9-5

C. Dodd, NRC Contractor

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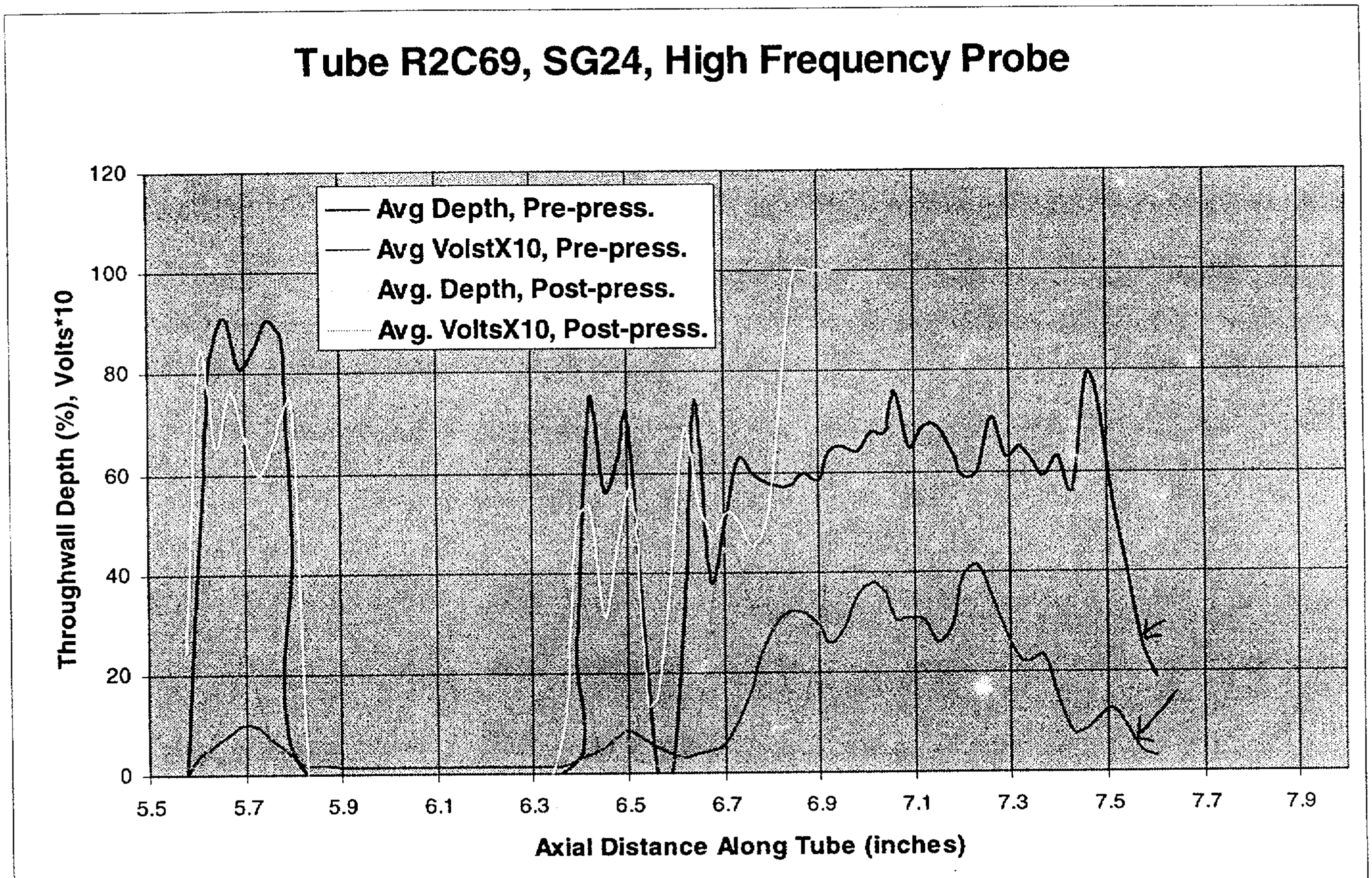
To: OWFN_DO.owf2_po(ELM),OWFN_DO.owf4_po(SMC1) E.Murphy, S.Coffin NRC
Date: Thu, Apr 20, 2000 8:33 AM
Subject: IP5 report

Emmett and Stephanie:
I have finished profiling all of the before-and-after high-frequency u-bend tests. I still have several more tubes to profile for you. I'll talk to you at 10:00 am.
Caius

J/162

Comparison of tube scans before and after pressure testing



Scans were made on the three leaking tubes in Steam Generator 24 after the pressure tests. These scans revealed a considerable change in the eddy-current response. Of most interest is the scan of 2-69. In Figure 1 we show the pre-pressure test scan of this tube, with the post-pressure test of the tube superimposed. The region on the right has only the pre-pressure test scan, since the probe would not run through the tube after the test. The amplitude of the scan is large enough to be more accurately measured. Figure 2 has the pre-scan graphics and Figure 3 has the post-scan graphics. The defect on the left was not included in the profile of this tube, but it was reported on the data sheets. In Figure 4 we show the profile of tube R2C74 of steam generator 24, and in

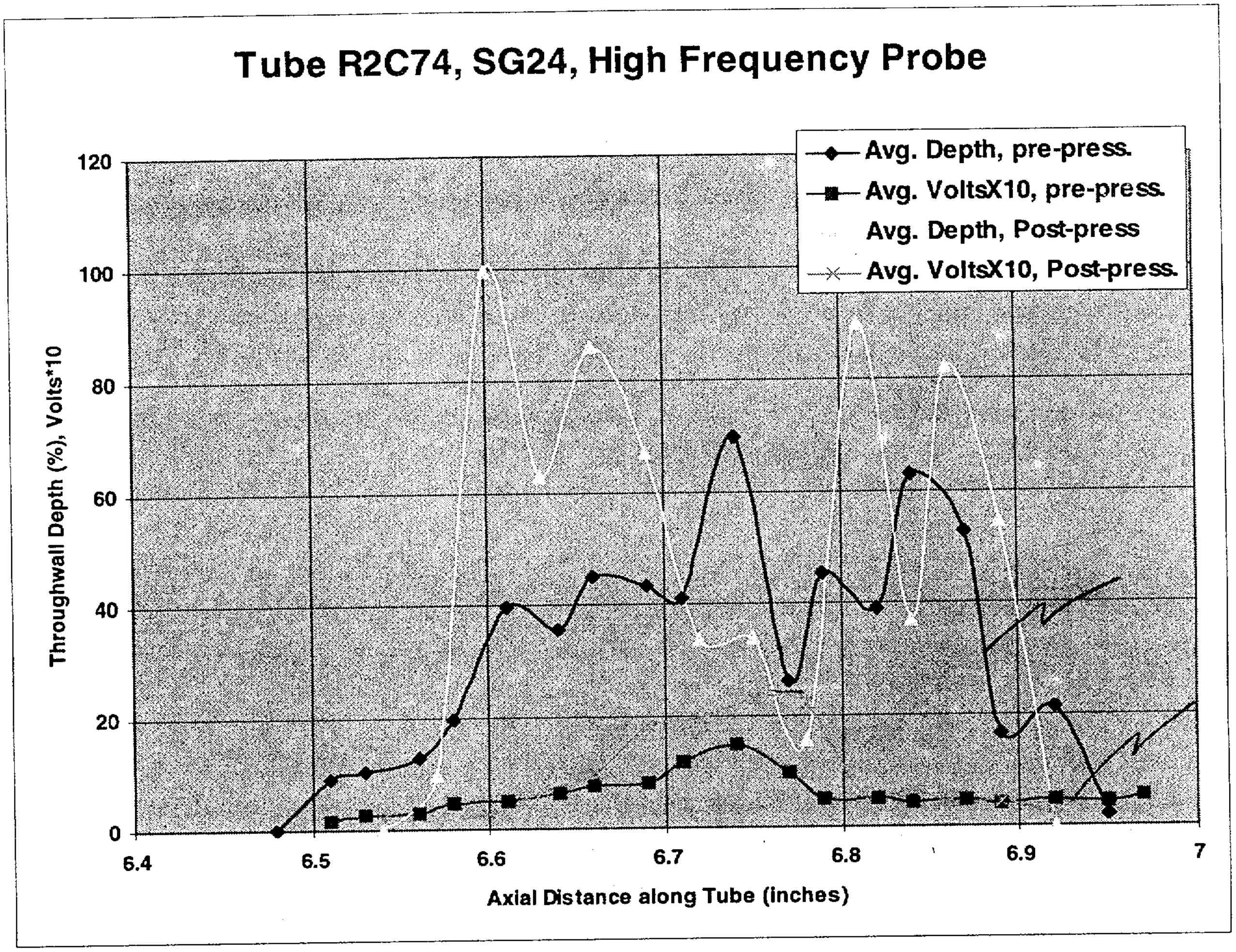
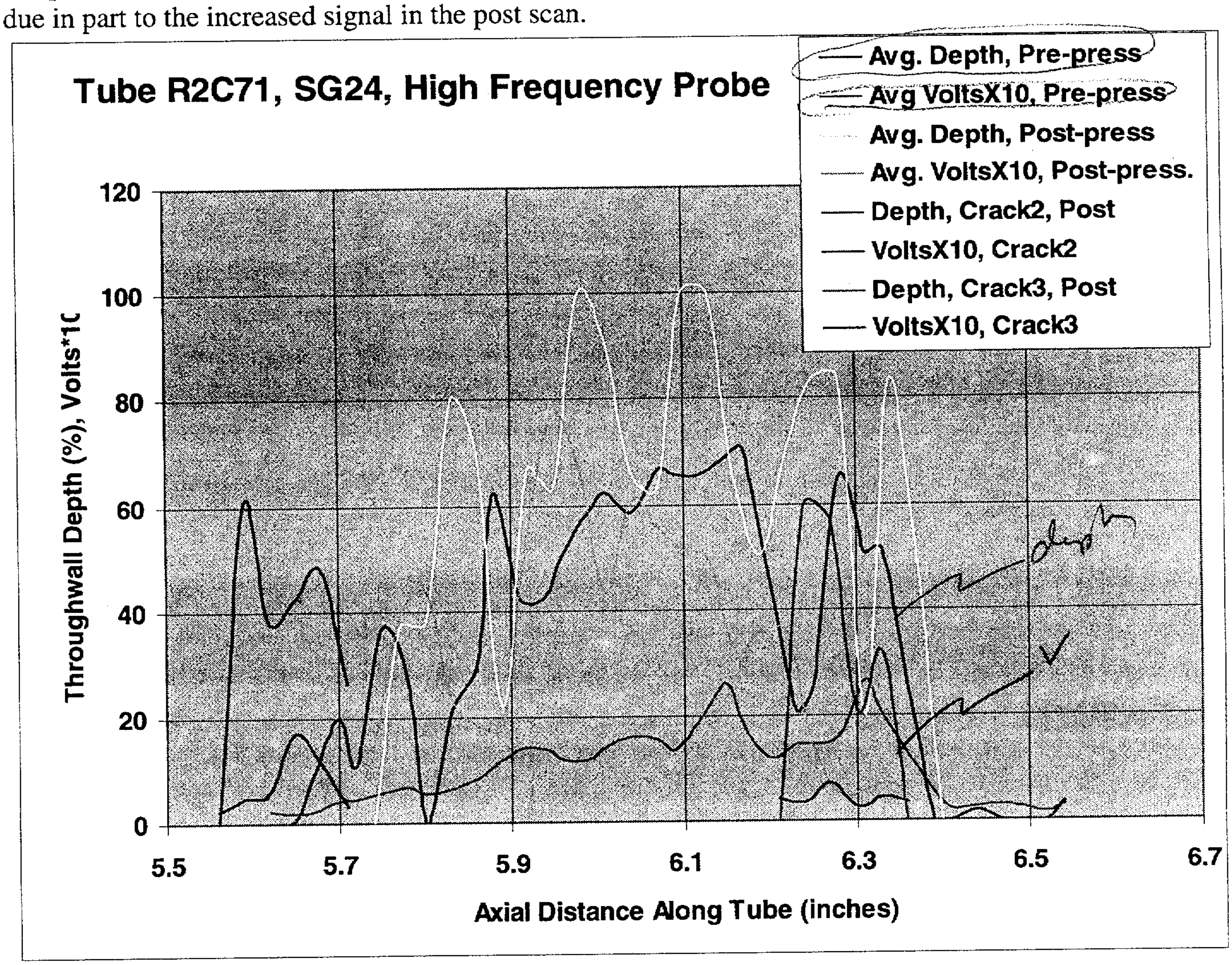
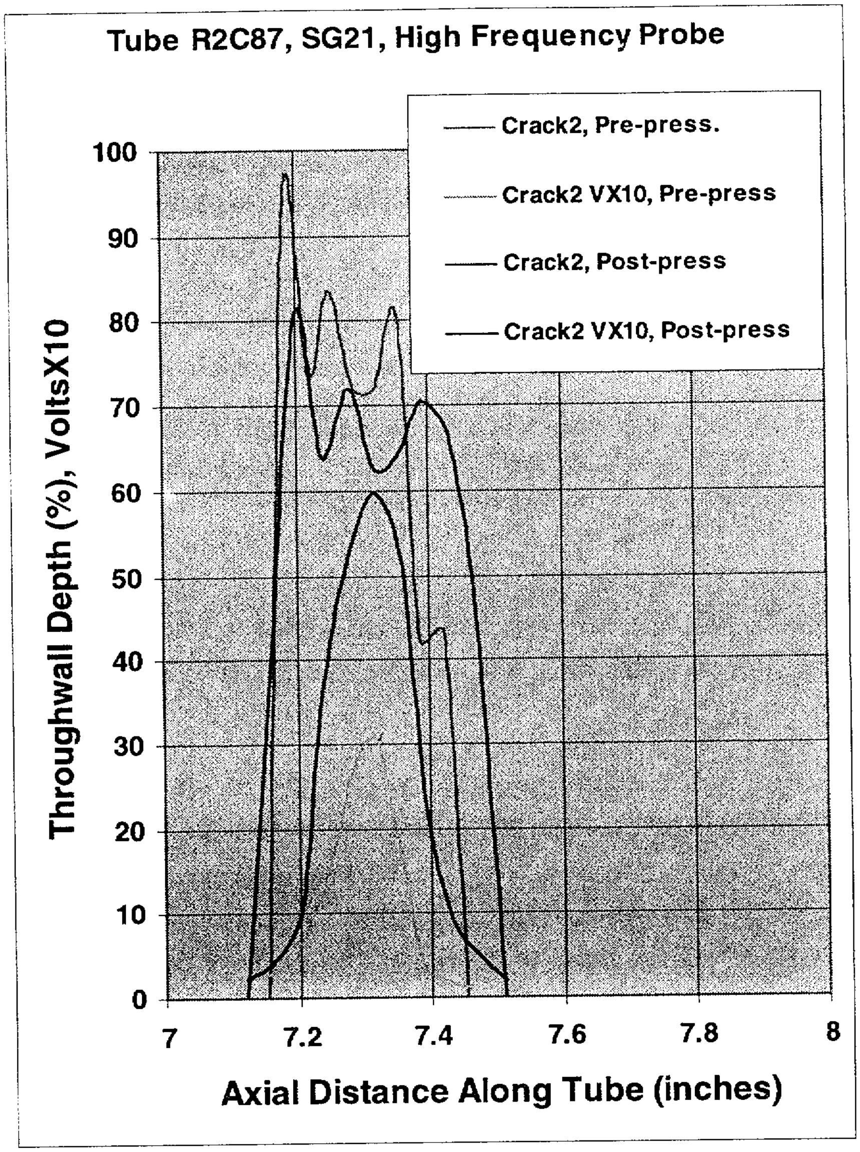

Tube R2C74, SG24, High Frequency Probe
Avg. Depth, pre-press.
Avg. VoltsX10, pre-press.
Avg. Depth, Post-press
Avg. VoltsX10, Post-press.
Throughwall Depth (%), Volts*10
120
100
80
60
40
20
0
6.4
6.5
6.6
6.7
6.8
6.9
7
Axial Distance along Tube (inches)

Figure 5 we show the pre-scan of tube R2C74 and in Figure 6 we show the post scan. The defect has penetrated the wall and this tube, as with the other two, leaked. The signal-to-noise is better, due in part to the increased signal in the post scan.

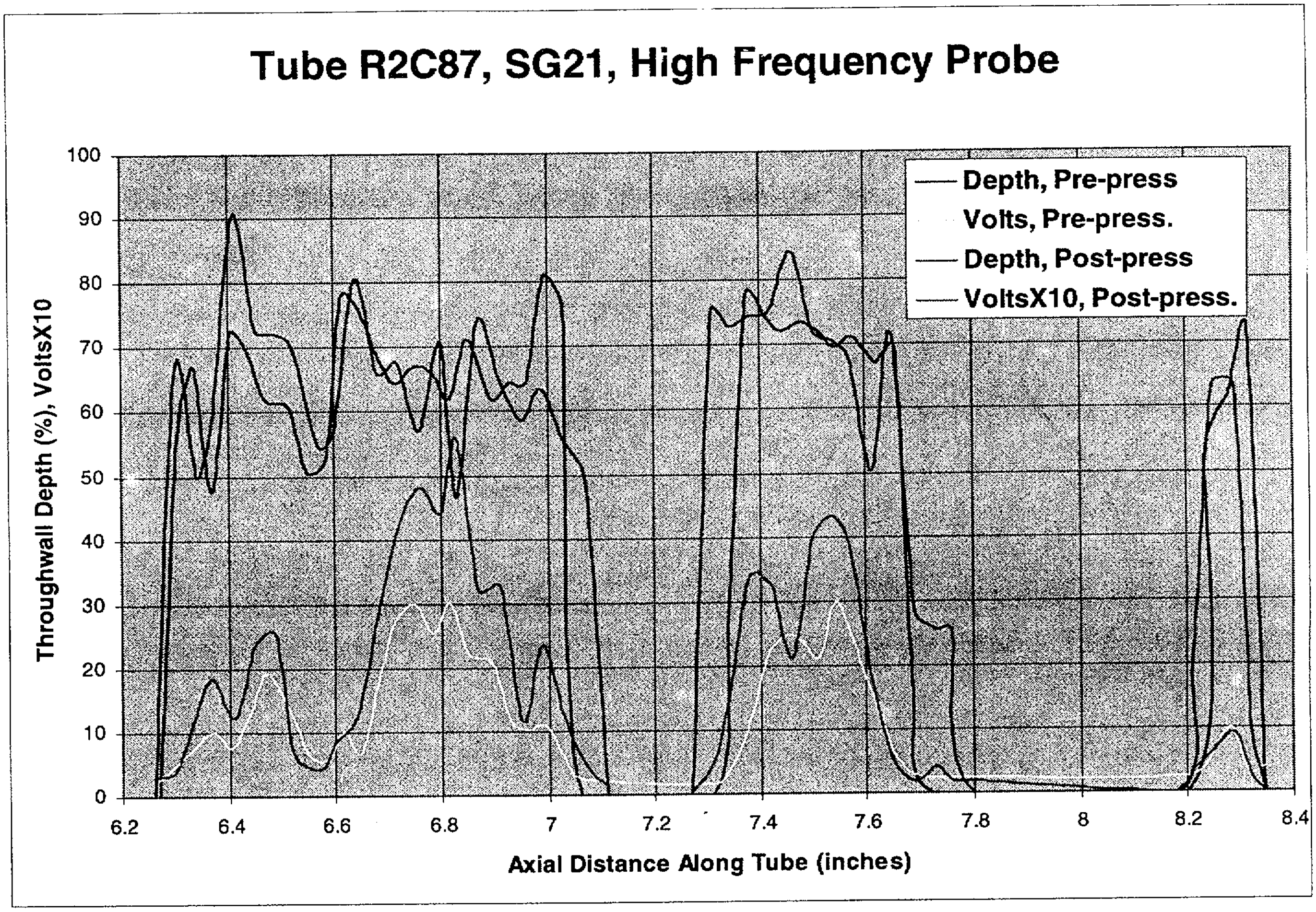


The pressure testing of tube R2C71 of steam generator 24 shows the presence of two new cracks that were not visible on the scan of the pre-pressure test scan. It is unknown if the cracks were there previously or were created by the pressure testing. However, they are clearly visible now, and they are profiled as crack2 and crack3 in Figure 7. If these cracks were present before the testing their amplitude was too small for them to be detected and sized. In Figure 9 these cracks appear in the foreground, where they were not visible in the scan in Figure8.

In Figure10and in Figure 11 we show the profile of cracks found in tube R2C87 of steam generator 21. This tube had a secondary crack about 0.35-inches long with a depth of about 70% of the wall. The voltage amplitude of this crack has approximately doubled with the pressurization. The depth appears slightly less and the length appears slightly longer after pressurization, but this is probably due to the crack being easier to detect at the edges, and the measurement is probably more accurate with the larger voltage.



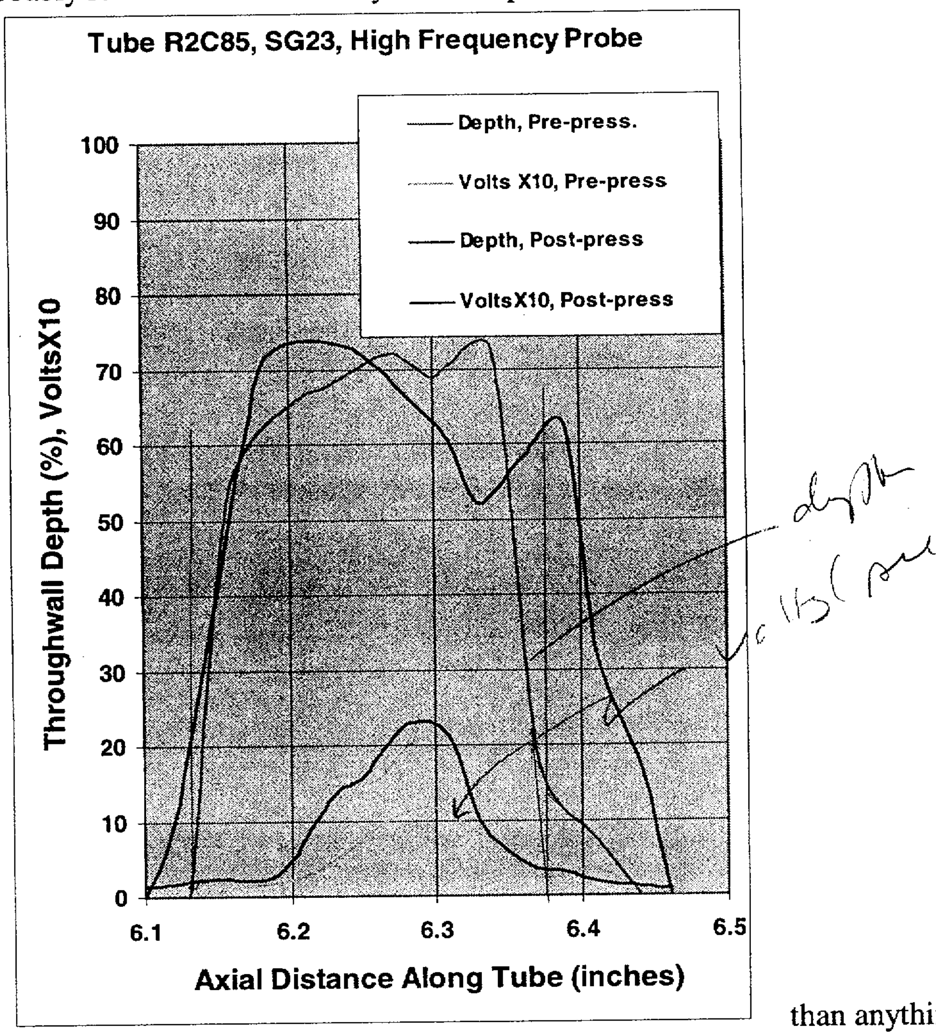
The primary crack shows a similar change with pressurization. It appears to be between 60 to 70% deep, with two ligaments of conducting material across the crack face. The overall length of the crack is about 2-inches. There is a bridge from about 7.1-inches to 7.3-inches and another from about 7.8-inches to 8.2 inches. The crack depth probably does not go to zero along these bridges, but down to a value (20% or less, after pressurization) small enough not to be detected. In Figure 12 we show the pre-scan of tube R2C87, showing both of the cracks and Figure 13 shows the post-scan of the tube. It appears that the defect was scanned from different directions (the pull on one scan and the push on the other scan) between the two scans. The scans can be made to have the same axial orientation, but this results in the secondary crack being on



different sides of the primary crack.

In Figure 14 we show the effects of pressure testing on the crack found in tube R2C85 of steam generator 23. This crack showed the same phenomenon as the others, to a lesser extent. The depth appears to be about the same and the length appears to increase slightly. In Figure 15 we show a C-scan of the tube before pressure testing and in Figure 16 we show a scan of the tube after pressure testing. The scans in this case are quite similar, with no new cracks appearing.

In some cases the post-pressure test scan shows a deeper crack than the pre-scan test. This probably reflects the uncertainty in the depth measurements of the low amplitude signals more



than anything else. However, it could be due to the inner portions of the crack producing a larger amplitude signal than the outer portions, due to the inner portion opening more. The vector result of the combined signal, which is what the eddy-current probe sees is therefore biased to the more shallow portion of the crack, and the result appears as a more shallow crack. This same phenomenon was observed for the IGA on the inner surface of the tube after pressurization at Three Mile Island, Unit 1.

None of these profiles are adjusted for the edge effects that the plus-point (and other eddy-current) probes will produce. For the low level signals, small noise perturbations can cause large errors in the depth readings, particularly for signals under a volt in amplitude. The analyst uses a certain amount of judgement in profiling these cracks, and the readings are influenced by what the analyst believes the crack should look like.

These profiles and scans clearly show how the detectability of these small u-bend defects is increased due to the pressure testing of these tubes. Although it varies from crack to crack, the amplitude of these small cracks increases by about a factor of two due to the pressurization.