Item # 5

Lessons Learned - for Utilities and NDE inspectors

At every inspection, the lead level III should review the noise at various points in the tube and determine what size defects could be hidden in this noise. He should warn the utility of possible problems in the inspection rather than waiting for a tube rupture.

The utilities should have a staff level III in eddy-current testing that is capable of monitoring the work of the vendors and know when the inspection does not give the utility the level of assurance that major defects are not present in the tubing.

The utilities should write analyst guidelines that are easy to read and follow rather than something that looks like a legal document that only a lawyer can read. Spend a little more time on this document up front and make the training and performance of the large number of analyst doing your inspection better. This would save money in the long run.

Analyst use one method of looking at data (call everything that moves) when passing the test, and another (do not put too much burden on the resolution analyst, keep up with acquisition and do not make waves) when actually running plant data. The analyst performance should be monitored by something like the Judas Tube program, rather than one that encourages the analyst to under-call defects and speed up the inspections.

The utilities and their vendors should recognize the areas where their inspections are weak and take long term steps to improve these inspections. This should be faced head-on rather than trying to conceal the problems from NRR and sugar coat it.

There is a problem with analyst making errors in typing and editing errors when performing their tasks. Methods to correct this problem should be implemented. Most people that are good at analyzing data can not type, and the analysis software should not require them to type.

Lessons Learned for NRR

The utilities will insure NRR that they have near perfect inspections. Since they do not know enough about eddy-current inspection, they may actually believe this. NRR needs to review these inspections with enough scrutiny to know if this is true. Most utilities that have received this review have problems that range from severe to moderate. Don Adamonis of Westinghouse has stated that there are a lot of utilities that have similar signal-to-noise problems that Indian Point has. This should be verified and corrected if true.

The POD that EPRI and others tout, and that sometimes goes into safety evaluations is quite non-conservative. It is based on defects that analysts are able to find, not the actual defects that are in the generators. In 1997 there were 9 cracks in the u-bends of the tubes. Only one was found. However, this u-bend test was an EPRI qualified test with 80% probability of detection at a 90% confidence level.

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Perhaps NRR should hold a one or two day seminar to tell the utilities how they can improve their inspections.

The Judas Tube Program

The eddy-current practical exams are generally designed to insure that an analyst calls defects greater than a given depth or voltage at a 90% confidence level. Indian Point and many other utilities do not count off on their exam for false positives. This makes it possible for analyst to "call everything that moves" without going into a detailed study to determine if the indication is really a defect or not. When the analyst gets on the job, he can not make too many false positive calls because it would overburden the resolution analyst. The analyst's performance is monitored each day, and he gets feedback from this monitoring. Too many false positive calls will result in retraining and being sent home if this continues. Therefore, the level of performance of the analyst falls of during production data analysis. Some method of monitoring this performance during production is needed.

I believe that NRC should institute the "Judas Tube" program. This would consist of collecting tubes from the test and current inspection that had defects in them. They would be recycled back into the analysis data stream with the date, row and column disguised to match the other tubes in the cal group. The readings would be changed so they would match the cal standards in that cal group being done. This can be done with a simple c-program. Each cal group would contain at least one Judas Tube, and the analyst would be graded on their ability to detect these defects. If the analyst did not achieve a passing grade, they would have to be retrained and retested. Also, all cal groups that they analyzed would have to be redone by a qualified analyst. Into this collection of Judas Tubes, we would also insert a few "Monkey Tubes", such as R34C51 of Steam Generator 22, with defects so obvious that even a monkey could find them. If an analyst missed one of these tubes, that would be an automatic failure, and he would have to be retrained and tested. Also, all the tubes he had analyzed would have to be redone.

The analyst's evaluation program could be extended to include any normal defective tubes from the plant that come through the data analysis program. If the plant had enough normal defective tubes, then the Judas Tubes would not need to be inserted. However, this is seldom the case. It would also keep the analyst on their toes and insure that they would examine each tube, since they know that they will get some bad tubes in every cal group. This will slow down the analysis speed, more from the increased care that each analyst will take rather than the insertion of the extra tubes. However, it will insure that the tubes get the quality of inspection that NRC has been led to believe they are getting.

In keeping with the Judas Tube program, I think that the utility should re-analyze all of the cal groups done by the analysts who missed the "monkey tubes" at the Indian Point inspection. The utility should be notified as soon as possible about this so that they will have time to include this in their program without impacting their critical path.

Review of 1997 inspection of U-bend tubes at Indian Point2

Tube 2-69 of steam generator 24
The 400 kHz C-scan of tube 2-69 of steam generator 24, made in 1997, is shown in Figure 1. While the amplitude of this signal is small (1.2-volts), it does stand up above the noise, enough at

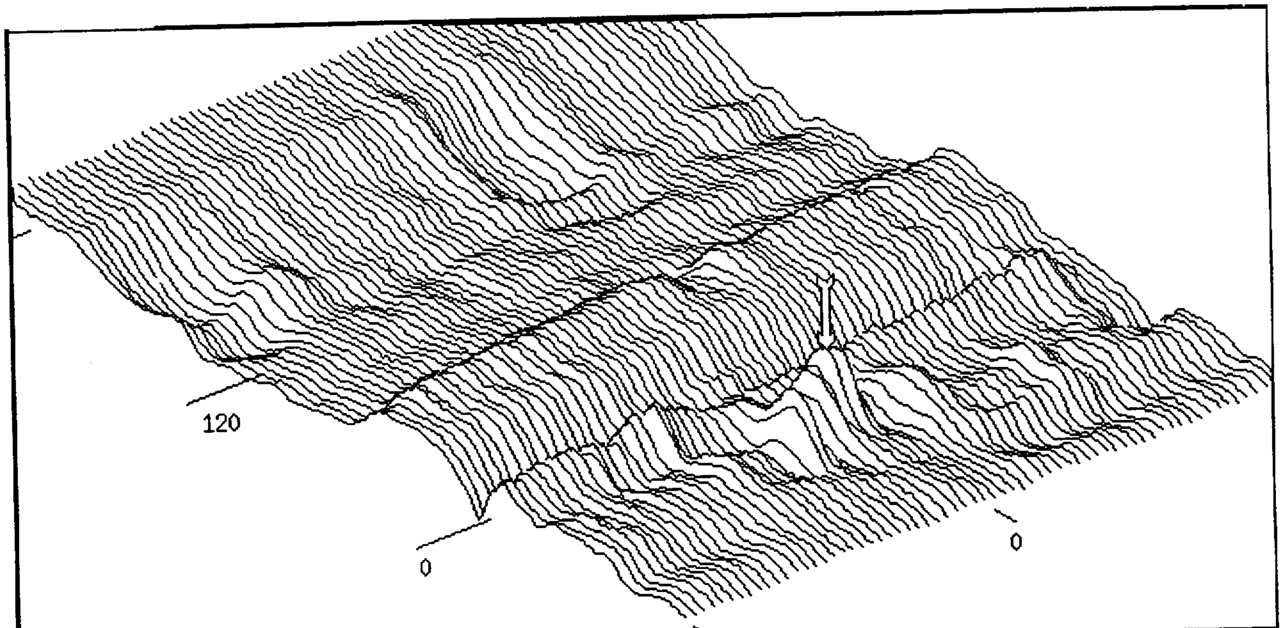

Figure 1 400 kHz C-scan of tube 2-69 of steam generator 24 made in 1997

least for the analyst to look at the Lissajous of the signal.

Tube 2-87 of steam generator 21
The C-scan of tube 2-87 of steam generator 21 is shown in Figure 2. This tube has a defect

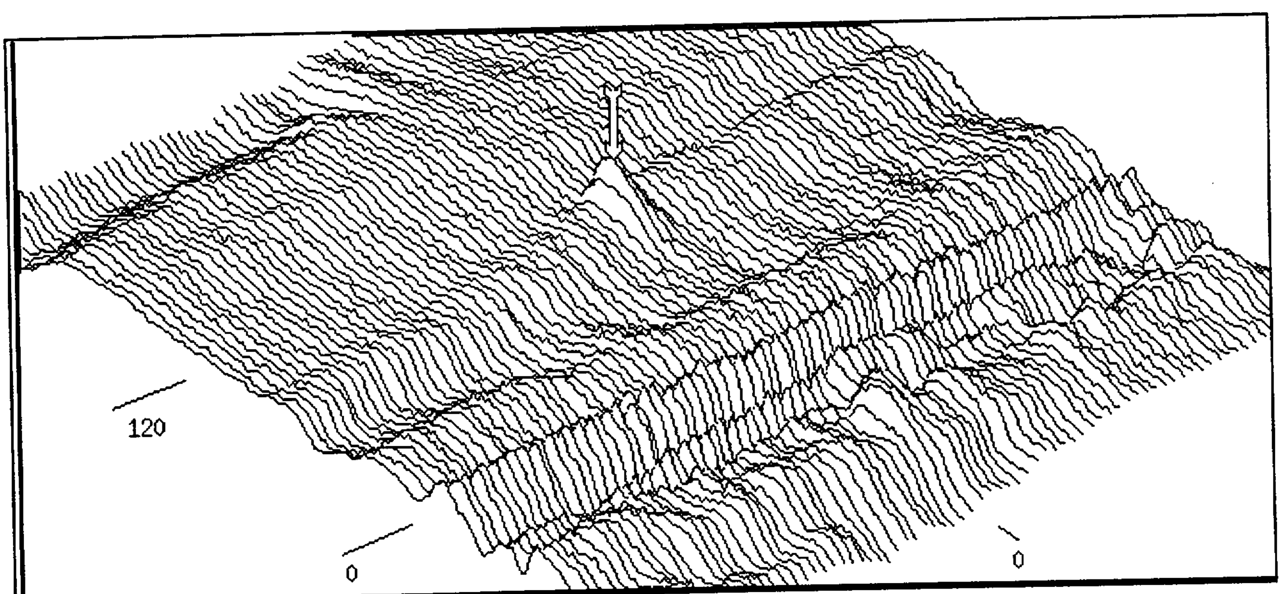

Figure 2 400 kHz C-scan of tube 2-87 of steam generator 21 made in 1997

signals of about 1-volt in a relatively clear part of the tube. This signal looks very much like the one found in tube 2-67 during the 1997 outage. A careful examination of the C-scan of this tube will show enough of a signal for the analyst to look at the Lissajous signal. This tube also has several long cracks at about the same axial location as the defect that is in the clean section. They are partially obscured by a noise ridge.

Tube 2-5 of steam generator 24

The C-scan of tube 2-5 of steam generator 24, made at 400 kHz in 1997 is shown in Figure3. The defect is shown riding on top of the deposit ridge. This defect becomes much more apparent if a circumferential average filter is used. The use of this filter on tube 2-5 is shown in Figure 4. This type of filter computes the average value of the vertical component of the signal over all of the axial extent of the scan, for each point around the circumference of the tube. This average value is then subtracted from the scan, and the scan of the difference is re-plotted. This is particularly effective in removing the long ridges of noise from the scans. The differences in the axial direction are then emphasized. The 1997 guidelines state that "Mixing and filters are not required but are optional." In general, Westinghouse does not encourage the use of filters.

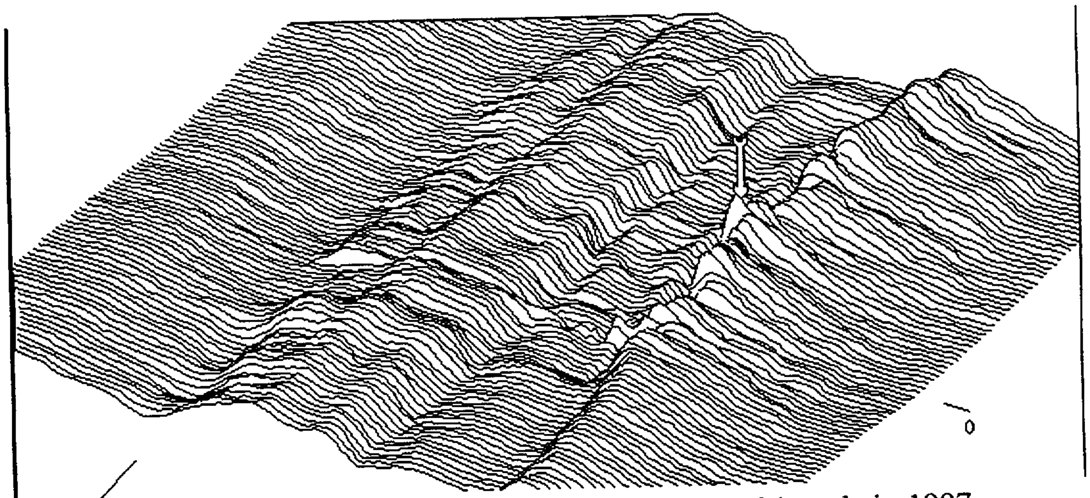

Figure 3 400 kHz C-scan of tube 2-5 of steam generator 24 made in 1997

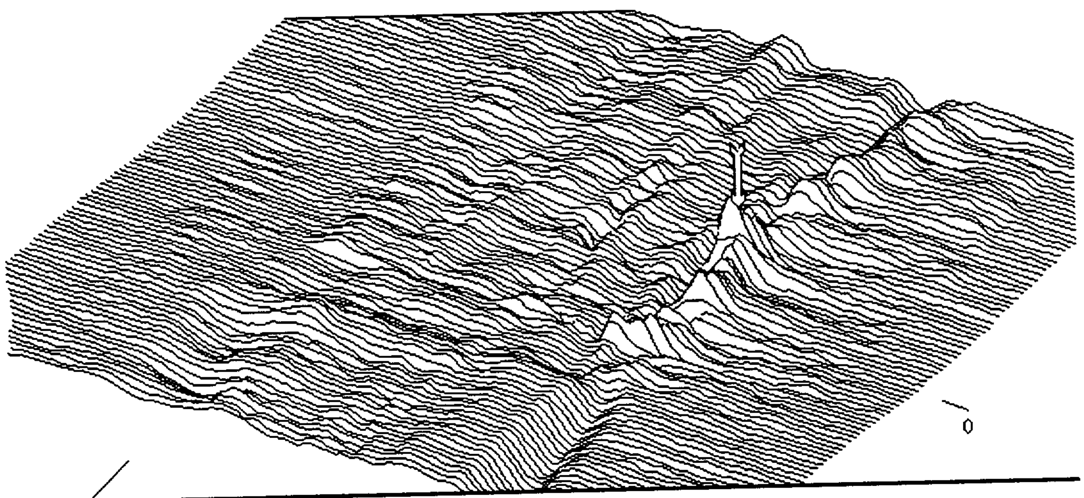

Figure 4 400 kHz C-scan of tube 2-5 of steam generator 24 using a circumferential average filter.

Tube 2-72 of Steam generator 24

Tube 2-72 of Steam generator 24 is similar to tube 2-5, and could possibly be detected from the C-scan, without the need of any filter, although a circumferential average filter would have

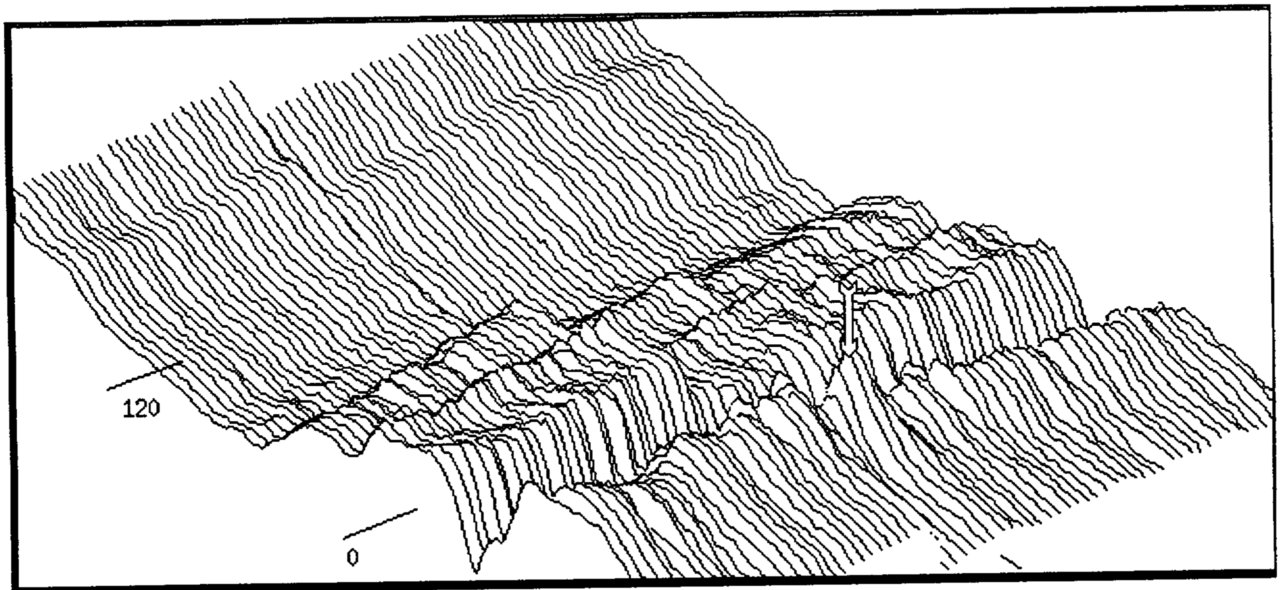

Figure 5 400 kHz C-scan of tube 2-72 of steam generator 24 made in 1997, with no filter applied

helped here also. This tube is shown in Figure 5.

Tube 2-71 of steam generator 24

Tube 2-71, as shown in Figure 6 needs the circumferential average filter applied for detection.

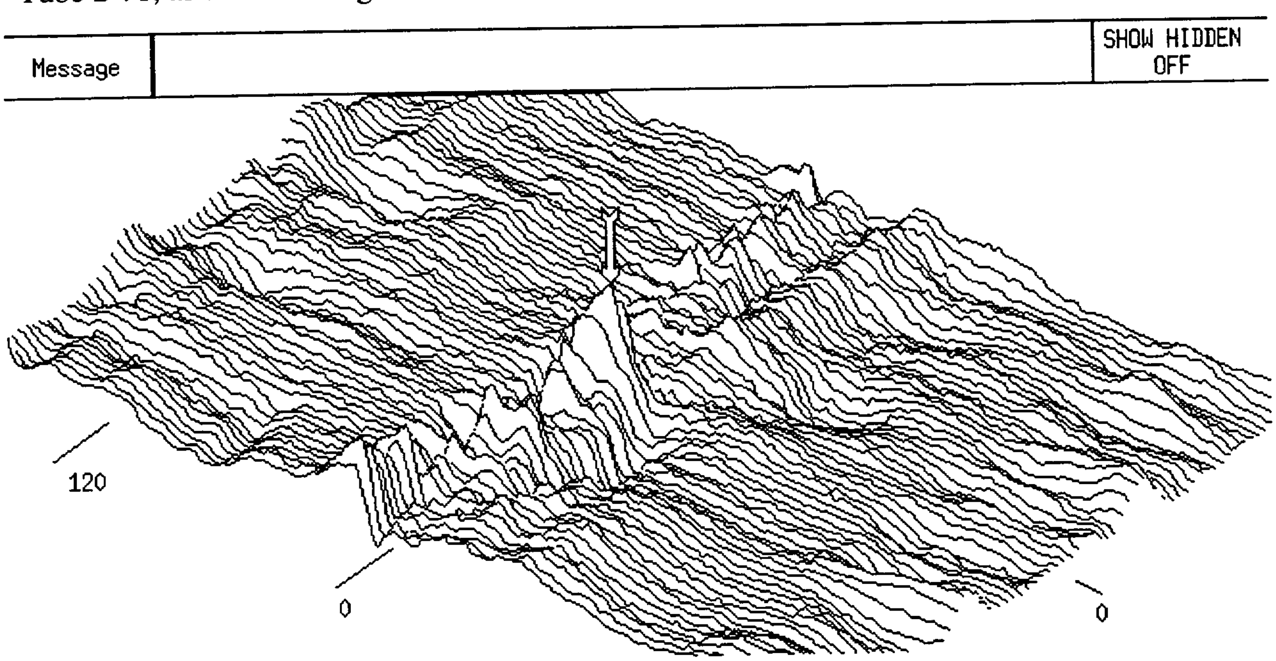

Figure 6 Tube 2-71 of SG24 in 1997 at 400 kHz, with circumferential average filter applied.

Tube 2-85 of steam generator 23

Tube 2-85 of steam generator 23 also needs the circumferential filter for detection, as shown in Figure 7.

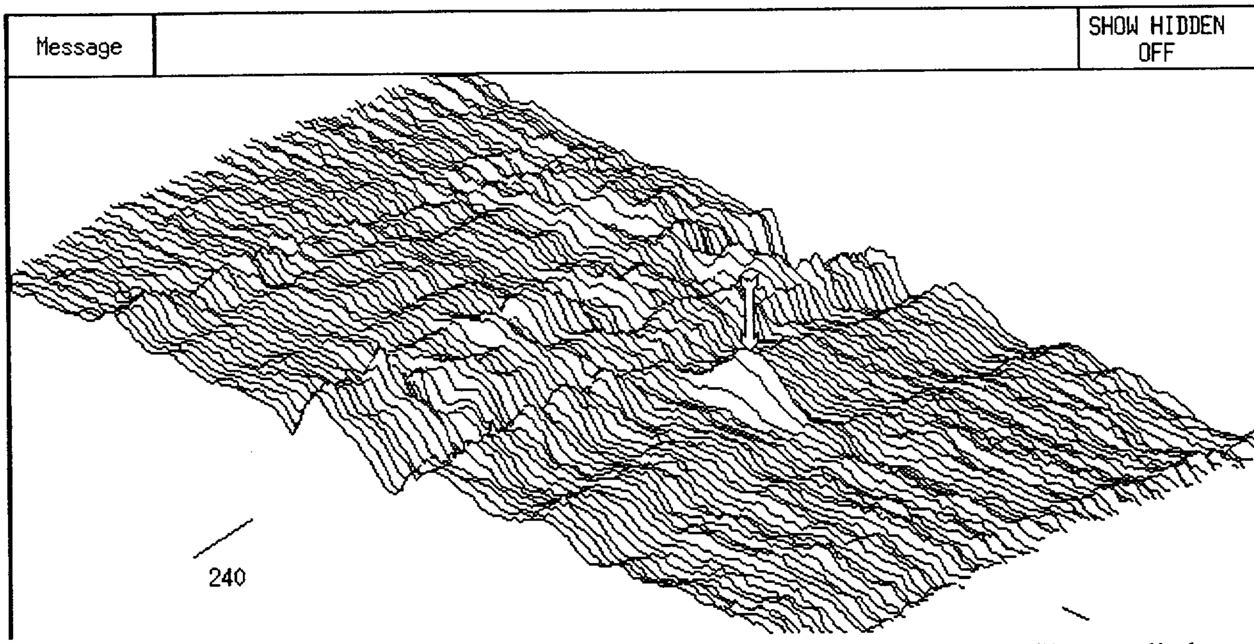

Figure 7 Tube 2-85 of SG23 in 1997 at 400 kHz, with circumferential average filter applied.

Tubes 2-4 and tubes 2-74 of steam generator 24

Tubes 2-4 and tubes 2-74 were questionable in the 1997 data. It was possible to find some indications, but I could not find a definite signal that I could be sure that this was the defect seen in 2000, even with the use of circumferential averaging filter.