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It should be noted that this phase setting is somewhat artificially high and it could result in shallow false positive id defect calls. However, in view of the fact that we have found very few measurements on id indications in the 40% deep range, this appears to be justified.

Review of Scans from Indian Point

A considerable number of scans from Indian Point 2 have been reviewed. Several of the defects have been profiled, including one at several frequencies to see the results of the accuracy of the depth measurements at different frequencies. The signal-to-noise has improved considerably, and signals with amplitudes of a few tenths of a volt can be detected. However, with voltages this small, large errors in the phase shift measurements are likely. The larger, mid-range coil has some look-ahead and behind, due to the field spread of the probe. This spread has not been measured for this probe, but its size is about 75% that of the mid-range probe and a similar reduction in the field spread could be expected.

I believe that defect with a maximum voltage of 1.0 volt or higher should be detected. Once this defect has been detected, it can be tracked through the noise as small as about 0.2 to 0.4 volts. However, there will be considerable error in the measurement of the depth at voltages below 1 volt. In Figure 1 we show the profile of the defect in tube R2 C69 of steam generator 24. The tube has been profiled with the high-frequency probe at 1000 kHz and 800 kHz. The depth and the voltage (times 10 to fit on the scale) at each frequency is given. The voltage measured for the 1000 kHz is slightly higher than that for the 800 kHz. The signal-to-noise for the 800 kHz may be slightly better, since od indications are rotated more horizontal, while at 1000 kHz the rotation

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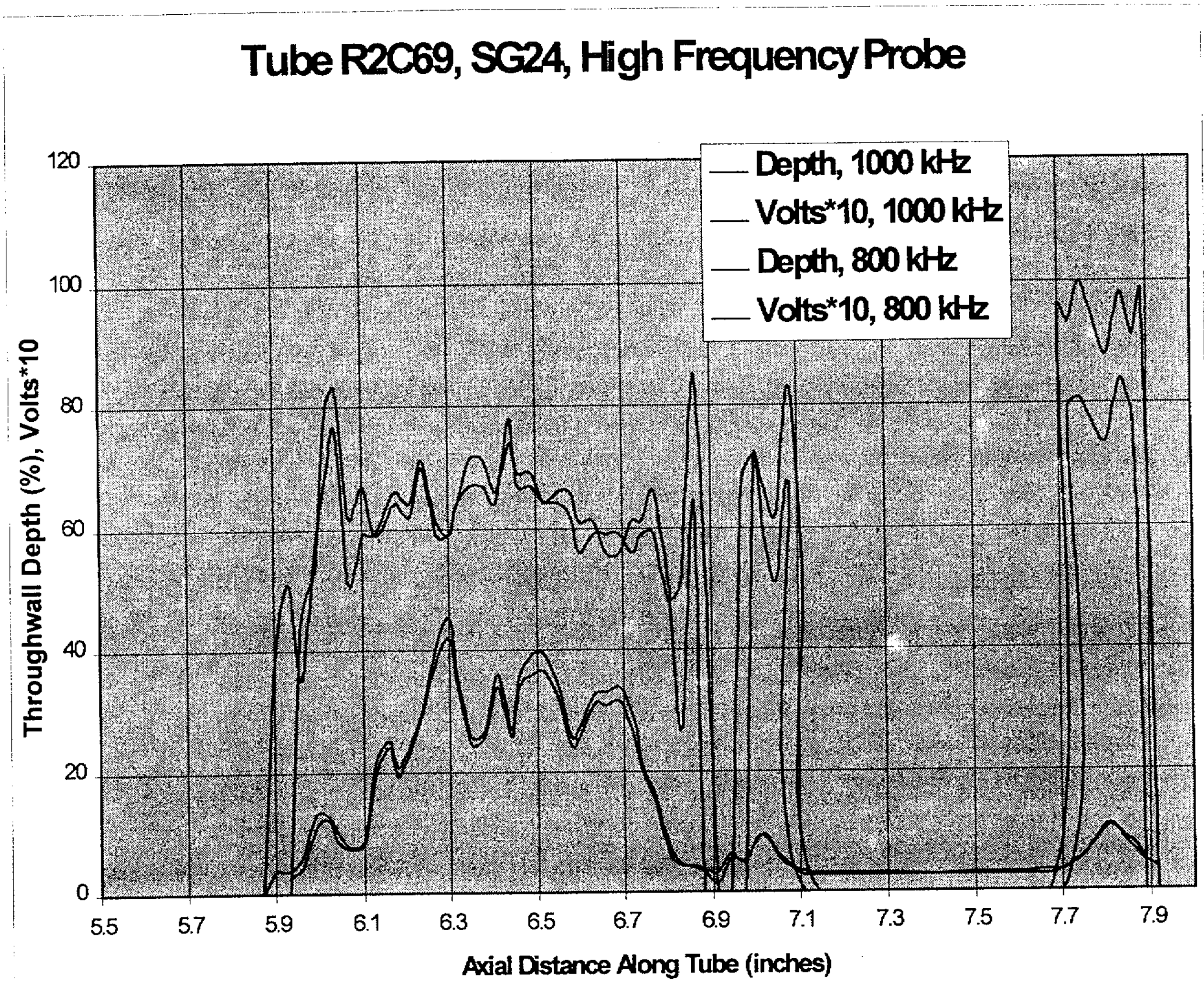

Figure 1 Profile of the defect in tube R2 C69 of steam generator 24 as measured with the high-frequency plus-point at 1000 kHz and 800 kHz.

asured at the two frequencies is about the same. However, this tube had very little noise even with the old mid-range plus-point probe. The indication located at about 7.8-inches has a maximum value slightly greater than a volt, and the agreement between the two frequencies is not as good in this region. This defect at 7.8-inches was not included in the profile mid-frequency plus-point results furnished by the utility.

For indications on the tube id, the voltage increases as frequency increases. The opposite effect is observed for indications on the tube od. Also, for od indications, the phase rotates clockwise as the frequency decreases. For id defects, with the calibration used above, the phase stays constant with frequency. This tube leaked at 5173 psig in the utility test.

In Figure 2 we show the profile of tube R2C71 of steam generator 24. This tube had a small leakage at 2841 psig. The pressure could not be increased past 4500 psig due to the lack of capacity of the pump. Note that this tube was missed in the earlier inspection with the mid-range probe. The depth profiles at 1000 kHz and 800 kHz do not match each other as well, which is

due mostly to the low voltages that are present. This tube has about the same depth measurements as tube R2 C69 in Figure 1, but the voltage values are only about half as large. Note the depth measurements do not agree well where

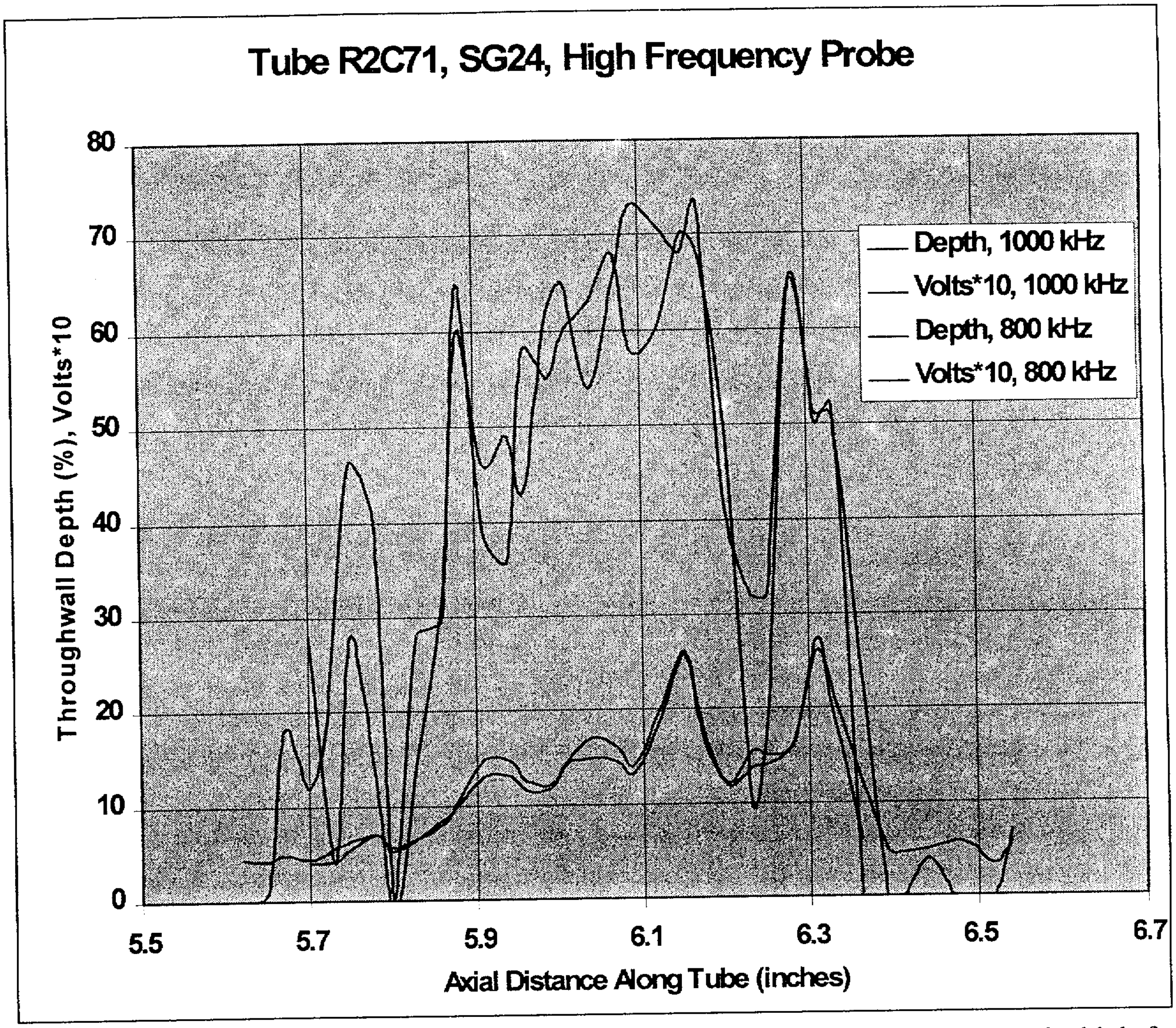

Figure 2 Profile of the defect in tube R2C71 in steam generator 24 as measured with the high-frequ plus-point at 1000 kHz and 800 kHz.

the magnitude of the voltage is low. When the voltage falls below 0.5 volts, the depth measurement becomes quite inaccurate.

The profile plot for tube 2-74 is shown in Figure 3.

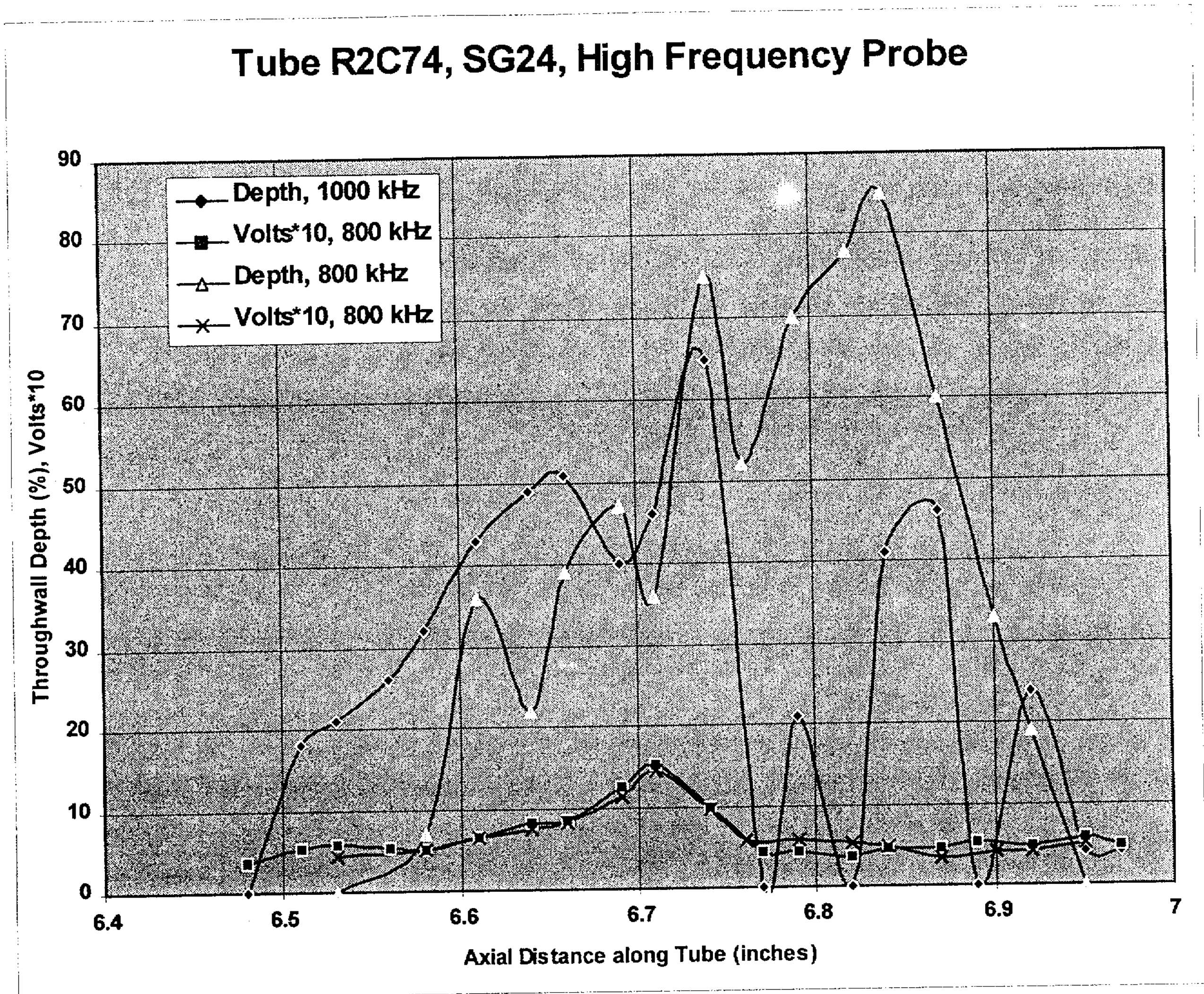

Figure 3 Profile of the defect in tube R2 C74 of steam generator 24 as measured with the high-frequency plus-point probe at 1000 kHz and 800 kHz.

The defect has a maximum voltage of only about 1.5 volts. There is very poor agreement in the depth measurement at the edges of the defect where the voltage is small. There was some noise that increased as frequency decreased at the 6.8 to 6.9-inch region of the tube. This tube has a portion of the defect that measures in the 40% to 50 % deep range, between 6.6 and 6.7-inches. This shows some of the probe's ability to measure and detect defects in this depth range. Unfortunately, this tube leaked at 5500 psig.

In Figure 4 we show the profile of tube R2 C4 of steam generator 24. This tube was profiled with the high-frequency probe at

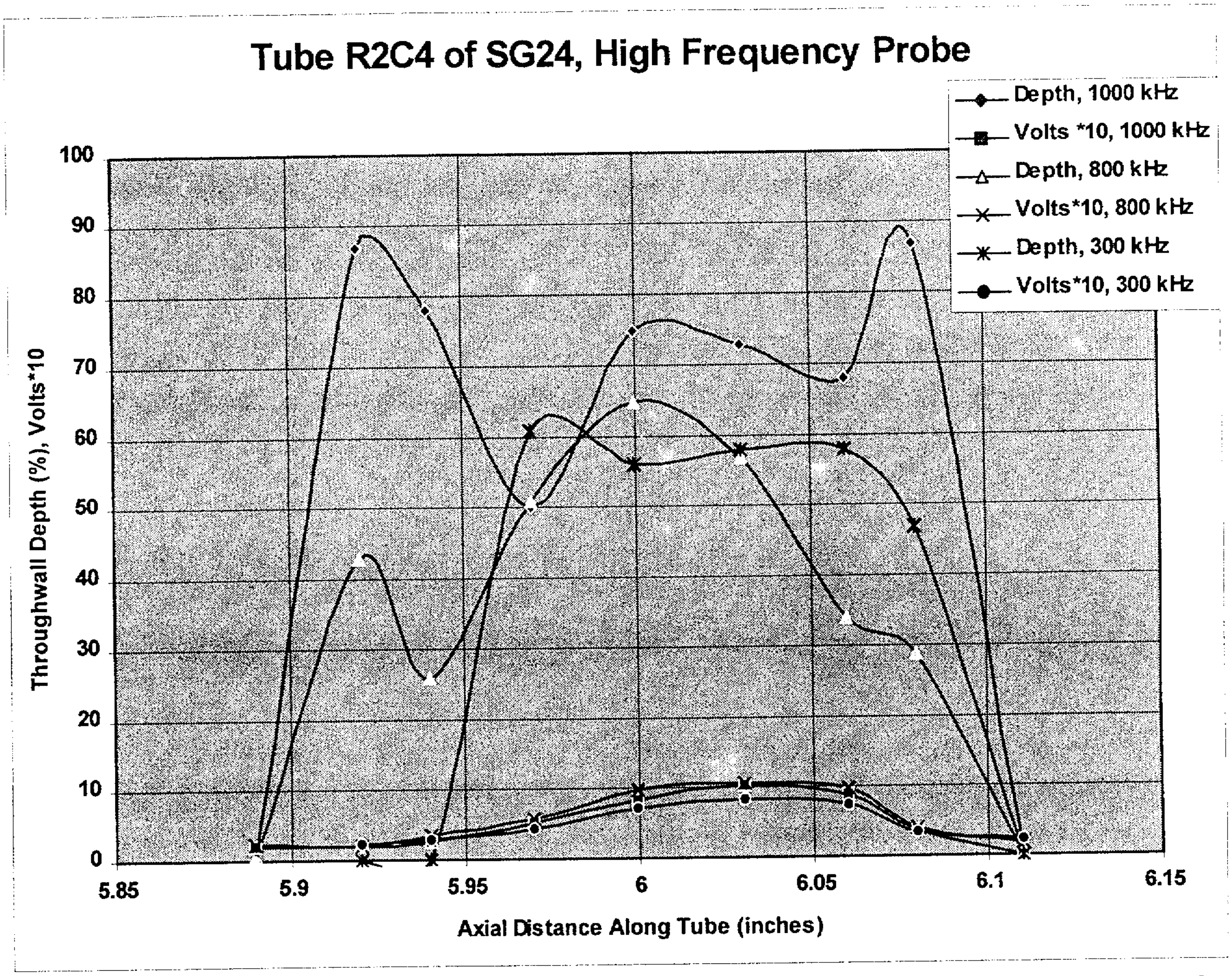

Figure 4 Profile of the defect in tube R2 C4 of steam generator 24 as measured with the high-frequenc plus-point at 1000 kHz, 800 kHz and 300 kHz.

1000 kHz, 800 kHz and 300 kHz. The maximum voltage measured for this tube was only slightly greater than a volt, which probably has caused the wide variation in depth measurements at the different frequency. This defect is the shortest of all of the defects that we have looked at thus far. This tube did not leak at 5500 psig.

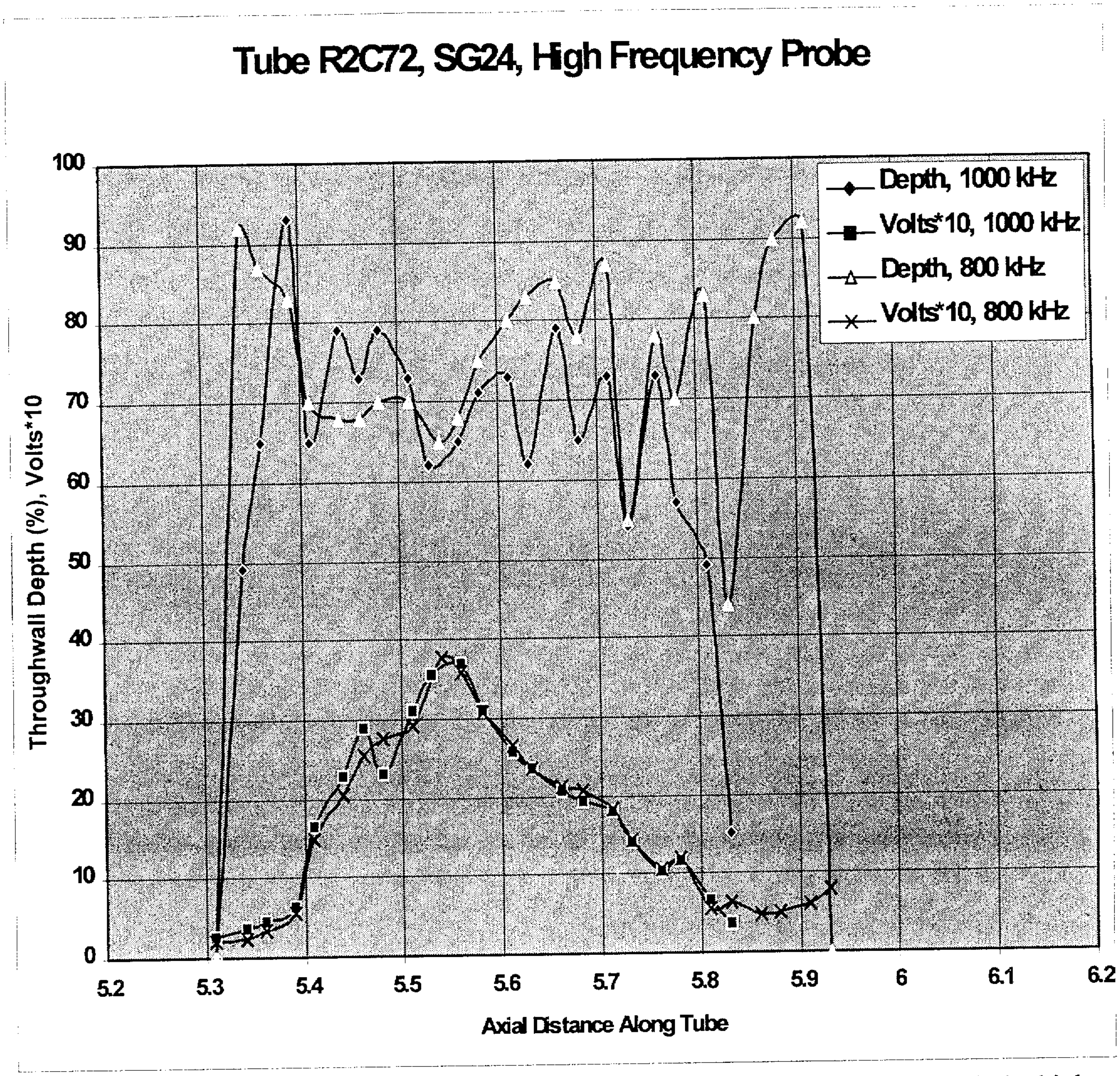

Figure 5 Profile of the defect in tube R2 C72 of steam generator 24 as measured with the high-frequency plus-point at 1000 kHz and 800 kHz.

In Figure 5 we show the profile of tube R2 C72 in steam generator 24. This tube has a relatively high voltage and the phase measurements show a deep depth. However, this tube did not leak at the 5500 psig pressure test, although tubes with more shallow defect measurements and lower voltages did leak. As with the previous tubes, the depth measurements made at higher-voltage agree but not for the lower voltage measurements. There appeared to be od deposits that were influencing the signal at the 5.8 to 5.9-inch location.

Scans on calibration standards

Due to the lack of information on the repeatability and accuracy of the probe, several scans were made on the calibration standard. These are intended to demonstrate the probe's ability to detect

and size small defects. It should be keep in mind that the calibration standard produces a larger signal than defects of a similar depth. Also, the calibration standard has none of the od deposits that are present in the generator. Finally, while these notches represent the best approximation to the actual defects that we have, they are essentially two dimensional, while the defects are three dimensional.

Comparisons of the smaller, high-frequency plus-point to the mid-range plus-point
For both probes calibrated at 20 volts for the 100% notch, the new probe gives a larger voltage for the other calibration notches. At higher frequencies, the id notches also give a larger signal on the notches than a lower frequencies. The reverse is true for od deposits and notches.

Widening of the signal due to deposits and lift-off
One source of error is the widening of the defect signal as influences due to od deposits and lift-off modify the signals due to a defect. While the defect may still be detected, the depth measurements, which depend on the phase can be in error. One depth will be measured if the phase is measured from the departing lobe and another if it is measured form the returning lobe. This error can be reduced by averaging the depths measured for each lobe. Figure shows a signal that will give two different depth measurements. Another somewhat easier but perhaps not as accurate method is to use alternate lobes for alternate measurements along the tube and average these results. It should be noted that eddy-current responses are notoriously nonlinear and either of these methods will give limited improvement.

cecco?

Use of the plus-point at the probe-of-reference in the sludge pile
The utility has stated that the plus-point will be the probe of reference for the inspection of the sludge pile region, as opposed to the bobbin probe. I agree with this decision for the following reasons. The Cecco probe uses transmit-receive coils that are permanently mounted on the coil-holder and not sprung against the side. The coils must be designed with a greater field reach than coils that are surfacing riding. Therefore, they will be more influenced by deposits on the od of the tube than the plus-point. In this regions, these deposits are very plentiful, and this will cause more false positives. In addition, the plus-point reduces the effect of od deposits somewhat due to its differential nature.

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