TesTex Off Surface Electromagnetic Technique (OSET) for Corrosion Under Insulation (CUI)

Off Surface Electromagnetic Technique:

What Is OSET?

Various exciter coils are used to induce an electromagnetic field at lower frequencies. That field will penetrate through the jacketing and insulation, and into the pipe wall. Anomalies in the pipe wall will distort the field and be detected by the various receiving coils. Differential sensors are used to find "abrupt" changes such as welds and pitting, while absolute sensors will pick up gradual wall losses.

Actual Inspection Summaries

CUI INSPECTIONS – PARTIAL PROJECT LIST

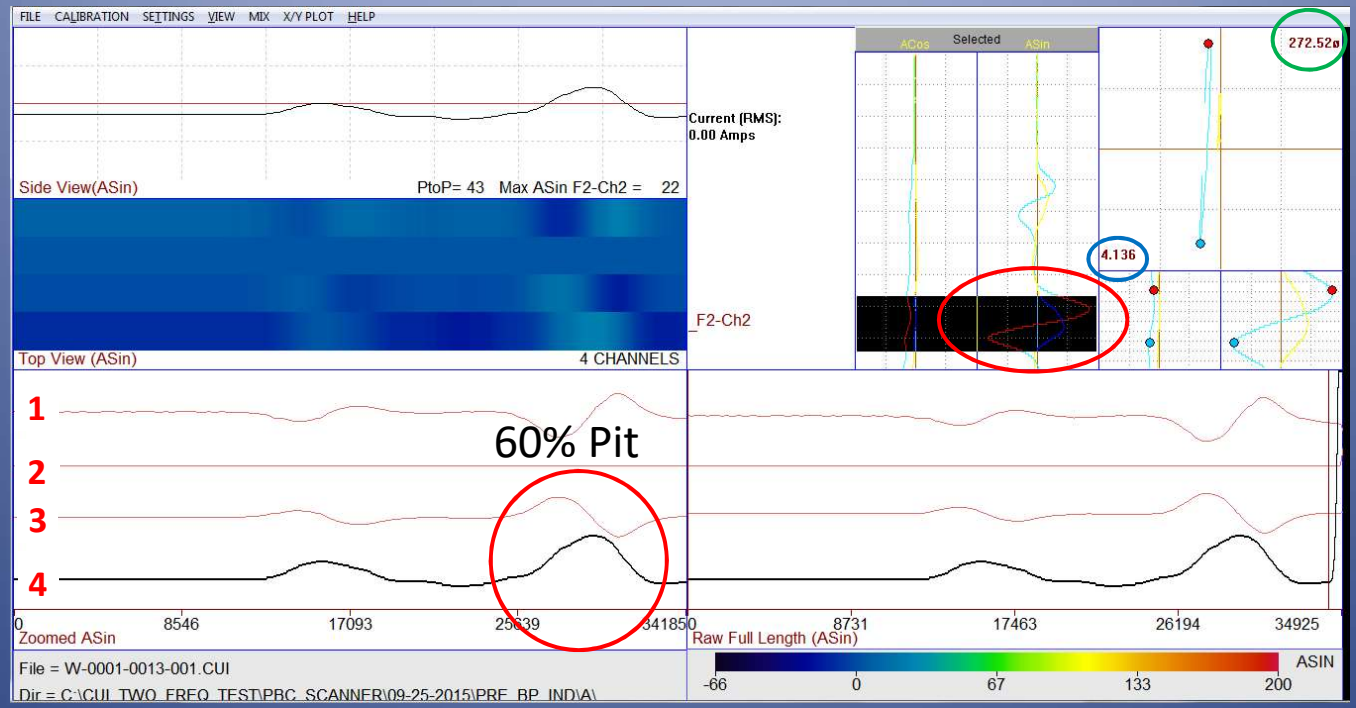
Project #	Customer	Pipe Size	Comments/Results
1	Braskem	4" & 6"	- Inspected approximately 10 piping circuits. - Detected wall loss on three (3) different pipes: UT prove up confirmed remaining wall thickness of 0.216" of nominal 0.240".
2	BP Whiting	4" - 16"	- Inspected approximately 25 piping circuits. - Identified area with wall thinning, confirmed 0.418" remaining wall thickness of nominal 0.500".
3	Marathon	6"	- Inspected one piping circuit. Detected wall loss, of 0.417“ wall remaining of nominal 0.432".
4	Huntsman	2" - 6"	- Inspected 4 piping circuits. Detected several areas of wall loss on one line. Customer did not want to “prep” line for UT prove up for fear of causing a leak.
5	Lubrizol	2" & 3"	- Inspected one piping circuit. No indications of wall loss.

Blind Trials

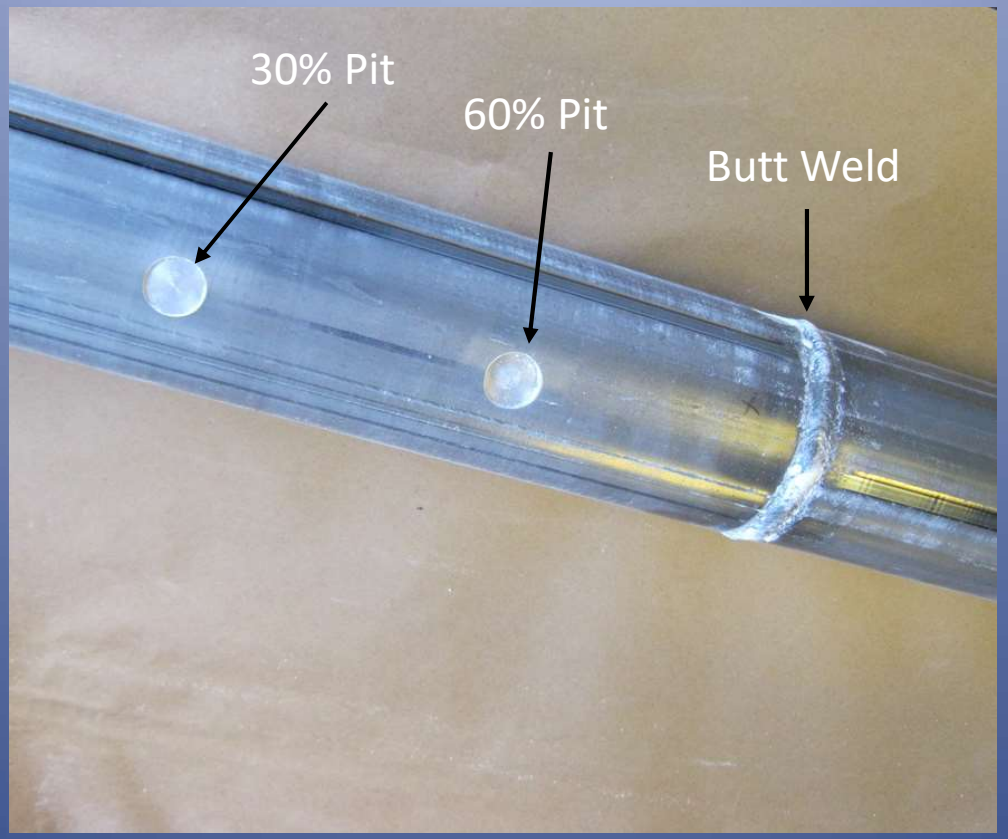
PARTIAL PROJECT LIST

Project #	Customer	Pipe Size	Comments/Results
6	Dow	4" & 6"	- Scanned three (3) naturally corroded sections of pipe that had been cut out of process lines as a test of the OSET technology. - Dow verified that areas of corrosion were successfully detected on all three (3) pipes and indicated that they want to conduct more inspections at this site to further evaluate the OSET technology. - Dow stated that the OSET system performed significantly better than a Pulsed Eddy Current system tested previously. - Have not received formal report from Dow as of 4/22/16
7	Marathon	4"	- Scanned a 4" section of naturally corroded pipe that had been cut out of a process line in order to test the OSET technology. - Detected multiple areas of corrosion, including (3) individual pits.
8	Marathon	NA	- Scanned a small section of a vessel wall as a field trial. No areas of corrosion were detected.
9	BP	4" - 10"	- Inspected five (5) sections of pipe to test the OSET technology. Some of the pipes were new with machined flaws, others were naturally corroded pieces cut from process lines, with both ID & OD corrosion. - BP verified that the OSET system detected the machined flaws and natural corrosion, including ID corrosion. Butt welds and changes in pipe schedule were also detected. - BP HAS APPROVED THE USE OF THE TESTEX OSET SYSTEM FOR ALL LOCATIONS BASED ON THE RESULTS OF THIS TRIAL AND THE INSPECTION MENTIONED ABOVE. TESTEX TECHNOLOGY HAS BEEN ENDORSED FOR USE ON SPECIFIC UPSTREAM APPLICATIONS.
10	PRCI	12”	- Scanned four (4) pipes, each with machined flaws that had been "repaired" with wraps using different types and thicknesses of composite materials. - OSET scored the best compared to at least 5-6 other methods.

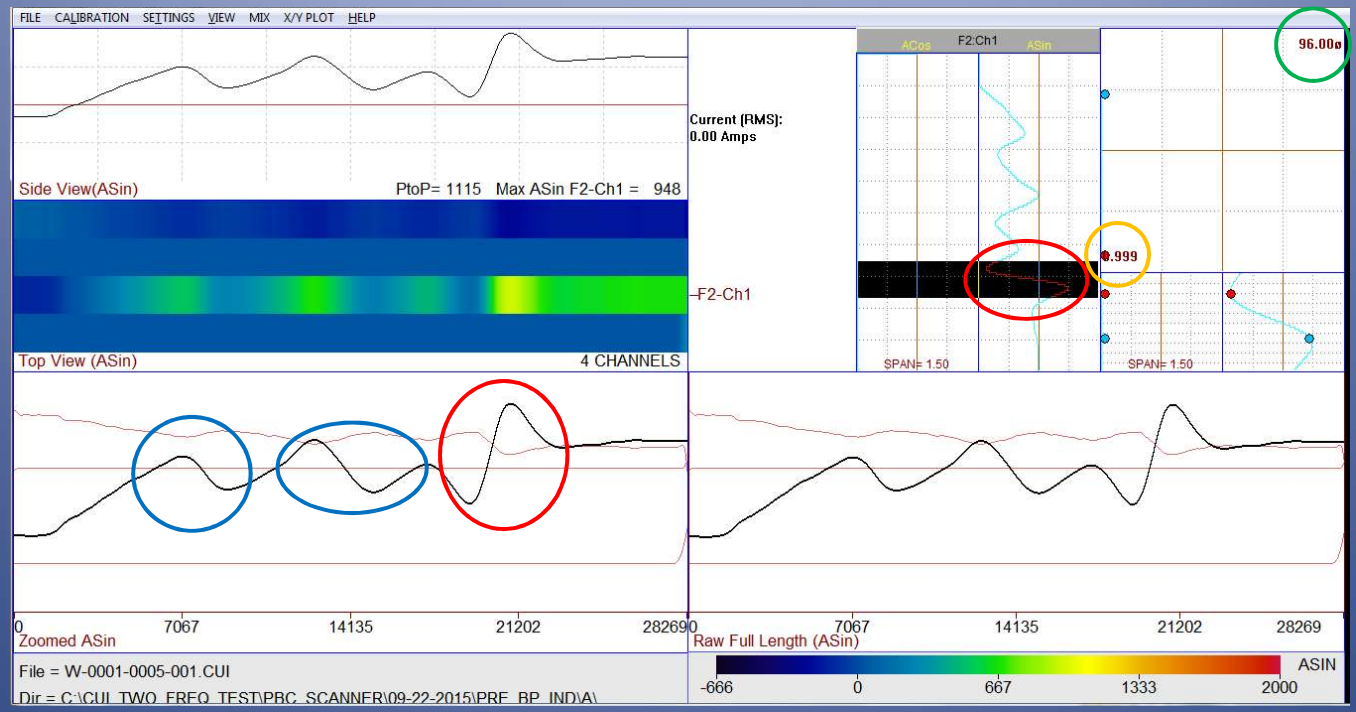
System Operation:



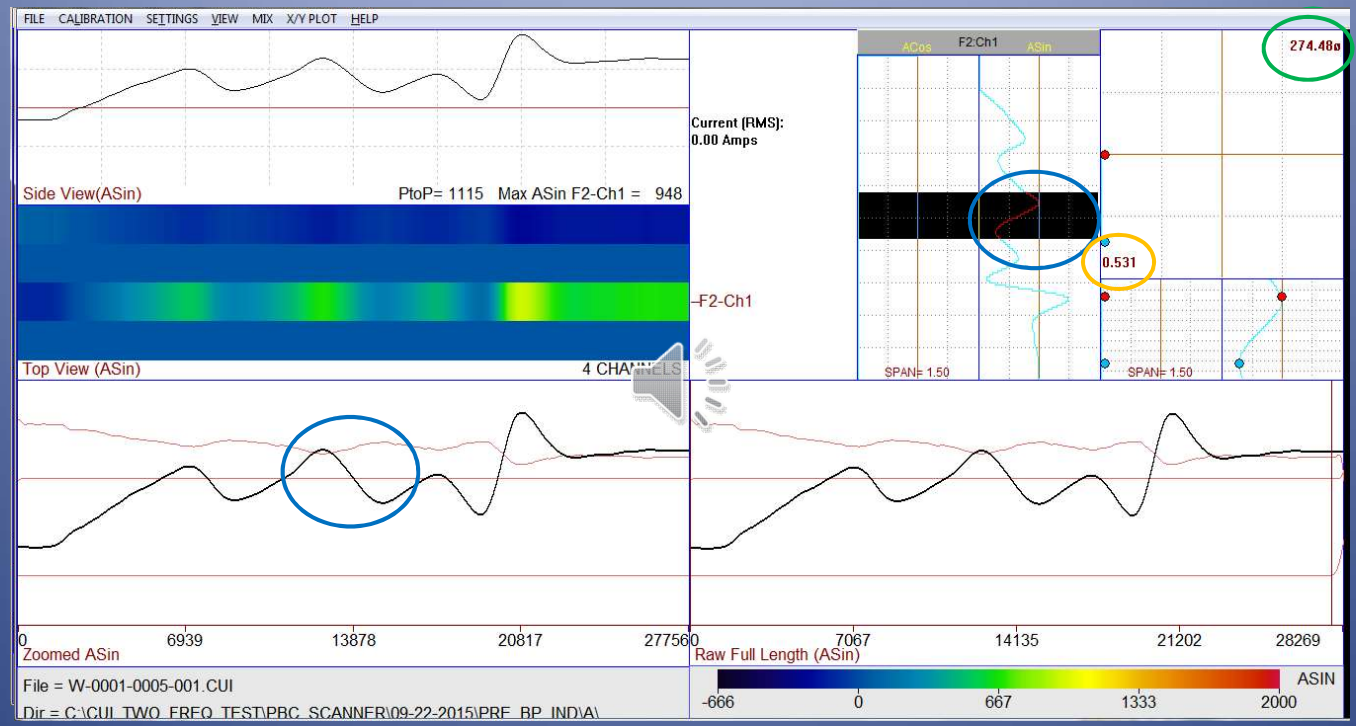
TesTex's current CUI detection system uses a dual frequency system and generates four (4) responses, as shown in the bottom left panel above; 1.) High Frequency Differential; 2.) High Frequency Absolute; 3.) Low Frequency Differential; and 4.) Low Frequency Absolute. The type/shape of response (red circles), magnitude (voltage span, blue circle), and phase angle (green circle) can be analyzed to identify the type of anomaly (such as a weld, pitting, or general wall loss). The circled indication is for a 60% deep "ring" that was machined into the OD of the pipe to simulate wall loss.



This picture shows a 4” schedule 40 carbon steel calibration pipe. From left to right on the pipe are a 30% deep pit, a 60% deep pit, and a butt weld. Calcium silicate insulation (2” thick) and an aluminum jacket were installed and the pipe was scanned with the OSET system, producing the wave form below.

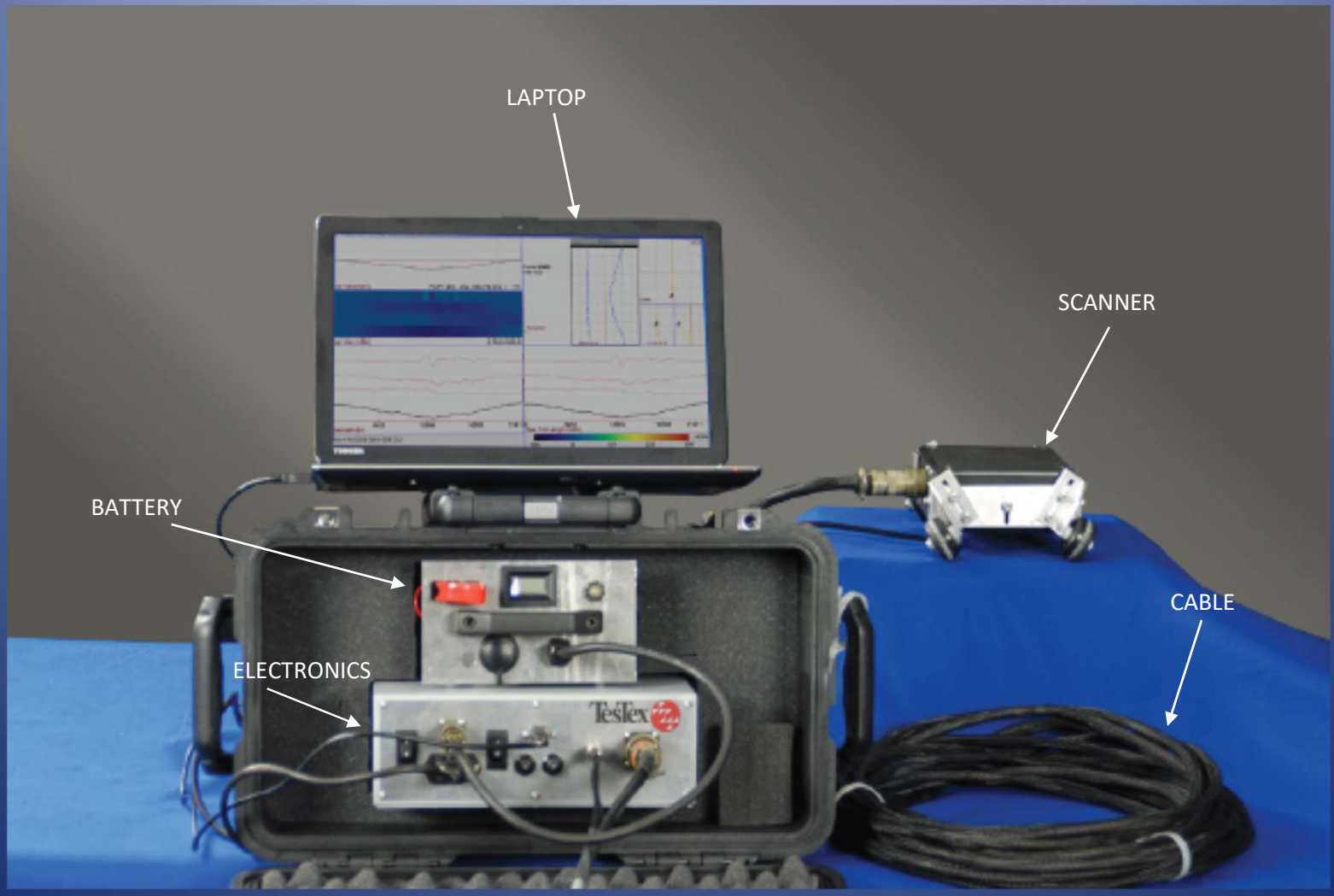


Indications of the two pits are circled in blue and the weld is circled in red. The weld signal is highlighted in the plot on the upper right of the screen (red circle), with a phase angle of 96° (green circle) and a voltage span of 0.999 (orange circle). (Note that the signal for the pits first rises above and then dips below the baseline, while the weld indication dips first and then rises.)

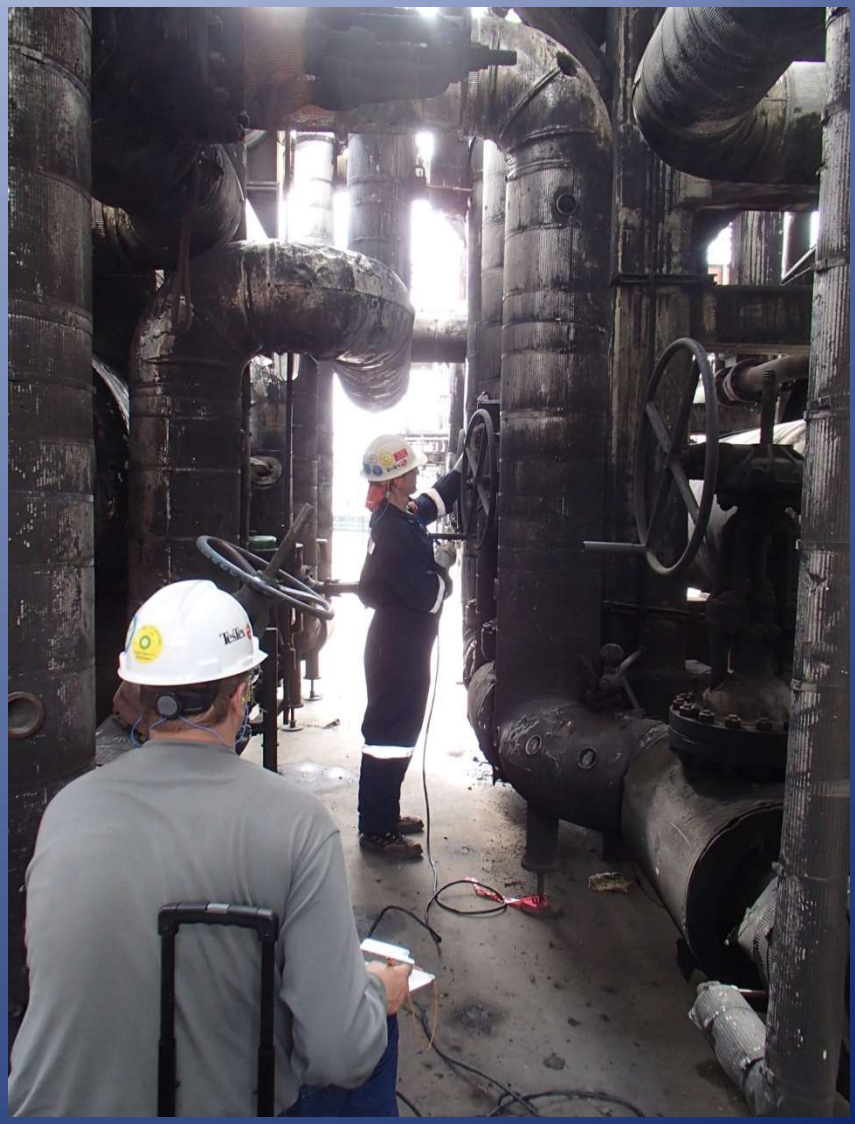


This is the same wave form with the 60% pit highlighted (blue circles). Note that the phase angle is about 274°, so approximately 180° from the weld angle. The 30% pit would show about the same phase angle and the voltage span would be somewhat less.

Equipment:



Scanning Pictures:



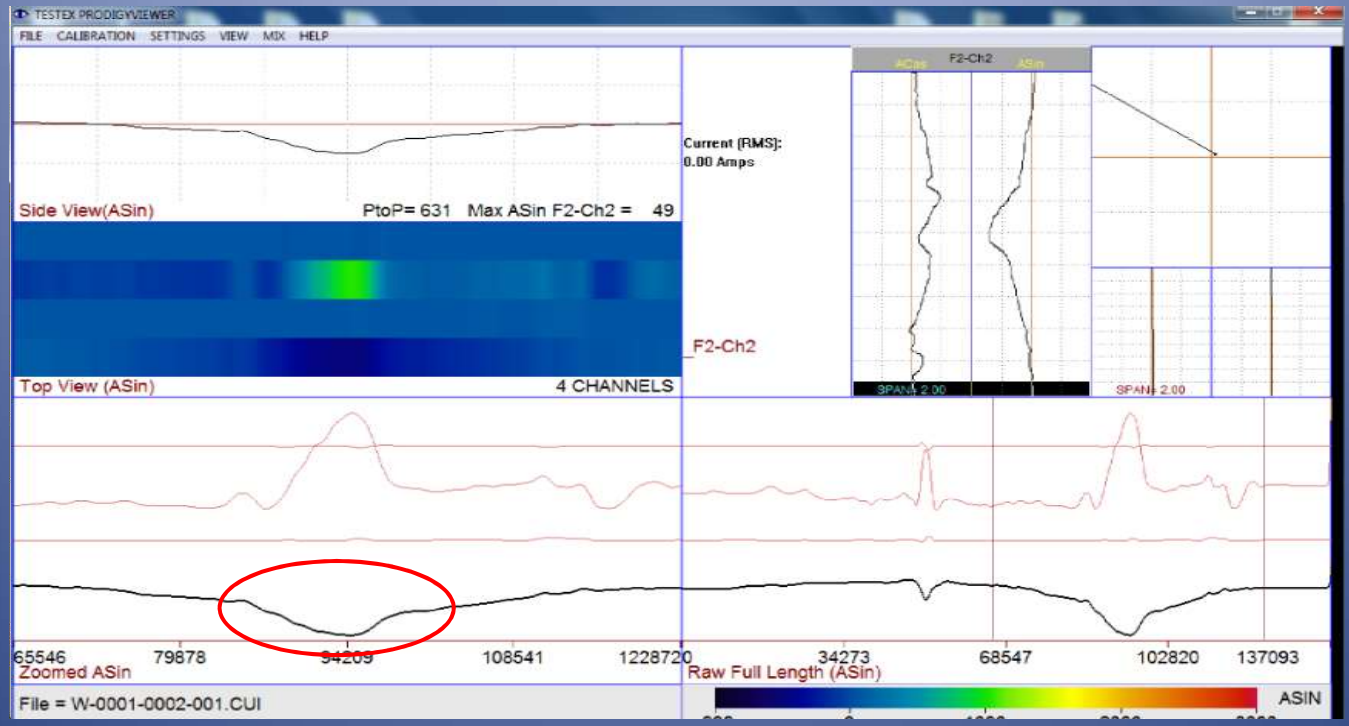
Scanning Pictures:

Scanning Video:

Braskem – Marcus Hook Inspection:

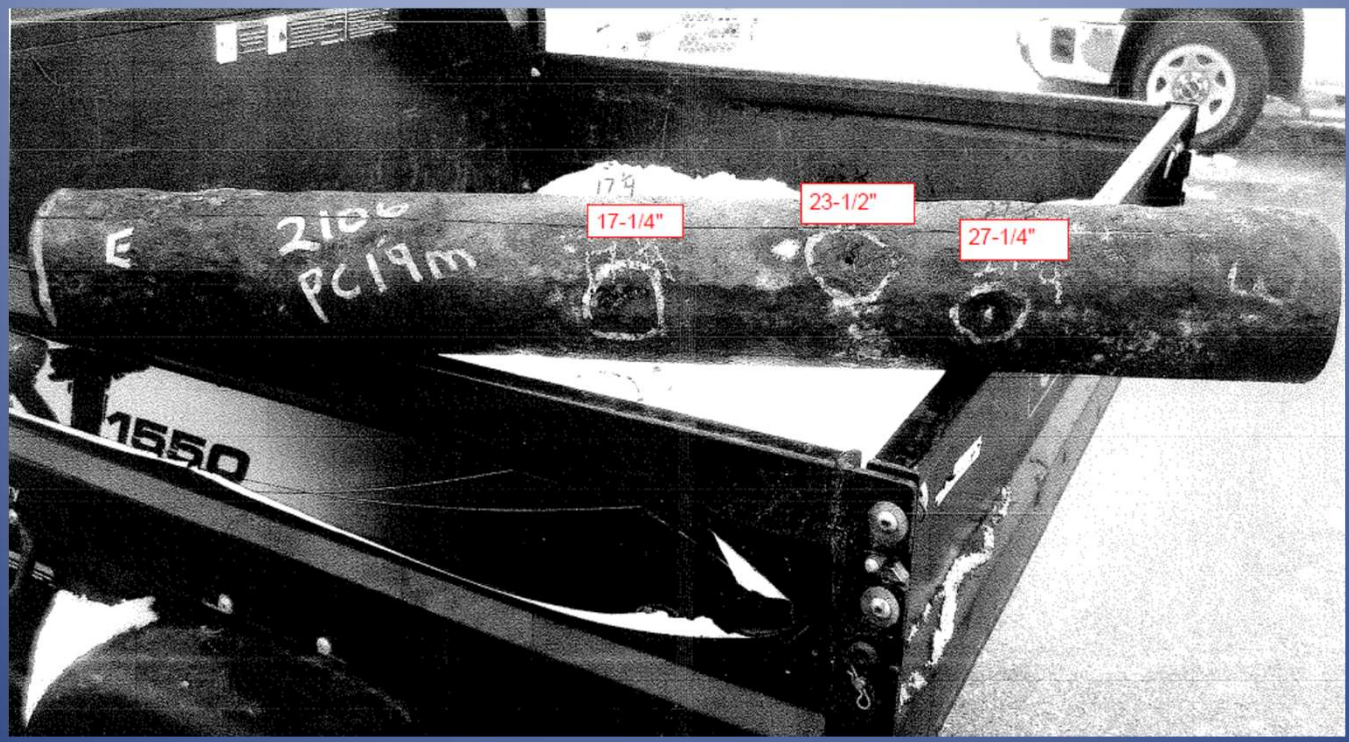
Pictures of a 4" pipe with suspected corrosion before & after the jacketing was removed.
UT testing confirmed that there was 0.216” wall thickness remaining from nominal 0.240”.

Braskem – Marcus Hook Inspection:



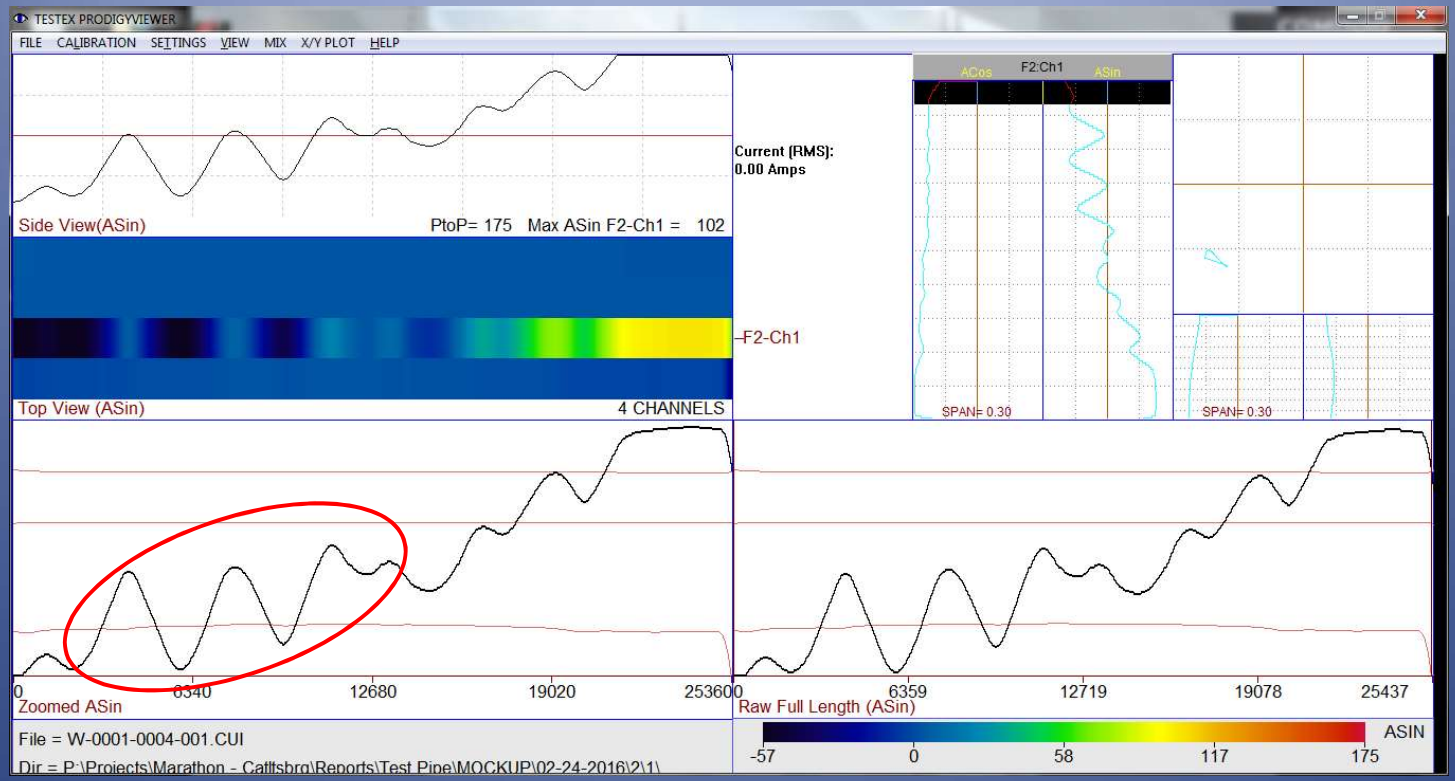
Wave form from the scan of the pipe above, with the low frequency absolute trace indicating wall loss (red circle). UT follow up determined that the wall thickness in this section of pipe ranged down to 0.216", vs nominal wall thickness of 0.240".

Marathon – Catlettsburg Test:



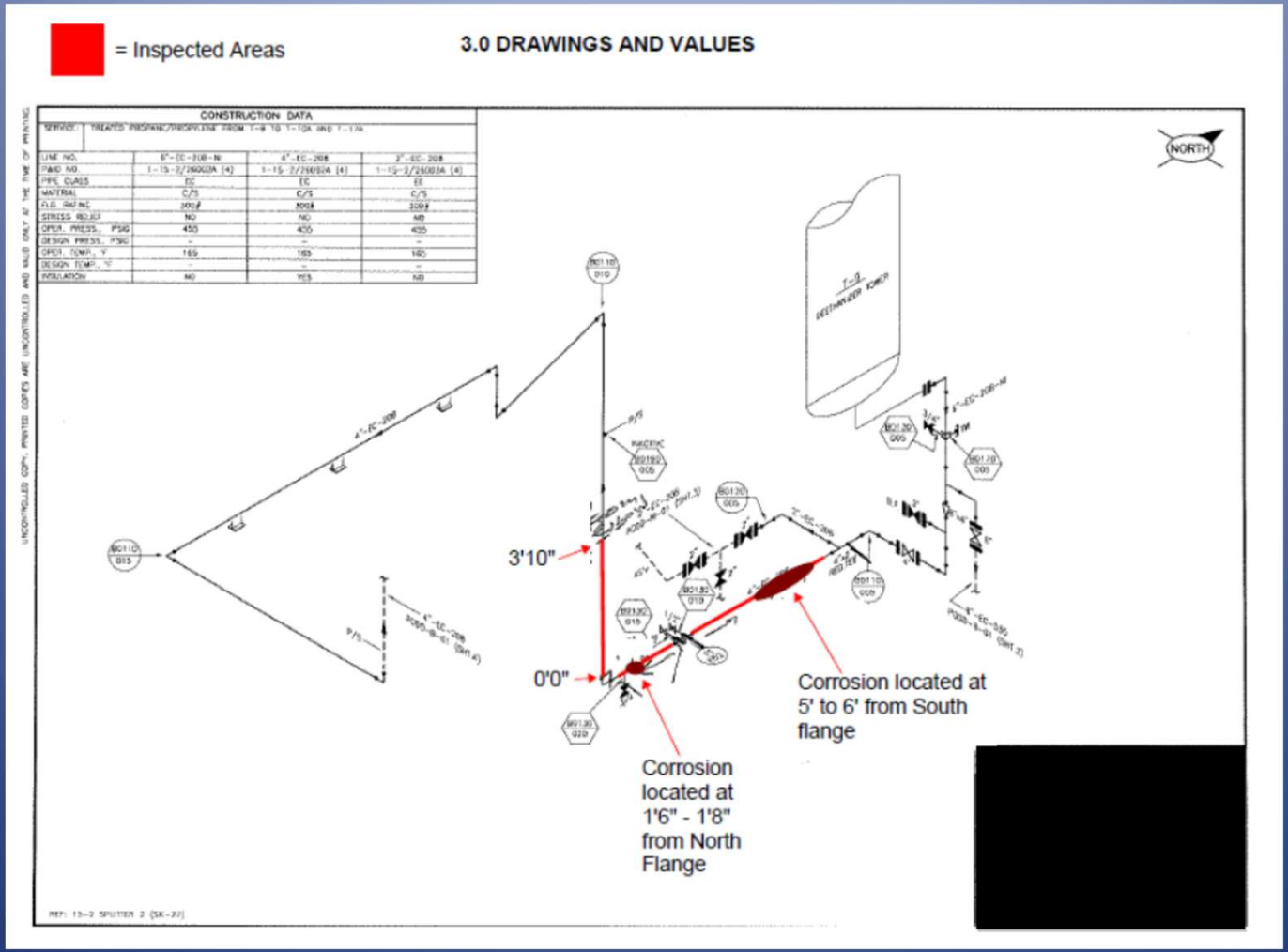
Picture of 4" naturally corroded test pipe that was removed from a process line at the refinery. In a blind test after new insulation and jacketing were installed, the OSET system detected the pitted areas that are circled, along with other flaws and general wall loss.

Marathon – Catlettsburg Test:



Wave form from the scan of the pipe above, with the low frequency differential trace indicating the three closely spaced pits (red circle) that are shown in the picture.

Reporting Information:

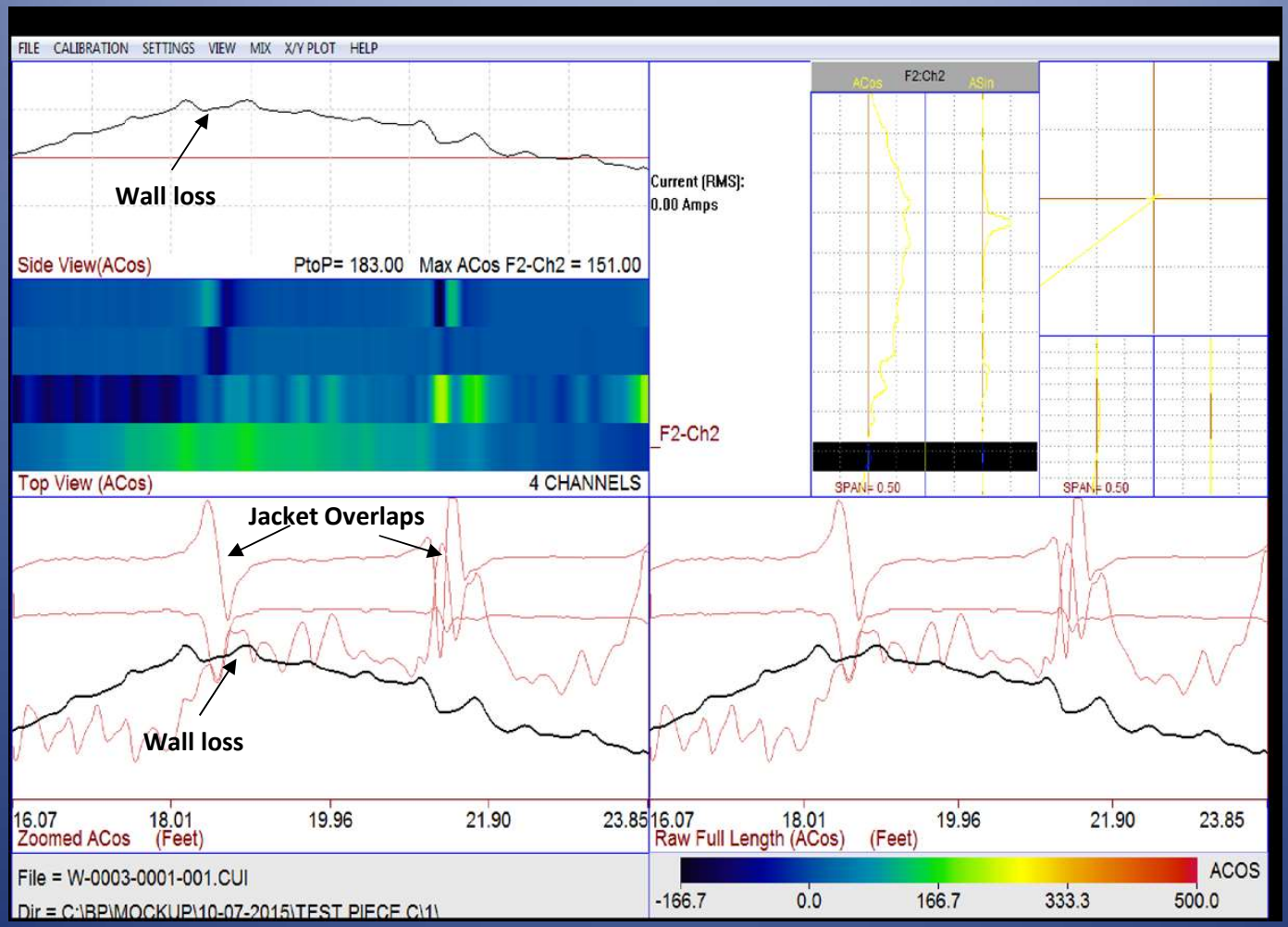


Reports can include drawings of the pipes that were inspected, sections that were scanned, and locations of any indications. Physical markers can also be placed on the actual piping.

Reporting Information:

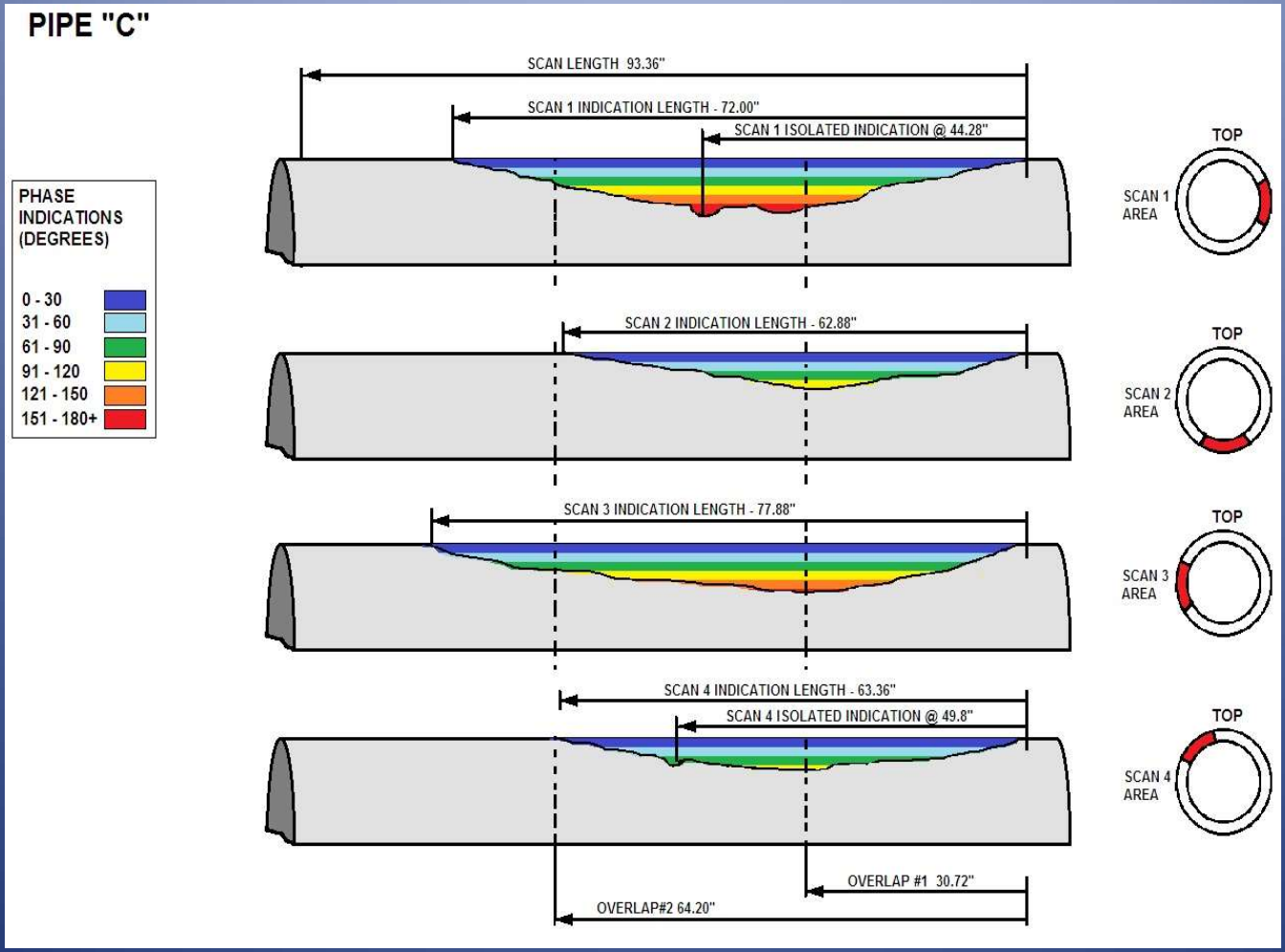
Picture of a pipe scanned as part of a test of the OSET technology. This was a pipe with natural corrosion that was removed from a process line.

Reporting Information:



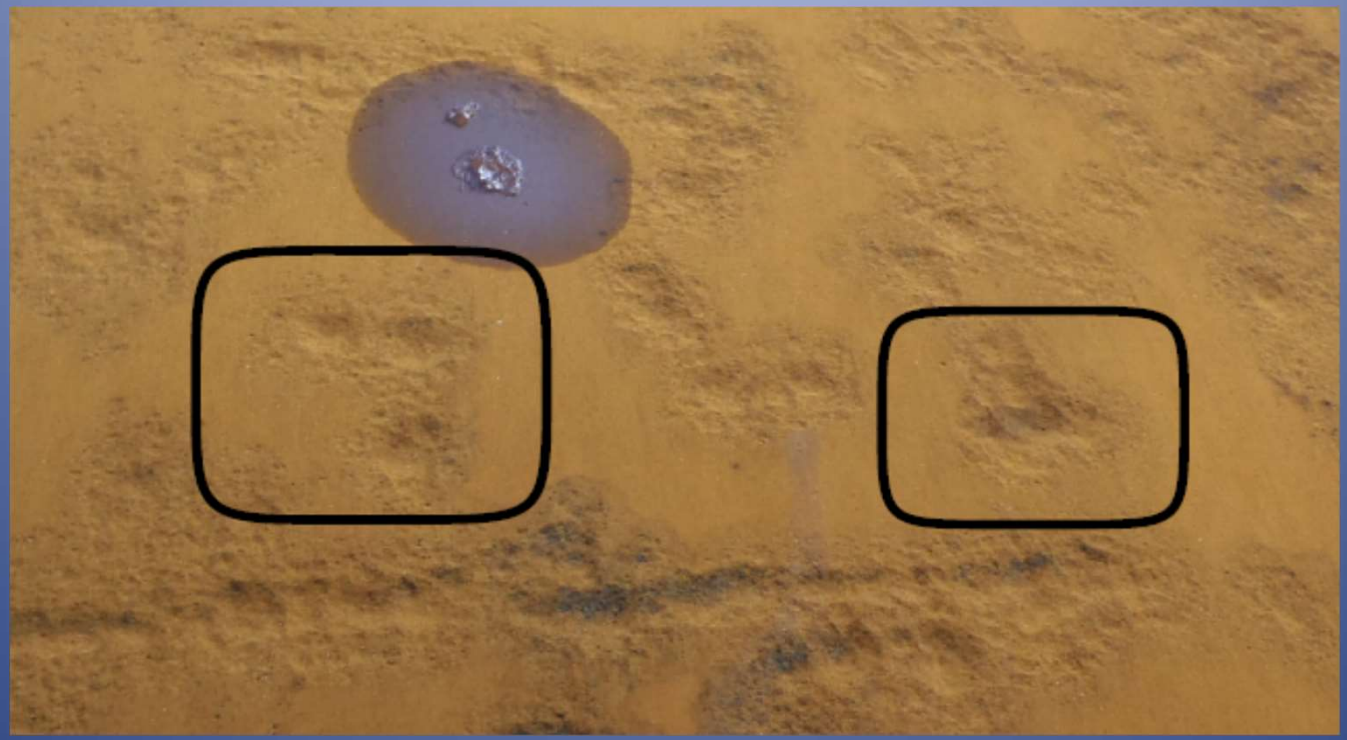
Wave form from the scan of the "3:00 O'clock" position of the pipe pictured in the previous slide. Note the fairly large deviation from the base line in the upper left section of the wave form, indicating the corrosion at the 3:00 O'clock position.

Reporting Information:



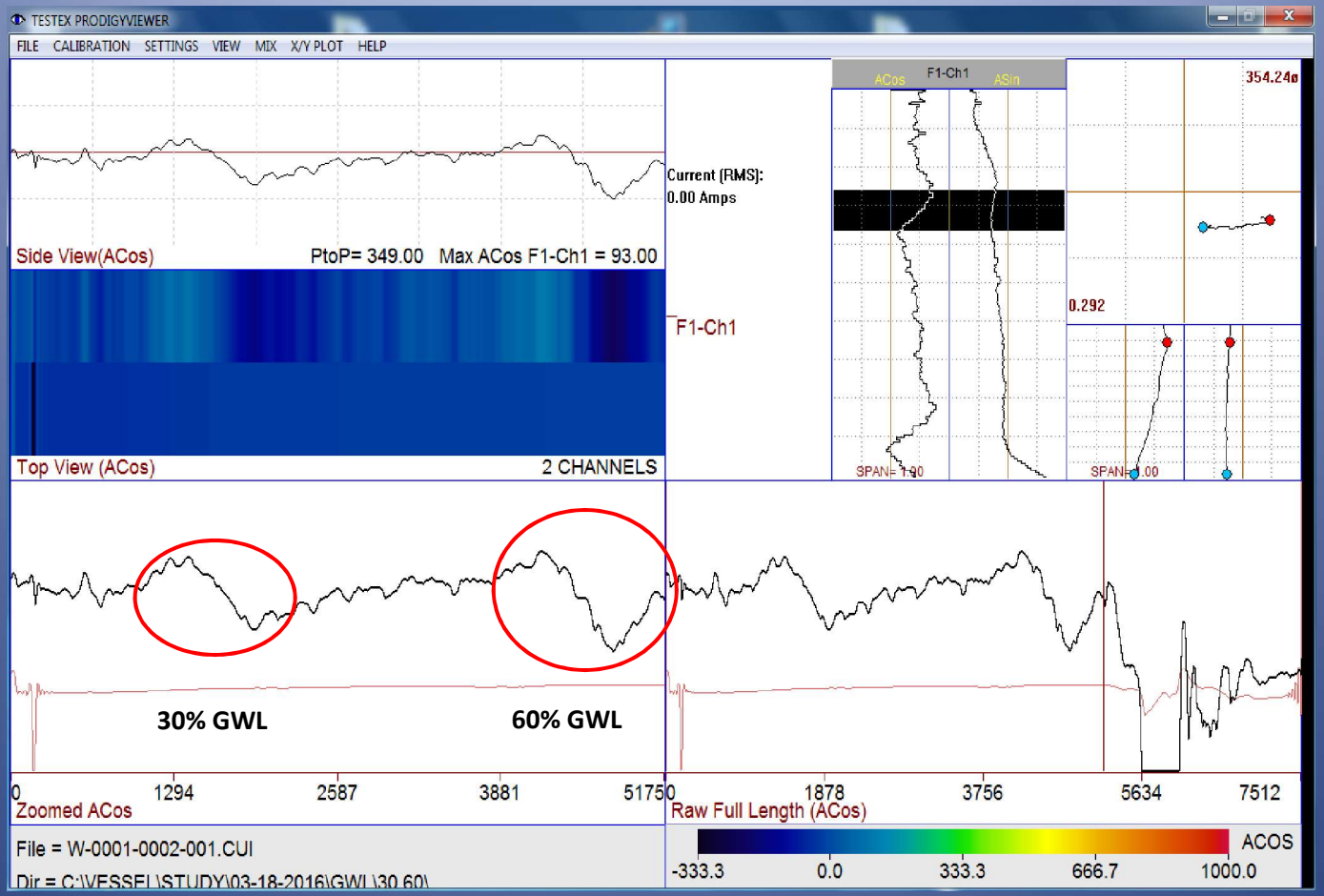
This is a representation of the scanned pipe showing wall loss at various scanned clock positions. Note that the corrosion is most extensive at the 3:00 O'clock and 9:00 O'clock positions.

What's Next?: Pressure Vessels



TesTex recently completed the first round of tests to detect CUI on insulated vessels and tanks. These first tests were designed to find areas of isolated wall loss as shown in the picture.

Marathon provided a 38” long x 12” wide by 1/2” thick plate with a 2-1/2” wide support ring to simulate a vessel wall. TesTex had two tapered flaws machined into the surface, one 30% deep and the other 60% deep. The plate was then scanned under 3” of insulation and an aluminum jacket.



This wave form shows the response of the OSET system to the two (2) tapered circular flaws. As noted, the indication on the left shows the 30% GWL tapered flaw and the one on the right is the 60% GWL flaw.

Once appropriate mock ups are fabricated, additional testing will be conducted to determine how to detect corrosion of insulation support rings and support lugs as well as other types of wall loss.

Current Capabilities:

Jacket material	Jacket thickness	Insulation thickness Weld detection	Insulation thickness Wall loss detection	Insulation thickness Pit detection
Stainless Steel	0.010"	up to 4"	up to 4"	up to 3"
Aluminum	0.010"	up to 3"	up to 3"	up to 2"
*** Galvanized**	0.010"	up to 1"	up to 2"	N/A

* This takes a different type of scanner which is presently in development.

Productivity:

Productivity of up to 1000 linear ft./shift can be achieved, depending on the pipe diameter and other variables such as accessibility and pipe geometry.

TesTex

End