

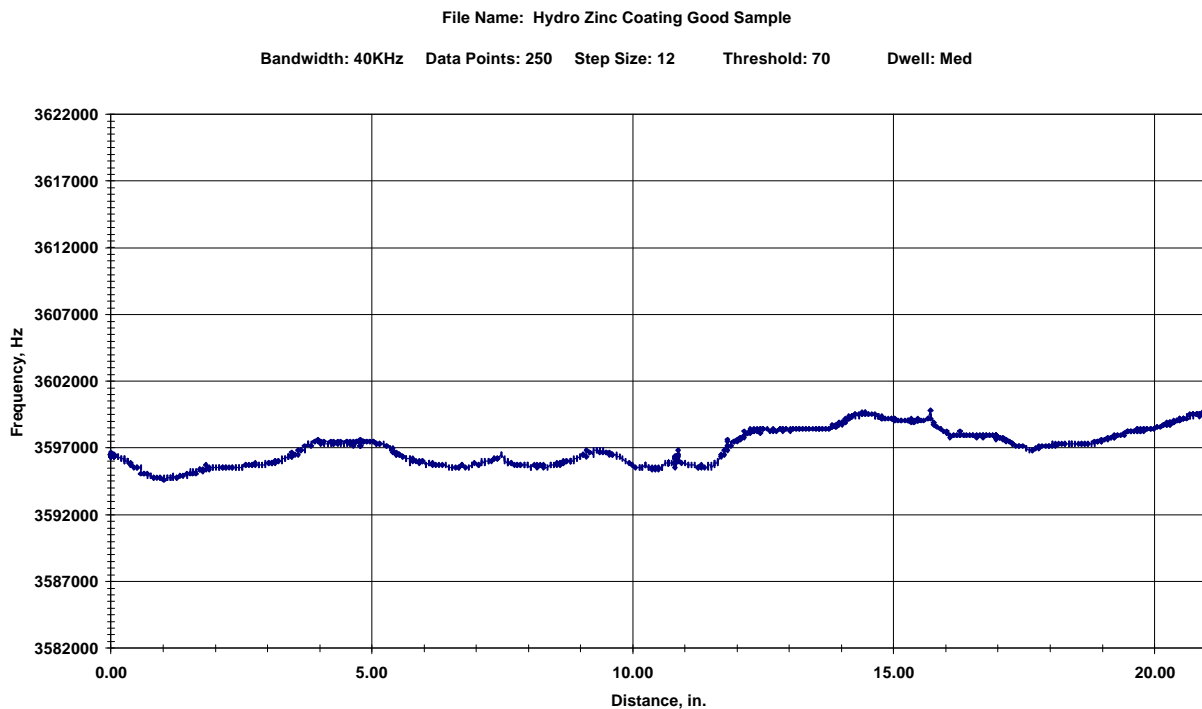
## **Case Study: Coating and Defect Analyses of Extruded Aluminum Alloy Heat Exchanger Strip**

Samples of extruded aluminum alloy heat exchanger strip were evaluated with the ARIS lab unit and a pair of .5" diameter shear wave generating resonance-mode electromagnetic acoustic transducers (RM-EMAT's). The samples with overall dimensions of 1.0" wide x .8 thick x 27" long were placed between the transducers in a test fixture that also included a rotary encoder that enabled a measurement of lineal distance along the sample.

The conditions that were presented for measurement efficacy of the ARIS technique in order of presentation include:

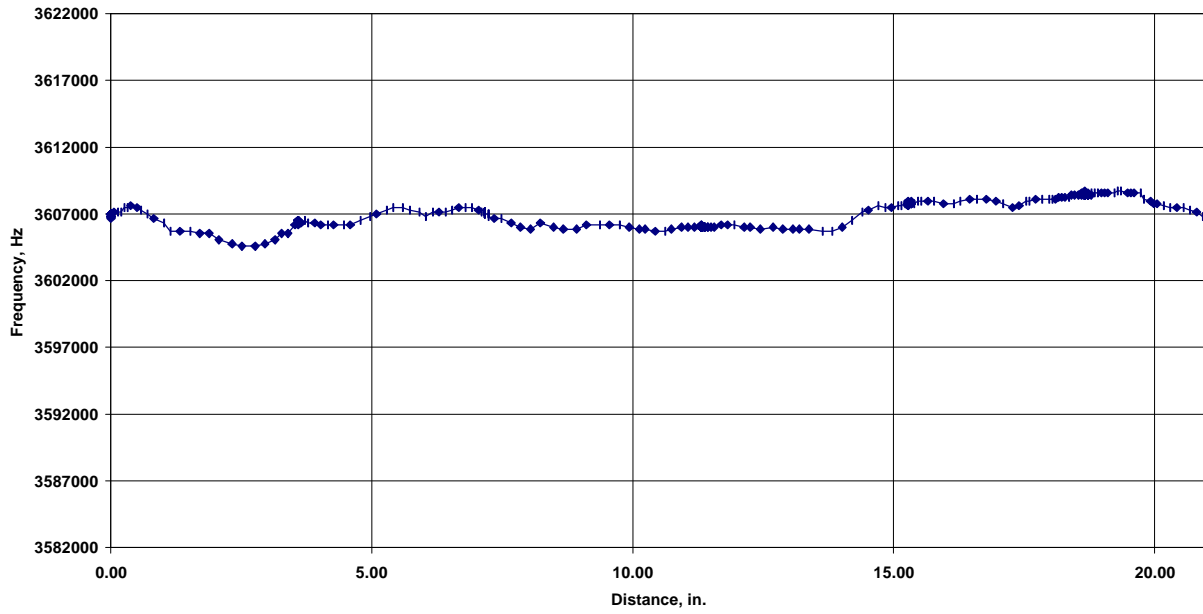
- Good sample
- Good Sample no zinc coating
- Billet Weld
- Zinc coating failure
- Zinc coating splatter

Placed into the fixture the samples were manually drawn through the opposing transducers and data was simultaneously recorded. The data is recorded in files containing both the resonant frequency and corresponding lineal distance as the sample is moved between the transducers. Attached are the charts as were prepared by a spreadsheet program. The charts indicate the ability to clearly resolve all of the conditions as presented with no effects from higher order material conditions such as residual stress or transducer to sample liftoff gap variance.



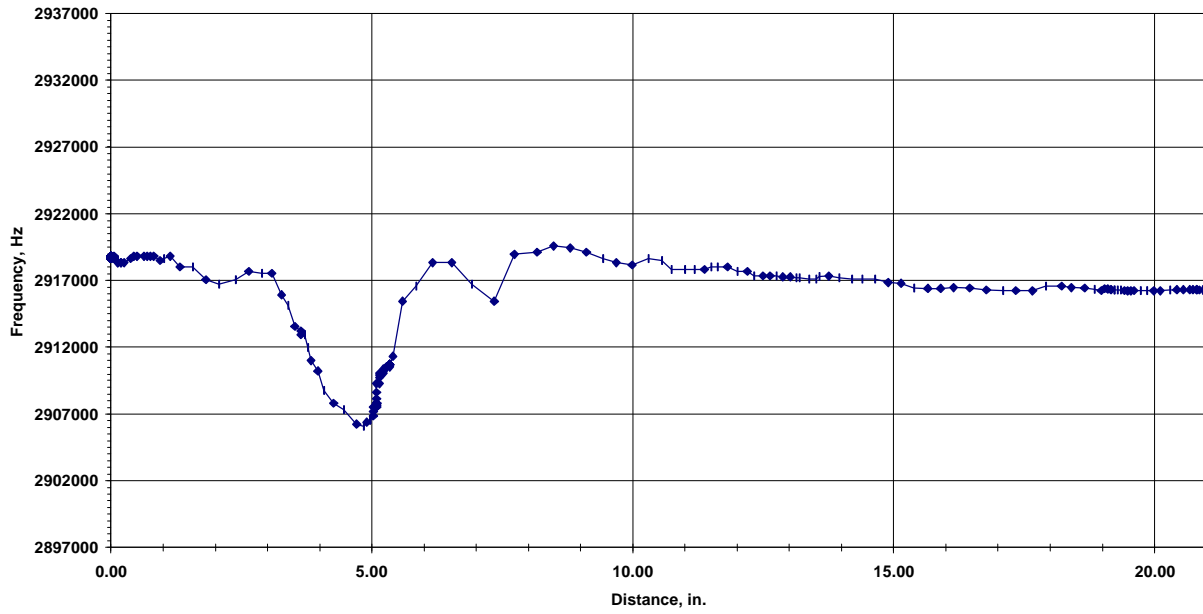
File Name: Hydro No Zinc Good Sample

Bandwidth: 40KHz Data Points: 250 Step Size: 12 Threshold: 70 Dwell: Med



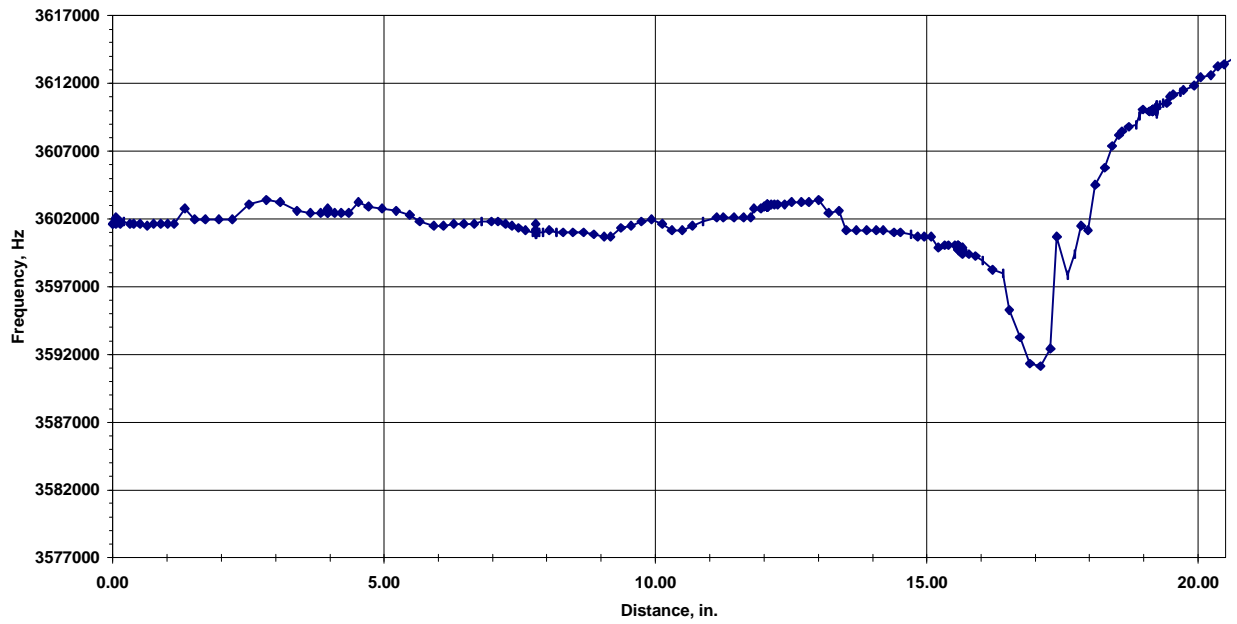
File Name: Hydro Bullet Wield

Bandwidth: 40KHz Data Points: 250 Step Size: 12 Threshold: 70 Dwell: Med



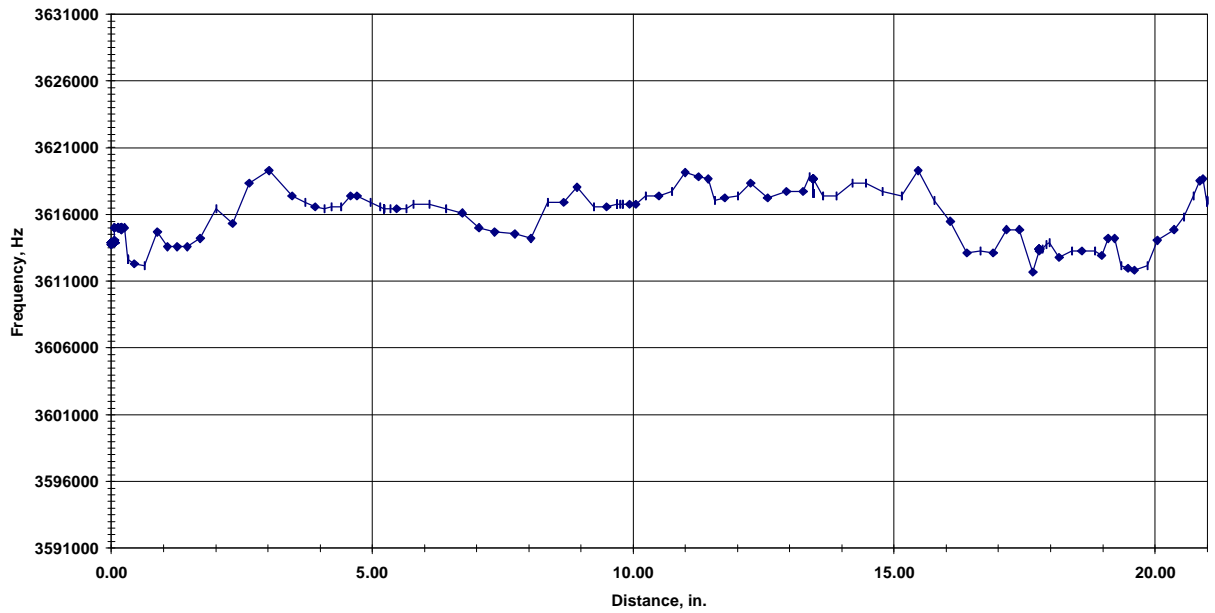
File Name: Hydro Zinc Failure

Bandwidth: 40KHz Data Points: 250 Step Size: 12 Threshold: 70 Dwell: Med



File Name: Hydro Zinc Splatter

Bandwidth: 40KHz Data Points: 250 Step Size: 12 Threshold: 70 Dwell: Med



The charts indicate the following from first to last:

Chart 1 Details the frequency response of the 4<sup>th</sup> order shear wave resonance of the “good sample”. The small deviations are due to surface dents and scratches, however the signal is stable to under .05% across the sample length.

Chart 2 Details the frequency response of the 4<sup>th</sup> order shear wave resonance of the “good sample no zinc coating”. The overall frequency difference from the good reference sample is approximately 10 kHz or .28%.

Chart 3 Indicates a difference in the 3<sup>rd</sup> order resonant response of the “welded” sample of over 11 kHz from the weld point to the furthest end from the weld on the sample the frequency difference exceeds 11 kHz or .38% from baseline.

Chart 4 Indicates a difference in the 4<sup>th</sup> order resonance of over 20 kHz from a region of no or faulty coating (leftmost and longest plot line) as it traverses into the coated zone with a frequency response similar to the “good” sample

Chart 5 Chart indicates a rather dirty response in reaction to the varying coating “splatter” conditions. This is the frequency of the 4<sup>th</sup> order resonance.

In conclusion all the effects present different and readily identifiable affects upon the resonant frequency of a shear wave propagating through the cross section of the sample. While not conclusive from a small sample test further testing will probably reveal the ability to quantify and isolate the source of even small differences in “good” material.

