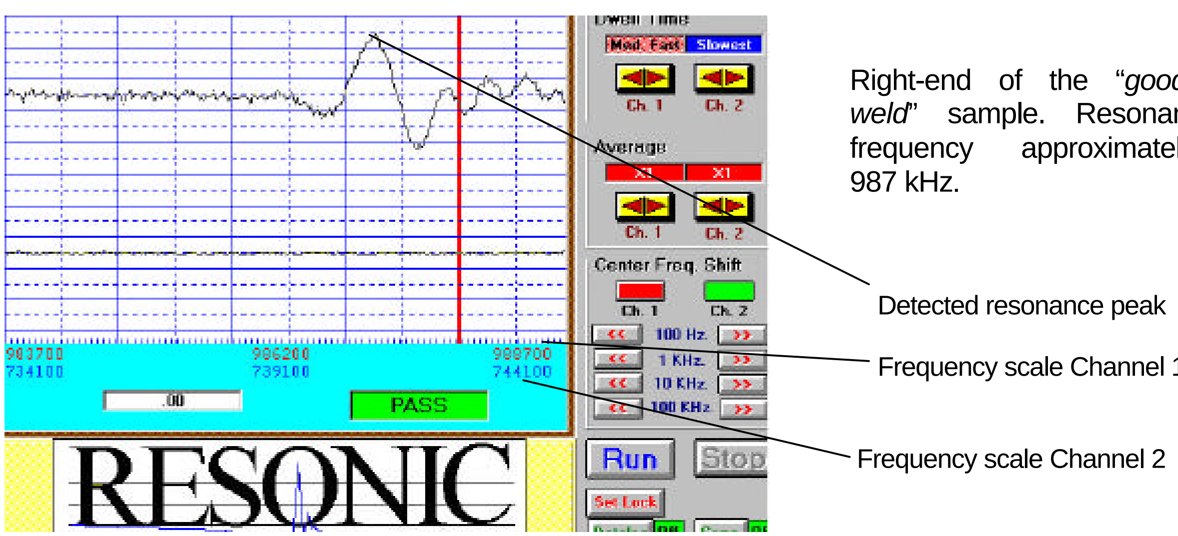
RESONIC
NDT SYSTEMS

Case Study: Welded Steel Tube

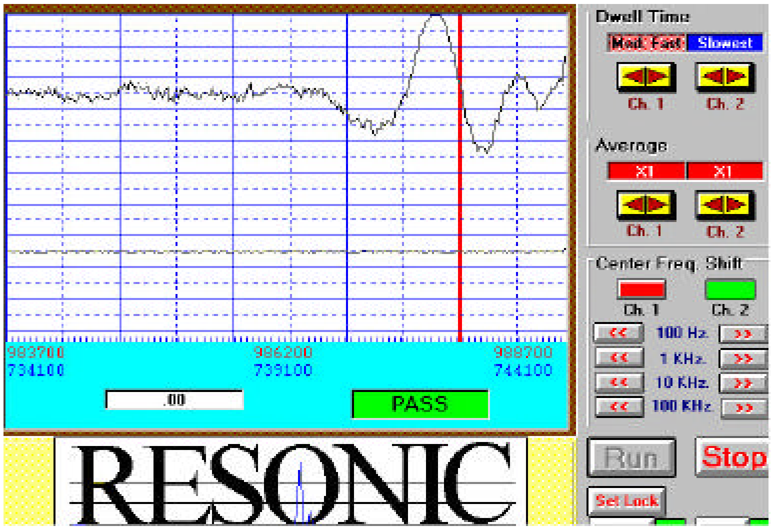
Three types of welded steel tubing samples were presented for evaluation of metallurgical conditions including:

1) Cold weld
2) Galfan coating integrity
3) Holes
4) Differences in I.D. bead height

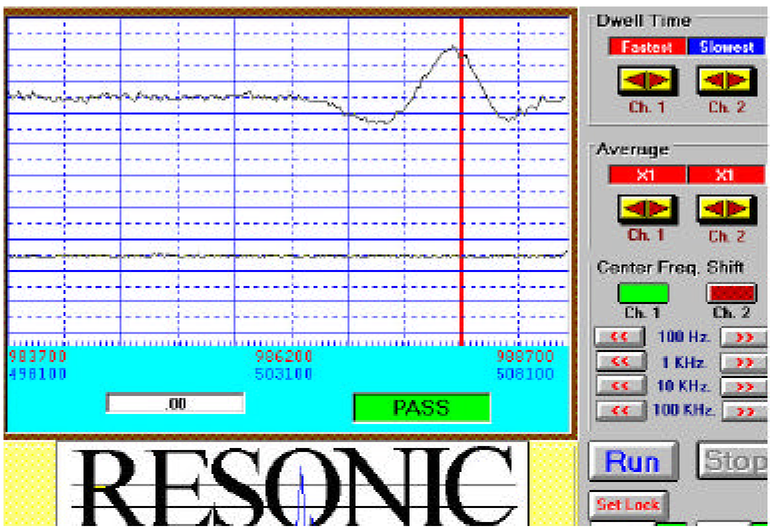
Three samples of .373" OD Galfan coated tube with a .043" nominal wall thickness were tested with an 8 wavelength .400" ID RM-EMAT. These three samples were marked "good weld", "bad weld" and one tube was unmarked. Galfan coating was removed by light filing from an approximately .9""long by .1""wide segment on the center of the *unmarked tube*. Also a .020" diameter hole was drilled into this sample approximately 2.35" from the tube end. Resonant frequency's for these samples were calculated at 965.673 kHz for the surface resonance and 1.756394MHz for the ID resonance. Screen plots were recorded isolating various features. Since these short tubes were hand straightened lineal distance versus frequency plots were not performed due to wide variances in signal amplitude this amplitude variance is the result of in excess of .210" runout over an 18.75" length. Resonic's lab transducer fixturing cannot keep a center on such a variance.
A single sample of 1.00' diameter .075" thick wall steel tube was tested with a six wavelength 1.050" ID RM-EMAT. For this test, the goal was to detect differences in the weld bead thickness on the tube ID. A Dremel tool was used to remove .008" from the ID bead on one end of the tube. Data was recorded and is presented.
The first set of three creenplots are from the tube marked "good weld". Taken at three points on the sample right end, mid-point and left end. What they depict is a frequency spread of less than 300Hz over the entire sample.



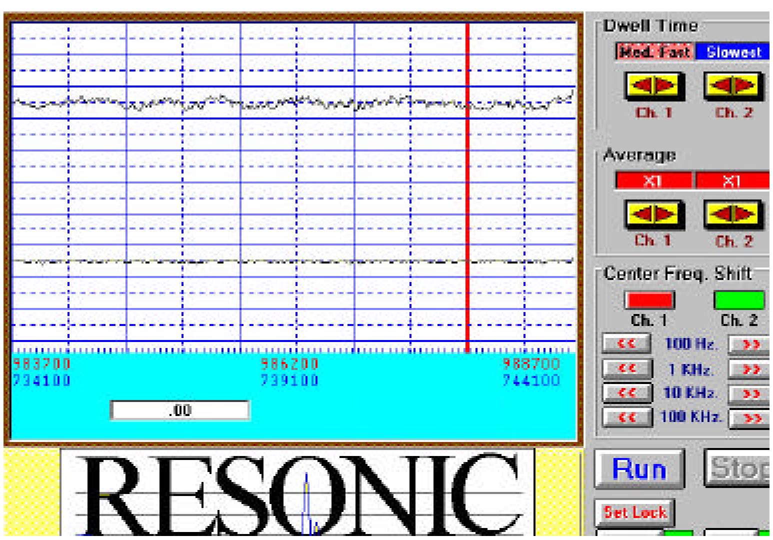
Right-end of the "*good-weld*" sample. Resonant frequency approximately 987 kHz.



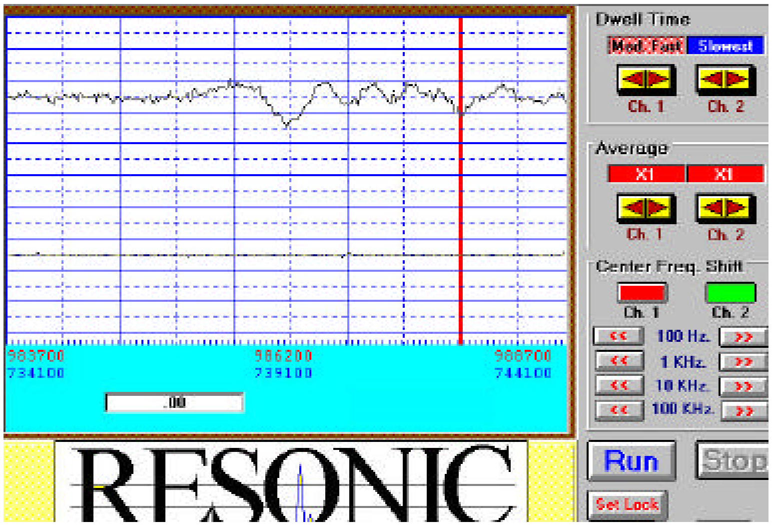
Mid section of "*good-weld*" tube. Resonant frequency approximately 987.5 kHz.



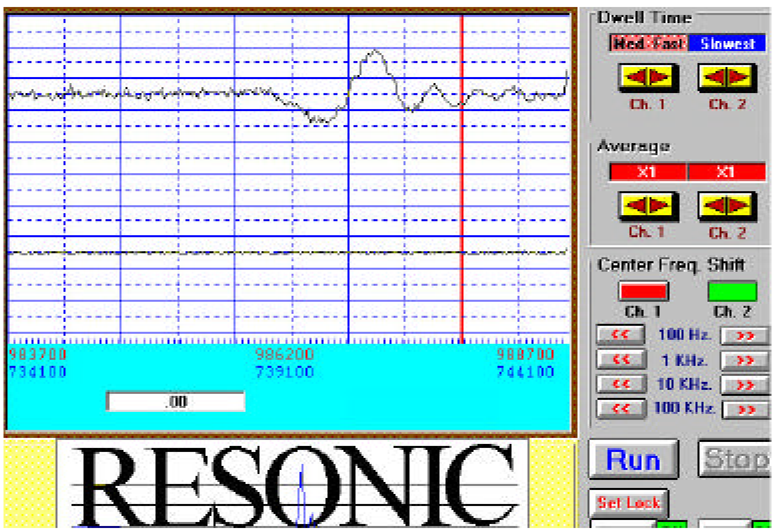
Left end of "*good-weld* " tube Resonant Frequency approximately 987.8 kHz.



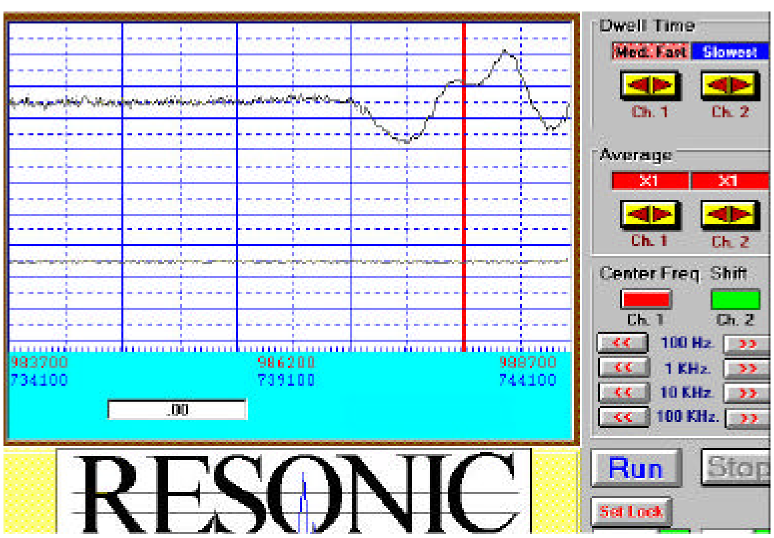
Mid section of tube marked "*marginal weld*". Nil signal detected.



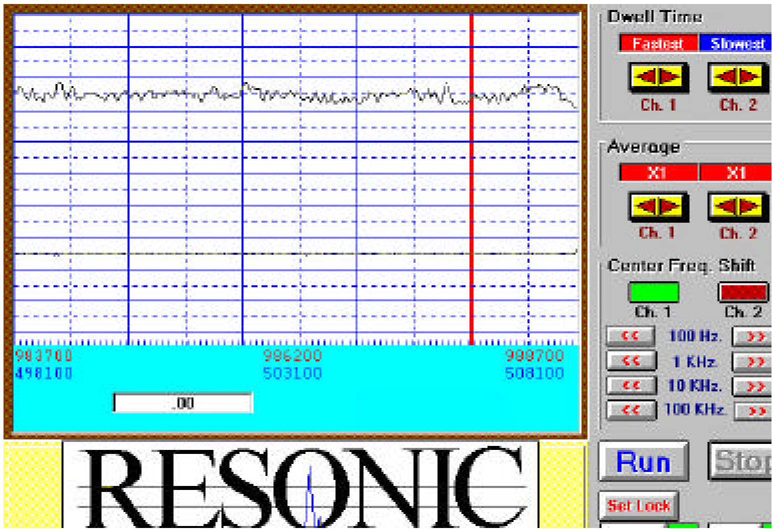
Left-end of "*marginal weld*" tube. Weak resonance at 986 kHz



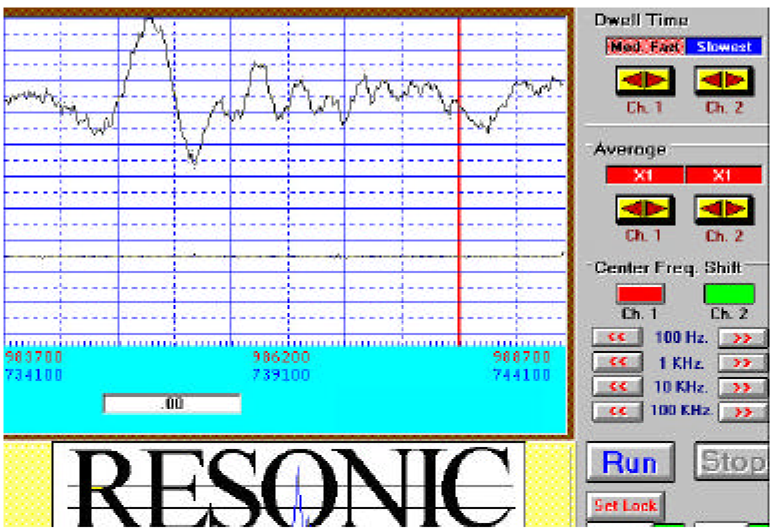
Right-end of "*unmarked*" coated tube. Resonant frequency 986.8 kHz



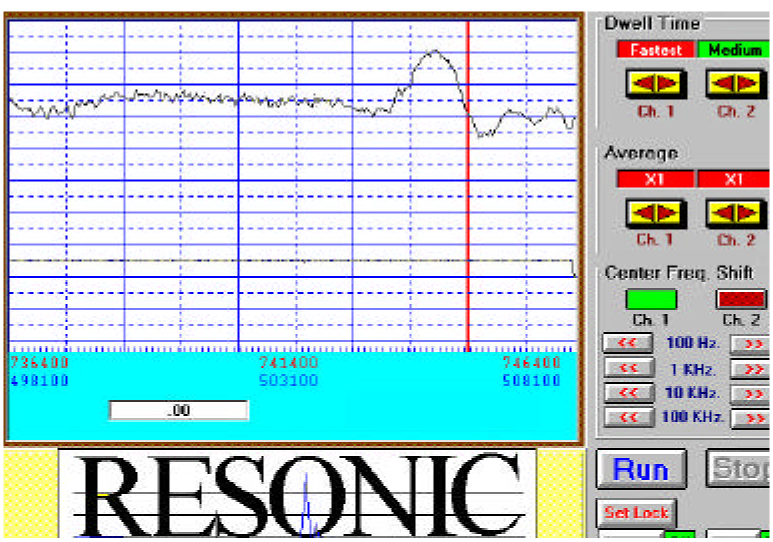
Left-end of "*unmarked*" tube. Resonant frequency 987.2 kHz



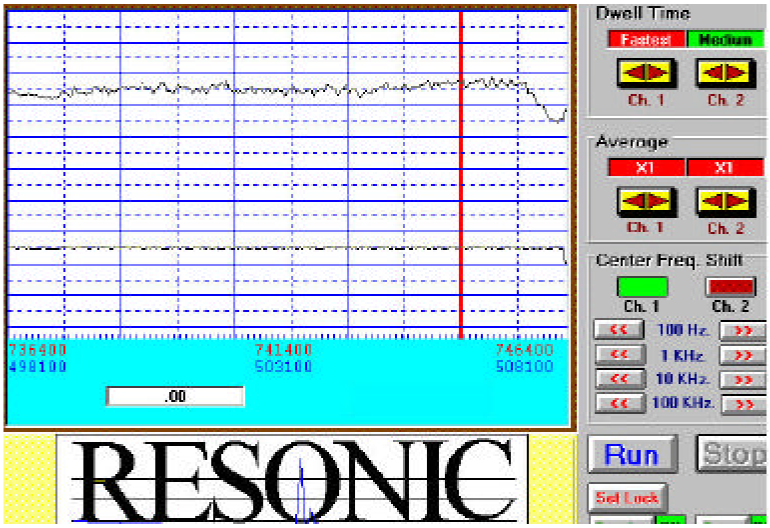
Unmarked tube with .020" hole drilled through wall



Unmarked tube with a small section of Galfan-coating removed



1.0"diameter steel tube resonant frequency 744.5 kHz. The entire sample displayed resonance at this frequency except for the reduced bead end.



1.0" Tube

ID weld bead removed as described on page 1. Resonant frequency 746.2 kHz. This sample was cut and a new segment of bead was ground down. The results of the two tests were consistent.

Notes:

Additionally the uncoated .375" (nominal .030" wall) diameter tube was tested and the results were consistent with the coated tubing. A shift of over 6 kHz was consistent between the "good" and "bad" weld samples. The "bad" weld sample possessing the lower frequency, hence the lower velocity of sound behavior. Screenplots were also recorded and are available.

ID resonance was generated on several of these samples and frequency differences, exceeding 10 kHz, were observed on the samples with the differing weld conditions.

Conclusions

The stable, narrow band frequency response of the 1.0" sample indicate consistent metallurgical properties with little deviation in frequency response due to other first order material effects such as residual stress. The reduction in the interior wall bead was detected (twice) as a frequency increase in excess of 2 kHz.

The coated samples set of generated frequency shifts generated by three known conditions; marginal weld, removal of surface coating and the effects of the stresses introduced by tube straightening or residual stresses. In addition, the differences in tube concentricity affected the Q of the resonance. The bandwidth or shape of the resonance increases as a function of the decrease in ideal concentricity of the sample. This only affects the sharpness of the resonant response and not its corresponding frequency. This non-concentricity was probably introduced during the early attempts to straighten the samples.

In the presence of these aforementioned effects, the coated tube exhibited a minimum of a 3 kHz difference in frequency between "good" and "marginal" weld with obvious shifts in samples with coating removed and defects such as holes.

While resolution would be significantly enhanced, with the use of a higher frequency transducer the test results indicate sufficient resolution to detect all conditions as presented.