Item 12 - #5

Subj: Indian Point Crack Growth
Date: 7/10/2000
To: elm@nrc.gov Emmett Murphy
CC: ejs@nrc.gov

File: C:\WP\FI\INDIAN13.NRR (1500955 bytes)
DL Time (32000 bps): < 13 minutes

Emmett:
This is a work in progress, that I still need to add some things to. These are the most accurate cracks that I could find, and they are not all that good. There are only three from the total set. I can do an average crack over the most accurate portion of the signal for each of the defects, and give you a number. I may be able to add some more of the cracks, but they may decrease the accuracy of the overall growth. The increase in crack voltage is more noticeable from outage to outage than the increase in depth. Give me a call when you get in.
Caius Dodd

Subj: IP2 growth rate
Date: 7/10/2000
To: elm@nrc.gov

File: C:\WP\FI\INDIAN13.NRR (1502065 bytes)
DL Time (32000 bps): < 13 minutes

Emmett:
I have selected the most accurate section of the crack profiles and computed the growth rates. I have recorded the growth rate and the crack segments over which they were calculated. The calculation for 2-69 is the most accurate, and the other two are not as accurate. The main thing that this demonstrates is the uncertainty in the measurement of the depth in the 1997 data.
Caius

Subj: Re: Sludge pile and U-bends
Date: 7/11/2000
To: WLS@nrc.gov, EJS@nrc.gov, JRS2@nrc.gov
To: SMC1@nrc.gov, ejs@nrc.gov, cdb@nrc.gov

Wayne:
I have two reports that I have already written that I can send you. One has the C-scan and profile of the "Monkey Tube", the other has the 1997 C-scans of three of the tubes that were detectable in the 1997 outage. I am working on ANO now and have taken the IP2 data off my computer. As soon as I get this emergency data done, I'll reload the IP2 data and make the graphics for you.
Caius

J 173

Subj: Three 1997 C-scans
Date: 7/11/2000
To: WLS@nrc.gov

File: C:\WP\FI\INDIAN13.NRR (1502065 bytes)
DL Time (32000 bps): < 13 minutes

Wayne:
Here is a report in progress that has three of the six C-scans. The first scan of each is the 1997 scan, the second the 2000 midrange probe scan, and the third the high-frequency scan.

Caius

Subj: Monkey tube
Date: 7/11/2000
To: WLS@nrc.gov

File: C:\WP\FI\INDIAN8.NRR (1378168 bytes)
DL Time (32000 bps): < 12 minutes

Wayne:
Here is my write-up on the monkey tube in the sludge pile. I am not as confident of the detection of all of the defects in the sludge pile as I am of the U-bend. The noise in general is a problem at this plant as well as a number of other plants, some of which are in your region. When we get a breather, maybe we can look at this problem.

Caius

Subj: Re: Question?
Date: 7/11/2000
To: WLS@nrc.gov
CC: cdb@nrc.gov, smc1@nrc.gov, ejs@nrc.gov

Wayne:
A stress-corrosion crack will produce a signal 20% to 50% of that of an EDM notch in the same location. There are EDM notches on both sides of the standard tube to allow one to gage this against. A person knowledgeable in eddy-current testing, such as a level III should know this. The level III should also point this out to the utility. The utility should care enough about the integrity of their generators to worry about what the noise could be hiding and try to take steps to remedy this. Noise such as this should run up a red flag.

Caius

Subj: Tube R2C5
Date: 7/12/2000
To: WLS@nrc.gov, elm@nrc.gov
CC: tees@airmail.net (Ian Barnes), smc1@nrc.gov

CC: ejs@nrc.gov

Wayne:
The noise signal on the tube looks somewhat like a defect looks in the Lissajous signal. The question an analyst has to decide is "Is this noise or a defect signal distorted by noise?" Later on in the tube, this signal becomes a definite defect. The answer that an analyst should conclude is that this test needs something to reduce the noise, because, with as much of this as is present on the tube, sooner or later we are going to miss something big and have a tube rupture.

The signal does look more like noise in one region of the scan and more like a defect in another region. There are regions that are "shades of gray" in this scan, which make this type of tube so hard to accurately profile.

You would need to check the Lissajous the entire length of the signal, which is about 10-inches. Even after checking it, you still cannot be completely sure. You would want to pressure test the tube to see if the signal changed. Only then could you really be sure.

This was actually done for some of the signals in the sludge pile. Some of the signals that everyone agreered were cracks turned out to be deposits. That's why I feel we need to work toward reducing the noise in the sludge pile region also.
Caius

Subj: IP should haves
Date: 7/17/2000
To: elm@nrc.gov, smc1@nrc.gov

File: C:\WP\FI\INDIAN14.NRR (192738 bytes)
DL Time (32000 bps): < 2 minutes

Stephanie and Emmett:
Here are graphics on the C-scans from 97 data. Some of the tubes need the circumferential average filter for detection, or improved detection. Two of the tubes definitely need it, two could be helped by it and two should have been called without it.
Caius

Subj: IP2 tubes with signals in 1997
Date: 7/17/2000
To: WLS@nrc.gov
CC: tees@airmail.net (Ian Barnes)

File: C:\WP\FI\INDIAN14.NRR (192738 bytes)
DL Time (32000 bps): < 2 minutes

Wayne:

Here are the final two tubes with defects present in 1997. With a diligent inspection, and by using circumferential average filtering, these defects are visible on the C-scan.

Caius

Subj: Re: IP2 tubes with signals in 1997
Date: 7/17/2000
To: tees@airmail.net, WLS@nrc.gov

Ian:
This filtering was not required by the guidelines, but perhaps should have been required. When an inspection has as much noise as these tubes, the designer of these tests should have used everything possible. The filter only improves the detection of the defect using the C-scan. Anything suspicious should prompt the analyst to look at the Lissajous of the scan.

I agree that these are not easy calls, but the data is there for the analysts to find these defects.

Caius

Subj: Re: IP2 tubes with signals in 1997
Date: 7/18/2000
To: WLS@nrc.gov
CC: elm@nrc.gov, smc1@nrc.gov
CC: tees@airmail.net (Ian Barnes), cdb@nrc.gov

Wayne:
I will be able to get back to working on Indian Point now that ANO is out of the way. I believe that with some awareness, and a careful analysis, the analysts could see the defects in 4 of the 8 tubes. With the use of the circumferential average filter, the analyst could pick up the defects in two additional tubes. For the final two tubes, even with the benefit of hindsight, I could not definitely identify the tubes as defective. The signal-to-noise ratio was just too poor.

As for the question about the 1997 guidelines -- could the analyst find these defects using the 1997 guidelines? Westinghouse and the utility argue that the errors in the guidelines is insignificant. If this is to be believed, then they should have found these defects. If the guidelines are in error enough to contribute to them not finding these defects, then the guidelines can be blamed for not being adequate.

As per Ian's suggestion, I will send you a graphics story on all the tubes, hopefully before the end of the day.

Subj: Missed tubes
Date: 7/18/2000
To: WLS@nrc.gov
CC: smc1@nrc.gov, tees@airmail.net (Ian Barnes)

CC: elm@nrc.gov

File: C:\WP\FI\INDIAN14.NRR (1185235 bytes)
DL Time (32000 bps): < 10 minutes

Wayne:
Here are the graphics for each of the tubes that could have been called in 1997, if the setup had been correct and the analyst encouraged to use the circumferential filter. They are listed in varying degrees of difficulty. Let me know if you need anything else.
Caius

Subj: Ian's Report
Date: 7/19/2000
To: tees@airmail.net (Ian Barnes)
CC: WLS@nrc.gov, smc1@nrc.gov

Ian:
Your report was very well written and to the point. I did not review the EPRI Performance Demonstration Data Base's ETSS myself, but was told by Gary Henry that the phase was set to 15 degrees rather than 10 degrees for the 40% TW id notches back in 1997. This is the only possible difference that may be present. If you read the document, I am sure that you have it correct.

We did not ask for their training and testing in 1997 when we were there, but they could not document their training and testing for this outage. I hope that the region will strongly urge them to do this before closing out this test. Good job Ian.
Caius

Subj: IP2
Date: 7/19/2000
To: WLS@nrc.gov

Wayne:
Let me know if you need anything else. I will leave the Indian Point data on my computer for a day or two.
Caius

Subj: Indian Point U-bends
Date: 7/19/2000
To: elm@nrc.gov, smc1@nrc.gov

Emmett:
This is a follow-up on the phone message that I left on your answering machine yesterday. Initially, I was not sure about the Indian Point U-bends since a new tube, 2-71 of steam generator 24, that was discovered with the high-frequency probe, failed the pressure test. However, this tube was already on the plugging list because the midrange

probe would not scan it due to the probe sticking. There were several cal. groups that had partial scans of this tube, indicating that they had tried unsuccessfully several times. Then it was scanned with the high frequency probe and the defect was detected. Therefore, it was not like the tube had passed midrange probe scan, which I initially believed.

It appears that the midrange test had caught all the tubes that it scanned that failed the three delta P. pressure test. The high frequency probe found smaller cracks, all of which passed the test. This should give us a better feeling about the integrity of the U-bend tubes.

One further note is that in the 1997 inspection, one scan of 2-5 failed due to the probe hanging. Probe hanging may be an indication of tube deformation that leads to severe and fast growing cracks, or maybe the reverse is true. Severe cracks allow the tube to deform.

Caius

Subj: Re: Exit Meeting w/Con Edison to discuss prelim findings
Date: 7/19/2000
To: DCL@nrc.gov
CC: smc1@nrc.gov

Dave:
I will participate in the phone call tomorrow. I understand that I am to start at 11:00 am, July 20, and either stay on the line or call in again at 2:00 pm. I believe that I am at least temporarily free of ANO and should be able to devote time to Indian Point2.

Caius

Subj: Email from Andy Neff
Date: 7/19/2000
To: tees@airmail.net (Ian Barnes)

Ian:
Below you will find the message from Andy Neff he sent me 5/4/2000. My system would not forward it the normal way so I copied it. This shows how the phase (and amplitude) was set for all the tubes in cal group 58 in 1997, which includes tube 2-5. This setup would be about 8 degrees low compared to the correct setup used in 2000, from readings made on the correct standard notch.

Caius

Caius,
The 100% Axial standard flaw from the stored setup from cal group 58 is 19.94 volts and 28 degrees. I can fax the graphics if you want.

Indian Point will respond to the missed indications issue through licensing.

Andy

Subj: Exit Meeting:
Date: 7/20/2000
To: smc1@nrc.gov, DCL@nrc.gov, WLS@nrc.gov
To: tees@airmail.net (Ian Barnes)

David, Stephanie, Wayne:
I have not received the Email with the 5 points that Ian and I are to respond to. If possible, could you remind the utility to Email me a copy. I will be glad to draft a response as soon as I get a copy. Who are we to send the response to? Also, for the record, I a not a NRC contractor, but a part time employee of NRC.

Caius Dodd

Subj: Rebuttal of talking points:
Date: 7/21/2000
To: WLS@nrc.gov

Wayne:
I have received the transmission from Westinghouse and have some ideas on how we should reply. The amplitude of the noise and the defects that were missed should be stated for all eight of the tubes. I believe that the noise at 300 kHz was greater than they have indicated. Also, I may be able to find some data about the amplitude of SCC as were applied to the alternate plugging criteria.

My phone number is (856) 966-5517 and I will be here the rest of the evening if you want to call.

Caius

Subj: Re: INFO NEEDED
Date: 7/24/2000
To: tees@airmail.net

Ian:
The values are:

| | 300 kHz | 400 kHz |
|---|---|---|
| 100 | 30 | 30 |
| 40 | 10 | 9 |
| 20 | 2 | 1 |

Since you did not state the frequency, I measured both for you. Talk to you later.

Caius

Subj: Rebuttal
Date: 7/24/2000

To: tees@airmail.net (Ian Barnes), WLS@nrc.gov
To: elm@nrc.gov, smc1@nrc.gov

File: C:\WP\FI\IPTUBNOI.NRR (19068 bytes)
DL Time (32000 bps): < 1 minute

Ian and Wayne:
Here is a first attempt at the rebuttal for item 1 and 5. I have received your Emails today with additional questions and will now work on them.
Caius

Subj: Re: Question?
Date: 7/24/2000
To: WLS@nrc.gov, ELM@nrc.gov, SMC1@nrc.gov
CC: tees@airmail.net, DCL@nrc.gov

Wayne:
I, along with Stephanie and Emmett reviewed the 1997 inspection and the 2000 inspection at Indian Point on March 9. We held an exit on March 10 when we left. I gave the utility the following points in the review, with the items in parenthesis being added during the next week:

Recommendations for U-bend inspection improvement, in decreasing order of importance.

1. Use a smaller, high-frequency plus-point probe. (I talked with the manufacturer of the plus-point probe, and "negotiated" a 0.075-inch long probe that would work to 1 MHz. The utility had ordered this probe, had EPRI test it, and applied it to the steam-generators. The results were excellent, as will be discussed later.)

2. Increase the frequency of the present midrange plus-point probe. (Zetec has said that these probes can be operated as high as 500 kHz. Gary Henry of EPRI has tested the probes to 750 kHz.)

3. Use a 400 kHz-100 kHz mix to reduce the effects of od noise. (Both the utility and I have checked this out and determined that more development will be needed to get any significant improvement in this. However, it allows the possibility of analyzing the data previously acquired, including the 1997 inspection. A method that utilizes the greater phase rotation with frequency for od artifacts may give the needed improvements. Also, using more frequencies may improve this type of mixing. At least a limited amount of data should be acquired in this region using the new probe, operated over a broad frequency range ( 300 kHz to 1 MHz). This type of mixing will require the addition of copper and ferrite to the od of the tubing calibration standard.)

4. Analyze the 400 kHz data in addition to the 300 kHz data that the guidelines now require. (I believe that the utility is now doing this.)

5. Use the correct phase setting for the different frequencies. (The utility is now doing this for the present analysis. This is also being applied at the "look-back" of the 1997 data. An increased phase setting may be required for the best analysis of the higher frequency data.)

6. Improve the guidelines.

7. Add an emphasis on loose parts detection to the guidelines.

A more detailed write-up is given in the file labeled indianpt2.nrr that I have already sent you.

Caius

Subj: Re: 100% TW NOTCH
Date: 7/24/2000
To: tees@airmail.net
CC: wls@nrc.gov

Ian:
For the 100% notch to produce the correct phase setting, all of the factors that are effecting the phase shift for all the different notches must be fixed, including such things as coil dimensions, frequency, wall thickness, conductivity and related parameters such as coil inductance and cable capacitance. If all of these are well known and fixed, then the phase shift of the different notches for all of these conditions must be well known. Then, the 100% notch becomes the best notch on which the phase shift can be set, since it gives the largest phase. However, if these parameters are not known and fixed, then the most shallow id notch that will give a repeatable phase shift should be used. The 20% notch does not produce a clean and repeatable enough signal to be used, but the 40% notch does. The variations changes in the coil dimensions, frequency, wall thickness, conductivity and related parameters such as coil inductance and cable capacitance will be smaller for the id notches than the 100% deep notch.

Caius

Subj: Phase shifts
Date: 7/25/2000
To: tees@airmail.net (Ian Barnes)
CC: WLS@nrc.gov

Ian:
The values for the different notches with the 100% set to 40 are:

| | 300 kHz | 400 kHz |
|---|---|---|
| 100 | 40 | 40 |

| | | |
|---|---|---|
| 60 | 27 | 23 |
| 40 | 23 | 19 |
| 20 | 15 | 11 |

These can vary a degree or so. A number of calibrations on different standards should be done to average out the results. Talk to you later.

Caius

Subj: Effect of wall thickness on the eddy-current depth measurement
Date: 7/26/2000
To: elm@nrc.gov
CC: cdb@nrc.gov, smc1@nrc.gov

Emmett:
You ask about the effect of wall thickness on the eddy-current depth measurement the other day. It occurred to me that we could at least estimate this using the VIC3D program. I am now running this and it does seem to have a significant effect. Do you have any idea about how much the wall thickness decreases on the top of the U-bend for row 2?

Cheryl, this is an example of how computations can aid us in the review of a utility's inspection. Have you heard anything about purchasing this from Sabbagh?

Caius

Subj: IP2sg12.wpg
Date: 7/26/2000
To: tees@airmail.net (Ian Barnes)
CC: WLS@nrc.gov

Ian:
A beautiful work. The only thing that I would suggest is that you drop the references to the 40% circumferential id notch, since the standard did include this. However, the axial 40% id notch is the one that should be used to set up on, and the one that is missing. The circumferential notch goes in the wrong direction for the plus-point, and also is too short to get a reliable signal on.

Your statement about "It is important that strict rules be established during the initial preparation and future maintenance and updating of the performance demonstration so that the overall integrity of the program is maintained...." for the 1997 outage is good. In spite of all the publicity, I do not think they are keeping adequate records of their training and testing for this outage. I also think they have ignored the loose parts inspection.

Caius

Subj: Voltage of od cracks
Date: 7/26/2000
To: smc1@nrc.gov

CC: elm@nrc.gov

Stephanie:
The amplitude of the OD notches on the standards are about 1 volt for the 60% notch and 0.3 volts for the 40% notch. The OD cracks will have a smaller response. The cracks that were found in the sludge pile region are on the order of 0.86 volts for 50% and 0.86 volts for 65% also. The ratio of detected OD crack voltage to the standard notch voltage thus far is 80% to 100%. However, there are some others that I have the data on and will get for you. These data are all for the midrange probe.

I will compare this to the noise and what has been detected thus far. The only redeeming factor is that the notch amplitude and the vertical max amplitude are about the same, since the phase is near 90 degrees.
Caius

Subj: Re: IP2sg12.wpg
Date: 7/26/2000
To: tees@airmail.net
CC: wls@nrc.gov

Ian:
I was wrong. I went back and looked at my drawings and there was not a 40% id circumferential notch.
Caius

Subj: Re: lessons learned from IP2
Date: 7/27/2000
To: LXL@nrc.gov
CC: smc1@nrc.gov

Louise:
I have a number of lessons that both the industry and NRC should learn. I will get them together for you.
Caius

Subj: Wall thickness variation
Date: 7/27/2000
To: elm@nrc.gov
CC: smc1@nrc.gov

Emmett:
I have been running the Vic3d program to compute the effects of calibrating with one wall thickness and then measuring tubes with another. If you have any estimate of the wall thickness for the low-row u-bend tubes I would appreciate it.
Thanks, Caius

Subj: Lessons learned
Date: 7/28/2000
To: LXL@nrc.gov (Louise Lund)
CC: tees@airmail.net (Ian Barnes), smc1@nrc.gov

File: C:\WP\FI\INDIAN15.NRR (9291 bytes)
DL Time (32000 bps): < 1 minute

Louise:
I have put down a few thoughts about the lessons learned. This is a "work in progress" and I will have some more thoughts in the next few days.
Caius

Subj: Rebuttal
Date: 7/28/2000
To: mcm@nrc.gov

File: C:\WP\FI\IPTUBNOI.NRR (22929 bytes)
DL Time (32000 bps): < 1 minute

Mike:
I am sending all of the work that I did for the rebuttal. I tried to summarize it the best I could at the end. There were so many things that I feel that they did wrong that I could not squeeze it into one paragraph.
Caius Dodd

Subj: Email to Mike Modes
Date: 7/28/2000
To: smc1@nrc.gov

File: C:\WP\FI\IPTUBNOI.NRR (22929 bytes)
DL Time (32000 bps): < 1 minute

Stephanie:
in response to a telephone from Mike Modes this morning, I sent him the following document. It is the same as I sent you earlier with the summary added for David Lew.
Caius

Subj: Effect of wall thickness on the calibration
Date: 7/31/2000
To: elm@nrc.gov, smc1@nrc.gov
CC: cdb@nrc.gov

File: C:\WP\FI\INDIAN16.NRR (163565 bytes)
DL Time (32000 bps): < 1 minute

Emmett and Stephanie:
It appears that the decrease in wall thickness can have an effect on the measurement of cracks on the top of the u-bends. This effect will depend on the amount of the wall thickness decrease, and will be in the non-conservative direction. Emmett, let me know the amount of wall thickness decrease that you have and I will try to estimate the error in the calibration.

Stephanie, I will try to generate a table of the percent of the standard voltage reading that is obtained for stress corrosion cracks, and the voltage readings on the standards.

Caius

Subj: Another lesson learned
Date: 7/31/2000
To: LXL@nrc.gov (Louise Lund)
CC: smc1@nrc.gov, tees@airmail.net (Ian Barnes)

Louise:
It has been demonstrated at several plants (TMI and later at Indian Point) that insitu pressure testing will cause any significant defect to grow in amplitude, even if the tube does not fail. Therefore, all tubes that have been pressure tested should be re-inspected with eddy-currents. This will show if:

a. The defect detected in the tube is a real and significant defect.

b. There are any other significant defects in the tube that had been missed in the initial inspection.

The utility should not be too hasty to plug tubes that may be needed for insitu testing (as Indian Point has done).

Caius