R2C5.NRR 3

Review of Tube R2C5 in Steam Generator 24
Phase settings between 1997 and 2000

In 1997 the phase rotation for the eddy-current calibration was set too low, resulting in a decrease in the vertical signal that the analyst uses for screening for defects. In Figure 1 we show the c-scan plot with the phase set too low. In Figure 2 we show the phase setting that is being used for the current inspection. The indication, which is riding on a noise ridge, is easier to see.

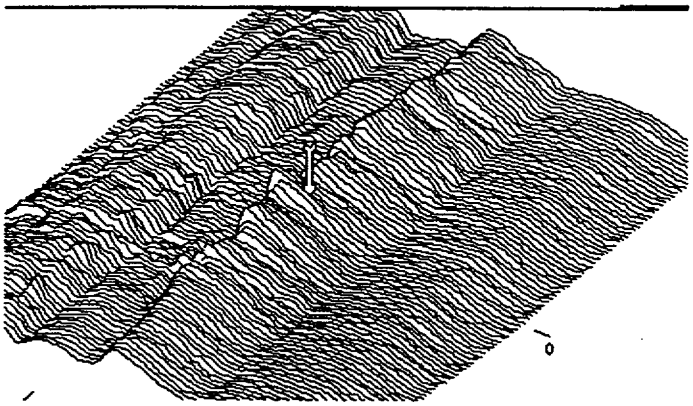

Figure 1 C-scan with1997 phase setting.

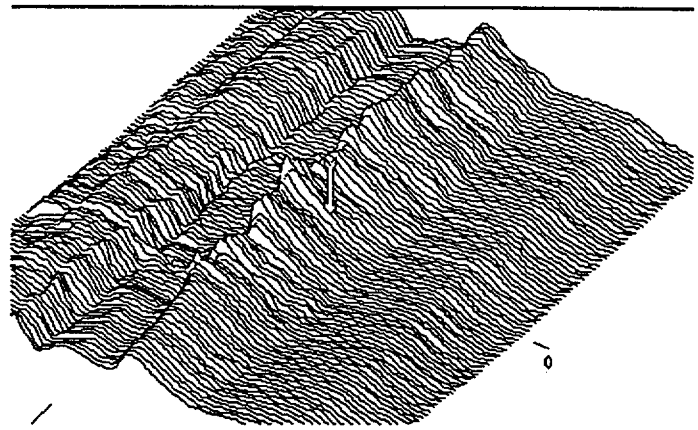

Figure 2 C-scan with the 2000 phase setting.

With proper training the analyst would be more likely to discover the indication with this phase setting. In Figure 3 we show the Lissajous of the indication that the arrow is pointed to.

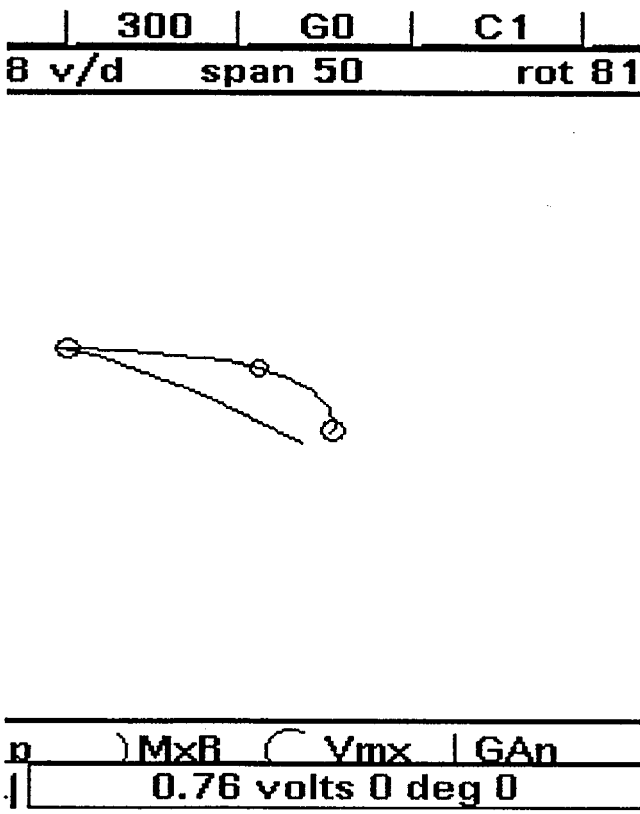

Figure 4 Lissajous of defect with 1997 phase setting.

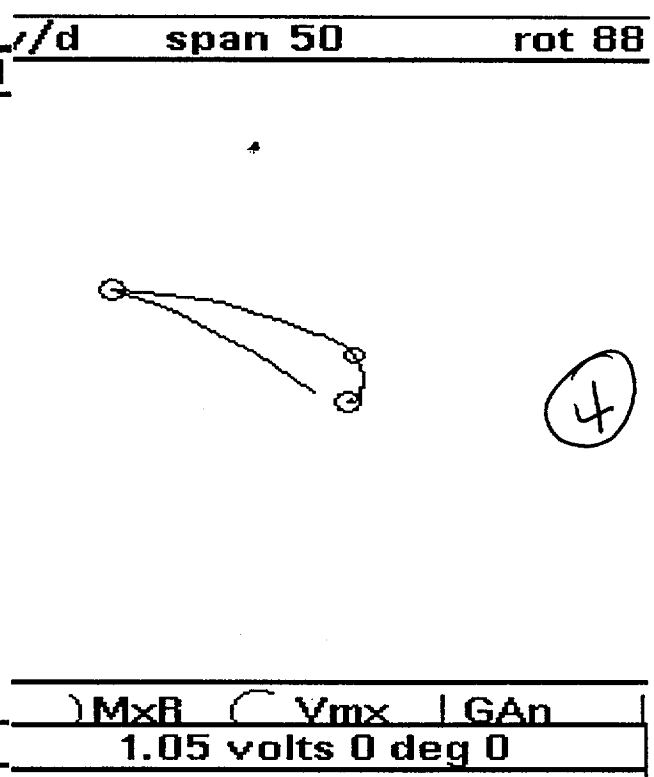

Figure 3 Lissajous of defect with 2000 phase setting.

The vertical signal with the correct phase

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setting changes from 0.76-volts to 1.05-volts, giving the analyst an increased chance to notice the defect. When the analyst notices the defect, he will then click on it and make a reading from the lissajous screen. The shape of the indication clearly identifies it as a crack in both Figures 3 and 4. It is slightly easier to spot in Figure 2 than it is in figure 1, due to the increased vertical amplitude. The phase setting of Figure 1 is 7 degrees lower than that of Figure 2. With the new, high-frequency probe the noise is considerably decreased, and rotated horizontal, while the signal is increased. This results in much improved detectability for these defects.

The defect signal sits on a noise ridge that runs the length of the tube. This noise ridge is about 1-volt in amplitude and measures as a deep id defect, on the order of 70 to 100% deep. This ridge makes both the detection and sizing of this defect more difficult. In Figure 5 we show the lissajous of the noise ridge. The signal-to-noise is slightly better for the 400 kHz frequency than the 300 kHz.

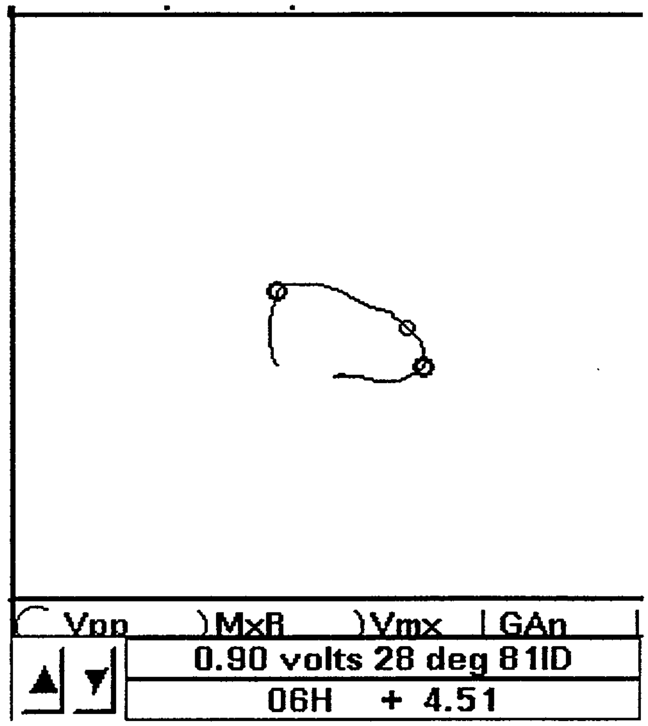

Figure 5 Noise signal that runs the length of the u-bend.

There is a signal on the 10 kHz channel that follows the defect. It is not known why the signal is visible at this frequency, although it may be due to a slight ferromagnetism of the crack. In Figure 6 we show the c-scan of the signal that has the same outlines as the crack. This scan also has signal-to-noise problems. In some cases the analyst will remove any indication from the defective tubing list if a signal such as this is present.

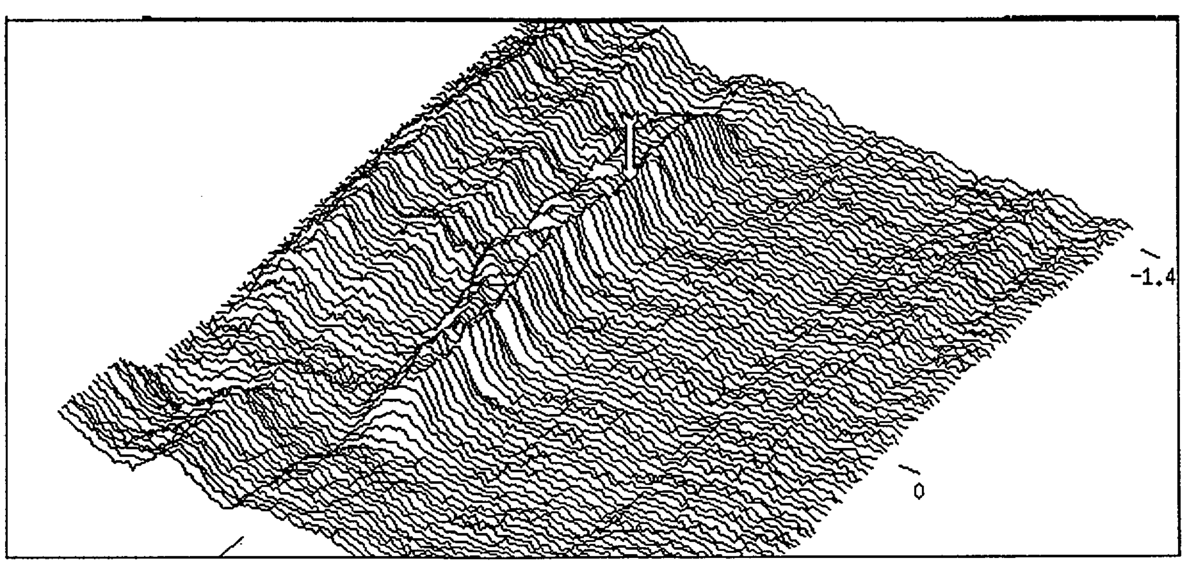

Figure 6 C-scan of the crack at 10 kHz

The indication has been profiled for both frequencies, as is shown in Figure 7. The 400kHz profile is probably slightly more accurate than the 300 kHz profile. Neither is very accurate, and until the defect voltage increases above 1.2-volts, there is considerable error. This can be

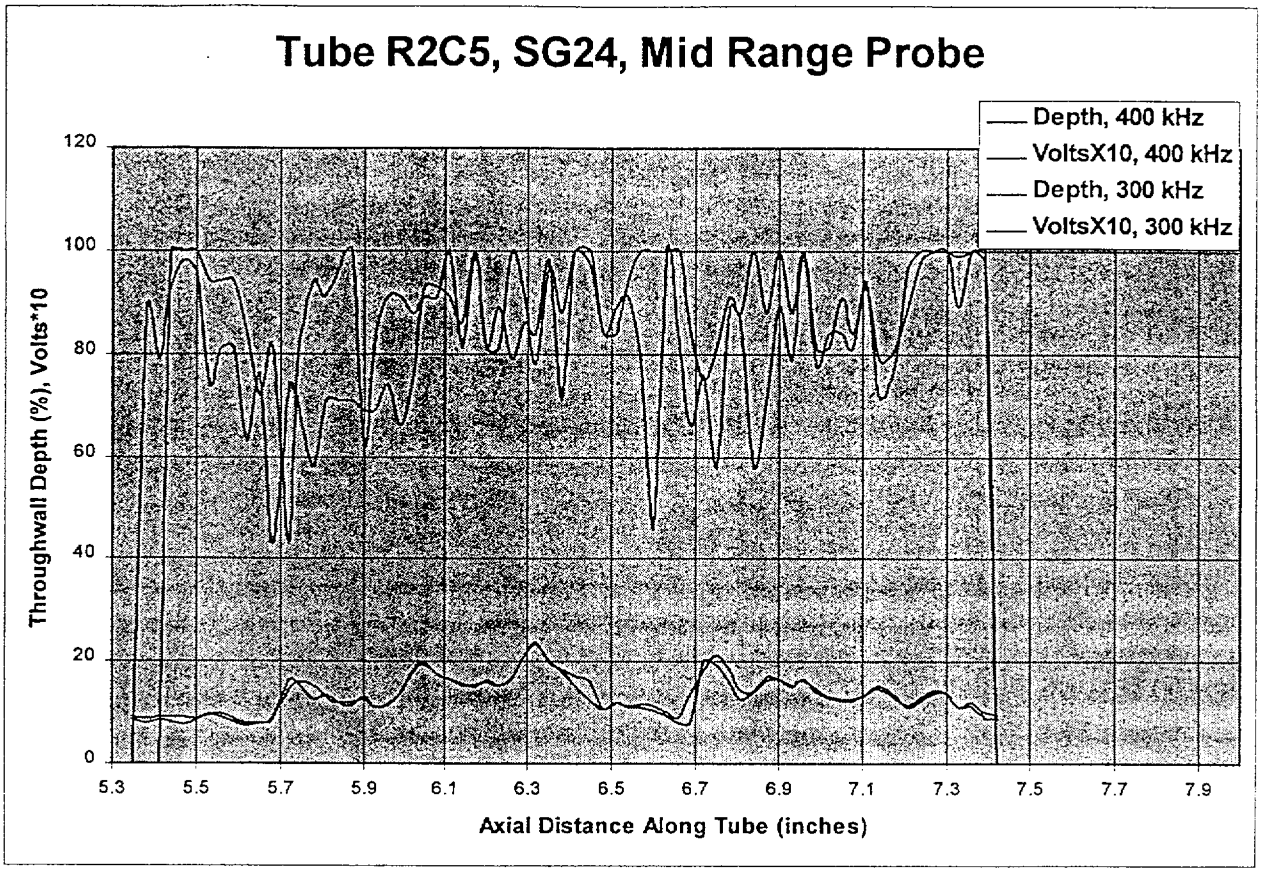

Figure 7 Contour of the crack in tube R2C5 in SG24 using the 1997 data from the mid-range plus-point probe.

contrasted to the 0.4-volt threshold for the high-frequency probe. No attempt has been made to adjust these profiles for the end effects of the probe.

Signal Filtering

The Zetec software (and I believe also the Anser software) has the ability to subtract an average signal or a single line signal from both the axial and circumferential c-scan plots. The main use if these "filters" is for cases like this were you need to separate a defect from other naturally occurring signals with relatively constant shapes, such as tube supports or these ridges. A number of different processing methods are referred to as filters, including this type of simple subtraction filter and frequency filters. Westinghouse discourages the use of filters in general since they throw away some of the signal that may contain a defect. The analyst guidelines states that the analyst does have the option of using filters, but it is not mandatory. In Figure 8 we show a C-scan of the R2C5 using the circumferential line filter. We are subtracting the signal form a single circumferential line set at the location of the arrow. The defect is easier to see at this location. The signal from the ridges cancels out near the location that we set the line filter,

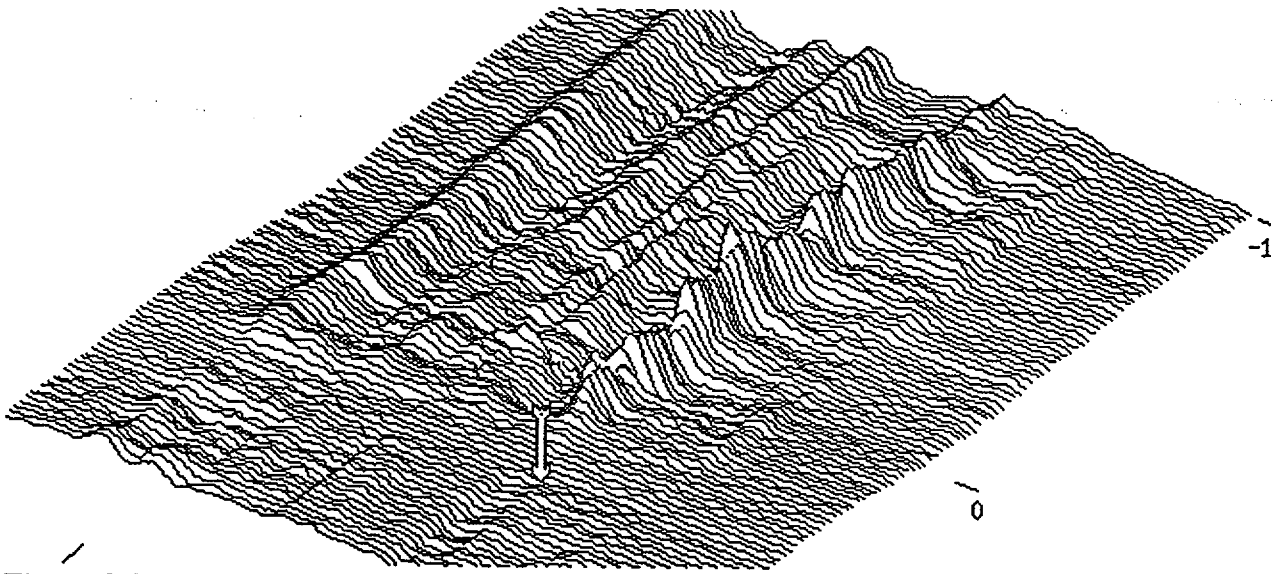

Figure 8 C-scan of tube r2c5 of steam generator 24 using the circumferential line filter.

but, due to the variation of the axial ridges with distance along the tube, it reappears a short distance away. However, the defect signal is displayed in a form easier to recognize. This scan can be compared to the scan in Figure 2 with the line filter off. This method can be used as a tool to help the analyst, but it also does not do as good a job of eliminating the noise signals as the high-frequency probe. It is hard to use the filters and do a profile of the tube since the filters turns off when the next line scan button is pushed.

(A) Probe skipping has been mentioned as a possible factor in this signal being missed. A review of the data indicates that this was not a significant factor in any of the defects in 1997 being missed.

Conclusions

The main reasons for this defect being missed was due to poor analyst performance and the use of a technique that was designed for od defects being used for id defects. The reason for the poor analyst performance is not clear because there is no documentation on the training that the analyst received in 1997. The guidelines that the analyst used in 1997 was of poor quality and difficult to read.