	Wire Bristle	3/8"L X 1/64"	No
9	HL R38C35	Wire Bristle	1/4" L X 1/64"	No
10	HL R37C35	Assorted Wire Bristle	1/4" L X 1/64" to 3/8"L x 1/64"	No
11	HL R12C40	Assorted Wire Bristle / Collaring	1/4" L X 1/64" to 3/8"L x 1/64"	No
12	HL R11C40	Wire Bristle	5/8" L X 1/64" Dia.	No
13	HL R42C43	Wire Bristle	1/2" L X 1/64" Dia.	No
14	CL R18C5	Anomaly In Tube Sheet (Treated As Sludge)	1/4" W X 3/4"L X 1/32" Deep	N/A
15	CL R26C10	Sludge Rock	1/4" X 3/8"	No
16	CL R23C10	Assorted Wire Bristle	1/4" L X 1/64" to 3/8"L X 1/64"	No
17	CL R22C10	Assorted Wire Bristle	1/4" L X 1/64" to 3/8"L x /64"	No
18	CL R18C10	Wire Bristle	3/8"L X 1/64" Dia.	No
19	CL R13C10	Wire Bristle	1/2"L X 1/64" Dia.	No
20	CL R8C15	Wire Bristle	1/4" L X 1/64" Dia.	No
21	CL R29C15	Wire Bristle	3/8"L X 1/64" Dia.	No
22	CL R23C15	Assorted Wire Bristle	1/4" L X 1/64" to 3/8"L x 1/64"	No
23	CL R15C15	Wire Bristle	3/8"L X 1/64" Dia.	No
24	CL R35C20	Assorted Wire Bristle	1/4" L X 1/64" to 1/2"L x 1/64"	No
25	CL R15C20	Wire Bristle	3/8"L X 1/64" Dia.	No
26	CL R7C20	Wire Bristle	3/8"L X 1/64" Dia.	No
27	CL R39C40	Wire Bristle	3/8"L X 1/64" Dia.	No
28	CL R28C72	Wire Curl	1/4" H X 1/4"L X 1/64" Dia.	No
29	HL R38C57	Wire Bristle	3/8"L X 1/64" Dia.	No
30	HL R34C52	Wire Bristle	3/8"L X 1/64" Dia.	No

Table C-3 – Objects Found in S/G 23

Item #	LOCATION	DESCRIPTION	DIMENSIONS	RETRIEVED YES / NO
1	CL R29C30	Wire Bristle	3/4"L x 1/64" Dia.	No
2	CL R32C35	Wire Bristle	1/4"L x 1/64" Dia.	No
3	CL R32C35	Wire Bristle	1/4"L x 1/64" Dia.	No
4	CL R38C40	Wire Bristle	1/4"L x 1/64" Dia.	No
5	CL R32C40	Wire Bristle	1/4"L x 1/64" Dia.	No
6	CL R30C40	Wire Bristle	1/4"L x 1/64" Dia.	No
7	CL R40C43	Wire Bristle	1/8"L x 1/64 Dia.	No
8	CL R35C43	Wire Bristle	3/4"L x 1/64 Dia.	No
9	CL R28C43	Wire Bristle	3/4"L x 1/64 Dia.	No
10	HL R27C20	Wire Bristle	1/2"L x 1/64 Dia.	No
11	HL R25C20	Wire Bristle	1/2"L x 1/64 Dia.	No
12	HL R23C20	Wire Bristle	1/2"L x 1/64 Dia.	No
13	HL R35C25	Wire Bristle	3/4"L x 1/64 Dia.	No
14	HL R32C25	Sludge Rock	1/8" Dia.	No
15	HL R35C30	Wire Bristle	1/3"L x 1/64"	No
16	HL R32C30	Wire Bristle	1/2" x 1/64"	No
17	HL R41C35	Wire Bristle	1 1/2"L x 1/64" Dia.	No
18	HL R37C35	Wire Bristle	1"L x 1/64" Dia.	No
19	HL R35C35	Sludge Rock	1/3" Dia.	No
20	HL R31C35	Wire Bristle	1/3"L x 1/64" Dia.	No
21	**HL R42C40**	**Weld Slag**	**3/4" x 1/3"**	**Yes**
22	**HL R42C40**	**Weld Slag**	**3/4" x 1/3"**	**Yes**
23	HL R39C40	Wire Bristle	1"L x 1/64" Dia.	No
24	CL R32C67	Wire Bristle	1/2"L x 1/64 Dia.	No
25	CL R35C62	Wire Bristle	1/4"L x 1/64 Dia.	No
26	CL R35C57	Wire Bristle	1/4"L x 1/64 Dia.	No
27	CL R35C52	Wire Bristle	1/2'L x 1/64 Dia.	No
28	HL R42C67	Wire Bristle	1/2"L x 1/64 Dia.	No
29	HL R43C57	Wire Bristle	1/2" x 1/2" x 1/2" x 1/8" W	Yes

Table C-4 – Objects Found in S/G 24

Item #	LOCATION	DESCRIPTION	DIMENSIONS	RETRIEVED YES / NO
1	**HL annulus**	**Steel Block w/ Bolt**	**1" X 1/64"Dia.**	**Yes**
2	**HL annulus**	**Steel Block**	**1" X 1/64"Dia.**	**Yes**
3	**HL annulus**	**Block Magnet**	**1" X 2" X 3/8"**	**Yes**
4	**HL annulus**	**Block Magnet**	**1" X 2" X 3/8"**	**Yes**
5	**HL annulus**	**Block Magnet**	**1" X 2" X 3/8"**	**Yes**
6	**HL annulus**	**Block Magnet**	**1" X 2" X 3/8"**	**Yes**
7	**HL annulus**	**Block**	**1" X 2" X 1/4"**	**Yes**
8	**HL annulus**	**Block**	**1" X 2" X 1/4"**	**Yes**
9	**HL annulus**	**Block**	**1" X 2" X 1/4"**	**Yes**
10	HL R42C35	Sludge Pebble	1/8" X 1/16"	No
11	HL R39C35	Wire Bristle	1/2" X 1/64" Dia.	Yes
12	HL R32C35	Wire Bristle	5/8" X 1/64" Dia.	Yes
13	HL R15C35	Wire Bristle	1/2" X 1/64" Dia.	Yes
14	HL R43C40	Rivet	3/16" Dia. X 1/2"lg.	Yes
15	HL R42C40	Wire Bristle	5/8" X 1/64" Dia.	No
16	HL R31C40	Wire Bristle	3/8" X 1/64"Dia.	No
17	HL R20C40	Wire Bristle	3/8"X 1/64"Dia.	Yes
18	HL R41C43	Sludge Rock	1/4" X 3/16"	No
19	HL R12C43	Wire Bristle	1/2" X 1/64"Dia.	No
20	HL R11C43	Wire Bristle	X 1/64"Dia.	No
21	HL R10C43	Sludge Pebble	1/4" X 1/4"	No
22	CL R31C35	Wire Bristle	3/8" X 1/64"Dia.	No
23	CL R42C43	Sludge Rock	1/4" X 3/16"	No
24	HL R40C52	Wire Bristle	3/8" X 1/64"Dia.	No
25	HL R40C52	Wire Bristle	3/8" X 1/64"Dia.	No
26	HL R39C52	Sludge Rock	3/16" X 3/16"	No
27	HL R35C52	Wire Bristle	1/2" X 1/64"Dia.	No
28	**HL R37-38C22-24**	**Metal Lever**	**2 5/8 " x 1/4" x 1/4"**	Yes

APPENDIX D

Stabilization Recommendations

To: David J. Ayres
cc: R. J. Sterdis
P. R. Nelson

Date: November 15, 2002

From: Hermann O. Lagally

Your ref:

Ext: WIN 224-5082

Our ref: LTR-SGDA-02-372, Rev. 1

Fax: WIN 224-5889

Subject: **Stabilization Recommendations to Address Indian Point Unit 2 AVB Wear Identified During RFO15**

During the RFO15 inspection of Indian Point 2, AVB wear was reported in thirteen tubes in the 4 SG as shown on the following table.

SG	Row	Col	AVB1 Wear Depth (%TW)	AVB2 Wear Depth (%TW)	AVB3 Wear Depth (%TW)	AVB4 Wear Depth (%TW)
21	44	43	-	-	9	10
	45	45	17	20	20	14
	38	47	-	13	16	-
	45	47	14	18	-	-
	28	50	-	-	10	14
	28	79	-	-	12	-
22	39	37	-	-	10	-
23	41	46	12	17	20	17
	41	61	-		13	-
24	41	41	-	14	15	16
	34	51	-	12		-
	36	64	-	-	11	12
	36	66	11	-	-	-

Indian Point elected to administratively plug these tubes to maintain the option for an extended operating period until the next inspection of the SGs. Westinghouse recommended installation of a cable dampener in tubes 21-45/45 and 23-41/46, but noted that the installation of the dampener was optional at this time. The purpose of this letter is to discuss the rationale for this recommendation and to clarify the timing for installation of the cable dampener.

Tube wear at the AVBs continues after a tube is removed from service due to AVB wear. Deplugging of tubes at D.C. Cook, Millstone and Diablo Canyon some years after the original plugging, for reasons unrelated to AVB wear, has proved this by the discovery of water contained in the tube and inspection showing that the AVB wear had progressed to a throughwall condition. It is possible that an aggressively vibrating tube could wear through the cross section of the tube sufficiently so that the remaining section could break due to fatigue, and the tube ends become damage propagation mechanisms to adjacent, active tubes. The criterion that is used by Westinghouse for stabilization recommendations is prevention of tube-to-tube contact. The potential for tube-to-tube contact from AVB wear is not expected to occur at IP2 during the next two operating cycles.

Westinghouse has performed Wear Projection analyses for a number of operating SGs to determine the need for installation of cable dampeners in tubes that were repaired for AVB wear. The experience from these prior analyses shows that tubes that are recommended for stabilization are usually those that are plugged early in life. Further, the available operating data show that the characteristics of the most aggressively wearing tubes are similar – they have indications at all of the AVB contact points. Thus, the judgment was made that the two Indian Point tubes exhibiting wear at all four intersections would eventually be identified as the tubes requiring installation of a cable dampener.

From prior experience, the rate of the continuing AVB wear process allows for installation of a cable dampener in a subsequent outage, and the Westinghouse recommendation for stabilization does not suggest an immediate action. Rather, the recommendation is intended to provide flexibility such that the dampener can be installed in a later outage if needed to allow for adequate planning time.

If a linear depth wear rate is conservatively assumed, an additional four operating cycles would be required to attain a 100% throughwall condition. Additional wear would be required to reach a through-section condition that would result in tube-to-tube contact. Thus, it is conservatively estimated that the current IP2 condition has significant margin to the critical condition where tube separation could be a concern. The potential for tube-to-tube contact is not expected to occur during the next two operating cycles. Wear Projection analyses are required to provide a more quantitative assessment of the latest time to install the cable dampener in the two tubes at issue.

Author: ______________________

Hermann O. Lagally
S/G Design & Analysis

Verifier: ______________________

Kim J. Romanko
S/G Design & Analysis

APPENDIX E

NDE Noise Comparisons

Noise measurements have been obtained to compare the noise in the eddy current signals in the current inspection to the noise in the preservice inspection and to the noise in the corresponding EPRI ETSS data. The following data tables illustrate the noise levels for the various inspection techniques. Reference 9 provides the preservice inspection data and the EPRI ETSS data. In all cases, the noise is essentially unchanged from the preservice inspection. In all cases except the U-bends, the average of the noise is less than the EPRI ETSS data. In the case of U-bends, the 95th percentile is less than the 95th percentile of the noise in the EPRI ETSS dataset. For U-bend data, however, an additional acceptance criterion was established whereby no row 1 or 2 U-bend could exceed 0.65 volts (vert. max.) at the apex. This criterion was conservatively based on the 95% confidence of 0.71 volts from the EPRI measurements and experience at Indian Point 2. In addition, if the signal at the U-bend was greater than 0.50 volt at the apex, the resolution analyst, as well as the primary and secondary analysts, was also required to analyze the entire U-bend. The noise levels measured indicate that the detection capabilities of the inspection techniques are consistent with the detection capabilities defined in the corresponding EPRI ETSS.

Table E-1A – Bobbin Noise at Supports: Indian Point 2 SG 21

Indian Point 2 Baseline Vs. 2002 Comparison Of Bobbin Noise At Supports

Bobbin noise Measurements performed with window open to encompass entire mix residual on unflawed quatrefoil supports. Measurements for **Steam Generator 21**. Measurements of Vpp noise(Volts peak to peak) value and Vvm (Volts vert. max.) from Mix 1 (400/100 kHz diff.) Setup for Mix 1 is 20% FBH set to 4.0 volts and normalized to Mix 1. Probe motion set horizontal with flaws starting down.

			2000 Baseline	**Fall 2002**	**2000 Baseline**	**Fall 2002**
S/G 21			**Vpp volts**	**Vpp volts**	**Vvm volts**	**Vvm volts**
ROW	**COL**	**Location**	**P1 (400/100 diff.)**	**P1 (400/100 diff.)**	**P1 (400/100 diff.)**	**P1 (400/100 diff.)**
12	66	1H	0.91	0.92	0.27	0.22
		2H	0.81	0.84	0.27	0.24
18	66	1H	1.08	0.93	0.28	0.26
		2H	1.55	1.45	0.28	0.21
19	47	1H	0.78	1.07	0.24	0.23
		2H	0.63	0.59	0.26	0.25
12	47	1H	0.77	0.98	0.26	0.22
		2H	0.6	0.81	0.24	0.2
15	48	1H	0.92	0.99	0.26	0.24
		2H	0.78	0.9	0.23	0.24
17	51	1H	1.17	1.33	0.24	0.21
		2H	1.08	1.19	0.22	0.18
13	54	1H	0.39	0.51	0.23	0.25
		2H	0.29	0.52	0.26	0.24
22	54	1H	0.88	0.88	0.24	0.23
		2H	0.77	1.39	0.22	0.22
18	57	1H	0.91	0.88	0.26	0.23
		2H	1.13	1.39	0.27	0.22
11	57	1H	0.45	0.55	0.25	0.22
		2H	0.7	0.92	0.2	0.18
18	39	1H	0.63	0.65	0.22	0.24
		2H	0.57	0.58	0.19	0.22
15	39	1H	0.68	0.82	0.2	0.24
		2H	1.11	1.3	0.19	0.22
12	40	1H	0.59	0.83	0.16	0.21
		2H	0.69	0.8	0.15	0.22
22	40	1H	0.92	1.07	0.2	0.18
		2H	0.59	0.63	0.17	0.24
21`	43	1H	0.49	0.61	0.22	0.25
		2H	1.01	1.32	0.17	0.22
16	43	1H	0.68	0.93	0.19	0.21
		2H	0.87	1.04	0.2	0.221
20	44	1H	0.66	0.73	0.18	0.23
		2H	0.76	0.94	0.19	0.19
13	35	1H	0.61	0.78	0.2	0.28
		2H	0.39	0.62	0.21	0.28
12	36	1H	0.68	0.65	0.22	0.25
		2H	0.94	1.13	0.19	0.19
22	36	1H	0.57	0.62	0.22	0.24
		2H	0.75	0.84	0.22	0.22
	AVG.		0.73	0.90	0.22	0.23
	SD		0.25	0.26	0.03	0.02
	95%		1.14	1.33	0.28	0.27

Table E-1B – Bobbin Noise at Supports: Indian Point 2 SG 23

Indian Point 2 Baseline Vs. 2002 Comparison Of Bobbin Noise At Supports

Bobbin noise Measurements performed with window open to encompass entire mix residual on unflawed quatrefoil supports. Measurements for **Steam Generator 23**. Measurements of Vpp noise(Volts peak to peak) value and Vvm (Volts ver. max.) from Mix 1 (400/100 kHz diff.) Setup for Mix 1 is 20% FBH set to 4.0 volts and normalized to Mix 1. Probe motion set horizontal with flaws starting down.

S/G 23			2000 Baseline Vpp volts	Fall 2002 Vpp volts	2000 Baseline Vvm volts	Fall 2002 Vvm volts
ROW	**COL**	**Location**	**P1 (400/100 diff.)**	**P1 (400/100 diff.)**	**P1 (400/100 diff.)**	**P1 (400/100 diff.)**
11	54	1H	1.04	0.83	0.26	0.22
		2H	1.12	0.94	0.26	0.2
12	55	1H	0.77	0.63	0.26	0.28
		2H	0.91	0.88	0.29	0.24
16	55	1H	0.91	0.89	0.26	0.24
		2H	0.9	0.88	0.27	0.27
20	58	1H	0.67	0.41	0.26	0.25
		2H	0.66	0.66	0.27	0.22
10	58	1H	0.86	0.68	0.26	0.22
		2H	0.66	0.57	0.23	0.23
14	62	1H	0.74	0.54	0.33	0.27
		2H	0.89	0.76	0.27	0.26
19	49	1H	0.58	0.6	0.26	0.24
		2H	0.42	0.36	0.25	0.27
12	49	1H	0.69	0.56	0.27	0.22
		2H	0.74	0.75	0.26	0.22
22	50	1H	0.82	0.75	0.21	0.22
		2H	0.54	0.54	0.26	0.25
13	51	1H	0.52	0.5	0.25	0.22
		2H	0.35	0.44	0.28	0.26
19	51	1H	0.64	0.54	0.24	0.25
		2H	0.69	0.57	0.27	0.27
22	54	1H	0.51	0.41	0.24	0.25
		2H	0.37	0.35	0.28	0.28
20	45	1H	0.66	0.5	0.21	0.25
		2H	0.59	0.49	0.25	0.26
15	45	1H	0.66	0.65	0.23	0.2
		2H	0.59	0.64	0.23	0.23
16	48	1H	0.68	0.68	0.2	0.23
		2H	0.79	0.67	0.23	0.25
22	48	1H	0.86	0.59	0.23	0.25
		2H	0.49	0.4	0.19	0.25
13	38	1H	0.86	0.57	0.23	0.22
		2H	0.51	0.33	0.26	0.25
20	37	1H	0.59	0.51	0.21	0.25
		2H	0.6	0.44	0.21	0.23
12	40	1H	0.71	0.56	0.24	0.21
		2H	0.72	0.4	0.21	0.3
21	40	1H	0.83	0.56	0.18	0.21
		2H	0.58	0.4	0.28	0.3
	AVG.		0.69	0.59	0.25	0.24
	SD		0.17	0.16	0.03	0.02
	95%		0.98	0.85	0.30	0.28

Table E-1C – Bobbin Noise at Supports: EPRI ETSS DATA

Bobbin Noise Measurements from EPRI ETSS #96008.1			
		Vpp (400/100)	Vvm (400/100)
EPRI ETSS	**AVG.**	1.51	0.77
# 96008.1	**SD**	0.73	0.53
	95%	2.72	1.65

Table E-2A – Low Row U-Bends: Indian Point 2 Row 2

Indian Point 2 Baseline 2000 Versus Fall 2002 Low Row U-Bend Noise Study

Plus Point RPC noise Measurements taken with window open to one scan line wide. 100 % axial notch set to 35 degrees and 20 volts. Measurements of Vpp (horizontal) and Vvm (Vertical) max noise value in U-bend at the apex. Following measurements are at both **300** and **400 kHz** for 20 random **Row 2 U-bends in S/G 21 and 23.**

S/G	ROW	COL	2000 Baseline Apex Vpp 400 kHz	Fall 2002 Apex Vpp 400 kHz	2000 Baseline Apex Vvm 400 kHz	Fall 2002 Apex Vvm 400 kHz	2000 Baseline Apex Vpp 300 kHz	Fall 2002 Apex Vpp 300 kHz	2000 Baseline Apex Vvm 300 kHz	Fall 2002 Apex Vvm 300 kHz
21	2	53	0.61	0.83	0.19	0.35	0.54	0.74	0.19	0.3
21	2	48	0.68	0.86	0.19	0.35	0.62	0.77	0.2	0.32
21	2	43	0.73	0.64	0.19	0.33	0.66	0.57	0.18	0.33
21	2	39	0.66	0.77	0.17	0.29	0.59	0.72	0.18	0.28
21	2	35	0.65	0.66	0.23	0.25	0.58	0.57	0.21	0.23
21	2	30	0.62	0.83	0.24	0.3	0.55	0.74	0.23	0.27
21	2	25	0.6	0.94	0.2	0.28	0.55	0.82	0.2	0.24
21	2	16	0.5	0.73	0.22	0.24	0.44	0.66	0.19	0.25
21	2	7	0.49	0.9	0.21	0.3	0.42	0.77	0.18	0.26
21	2	2	0.46	0.76	0.21	0.26	0.39	0.68	0.19	0.23
23	2	58	0.62	0.52	0.21	0.24	0.54	0.48	0.21	0.24
23	2	52	0.61	0.5	0.21	0.22	0.54	0.45	0.21	0.23
23	2	47	0.67	0.48	0.18	0.24	0.57	0.44	0.18	0.23
23	2	35	0.68	0.67	0.22	0.34	0.61	0.6	0.22	0.32
23	2	30	0.76	0.7	0.21	0.33	0.68	0.63	0.21	0.32
23	2	26	0.6	0.55	0.2	0.3	0.51	0.51	0.21	0.28
23	2	20	0.59	0.49	0.19	0.23	0.54	0.46	0.19	0.24
23	2	13	0.68	0.48	0.19	0.22	0.54	0.43	0.19	0.22
23	2	8	0.58	0.48	0.17	0.27	0.51	0.44	0.18	0.27
23	2	2	0.58	0.49	0.17	0.24	0.51	0.45	0.17	0.23
INDIAN PT. 2		**AVG.**	0.62	0.66	0.20	0.28	0.54	0.60	0.20	0.26
		SD	0.08	0.16	0.02	0.04	0.07	0.13	0.02	0.04
		95%	0.74	0.92	0.23	0.35	0.66	0.82	0.22	0.32
EPRI ETSS 96511 AVG.			1.22	1.22	0.41	0.41	1.09	1.09	0.40	0.40
		SD	0.32	0.32	0.19	0.19	0.35	0.35	0.17	0.17
		95%	1.62	1.62	0.71	0.71	1.79	1.79	0.68	0.68

Table E-2B – Low Row U-Bends: Indian Point 2 Row 1

Indian Point 2 Baseline 2000 Low Row U-Bend Noise Study

Plus Point RPC noise Measurements taken with window open to one scan line wide. 100 % axial notch set to 35 degrees and 20 volts. Measurements of Vpp (horizontal) and Vvm (Vertical) max noise value in U-bend at the apex. Following measurements are at both **300** and **400 kHz** for 20 random **Row 1 U-bends** in S/G 21 and 23

S/G	ROW	COL	2000 Baseline Apex Vpp 400 kHz	Fall 2002 Apex Vpp 400 kHz	2000 Baseline Apex Vvm 400 kHz	Fall 2002 Apex Vvm 400 kHz	2000 Baseline Apex Vpp 300 kHz	Fall 2002 Apex Vpp 300 kHz	2000 Baseline Apex Vvm 300 kHz	Fall 2002 Apex Vvm 300 kHz
21	1	2	0.98	1.07	0.25	0.41	0.88	0.99	0.28	0.39
21	1	5	0.87	0.92	0.33	0.43	0.74	0.86	0.23	0.4
21	1	11	0.92	1.01	0.32	0.4	0.82	0.94	0.29	0.41
21	1	17	1.09	1.3	0.32	0.47	0.82	1.19	0.29	0.49
21	1	20	1.13	1.45	0.33	0.53	0.99	1.3	0.34	0.53
21	1	26	1.12	1.22	0.39	0.42	1.02	1.11	0.41	0.46
21	1	54	0.86	1.15	0.31	0.68	0.76	1.11	0.28	0.63
21	1	61	0.95	1.1	0.31	0.37	0.84	0.98	0.33	0.37
21	1	67	1	1.11	0.32	0.45	0.88	1.01	0.33	0.44
21	1	80	1.07	1.07	0.34	0.45	0.91	0.97	0.36	0.44
23	1	59	0.85	0.85	0.36	0.46	0.79	0.76	0.38	0.43
23	1	53	0.94	0.85	0.34	0.49	0.84	0.77	0.34	0.45
23	1	48	0.97	0.94	0.31	0.54	0.87	0.88	0.31	0.5
23	1	40	1.27	0.98	0.48	0.5	1.14	0.89	0.5	0.48
23	1	32	1.06	0.9	0.49	0.37	0.99	0.74	0.5	0.39
23	1	26	0.95	0.96	0.38	0.57	0.87	0.84	0.39	0.51
23	1	21	0.69	0.83	0.31	0.42	0.69	0.75	0.37	0.39
23	1	16	1.02	0.92	0.42	0.39	0.92	0.81	0.43	0.36
23	1	13	0.98	0.94	0.39	0.44	0.88	0.81	0.4	0.37
23	1	5	0.93	0.88	0.33	0.44	0.83	0.84	0.34	0.45
INDIAN PT. 2		**AVG.**	0.98	1.02	0.35	0.46	0.87	0.93	0.36	0.44
		SD	0.12	0.16	0.06	0.07	0.10	0.16	0.07	0.07
		95%	1.19	1.29	0.45	0.59	1.05	1.18	0.47	0.55
EPRI ETSS 96511 AVG.			1.22	1.22	0.41	0.41	1.09	1.09	0.40	0.40
		SD	0.32	0.32	0.19	0.19	0.35	0.35	0.17	0.17
		95%	1.62	1.62	0.71	0.71	1.79	1.79	0.68	0.68

Table E-3A – Top of Tubesheet and Freespan: Indian Point 2 Peak to Peak Volts

Indian Point Comparison Of Baseline 2000 +Point Top Of Tubesheet And Freespan Noise To Fall 2002 Data.

Plus Point RPC noise Measurements taken with window open to one scan line wide. 100 % axial notch set to 35 degrees and 20 volts. Measurements of **Vpp (Volts Peak to Peak.)** noise value at top, bottom, and center of hot leg top of tubesheet transition.Also measure noise at approx. 1.0" above top of tubesheet in freespan. Following measurements are at **200 kHz** for 40 random top of tubesheet tests. 20 tests are from S/G 22 and 20 tests are from S/G 24. Great majority of the tests are located in the region near center of S/G where sludge is most likely to occur.

S/G	ROW	COL	2000 Baseline Exp. Trans. Center Vpp	Fall 2002 Exp. Trans. Center Vpp	2000 Baseline Exp. Trans. Top Vpp	Fall 2002 Exp. Trans. Top Vpp	2000 Baseline Exp. Trans. Bottom Vpp	Fall 2002 Exp. Trans. Bottom Vpp	2000 Baseline Freespan above TTS Vpp	Fall 2002 Freespan above TTS Vpp
22	18	35	0.38	0.64	0.28	0.64	0.37	0.41	0.19	0.18
22	13	35	0.46	0.65	0.26	0.15	0.35	0.74	0.16	0.15
22	18	36	0.57	0.22	0.35	0.15	0.19	0.18	0.05	0.05
22	20	39	0.58	0.88	0.44	0.21	0.46	0.59	0.16	0.15
22	13	39	0.54	0.29	0.25	0.29	0.33	0.44	0.08	0.07
22	15	40	0.43	0.67	0.18	0.16	0.3	0.24	0.18	0.15
22	15	43	0.51	0.46	0.17	0.39	0.42	0.73	0.15	0.14
22	13	43	0.73	0.26	0.28	0.13	0.3	0.58	0.1	0.1
22	17	44	0.65	0.56	0.2	0.13	0.37	0.55	0.09	0.07
22	11	48	0.41	0.62	0.33	0.15	0.51	0.24	0.09	0.07
22	18	47	0.51	1.06	0.2	0.28	0.28	0.44	0.08	0.06
22	20	47	0.5	0.98	0.15	0.29	0.41	0.35	0.11	0.1
22	17	48	0.39	0.31	0.21	0.15	0.46	0.3	0.11	0.07
22	20	48	0.43	0.7	0.29	0.31	0.5	0.75	0.15	0.14
22	20	50	0.4	0.81	0.15	0.37	0.33	0.47	0.12	0.13
22	11	51	0.56	0.43	0.45	0.2	0.36	0.23	0.11	0.1
22	14	53	0.54	0.35	0.24	0.14	0.35	0.24	0.09	0.08
22	17	53	0.5	0.84	0.26	0.34	0.46	0.13	0.1	0.07
22	11	54	0.54	0.55	0.27	0.41	0.42	0.2	0.07	0.07
22	15	61	0.61	0.56	0.28	0.11	0.44	0.7	0.15	0.14
24	19	43	0.33	0.33	0.2	0.18	0.24	0.29	0.14	0.14
24	23	43	0.37	0.49	0.68	0.3	0.49	0.35	0.12	0.1
24	20	44	0.26	0.42	0.2	0.32	0.36	0.29	0.12	0.12
24	23	47	0.53	0.28	0.25	0.09	0.23	0.13	0.05	0.05
24	13	47	0.48	0.33	0.16	0.51	0.18	0.19	0.06	0.06

(Table continued on next page)

Table E-3A (Continued) – Top of Tubesheet and Freespan: Indian Point 2 Peak to Peak Volts

Indian Point Comparison Of Baseline 2000 +Point Top Of Tubesheet And Freespan Noise To Fall 2002 Data.

Plus Point RPC noise Measurements taken with window open to one scan line wide. 100 % axial notch set to 35 degrees and 20 volts. Measurements of **Vpp (Volts Peak to Peak.)** noise value at top, bottom, and center of hot leg top of tubesheet transition.Also measure noise at approx. 1.0" above top of tubesheet in freespan. Following measurements are at **200 kHz** for 40 random top of tubesheet tests. 20 tests are from S/G 22 and 20 tests are from S/G 24. Great majority of the tests are located in the region near center of S/G where sludge is most likely to occur.

S/G	ROW	COL	2000 Baseline Exp. Trans. Center Vpp	Fall 2002 Exp. Trans. Center Vpp	2000 Baseline Exp. Trans. Top Vpp	Fall 2002 Exp. Trans. Top Vpp	2000 Baseline Exp. Trans. Bottom Vpp	Fall 2002 Exp. Trans. Bottom Vpp	2000 Baseline Freespan above TTS Vpp	Fall 2002 Freespan above TTS Vpp
24	21	52	0.49	0.44	0.12	0.27	0.22	0.26	0.09	0.07
24	18	52	0.35	0.32	0.14	0.13	0.18	0.25	0.08	0.08
24	13	55	0.52	0.49	0.47	0.28	0.32	0.26	0.1	0.1
24	20	55	0.42	0.46	0.47	0.19	0.31	0.21	0.14	0.14
24	15	56	0.34	0.24	0.17	0.12	0.3	0.16	0.07	0.06
24	20	56	0.41	0.29	0.17	0.25	0.32	0.26	0.14	0.13
24	10	58	0.44	0.4	0.13	0.1	0.21	0.24	0.07	0.07
24	13	60	0.55	0.37	0.1	0.1	0.24	0.21	0.06	0.06
24	19	60	0.52	0.53	0.12	0.15	0.31	0.24	0.09	0.08
24	14	62	0.35	0.43	0.12	0.17	0.19	0.2	0.12	0.11
24	21	62	0.34	0.14	0.19	0.15	0.21	0.14	0.08	0.06
24	17	65	0.21	0.34	0.13	0.1	0.23	0.16	0.1	0.09
24	12	65	0.26	0.43	0.16	0.17	0.16	0.17	0.13	0.12
24	24	41	0.51	0.52	0.27	0.17	0.27	0.25	0.05	0.04
24	17	42	0.52	0.6	0.33	0.18	0.32	0.22	0.08	0.07
INDIAN PT. 2		**AVG.**	0.46	0.49	0.25	0.22	0.32	0.32	0.11	0.10
		SD	0.11	0.21	0.12	0.12	0.10	0.18	0.04	0.04
		95%	0.64	0.84	0.45	0.42	0.48	0.62	0.17	0.16

Table E-3B – Top of Tubesheet and Freespan: Indian Point 2 Vertical Maximum Volts

Indian Point Comparison Of Baseline 2000 +Point Top Of Tubesheet And Freespan Noise To Fall 2002 Data.

Plus Point RPC noise Measurements taken with window open to one scan line wide. 100 % axial notch set to 35 degrees and 20 volts. Measurements of V-vm **(vertical max)** noise value at top, bottom, and center of hot leg top of tubesheet transition. Also measure noise at approx. 1.0" above top of tubesheet in freespan. Following measurements are at **200 kHz** for 40 random top of tubesheet tests. 20 tests are from S/G 22 and 20 tests are from S/G 24. Great majority of the tests are located in the region near center of S/G where sludge is most likely to occur.

S/G	ROW	COL	2000 Baseline Exp. Trans. Center Vvm	Fall 2002 Exp. Trans. Center Vvm	2000 Baseline Exp. Trans. Top Vvm	Fall 2002 Exp. Trans. Top Vvm	2000 Baseline Exp. Trans. Bottom Vvm	Fall 2002 Exp. Trans. Bottom Vvm	2000 Baseline Freespan above TTS Vvm	Fall 2002 Freespan above TTS Vvm
22	18	35	0.1	0.17	0.15	0.33	0.08	0.11	0.07	0.08
22	13	35	0.09	0.26	0.15	0.09	0.06	0.11	0.06	0.06
22	18	36	0.1	0.06	0.14	0.14	0.07	0.09	0.04	0.02
22	20	39	0.12	0.21	0.22	0.13	0.14	0.2	0.08	0.08
22	13	39	0.1	0.07	0.11	0.19	0.08	0.15	0.05	0.03
22	15	40	0.14	0.15	0.11	0.09	0.13	0.12	0.07	0.08
22	15	43	0.15	0.14	0.12	0.22	0.19	0.1	0.07	0.06
22	13	43	0.11	0.11	0.12	0.09	0.11	0.08	0.04	0.04
22	17	44	0.14	0.11	0.13	0.08	0.05	0.1	0.04	0.04
22	11	48	0.2	0.1	0.18	0.14	0.12	0.06	0.04	0.04
22	18	47	0.14	0.22	0.13	0.24	0.07	0.14	0.05	0.03
22	20	47	0.12	0.19	0.12	0.22	0.08	0.11	0.05	0.03
22	17	48	0.15	0.12	0.18	0.14	0.15	0.11	0.11	0.04
22	20	48	0.13	0.16	0.21	0.22	0.13	0.17	0.07	0.08
22	20	50	0.17	0.18	0.11	0.23	0.08	0.17	0.06	0.06
22	11	51	0.12	0.07	0.14	0.12	0.1	0.05	0.05	0.02
22	14	53	0.1	0.08	0.17	0.12	0.09	0.16	0.04	0.04
22	17	53	0.11	0.18	0.15	0.27	0.09	0.07	0.04	0.04
22	11	54	0.14	0.17	0.17	0.25	0.11	0.09	0.05	0.04
22	15	61	0.11	0.07	0.16	0.05	0.13	0.07	0.07	0.05
24	19	43	0.12	0.33	0.08	0.18	0.07	0.13	0.08	0.09
24	23	43	0.1	0.2	0.11	0.18	0.13	0.12	0.03	0.05
24	20	44	0.16	0.15	0.13	0.18	0.13	0.09	0.07	0.06
24	23	47	0.11	0.14	0.14	0.07	0.1	0.08	0.04	0.04
24	13	47	0.13	0.26	0.09	0.21	0.07	0.07	0.03	0.03

(Table continued on next page)

Table E-3B (Continued) – Top of Tubesheet and Freespan: Indian Point 2 Vertical Maximum Volts

Indian Point Comparison Of Baseline 2000 +Point Top Of Tubesheet And Freespan Noise To Fall 2002 Data.

Plus Point RPC noise Measurements taken with window open to one scan line wide. 100 % axial notch set to 35 degrees and 20 volts. Measurements of V-vm **(vertical max)** noise value at top, bottom, and center of hot leg top of tubesheet transition. Also measure noise at approx. 1.0" above top of tubesheet in freespan. Following measurements are at **200 kHz** for 40 random top of tubesheet tests. 20 tests are from S/G 22 and 20 tests are from S/G 24. Great majority of the tests are located in the region near center of S/G where sludge is most likely to occur.

S/G	ROW	COL	2000 Baseline Exp. Trans. Center Vvm	Fall 2002 Exp. Trans. Center Vvm	2000 Baseline Exp. Trans. Top Vvm	Fall 2002 Exp. Trans. Top Vvm	2000 Baseline Exp. Trans. Bottom Vvm	Fall 2002 Exp. Trans. Bottom Vvm	2000 Baseline Freespan above TTS Vvm	Fall 2002 Freespan above TTS Vvm
24	21	52	0.09	0.14	0.06	0.13	0.08	0.13	0.04	0.04
24	18	52	0.17	0.12	0.08	0.1	0.12	0.14	0.07	0.04
24	13	55	0.19	0.16	0.19	0.18	0.1	0.07	0.06	0.07
24	20	55	0.1	0.14	0.24	0.11	0.14	0.12	0.07	0.07
24	15	56	0.11	0.2	0.12	0.11	0.16	0.06	0.05	0.04
24	20	56	0.13	0.17	0.1	0.17	0.12	0.1	0.07	0.06
24	10	58	0.14	0.09	0.07	0.07	0.21	0.09	0.03	0.04
24	13	60	0.17	0.12	0.1	0.07	0.09	0.08	0.02	0.03
24	19	60	0.13	0.11	0.09	0.11	0.08	0.08	0.04	0.05
24	14	62	0.06	0.11	0.09	0.13	0.1	0.08	0.08	0.06
24	21	62	0.05	0.14	0.1	0.12	0.05	0.05	0.04	0.05
24	17	65	0.18	0.14	0.1	0.09	0.13	0.05	0.06	0.07
24	12	65	0.14	0.13	0.12	0.17	0.06	0.09	0.05	0.07
24	24	41	0.1	0.13	0.16	0.14	0.05	0.09	0.04	0.04
24	17	42	0.09	0.13	0.18	0.13	0.13	0.08	0.03	0.06
INDIAN PT. 2		AVG.	0.13	0.15	0.13	0.15	0.10	0.10	0.05	0.05
		SD	0.03	0.06	0.04	0.06	0.04	0.04	0.02	0.02
		95%	0.18	0.24	0.20	0.25	0.17	0.16	0.08	0.08

Table E-3C – Top of Tubesheet and Freespan: EPRI ETSS DATA

DATA FROM	Vpp *Exp. Trans.	Vpp Freespan	Vvm *Exp. Trans.	Vvm Freespan
ETSS # 21409.1	N/A	0.56	N/A	0.43
ETSS # 21410.1	0.53	N/A	0.30	N/A
ETSS # 20510.1	1.18	N/A	0.64	N/A
ETSS # 20511.1	1.41	N/A	0.54	N/A

* For the EPRI ETSS data, the max noise was recorded wherever it occurred within the transition, not including flaw influence.

Table E-4A – Bobbin Freespan: Indian Point 2 Data

Indian Point 2 Baseline 2000 Vs. Fall 2002 Freespan Noise Measurements

Bobbin noise Measurements performed with window open to encompass 1.0 " axially at approximately 1" above the top of tubesheet Volts Peak to Peak measured. Mix 1(630/150 kHz diff.) used for measurements. Setup for Mix 1 is 20% FBH set to 4.0 volts and normalized to Mix 1. Probe wobble set horizontal.

S/G	ROW	COL	Location	2000 Baseline Vpp Volts Mix 1 (630/150diff)	FALL 2002 Vpp Volts Mix 1 (630/150diff)
21	13	35	TSH + 1	0.52	0.54
21	12	36	TSH + 1	0.53	0.36
21	22	36	TSH + 1	0.5	0.43
21	18	39	TSH + 1	0.49	0.45
21	15	39	TSH + 1	0.71	0.42
21	12	40	TSH + 1	0.74	0.62
21	22	40	TSH + 1	0.5	0.43
21	21	43	TSH + 1	0.55	0.48
21	16	43	TSH + 1	0.5	0.39
21	20	44	TSH + 1	0.42	0.31
21	19	47	TSH + 1	0.72	0.72
21	12	47	TSH + 1	0.57	0.43
21	15	48	TSH + 1	0.7	0.65
21	17	51	TSH + 1	0.82	0.84
21	13	54	TSH + 1	0.56	0.49
21	22	54	TSH + 1	0.65	0.6
21	18	57	TSH + 1	0.59	0.57
21	11	57	TSH + 1	0.45	0.41
21	12	66	TSH + 1	0.61	0.42
21	18	66	TSH + 1	0.81	0.75
23	13	38	TSH + 1	0.24	0.23
23	20	37	TSH + 1	0.34	0.29
23	12	40	TSH + 1	0.41	0.31
23	21	40	TSH + 1	0.45	0.39
23	20	45	TSH + 1	0.45	0.32
23	15	45	TSH + 1	0.49	0.49
23	16	48	TSH + 1	0.43	0.35
23	22	48	TSH + 1	0.26	0.32
23	19	49	TSH + 1	0.23	0.25
23	12	49	TSH + 1	0.64	0.54
23	22	50	TSH + 1	0.51	0.39
23	13	51	TSH + 1	0.32	0.29
23	19	51	TSH + 1	0.66	0.55
23	22	54	TSH + 1	0.29	0.33
23	11	54	TSH + 1	0.5	0.38
23	12	55	TSH + 1	0.81	0.61
23	16	55	TSH + 1	0.42	0.38
23	20	58	TSH + 1	0.63	0.54
23	10	58	TSH + 1	0.75	0.69
23	14	62	TSH + 1	0.64	0.45
Indian Pt. 2		**AVG.**		0.54	0.46
		SD		0.16	0.14
		95%		0.80	0.70

Table E-4B – Bobbin Freespan: EPRI ETSS DATA

Results Of Bobbin Freespan and Sludge Pile Noise Comparison	
The avg. peak to peak voltage of the noise measurements in the sludge pile at Indian Point Unit 2 were compared with the noise measurements performed on EPRI ETSS's 96008.1, 96005.2, and 96001.1	
DATA FROM	**AVG. VOLTS Peak to Peak**
EPRI ETSS # 96008.1	1.37
EPRI ETSS # 96005.2	4.19
EPRI ETSS # 96001.1	3.47

Table E-5A – AVB Wear: Indian Point 2 Data

IP2 Baseline 2000 versus FALL 2002 AVB Location Noise Measurements Comparison

Bobbin noise Measurements performed with window open to encompass entire mix residual on an unflawed AVB in tube. Measurements of Vvm noise (Vertical max) value from Mix 1 (430/100 kHz diff.). Setup for Mix 1 is 20% FBH set to 4.0 volts and normalized to Mix 1. *Probe motion set horizontal.*

S/G	ROW	COL	Location	2000 Baseline Vvm volts Mix 1 (400/100diff)	Fall 2002 Vvm volts Mix 1 (400/100diff)
21	32	18	AV2	0.14	0.12
21	35	20	AV3	0.18	0.14
21	32	21	AV2	0.16	0.12
21	36	20	AV2	0.22	0.17
21	40	25	AV3	0.19	0.15
21	34	23	AV2	0.1	0.07
21	41	29	AV2	0.19	0.23
21	33	27	AV3	0.12	0.11
21	35	28	AV2	0.12	0.12
21	40	28	AV3	0.15	0.19
21	42	30	AV3	0.18	0.18
21	36	31	AV1	0.15	0.12
21	43	34	AV4	0.18	0.19
21	41	35	AV2	0.19	0.21
21	36	36	AV2	0.14	0.14
21	40	36	AV2	0.21	0.24
21	43	39	AV3	0.19	0.17
21	45	41	AV2	0.14	0.18
21	43	47	AV3	0.19	0.16
21	42	54	AV3	0.2	0.22
23	35	31	AV2	0.17	0.19
23	41	31	AV2	0.19	0.23
23	34	34	AV3	0.17	0.21
23	43	34	AV2	0.15	0.15
23	44	36	AV3	0.19	0.19
23	38	38	AV3	0.15	0.18
23	30	38	AV2	0.15	0.16
23	42	39	AV3	0.15	0.16
23	45	42	AV2	0.16	0.15
23	32	48	AV2	0.2	0.24
23	39	48	AV3	0.19	0.21
23	45	49	AV2	0.17	0.27
23	36	49	AV2	0.17	0.14
23	31	49	AV2	0.14	0.11
23	41	50	AV3	0.24	0.2
23	37	51	AV3	0.17	0.15
23	35	54	AV2	0.2	0.22
23	40	59	AV4	0.18	0.2
23	40	62	AV1	0.19	0.17
23	33	62	AV2	0.14	0.15
		AVG.		0.17	0.17
		SD		0.03	0.04
		95%		0.22	0.24

Table E-5B – AVB Wear: EPRI ETSS DATA

Data from	% Wear Indication	Mix 1 (400/100 diff.) V-vm
EPRI ETSS 96004.1	10	0.27
EPRI ETSS 96004.1	15	0.4
Indian Point Unit 2 baseline data Cal Curve	12	0.3
Indian Point Unit 2 baseline data Cal Curve	15	0.4