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Review of Plus-Point with Ceramic Wear-Face

Due to probe wear problems with the 3-coil plus-point Indian Point decided to use a modified probe with a ceramic wear face. The standard 3-coil probe has a mid-range plus-point coil, a 0.115-inch pancake coil and a 0.080-inch high-frequency pancake coil. The Indian Point inspection has required about 15,000 scans of 4-feet in length with this rotating probe. The inspection speed has depended on how fast Zetec could keep Indian Point supplied with probes. The ceramic wear face is manufactured by ABB and is ordered by the customer to epoxied by Zetec to the coils in place of the wear surface normally furnished by Zetec. The new wear face increases the probe life several times over that of the normal probe.

However, the ceramic wear face increases the nominal lift-off (probe face to tube surface distance) from 0.011-inches to 0.019-inches. This increase in lift-off must have been too much for the 0.080-inch high frequency coil because it has been omitted from the new probe. The new probe only has the plus-point and the 0.115-inch pancake coil. The ceramic wear face is much harder than the normal wear face. What damage this may do to the tubing is not known at this time. It is likely that this wear face will score the Inconel tubing to some extent, and may act as a crack initiation site. However, since the Indian Point generators are scheduled for replacement soon, this probably will not be a problem. It could be more important for the generators at Palo Verde, which are not scheduled for replacement soon.

Lift-off is an "essential variable" for eddy-current testing, and a variation this large should require at least a verification of the qualification process. In particular, since the defect voltage growth is an important factor in the pressure tests, the relative response between the 100% notch and the other notches should be verified. The "sharpness" of the response to tube flaws will also probably be reduced, due to the increased distance between the coil and the flaw, but this will be more difficult to measure.

Gary Henry stated that EPRI has decided to collect data on the probe and include a technique qualification for future reference.

I have performed a quick check on the response of the probes on the standard in steam generator 22. Both probes give about the same response on both the od and the id notches. In Figure 1 we show the response of both probes to the od notches. These are the most important in the sludge pile region, since the defects found thus far are on the od. The notches are 60%, 40% and 20% deep. Note that while the 20% od notch is detectable, the profile is quite poor. An average of this notch depth will give better agreement with the actual notch depth. The voltage reading on this notch is about 0.1-volts. At this voltage level, a small amount of noise will have a large influence on the depth measurement, which is determined from the phase angle of the defect signal. This is the reading on the standard, and readings on the tube usually contain more noise. The depth readings on the 40% notch are much better. The voltage of this vector has an amplitude of about 0.35-volts, which is large enough to give a stable phase reading. The 60% deep notch gives a much larger voltage, and a more stable depth reading. In general, when the voltage is above about 0.3-volts, the depth reading seems to be fairly reliable. This voltage level for an accurate depth readings will probably hold for relatively clean sections of the tube in the

J 1/71

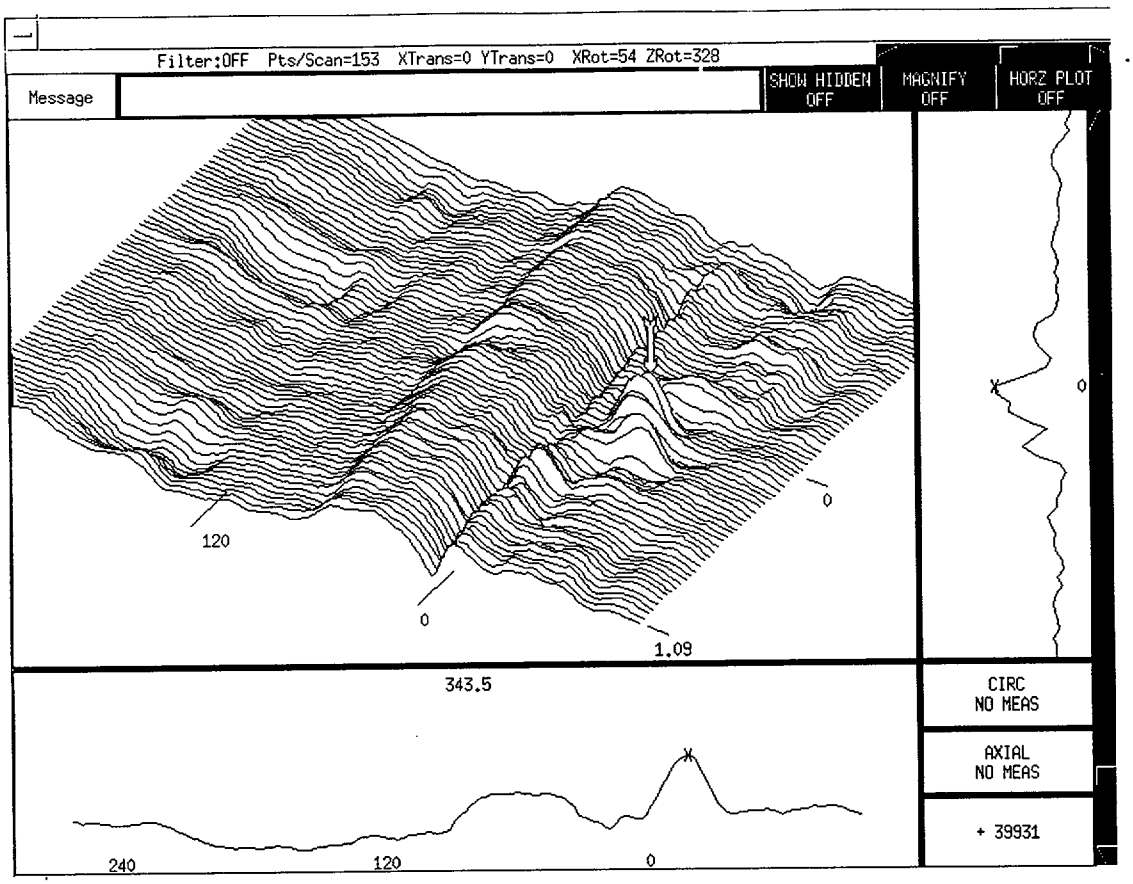

Figure 1 Tube R2C69 of steam generator 24 scanned in 1997

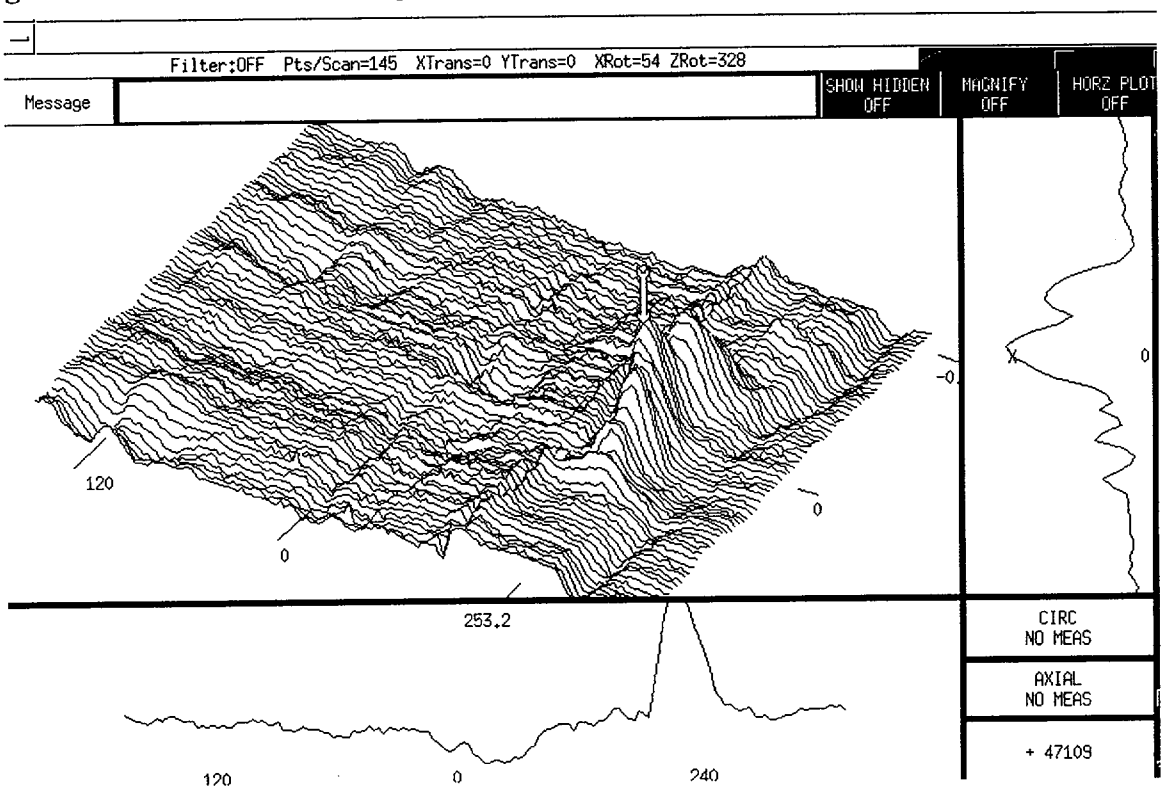

Figure 2 Tube R2C69 of steam generator 24 scanned in 2000

Here are scans of tube R2C69, both made with the mid-range probe at 400 kHz. It clearly appears larger in 2000. You already have scans made in 2000 with the high frequency plus-point, before and after the pressure test. Also, you have profiles of this tube made before and after the pressure test.