7/28/00

Rebuttal to Item Number 1

Review of Tube R2 C67 from 1997 data and the effect of noise:

A review of Tube 2-67 showed that the defect measured about 80% deep from 1997 data. The voltage was about 67% of that of the standard 80% EDM notch, as measured by Westinghouse. In addition, tube 2-87 had a long, possible defect that showed up on the 300 and 400 kHz scan, but rotated as a deposit on the 100 kHz scan. The presence of a 80 % deep defect at the end of a cycle indicates that the inspection is not sensitive enough and that action should be taken to improve the test. A measure of the noise in the table below shows that 2-87 had less noise in general than the other tubes in the generator. Also, it should be noted, that there was not any large noise signal in the immediate vicinity of this defect, so the signal-to-noise was actually better than

Tube /SG	Vp-p; 300 k	Vert max 300 k	Vp-p; 400 k	Vert max 400 k
2-67 SG24	3.63	1.50	3.62	1.55
Noise	1.26	0.43	0.90	0.44
2-5 SG24	2.33	1.10	2.39	1.24
Noise	1.20	0.87	1.16	0.85
2-69 SG24	1.36	0.53	1.36	0.54
Noise	1.36	0.60	1.21	0.50
2-87 SG21	0.68	0.31	0.68	0.36
Defect 2	1.06	0.33	1.01	0.40
Noise	1.11	0.46	1.05	0.52
2-71 SG24	1.12	0.45	1.17	0.55
Noise	2.48	0.60	2.16	0.86
2-72 SG24	0.84	0.44	0.85	0.48
Noise	1.24	0.56	1.10	0.67
2-85 SG23	0.53	0.13	0.58	0.20
Noise	1.39	0.71	1.37	0.45
2.74 SG24	**NDD**			
Noise	1.24	0.56	0.85	0.48
2-4 SG24	**NDD**			

J 153

Noise	1.93	0.86	1.70	0.95

indicated by the table. The other tubes, all of which were missed, did not have as good a signal-to-noise ratio, although some had a ratio better than 1:1, particularly in the region close to the defect. Defect 1 of tube 2-87 of steam generator 21 was sitting in a clean section of the tube, although there was considerable noise elsewhere in the tube.
It also seems that a signal-to-noise ratio better than 1:1 is needed in order to detect defects, unless there has been a recent tube-rupture at the plant being inspected.

The noise level can be reduced considerably by using filtering techniques, such as the circumferential average filter in the Eddynet software. The ANSER software has a comparable filter, but this was not and has not been used. The guidelines permit the use of a filter but do not encourage it.

A PWSCC (and a SCC defect in general) yields only 20 to 70 percent (and perhaps less) of the signal amplitude that a calibration standard yields. There is data in a Westinghouse report from the Alternate Plugging Criteria on this ratio somewhere, but I have not been able to locate it yet. If this data is not available, it should be generated from the voltages and depths of the defects found at each outage.

Calibration Standard
The Calibration standard was checked. I verified that a phase setting of 10 degrees was used for the values in the standard table.

Determine if possible the effect of tube-wall thinning due to the bending on the calibration of the defect depths. Also, determine the amount of thinning that was present. The present and former calibrations may have error due to the fact that the standard notches are in straight tubing with the proper wall thickness and the cracks are in the outside of the bend, where the tubing has been thinned during the forming.

The zero defect phase setting may be too high for the 2000 calibration of the high-frequency probe. This would bias the actual flaw depth too high for the low phase angles, which may account for no shallow defects being detected.

Noise Criteria
The statement that there is no quantitative noise criteria present in 1997 is correct, and there is no quantitative noise criteria present today. However, industry has been aware of the NRR's concern and NRR's desire for such a criteria for a number of years. Eddynet 95 incorporated noise measuring tools in their software, and there have been a number of attempts by industry committees to correct this problem.

One of the criteria would be to compare the amplitude of the noise in the tubes being inspected to the voltage of the defects that are expected. The ratio of the standard voltage to the defect voltage should be determined for the appropriate defects. A signal- to-noise ratio of 3-to-1 would insure the detection of defects, while with sufficient training and

care, a ratio of 2 or maybe even 1.5-to-1 would suffice. However, looking at the performance of the analysts in the 1997 outage shows that some caution is needed.

Probe Qualification

The probe qualification done on the EPRI data set in 1997 shows how erroneous these qualifications are. There were at least 9 cracks present in 1997, only one of which was found. The inclusion of EDM notches and laboratory grown samples biases the probability of detection. Also, for actual pulled tube samples, only the easily detectable cracks are ever found and pulled. This also forms a bias toward the flaws being easier to detect than they actually are.

Rebuttal to Item Number 5

A number of Level III analysts at the site (and in particular Gary Pierini) said that they would have caught the defect in the 1997 data if they had looked at it.

Rebuttal Summary to Item 1

Measurements on typical stress corrosion cracks has shown that the eddy-current voltage response from these cracks is almost never as large as that from a calibration standard. In general, the voltage response is on the order of 20% to 70% of that of a calibration notch of the same depth. This is on the stress corrosion cracks that have been detected. There may be others with less than 20% of the voltage that have remained undetected. These are the voltage numbers that should have been applied to the noise levels the other tubes, not tube 2-69 which is relatively clean. The defect depth measured on 2-67, using the 1997 data was 80%, not the 50% that was reported.

The vertical max. for the noise level in other tubes is on the order of 1-volt, which would correspond to a typical 80% deep stress corrosion crack. The signal-to-noise (vertical max. for both) of tube 2-5 at 400 kHz, with the proper phase adjustment, was 1.45 to 1. Since this crack was missed, it suggests that a signal-to-noise ratio greater than this is needed. This is assuming that the analyst is not going to look at the Lissajous unless he sees something on the C-scan. The analyst should be trained to look at the Lissajous if anything remotely suspicious is seen on the C-scan.

The signal-to-noise on the ETSS 96511 flaw matrix that was used to qualify the midrange probe is meaningless. All of these are flaws that are detectable in spite of the noise present. The performance of this probe in the field invalidates (missing 8 of the nine or more flaws that were present) the POD premises that EPRI has developed.

Noise criteria was not in place in 1997, but NRR has requested that industry put written noise criteria in the guidelines well in advance of 1997. In response to our requests, software was written by Zetec in their 1995 release of Eddynet that will measure the noise in tubes.