OLYMPUS

Semi Automated Corrosion Mapping

using

Phased Array Ultrasonics

5th Pan American NDT Conference

Cancun Mexico

October, 2011

Presentation Content

- Industry Survey
- Understanding Damage Mechanisms & Applications
- Considerations applicable to Corrosion Mapping
- Introduction to Corrosion Mapping with Phased Array Ultrasonics
- Applying Phased Array Ultrasonics for Corrosion and Mid Wall Anomaly Detection & Mapping

Industry Survey: Corrosion Mapping

The survey included:
•Major oil companies.
•Providers of inspection services
•Equipment manufactures and
•Individuals that perform Fitness for Service Calculations.

Twenty four companies and more than 70 people where included in the survey. Cumulative experience of the individuals surveyed exceeded 600 years of corrosion mapping experience. Most of the information gathered occurred during meetings with numerous key personnel that are directly involved with corrosion mapping services.

Fossil fuel process industry owner operators confirmed the current and increasing need for corrosion mapping. The driving force for corrosion mapping is the world demand for fuel. Safety, asset integrity assurance, contractual delivery of product, insurance requirements, compliance with government regulations and internal directives contribute to the utilization of corrosion mapping services.

Process facilities are required to remain on-line to meet the increasing fuel demands. Continuous operation of the equipment requires thorough integrity assessment using inspection techniques that can be applied while the equipment is in service. Wall thickness reduction due to corrosion and erosion are two of the greatest detriments that compromise containment of process.

Summary of Industry Survey

Included:

- Major Oil Companies
- Inspection Service Providers
- Engineering Companies perform FFS Calculations

Tallies:

- 24 companies, 7 countries
- >70 People including management, inspectors and equipment designers
- >600 years of experience in corrosion detection and mapping

Common Problems:

- Accurately Determine Corrosion Rate
- Repeatability of AUT Scans
- Differentiate between mid wall anomalies and ID connected wall loss
- Qualified Personnel
- Lack of Industry Standard for Corrosion Mapping

Why Perform Corrosion Mapping?

- Safety

  Current Condition of Equipment?

- Economics

  Reduced: Downtime, Vessel Entry.

- Determine Corrosion Rate

  Repeatability – Rerate – Repair – Replace – On-Line Monitor

- Determine Remaining Life

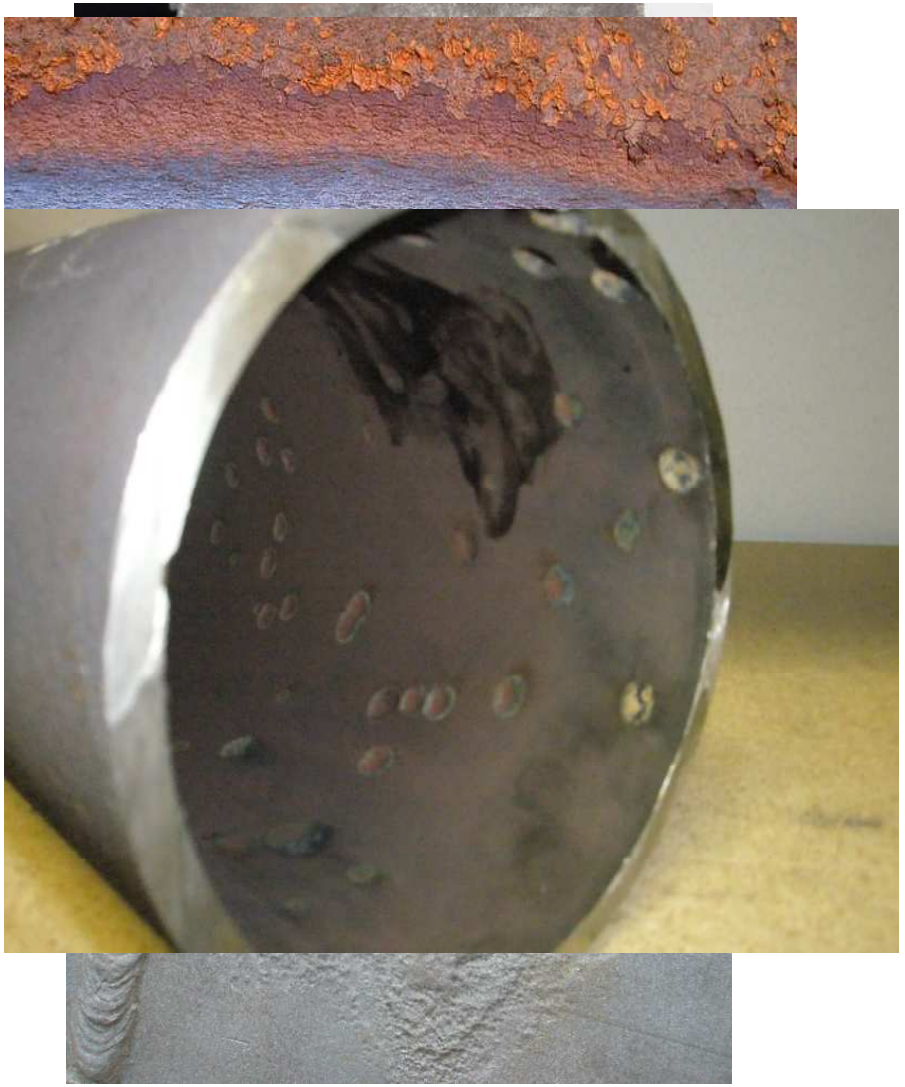
  How long will it operate at current process exposure

  Replacement planning

  Selection of material for replacement

Examples of Corrosion

- ID & OD Corrosion
- Preferential Weld Corrosion
- Microbiological Induced Corrosion
- Isolated Corrosion Pits



Mid-Wall Anomalies

- Wet H_2S Blistering

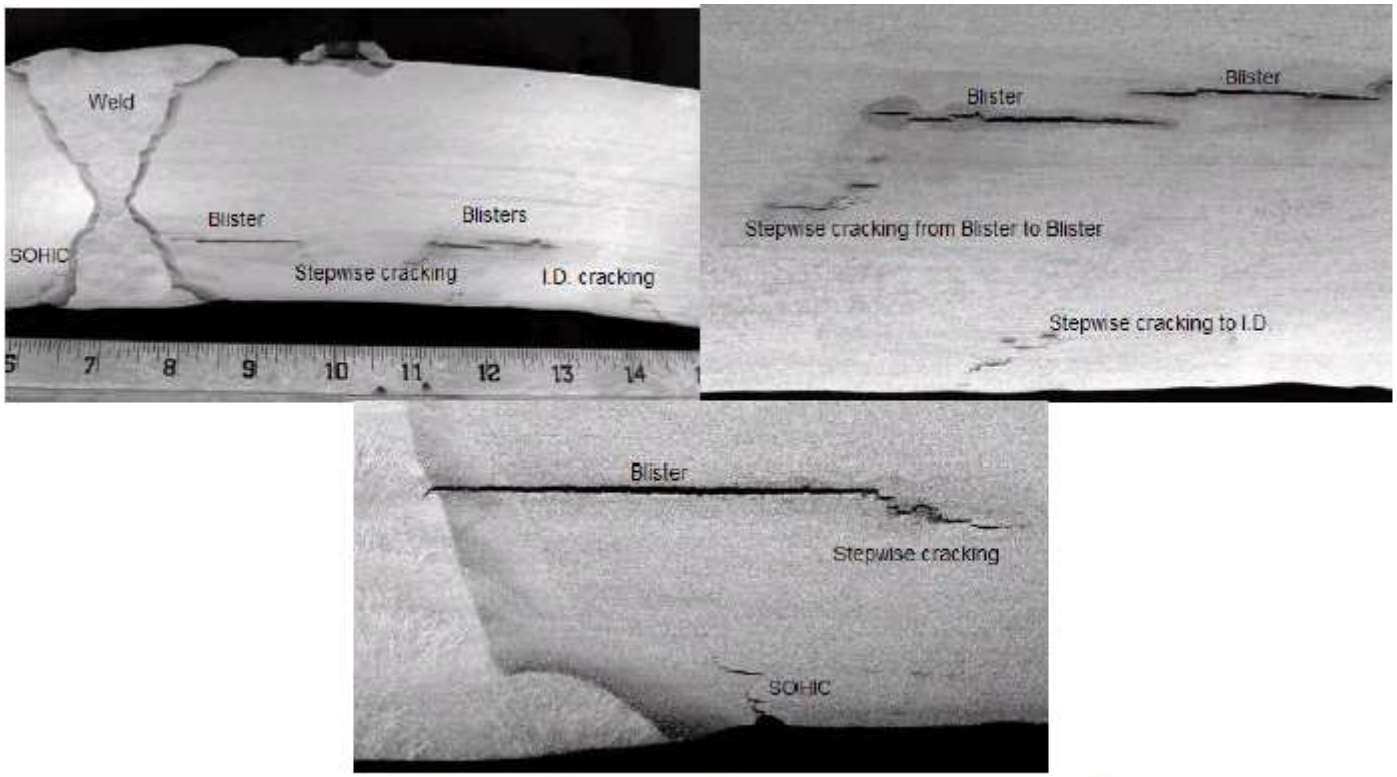
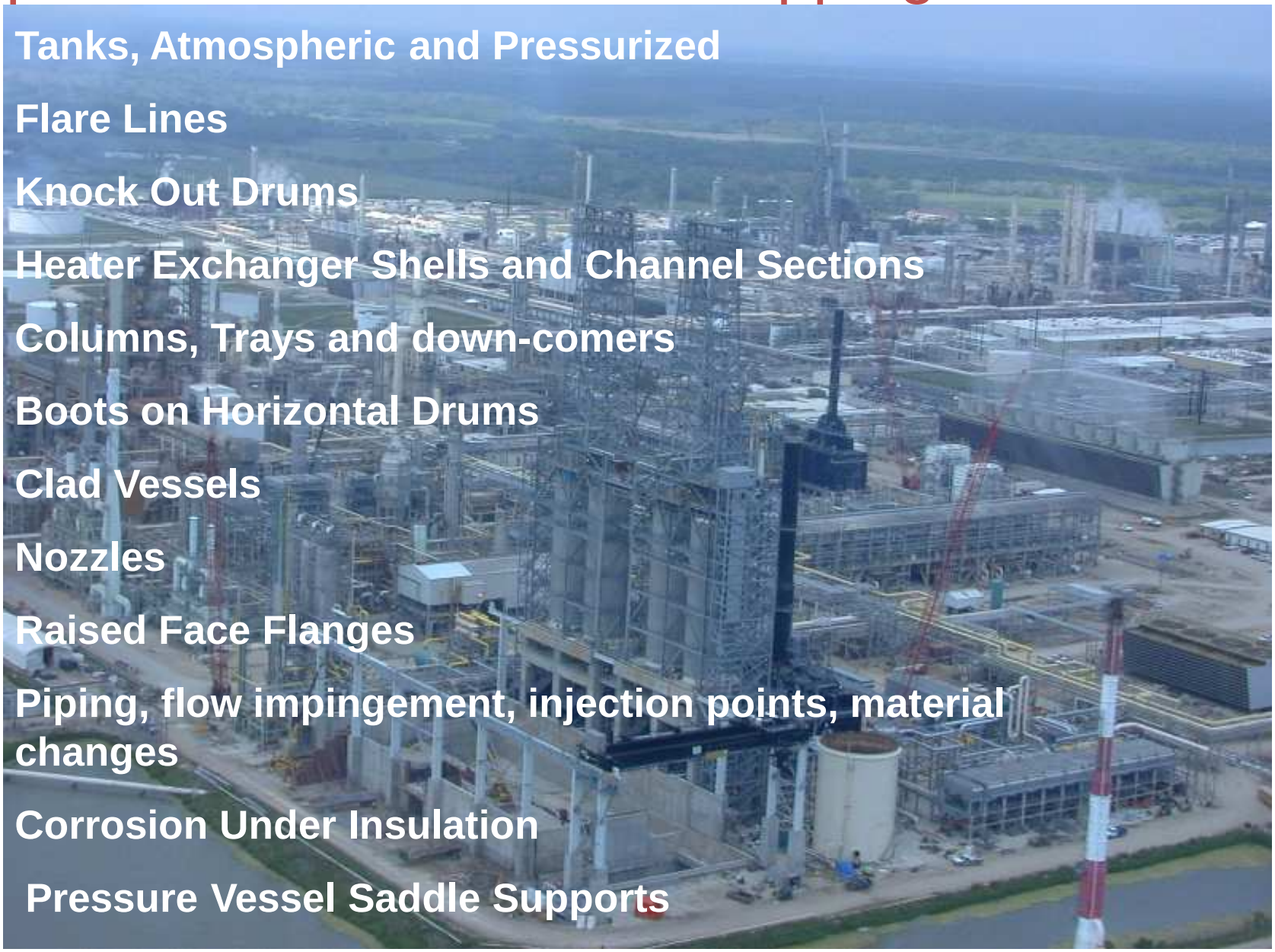


Figure 1 : Pictures of blisters and step-wise cracking due to HIC

- Laminations

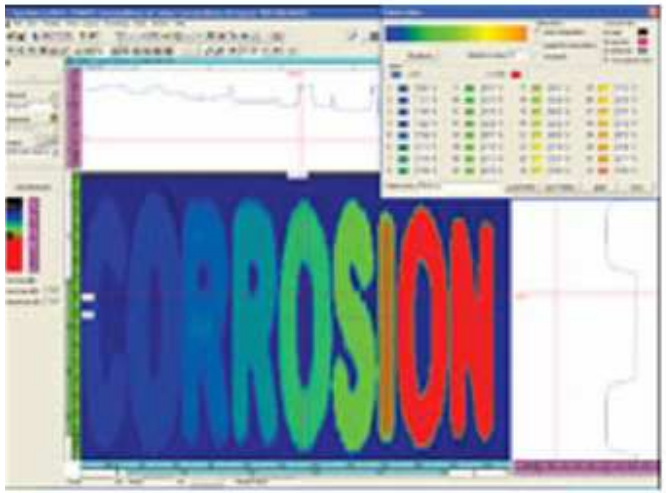
Applications for Corrosion Mapping

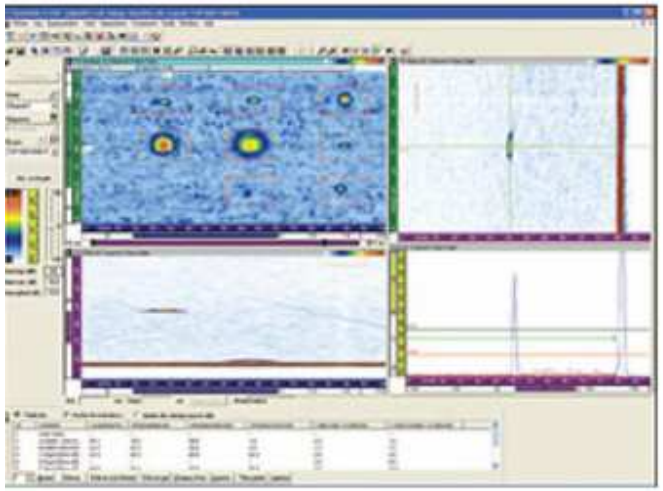


- Tanks, Atmospheric and Pressurized
- Flare Lines
- Knock Out Drums
- Heater Exchanger Shells and Channel Sections
- Columns, Trays and down-comers
- Boots on Horizontal Drums
- Clad Vessels
- Nozzles
- Raised Face Flanges
- Piping, flow impingement, injection points, material changes
- Corrosion Under Insulation
- Pressure Vessel Saddle Supports

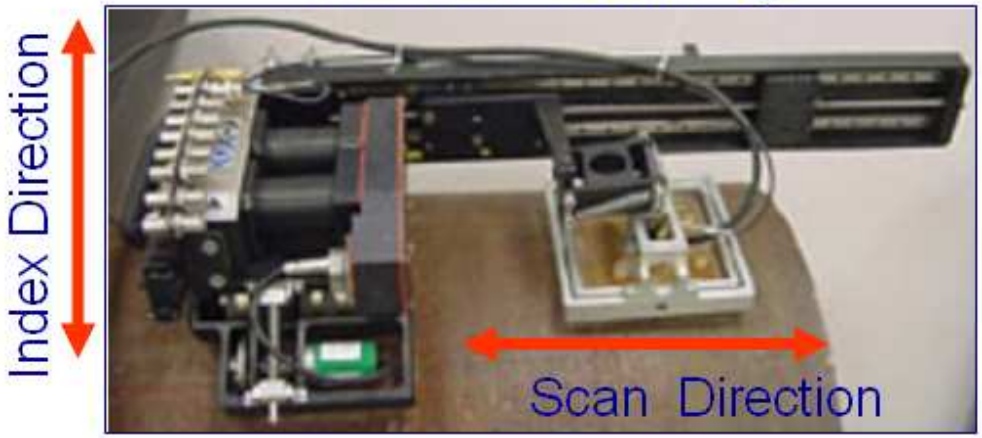
Considerations Applicable to Corrosion Mapping:

Automated UT, Corrosion Mapping

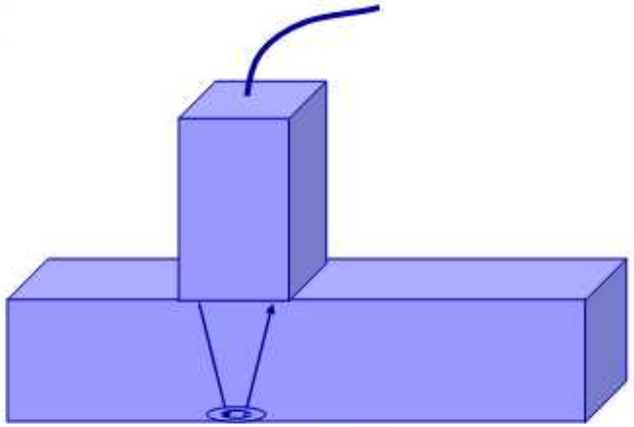




Raster Scanning



.375 Diameter



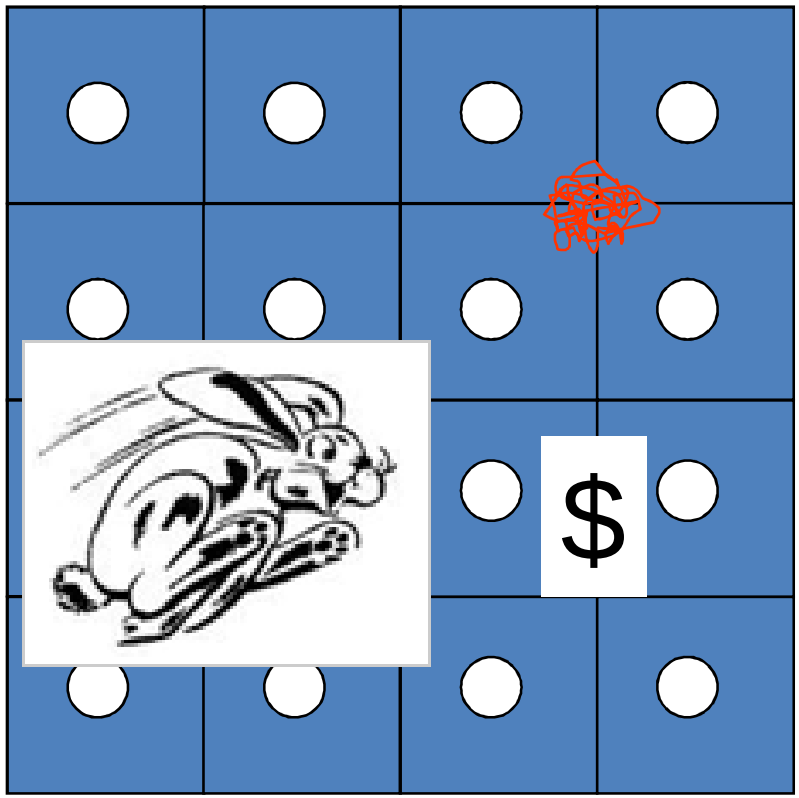
.187”

Effective Beam

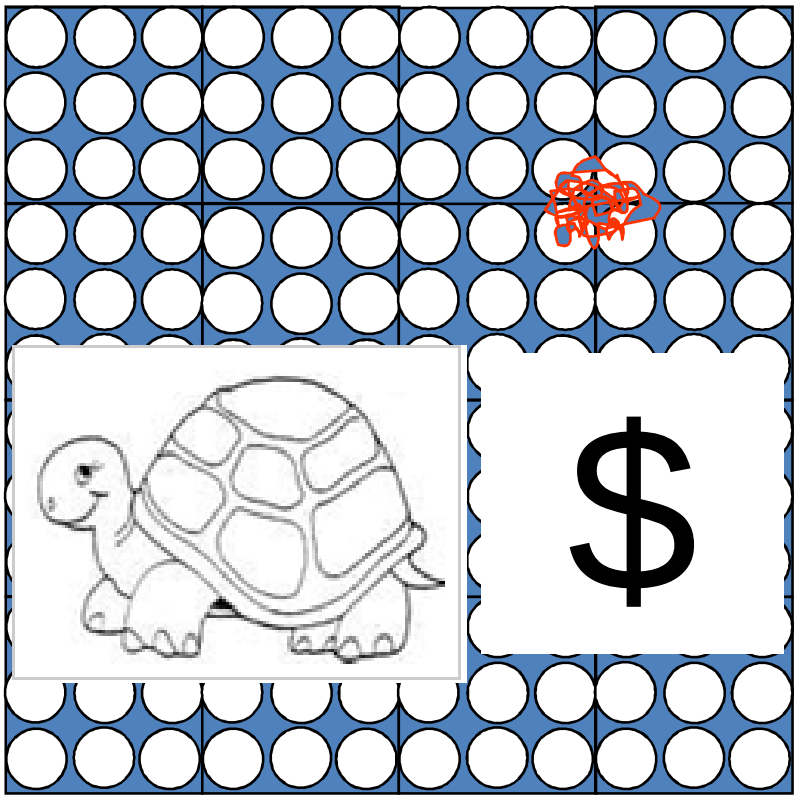
Considerations Applicable to Corrosion Mapping:

Data Point Density

Low Density

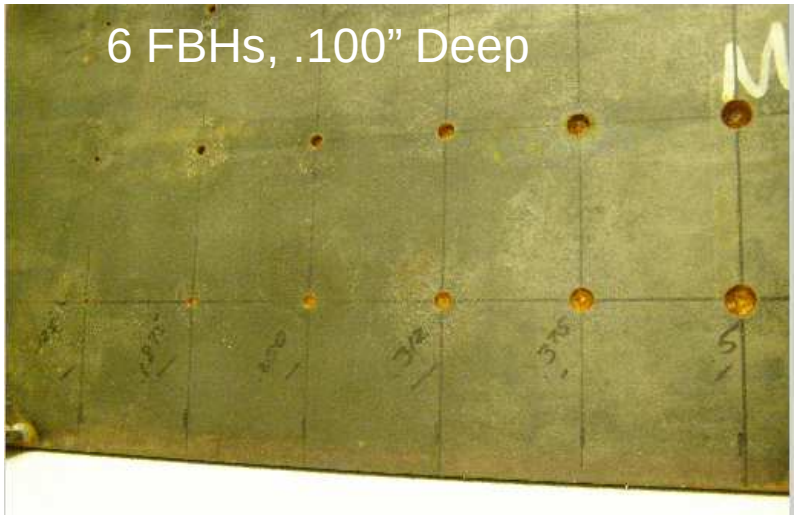


High Density

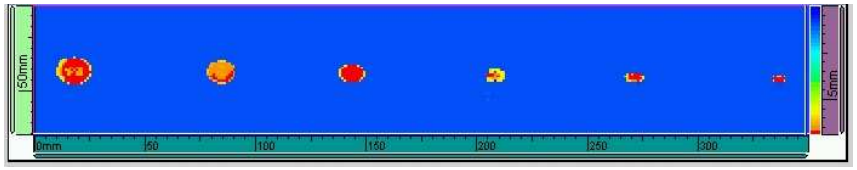


Considerations Applicable to Corrosion Mapping:

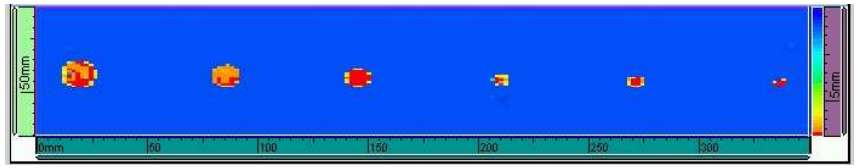
Variable Data Point Density



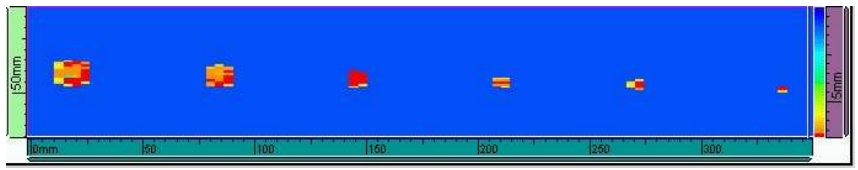
.040” x .040” / 1mm x 1mm



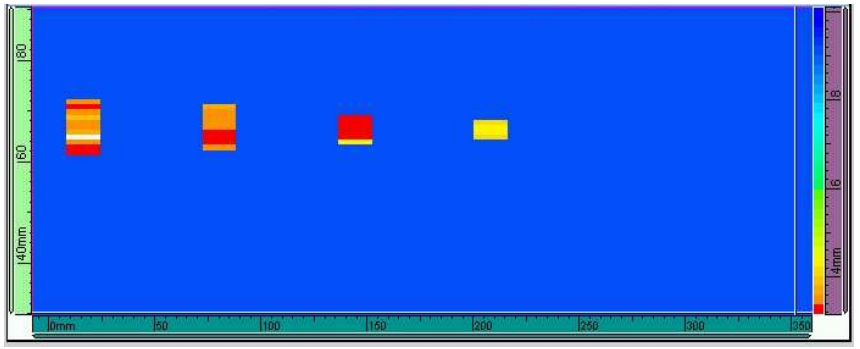
.080” x .040” / 2mm x 1mm



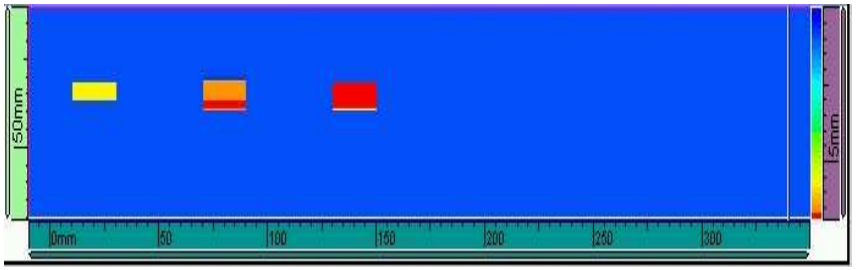
.160” x .040” / 4mm x 1mm



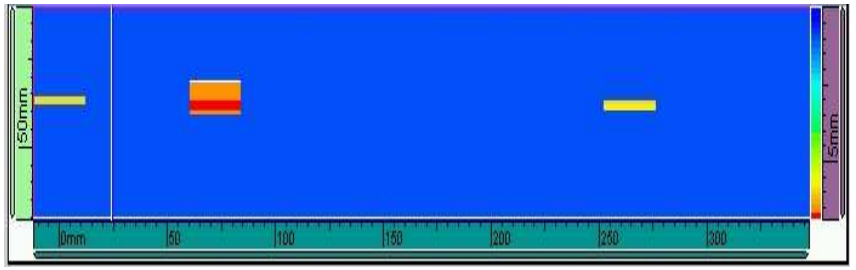
.640” x .040” / 16mm x 1mm



.800” x .040” / 20mm x 1mm



.960” x .040” / 24mm x 1mm



Considerations Applicable to Corrosion Mapping:

Critical Information

- Inspection Criteria
  - What size anomaly to be detected
  - Nominal Wall thickness
  - Data point density
- Surface Preparation
  - Painted
  - Grit Blasted
  - Rusted
- Equipment Information
  - Material of construction
  - Manufacturing process
  - Surface Temperature
- Damage Mechanisms
  - Process info = Type of Corrosion
  - Historical Information
  - Where to Inspect
- Deliverables
  - Content
  - Electronic or Hard Copy
  - How soon

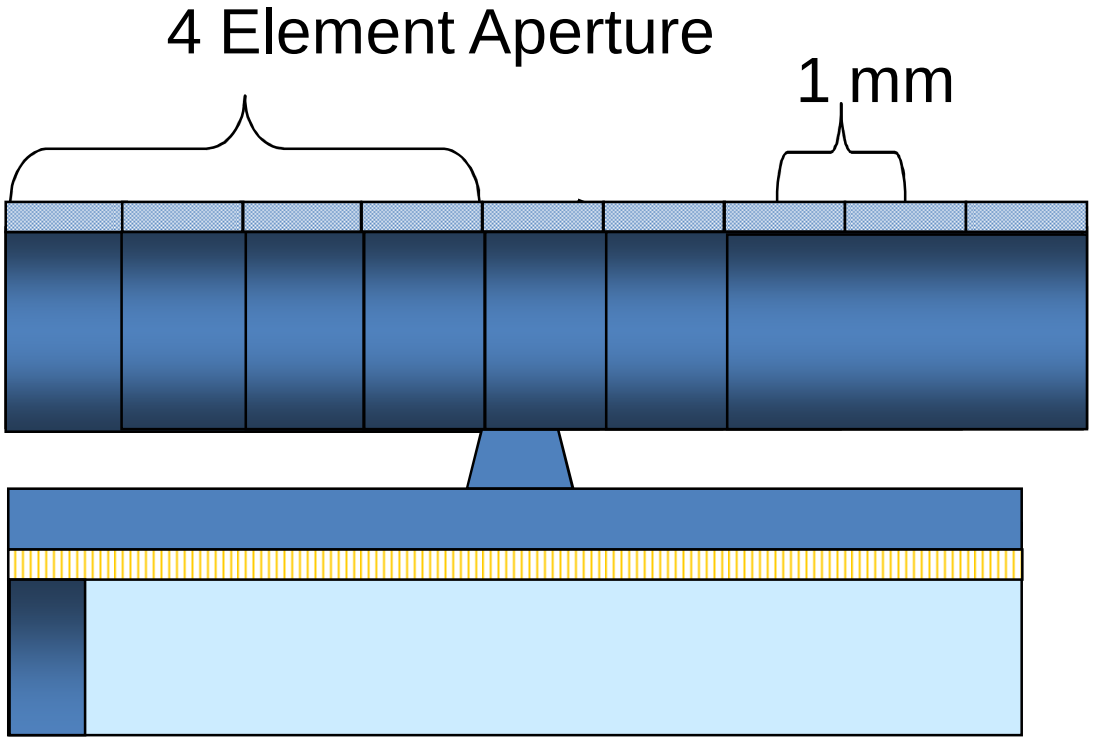
Introduction to Corrosion Mapping with Phased Array Ultrasonics:

Basic Principles:

- Phased Array Probes are composed of multiple piezoelectric elements

- Pulsing and receiving of the elements are computer controlled

- Linear Scan



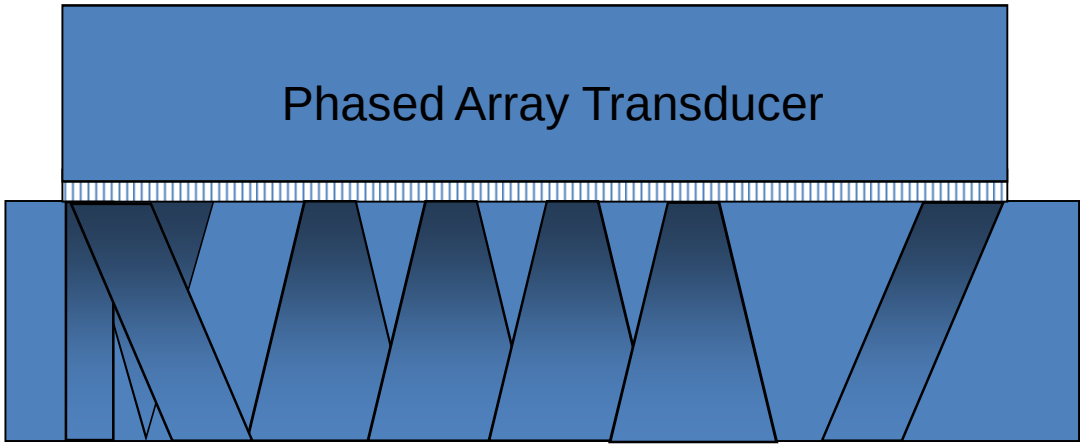
Multiple Beam Configurations

Focused

Non Focused

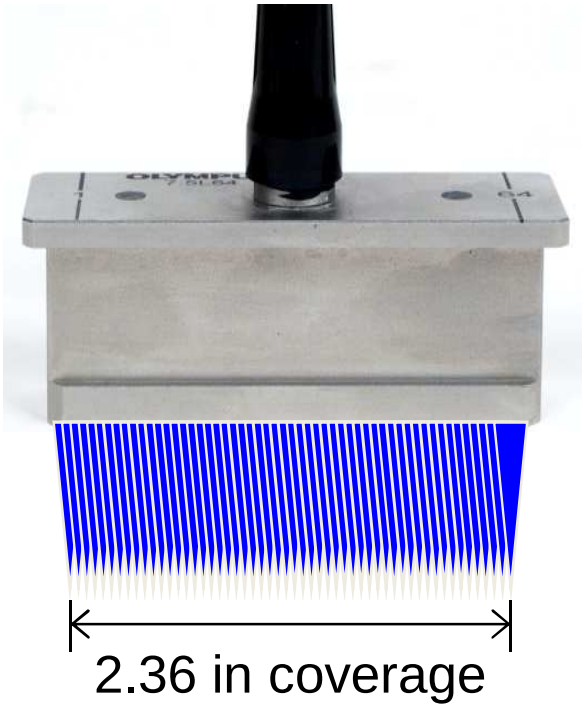
Angle Beam

Sectorial

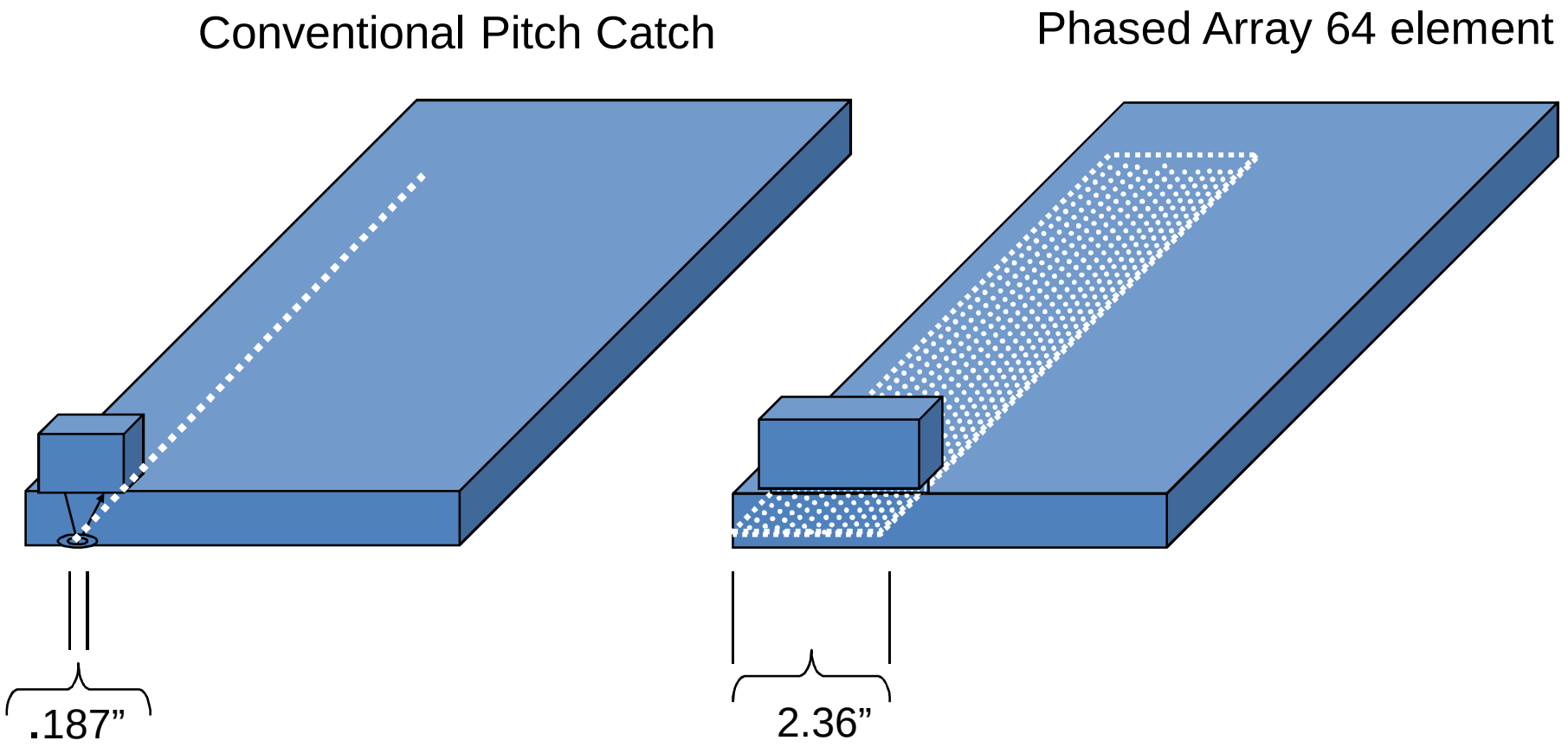


Phased Array Probe

- 7.5 MHz, 64 element
- 60 mm coverage (2.36 in)
- 1mm Pitch (.039” x .039”)
- Scan speed of 100 mm/s (4 in/s) 1mm x 1mm Data Point Density
- Near surface resolution 1.6 mm (.063in)
- Primary use linear scan at 0°



Large Effective Beam

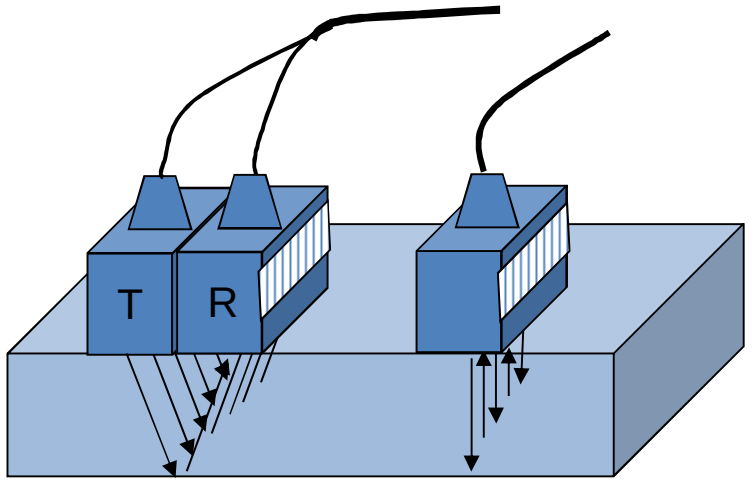


12 Times more coverage with phased array probe.

Three Techniques for PA Compression Wave

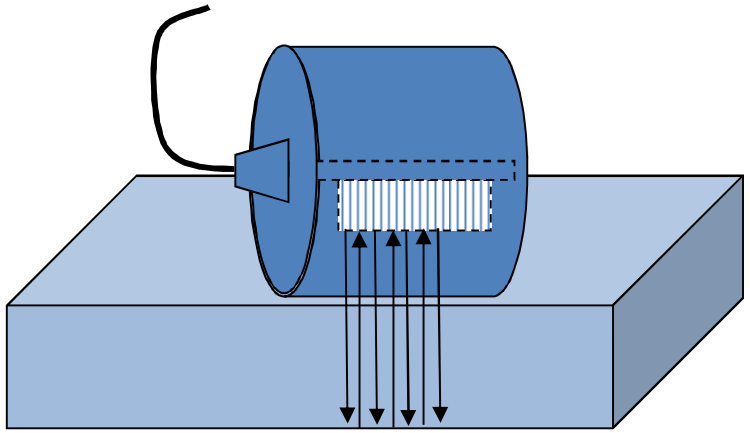
Contact:

Pitch Catch & Pulse Echo



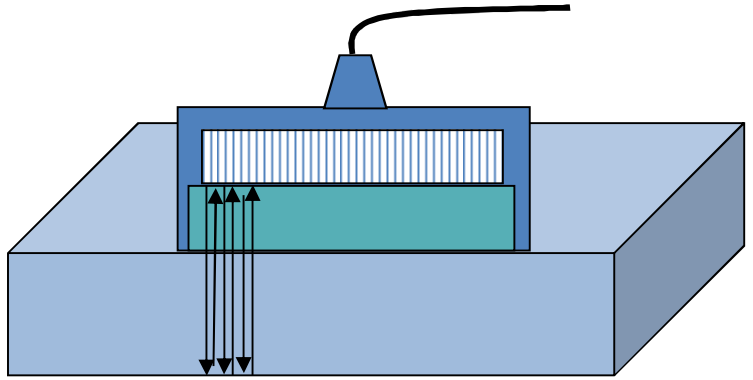
Wheel Probe:

Pulse Echo



Bubbler:

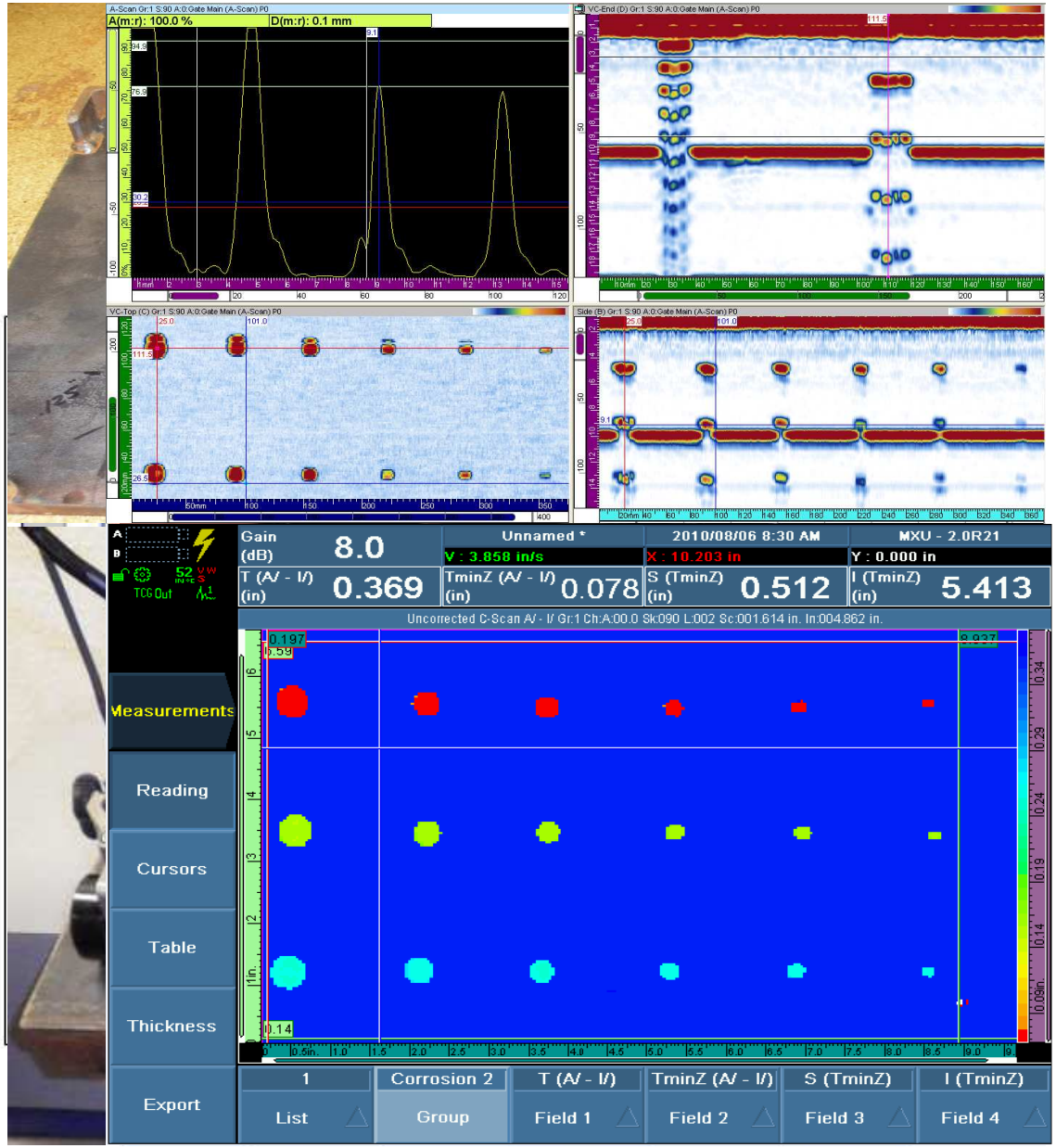
Pulse Echo



Applying Phased Array Ultrasonics for Corrosion and Mid Wall Anomaly Detection and Mapping:

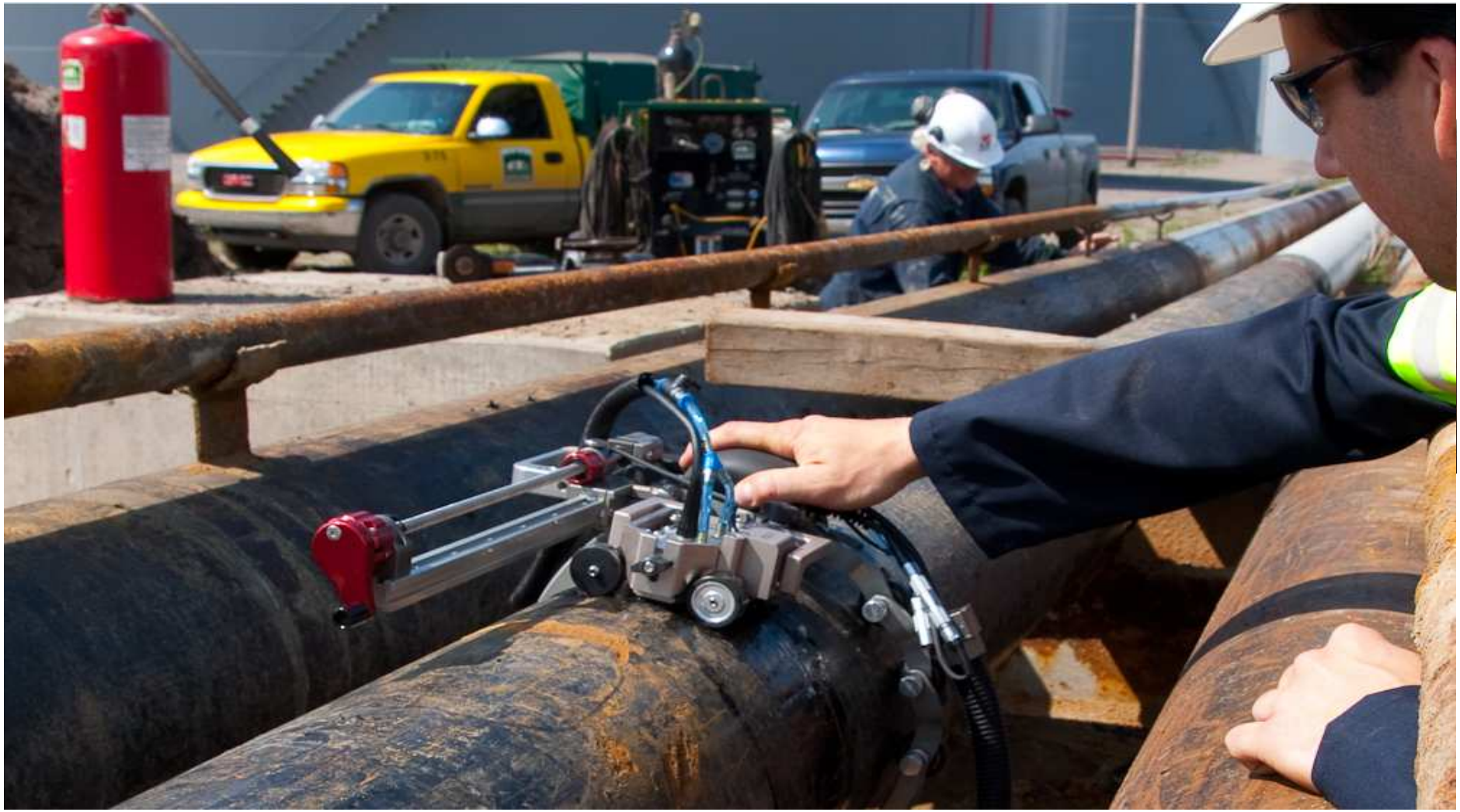
Calibration and Performance Demonstration

- Calibration
- Performance Demonstration
- Flat Bottom Holes
- Images via Excel



Applying Phased Array Ultrasonics for Corrosion and Mid Wall Anomaly Detection and Mapping:

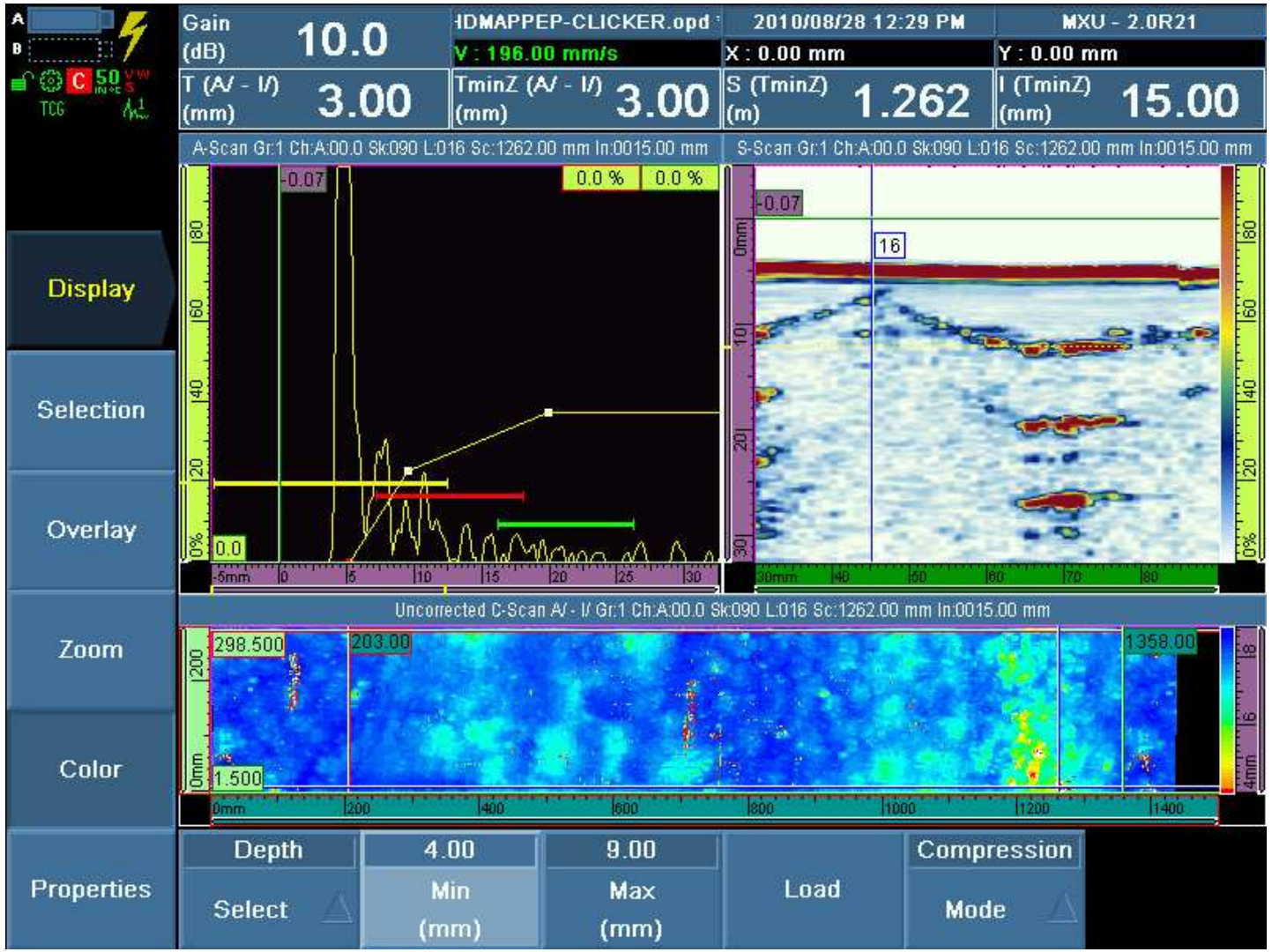
Semi Automated Phased Array for Corrosion Mapping



Applying Phased Array Ultrasonics for Corrosion and Mid Wall Anomaly Detection and Mapping:

Scan Views:

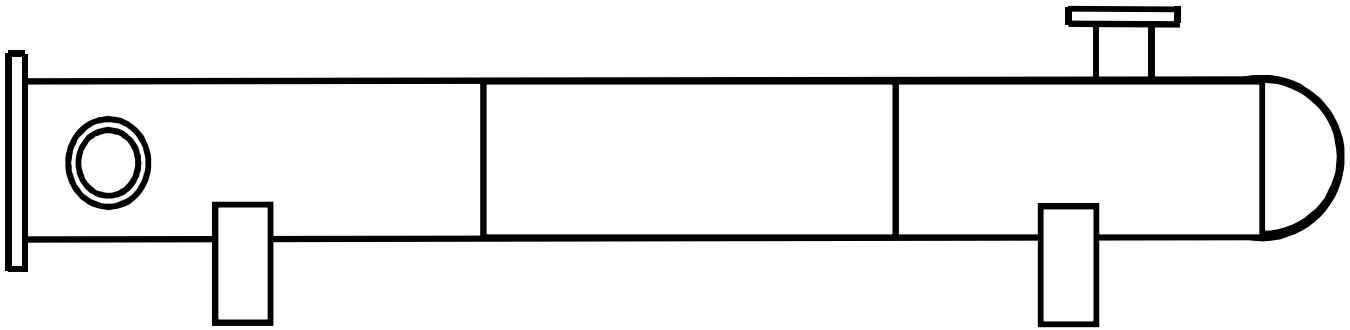
“A” “B” “C” Scans Simultaneously



Applying Phased Array Ultrasonics for Corrosion and Mid Wall Anomaly Detection and Mapping:

Scan Map

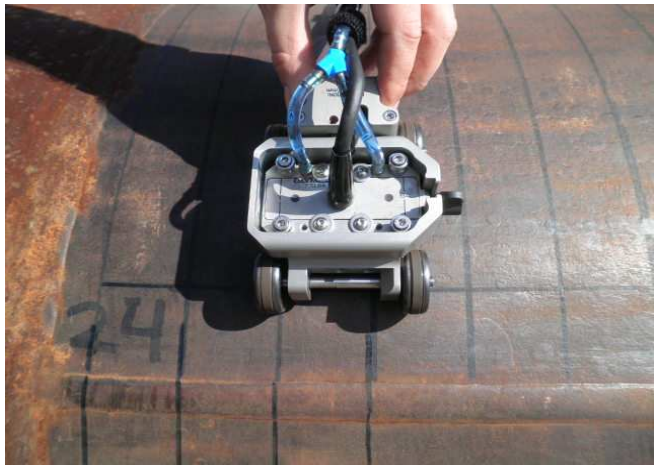
- View of areas scanned
- Precise measurements for repeat scans
- Location (s) of anomalies for monitoring
- Repair plans



Applying Phased Array Ultrasonics for Corrosion and Mid Wall Anomaly Detection and Mapping:

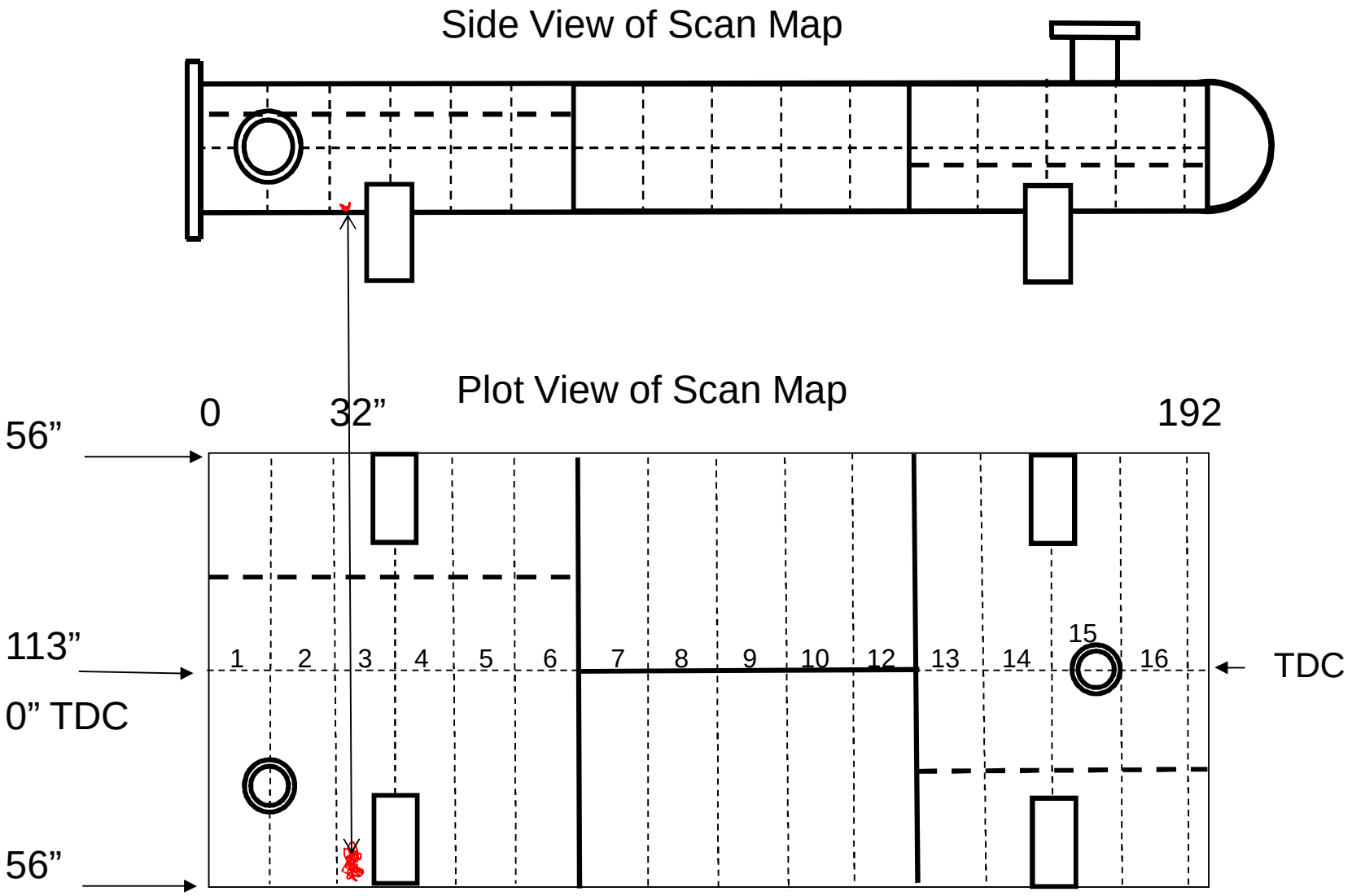
Heat Exchanger Shell Scan

Four square feet of surface area inspected in 2.5 minutes with .080” (2mm) x .040” (1mm) data point density.



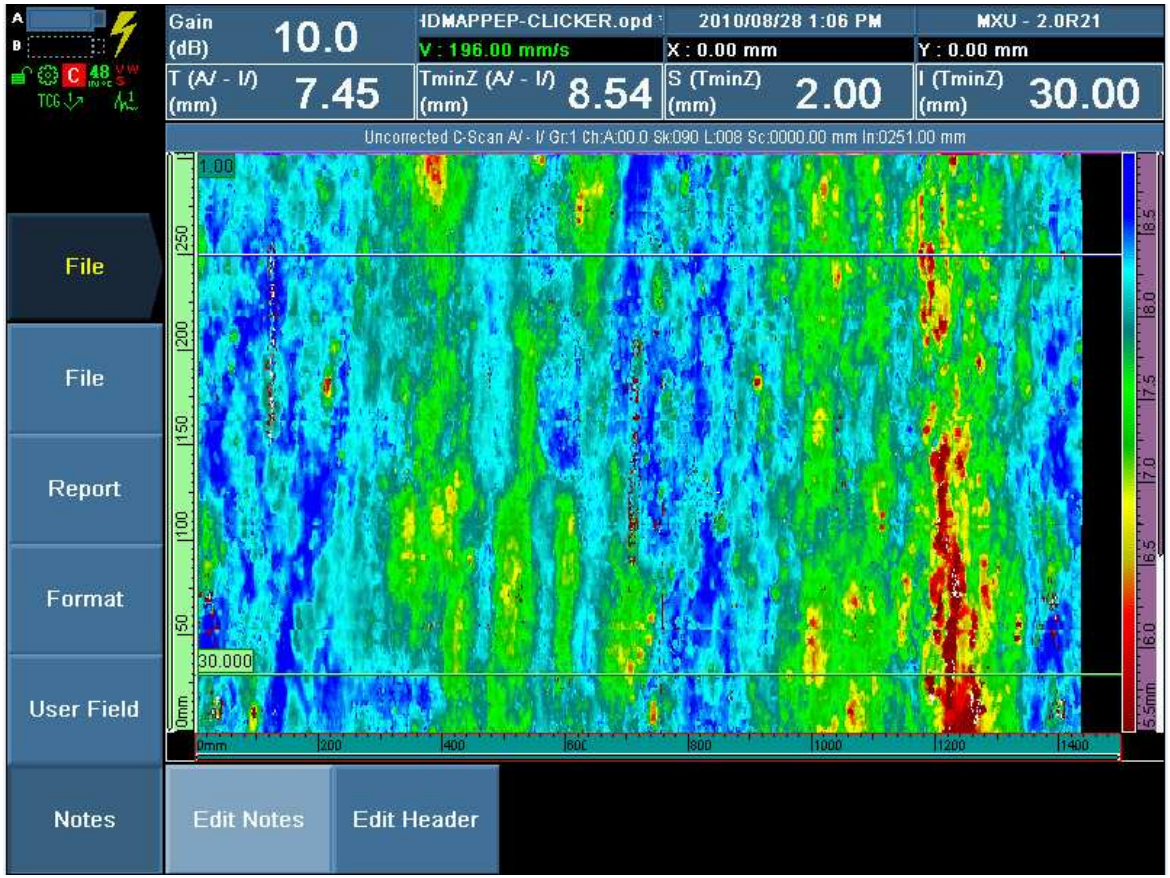
Applying Phased Array Ultrasonics for Corrosion and Mid Wall Anomaly Detection and Mapping:

Scan Map



Applying Phased Array Ultrasonics for Corrosion and Mid Wall Anomaly Detection and Mapping:

Example “C” Scan Image



Wall Loss below T Min in scan 3 at BDC.

Scan Position is 32”L X 55”C Reference from TDC & Flange to Shell Weld.

Conclusion

Positive Attributes of Phased Array Ultrasonics used for Corrosion Mapping: "TOP 3"

- ***Safety***

  Thorough and accurate assessment of remaining wall thickness compliments certainty of equipment integrity.

  Personnel Injuries Ignition Sources

  Impact Damage from Scanners Falling

- ***Corrosion Rate***

  High Data Point Density improves probability of detecting wall loss therefore enhances accuracy of engineering calculations.

  Wide effective beam optimizes repeatability of subsequent scans and comparison of wall loss shape and size.

- ***Detection and Characterization***

  Differentiate between mid wall anomalies and ID connected wall loss.

Questions and Discussion

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