STATE OF THE ART PRODUCTS & SERVICES
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HRSG FINNED TUBE STUDY USING THE

LOW FREQUENCY ELECTROMAGNETIC TECHNIQUE

TO EXAMINE TUBES FROM THE OUTSIDE DIAMETER

BY

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INTRODUCTION:

The overall objective of this project was to determine the sensitivity of the Low Frequency Electromagnetic Technique (LFET) for examining HRSG finned from the outside surface.

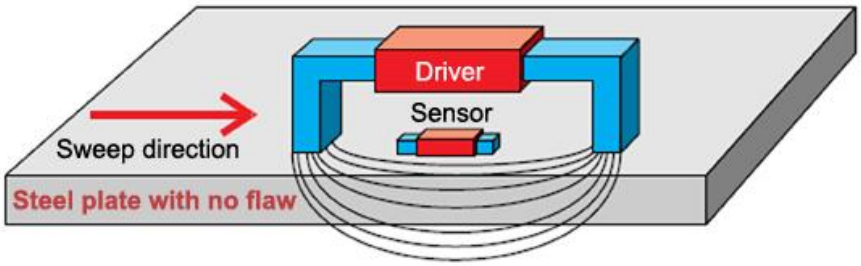
The Carbon Steel finned HRSG tubes used for this study have a 1.5" outside diameter with 0.750" high carbon steel fins. The tube wall thickness is 0.105". There are 6.5 fins per inch. Pits were machined into the inside surface of the tubes. The pits on sample #1 were 1/4" diameter with depths of 30% and 60% through wall and the pits on sample #2 were 1/8" diameter with depths of 30% and 60%. The results will be discussed in this paper.

The picture above shows a finned HRSG tube being scanned with an LFET Scanner to measure the wall thickness.

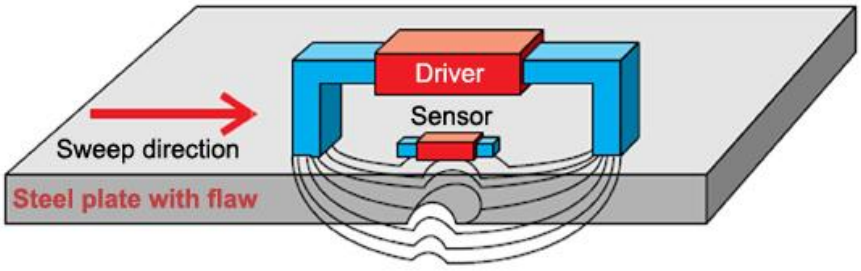
LOW FREQUENCY ELECTROMAGNETIC TECHNIQUE:

The "Low Frequency Electromagnetic Technique" (LFET) was initially developed to examine Above Ground Storage Tanks in the early 1990s. It has evolved into an effective means to inspect tubing and piping from the outside diameter, as well as pressure vessels.

LFET functions by injecting an electromagnetic signal into the test piece. The return signal strength is measured and stored for reference. Any changes in the signal are noted and the distorted signals are compared to the reference signal to create a delta. The delta is then compared to a calibration table to determine the amount of wall loss. LFET detects and quantifies I.D. and O.D. wall loss. The technique allows the inspection of different diameters of tubing, the inspection of bends, and the inspection of tubes in space-constricted areas. This technique is a dry non-contact method and contains no magnets. An LFET scanner has from 1 to 64 pickup sensors depending on the application and design. In general, the LFET system collects 1200 samples per second. The system is lightweight, modular, and uses digital signal processing electronics while being operated with a laptop computer. The results are displayed in real-time with high-resolution color graphics with 3D display.



With no flaw, sensor sees uniform magnetic field as probe sweeps across the plate.

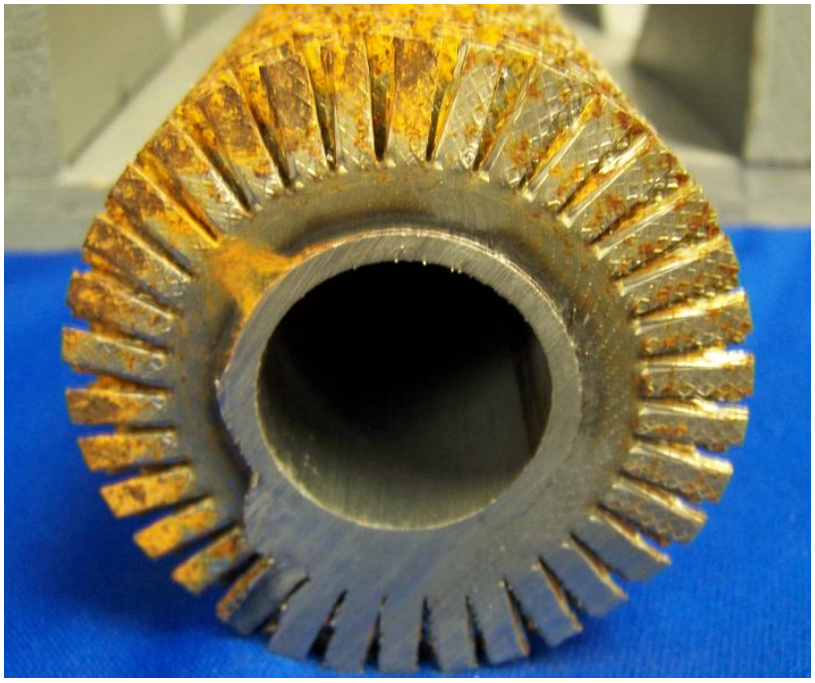


With flaw, sensor sees distorted magnetic field near the flaw as probe sweeps across the plate.

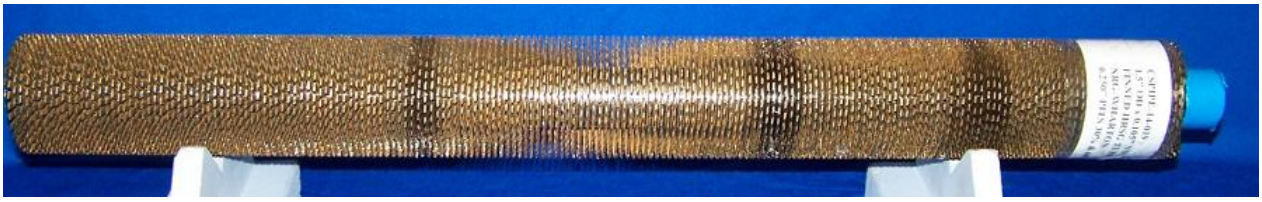
The figure above shows a schematic of how LFET functions.

LFET inspections are able to find pitting, general wall losses, caustic and phosphate gouging, corrosion cells, hydrogen damage, Microbiologically Induced Corrosion attack (MIC attack), Flow Accelerated Corrosion (FAC), cracking, erosion, and manufacturing defects. The technology is able to test through non-magnetic coatings up to ¼" thick. By adjusting the frequency level, magnetic and non-magnetic metals can be inspected. A general rule is the lower the test frequency, the greater the depth for signal penetration.

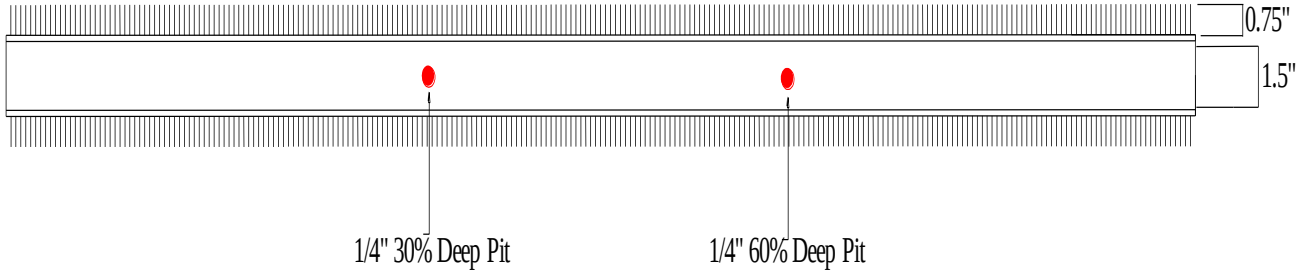
LOW FREQUENCY ELECTROMAGNETIC TECHNIQUE RESULTS:

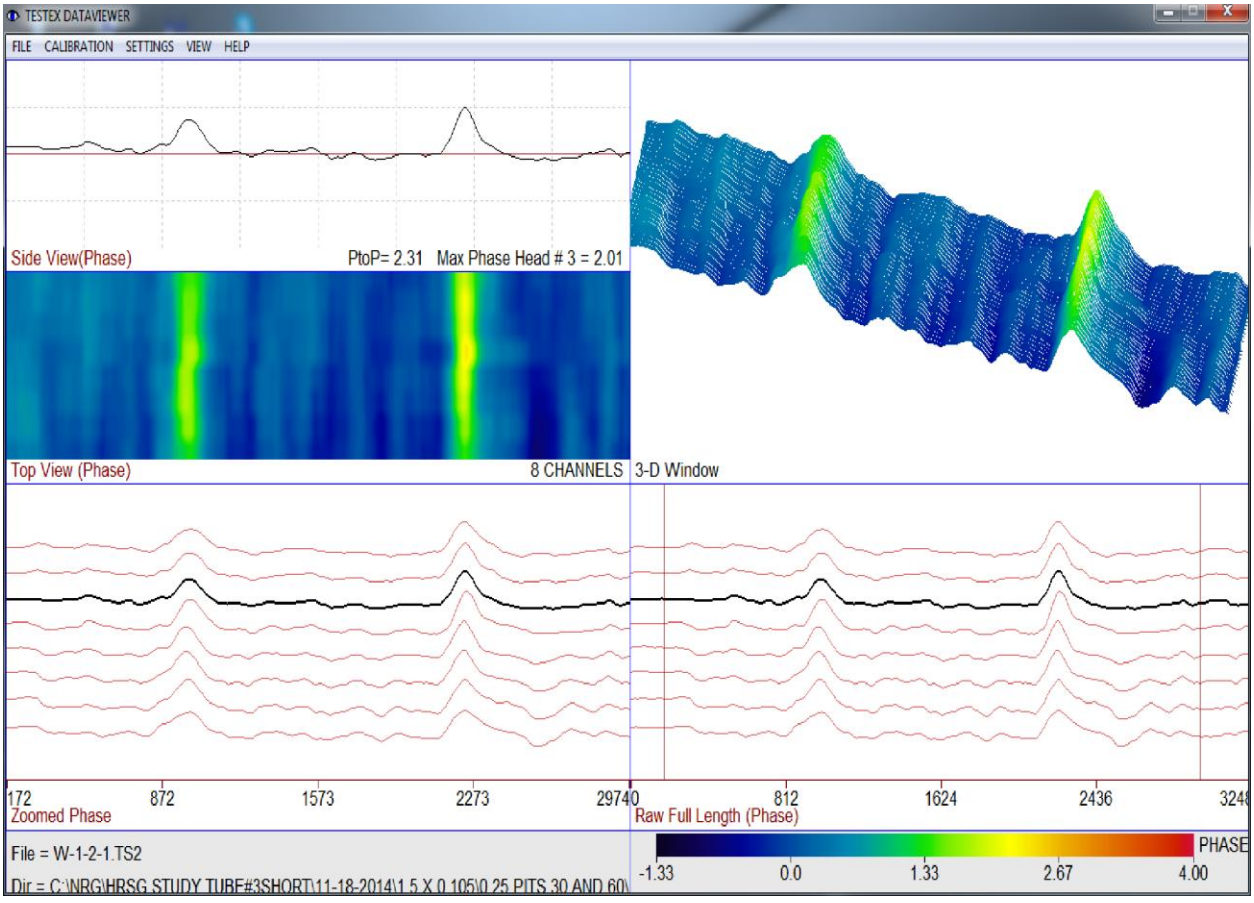


The picture shows the fins attached to the outside diameter.

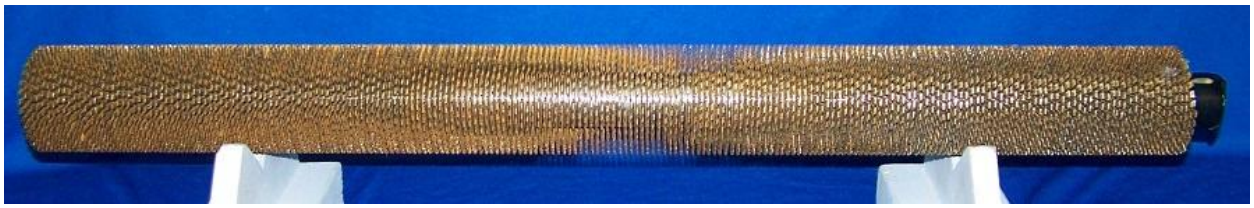


The picture above shows the study tube which has 1/4” diameter pits machined on the inside surface. The first pit is 30% deep and the second pit is 60% deep.

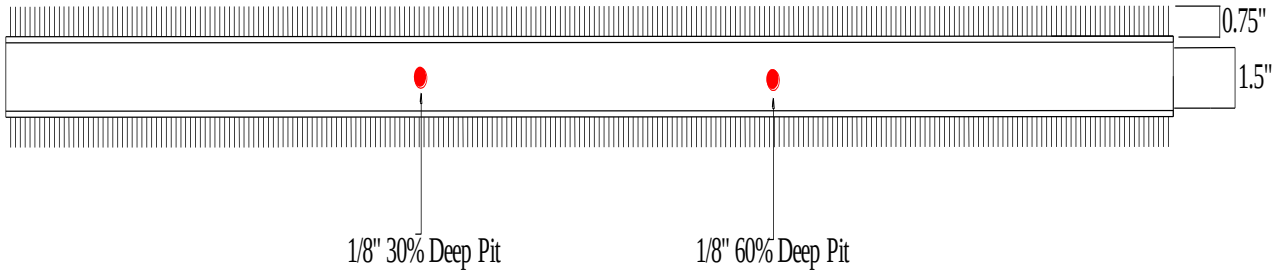


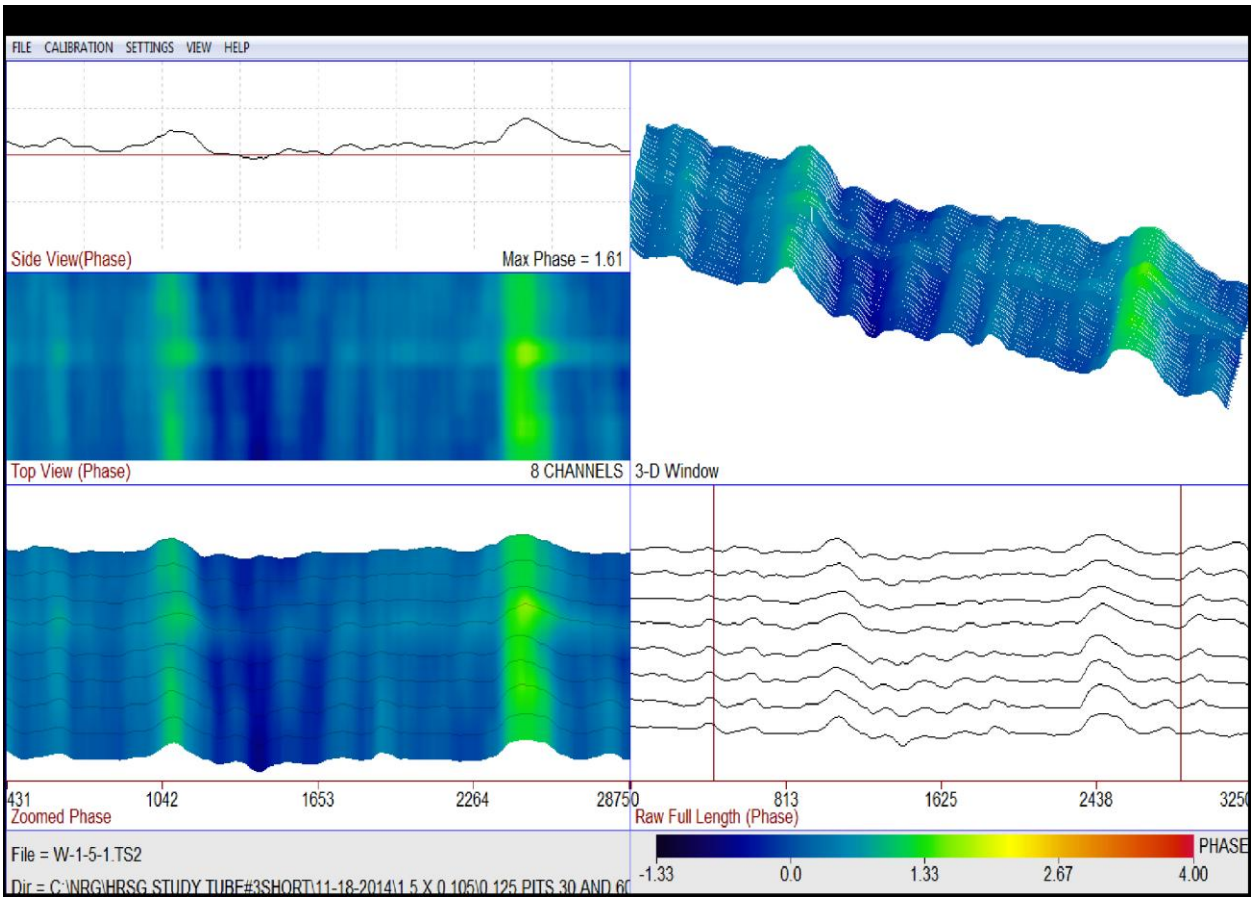


The LFET waveform above is from the study tube. The response of the ¼” pits is circled with the 30% being on the left and the 60% on the right.



The picture above shows the study tube which has 1/8” diameter pits machined on the inside surface. The first pit is 30% deep and the second pit is 60% deep.





LFET waveform above is from the study tube. The response of the1/8” pits is circled with the 30% being on the left and the 60% on the right.

CONCLUSION:

The results of this study show that the Low Frequency Electromagnetic Technique can detect localized wall losses such as pitting in finned Carbon steel HRSG tubes. The signal response clearly showed the location of the pits in the study tubes. Based on these tubes the threshold of detection is a 30% deep 1/8” diameter pit.

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APPENDIX A:

TUBE DETAILS AND INSPECTION DATA

Tube specifications:

Material: Carbon Steel with Carbon Steel fins.

Dimensions: 1.5” OD x 0.105” NWT with 0.750” fins

Fin spacing: 6.5 fins per 1.0”

Electronics:

Electronics box: TesTex TS2000. Serial# 08-3161-03

Scanner: 3.0” LFET hand scanner. Serial# 04-0788-09

Test Frequency: 15 Hz