


Oxide Scale Measurement Application Solution

Boiler Tube Oxide Layer Measurement

The object of the test is to perform a separate thickness measurements of the steel tube wall **and** the oxide scale layer on the ID wall of the tube simultaneously.

Measurement of the Oxide layer helps to solve two boiler operating problems.

Problem #1 – Loss in Boiler Thermal Transfer Efficiency

Boiler Tube Insulation

- As the oxide/scale builds up on the ID of the tube, it begins to act as an insulator reducing the ability of the tube to conduct the heat to the water.

Problem #2 – Mechanical Tube Strength Calculations

False thickness values

- Standard thickness readings include both the wall and oxide/scale thickness. The true mechanical strength of the tube is only based on the steel thickness

The Solution

Required Equipment

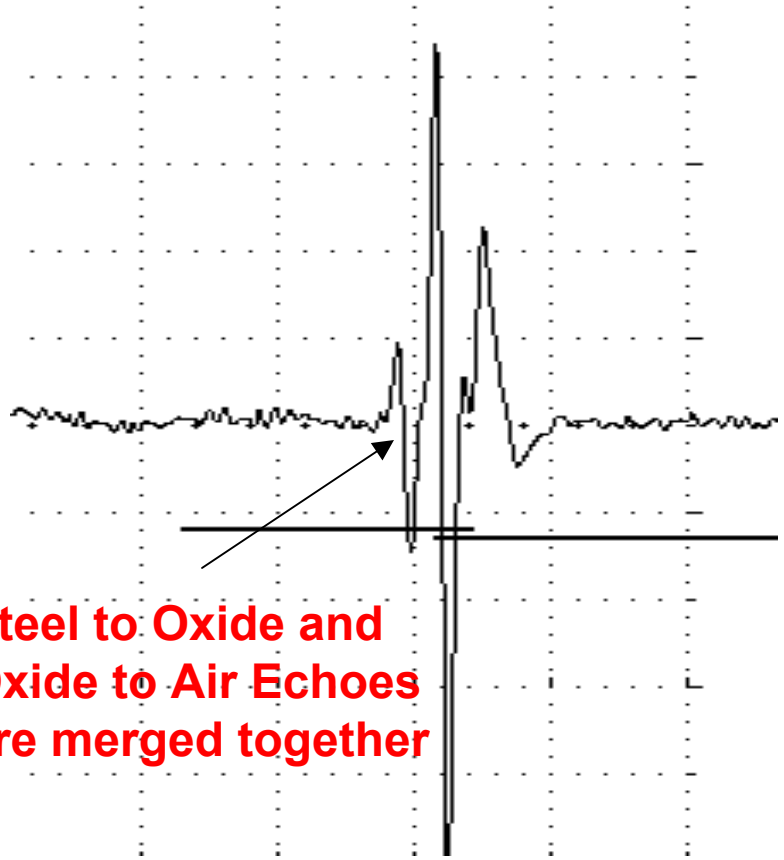
- USN-58L or USN-60 Flaw Detector
- Shear Wave DFR Probe (291-484-700)
- Probe Cable
- SLC-70 Couplant
- UltraDOC 4.4x Software
- PC Cable

Difficult Measurement Requirements

The interface echo from the tube to oxide is much smaller than the echo from the oxide to air interface. It is also very close (in time) to the oxide-air echo.

Thus the difficulty is separating these two echoes from each other and making the measurement between the two.

Measurement with USN-58L and conventional 25Mhz Alpha DFR

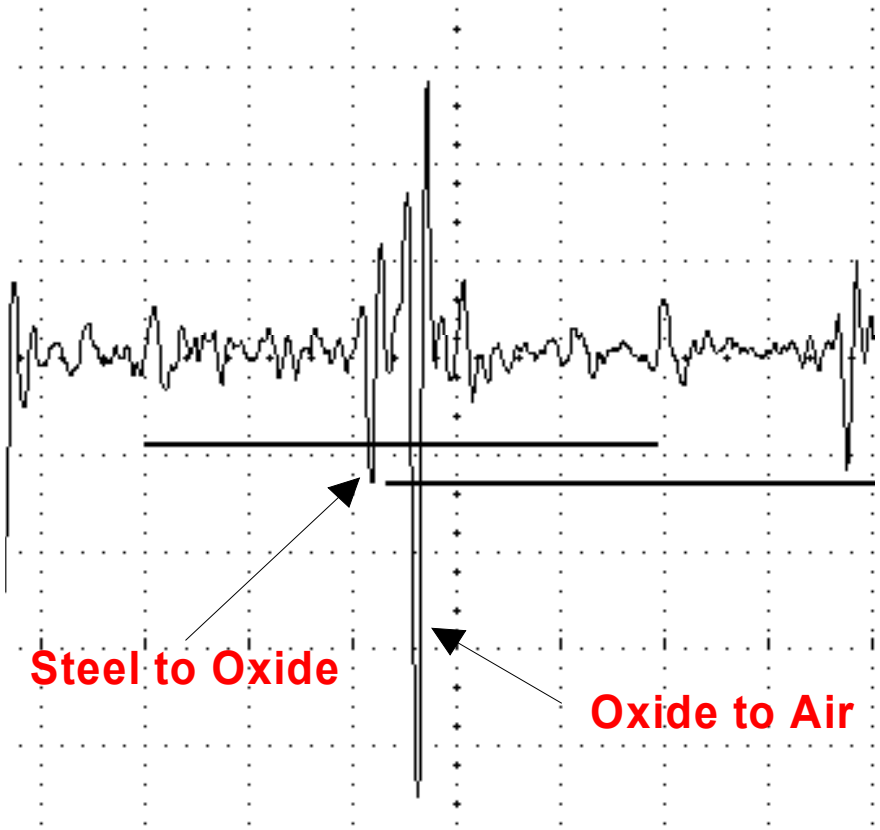


Resolving the Oxide Layer

Using the Special Shear Wave Probe enables separation and measurement between the two echoes.

The A-scan shows the steel to oxide interface echo at about 1/3 the amplitude of the oxide to air interface.

Measurement with USN-58L and 20 MHz Zero Degree DFR



Why Shear Wave?

The ability to measure the thin oxide layer relies on the ability to separate the echoes from the two interfaces.

By using a “shear wave” probe, the velocity is cut in half which doubles the time resolution and enables the system to measure thinner than with longitudinal probes.

Specially Designed Probes

20MHz, 1/4” crystal

The special Y-cut element in this Alpha probe produces a shear wave.

Replaceable delay lines

Shear Wave vs. Longitudinal Wave

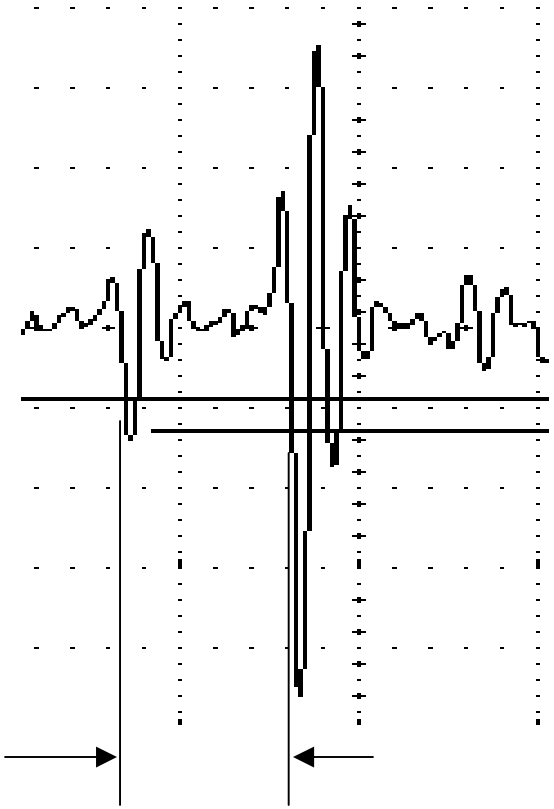
Following are comparisons of a standard 25 MHz Alpha DFR probe vs. 20 MHz Shear Wave DFR on different layers of oxide using the same instrument and set-up.

Note the larger separation between the two echoes with the shear wave probe.

Measuring Thick Oxide Layer (0.030”)

Easy measurement for both probes

Shear Wave

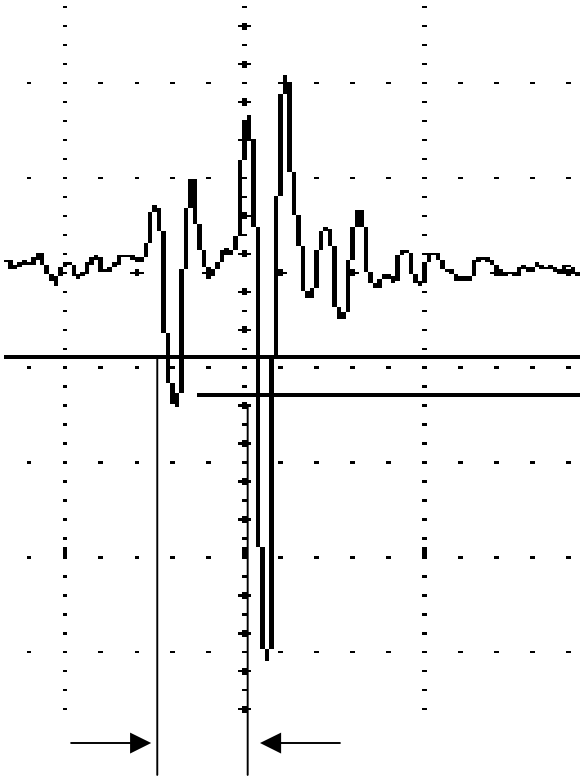


Longitudinal Wave

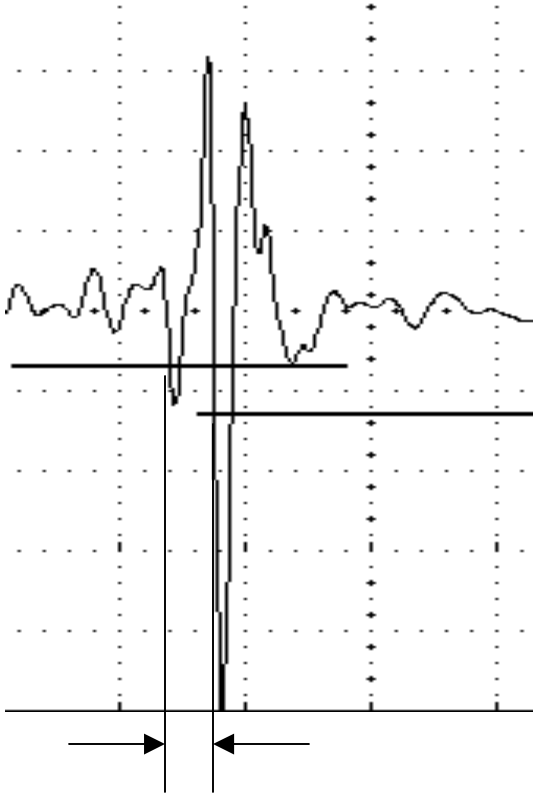
Measuring Average Oxide Layer (0.015”)

ONLY the Shear still shows two distinct echoes!

Shear Wave



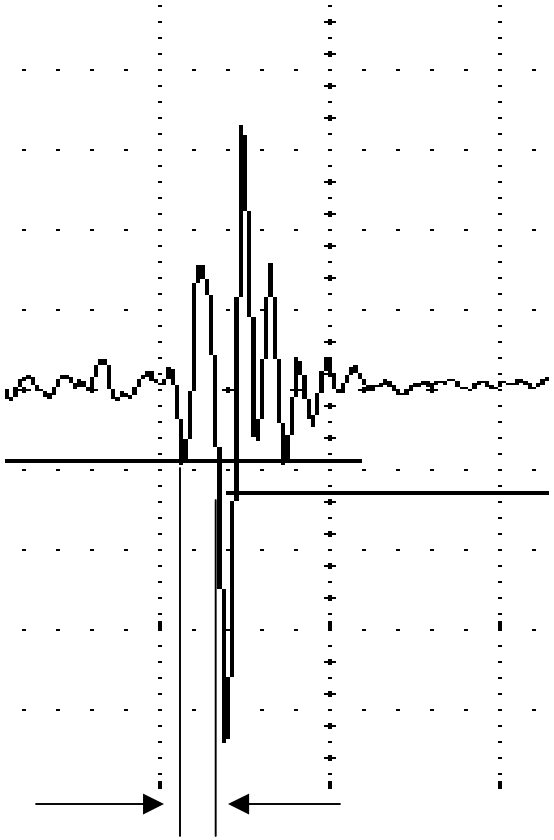
Longitudinal Wave



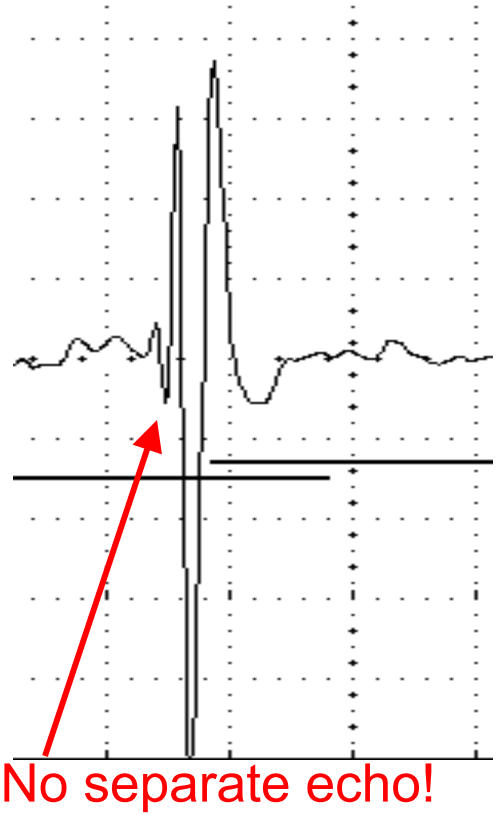
Measuring Thin Oxide Layer (0.007”)

Only the Shear wave probe can resolve the Thin Oxide Layer!

Shear Wave



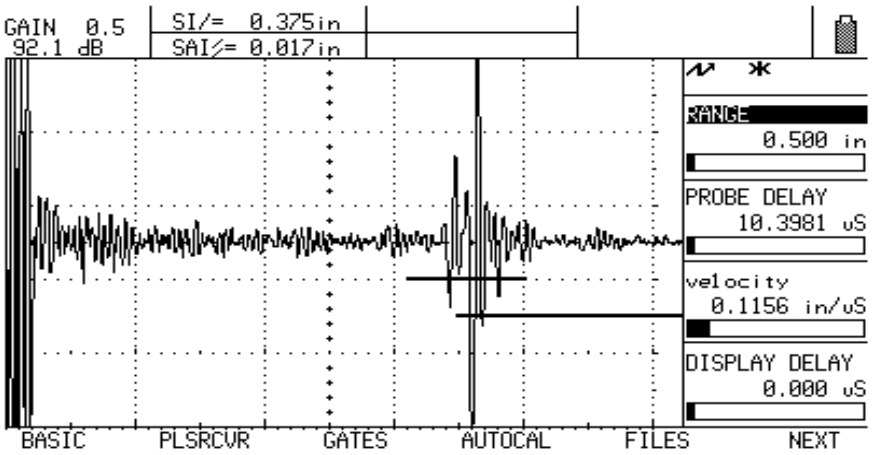
Longitudinal Wave



Measure Oxide on Thick Wall Tubes

Measure Oxide Scale on thick wall boiler tubes (as thick as 0.500”).

Thicker tube walls possible, but with limited thin oxide detection (depends on tube and oxide composition)



USN-58L : Filter set to 10-25MHz

Simple 4 Step Setup

Set USN-60/58L to immersion mode

- > Press NEXT
- > Select IF ADV
- > Select IMMERSION for delay mode

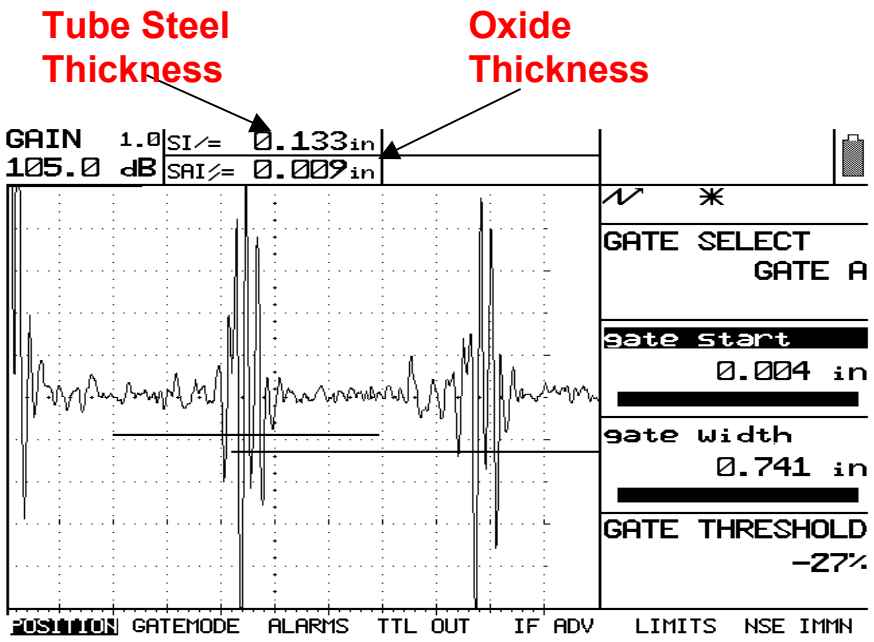
Set water path velocity to the velocity of steel (0.1260)

Set main velocity to to velocity of oxide (~0.1240)

Set gates to flank detection

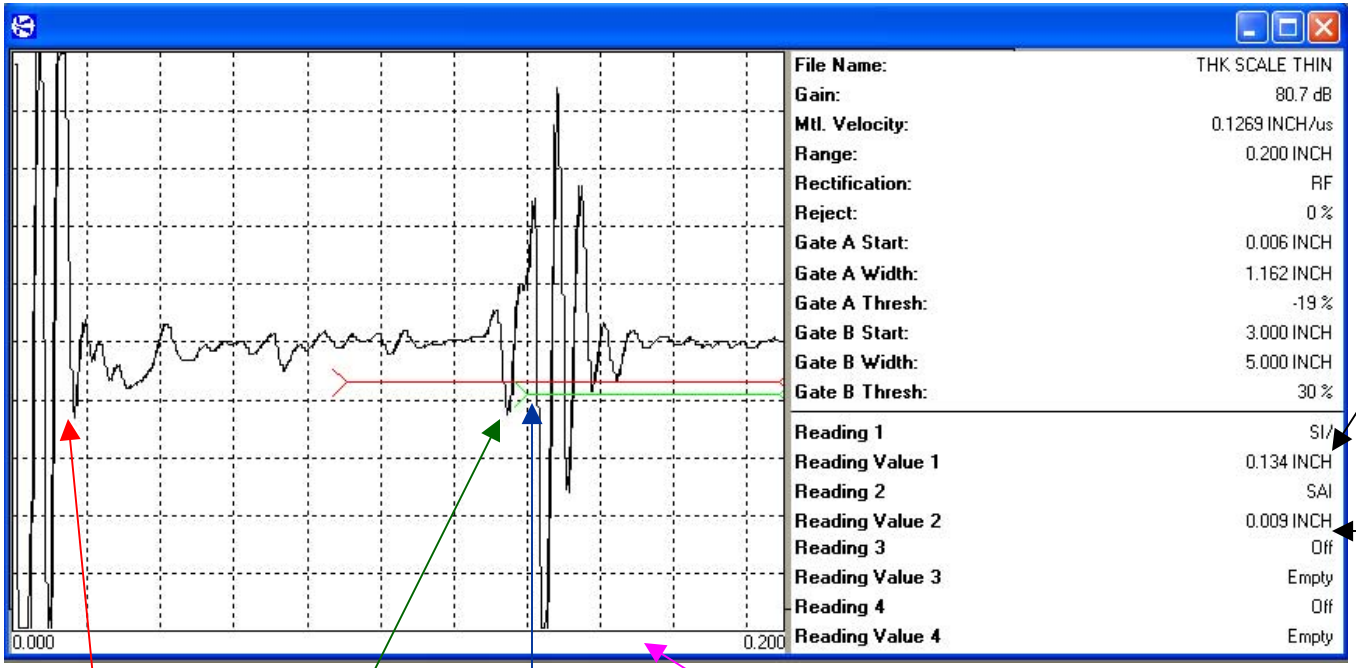
Set reading 1 to SI

Set reading 2 to SAI



Documented Results

USN-58L & Shear Wave DFR



Metal Wall Thickness

Oxide Thickness

Calibrated Scale (0-.200")

Oxide/Air Interface 0.009"

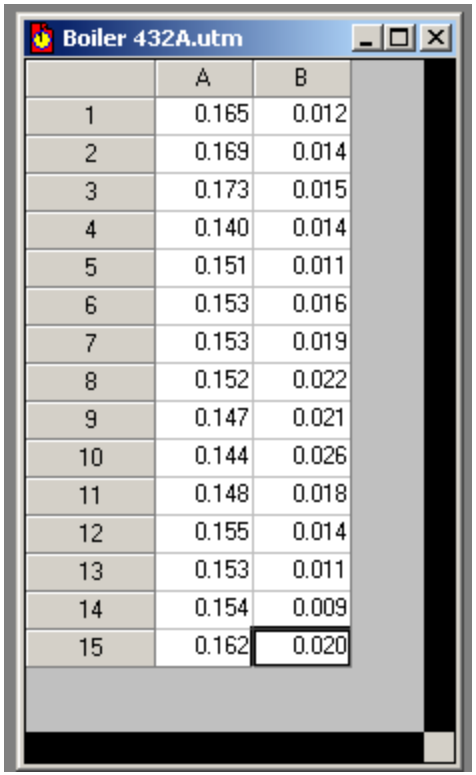
Tube Back Wall Oxide Interface 0.134"

Probe/Tube Interface

Record, Save and Document the Data

Store both Tube thickness and oxide layer thickness in the USN data recorder (using Multi-Store Function)

Download to UltraDOC to report, save and analyze the thickness data



	A	B
1	0.165	0.012
2	0.169	0.014
3	0.173	0.015
4	0.140	0.014
5	0.151	0.011
6	0.153	0.016
7	0.153	0.019
8	0.152	0.022
9	0.147	0.021
10	0.144	0.026
11	0.148	0.018
12	0.155	0.014
13	0.153	0.011
14	0.154	0.009
15	0.162	0.020

Couplant is important - SLC70

Sound attenuative couplant is required when using 0º shear wave probes.

- > High viscosity for vertical and overhead testing
- > Best performance for transmitting shear wave into test object

Benefits of the USN-60/58L

High Resolution Display (+400 pixel) has required resolution needed to view and measure the echoes

Separate velocity adjustments for the Steel and the Oxide

Measure Thinner Oxide/Scale layers with USN-60/58L & 0º S-Wave DFR Probe

Successfully measure Oxide/Scale layers on thick wall tubes

Save and recall A-Scan and instrument parameters in Data-Sets

Use “Compare Mode” to view set-up standard against actual measurement

Do more with the USN-60 or 58L!

Do more than just Oxide Layer and Thickness Measurements…

- Weld Inspection
- Lamination Detection
- Flaw Sizing
- Plus lots more!