




EvisiveScan™

Microwave Scanning NDT

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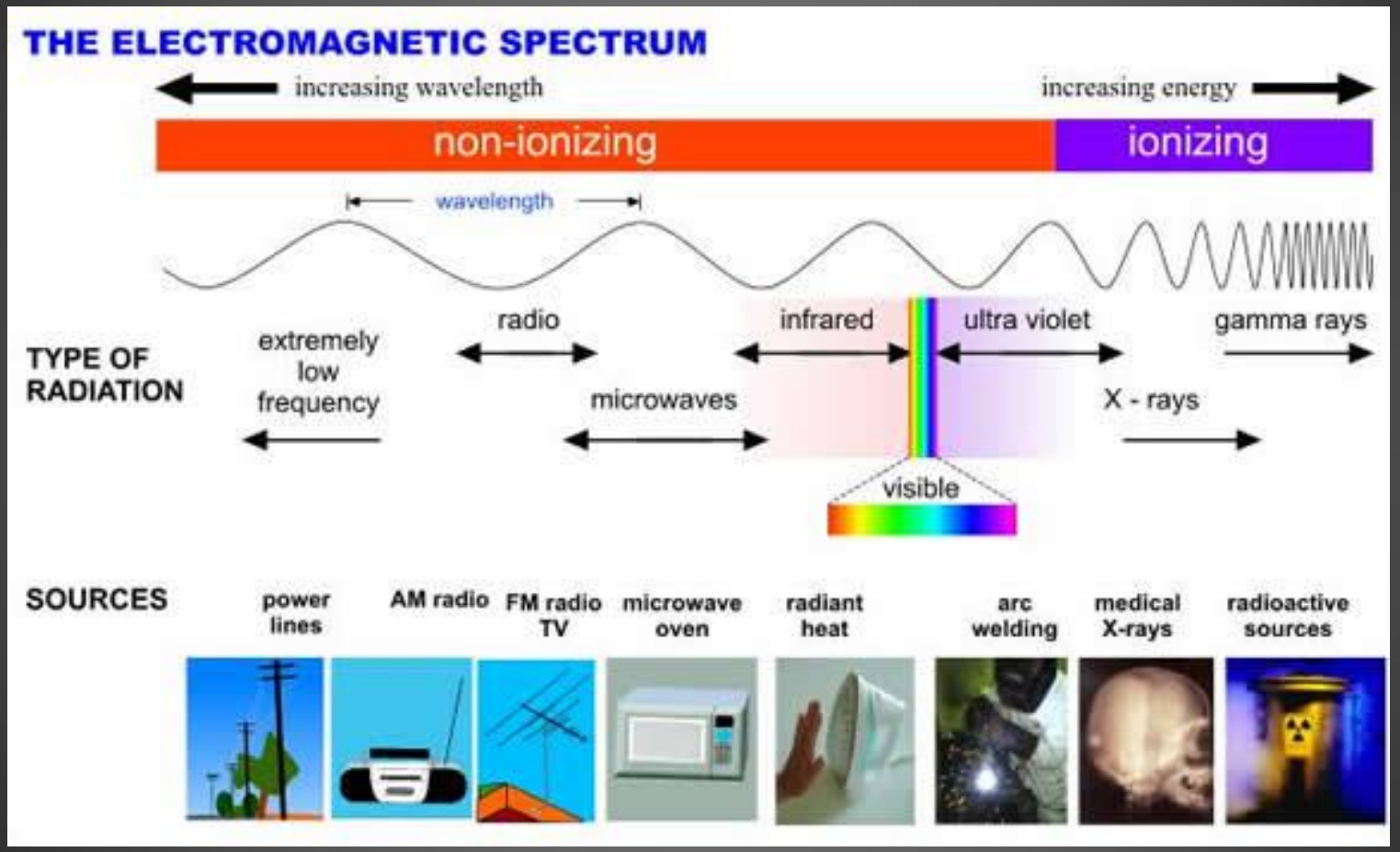
Evisive General Manager
Level III MW NDT

Microwave Definition

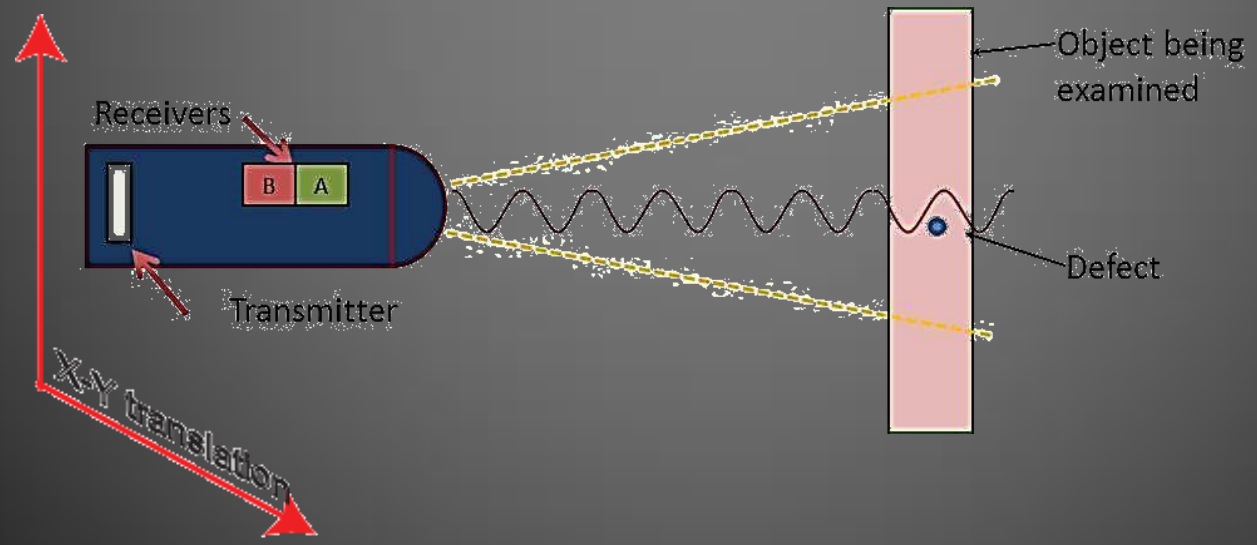


Frequencies: 1.6-30 GHz

Wavelengths: 187 - 10 mm

Microwave inspection Principles of Operation

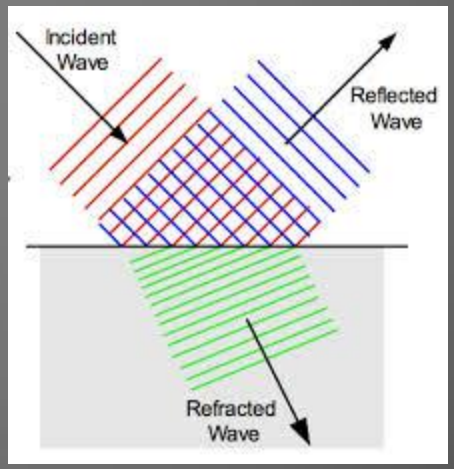
- Material under inspection is bathed in MW energy of an essentially constant frequency creating a series of standing waves in the object



Principles of Operation

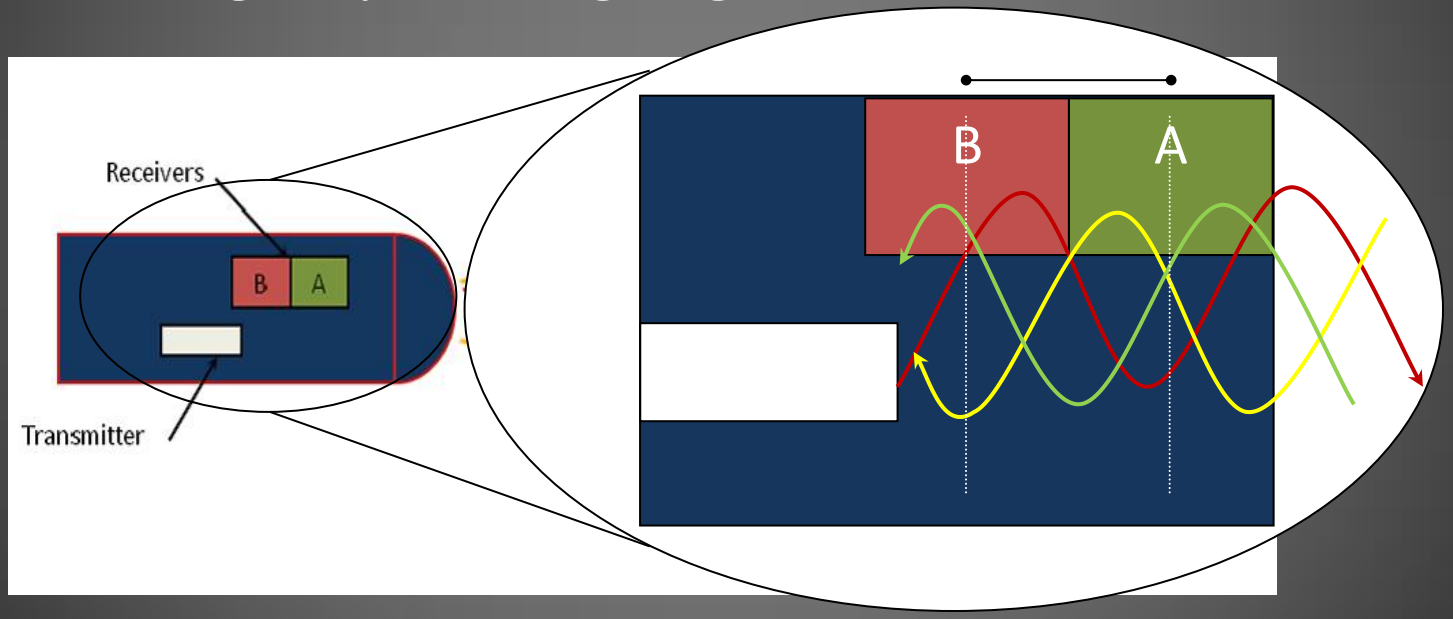
Energy is reflected from each interface of differing relative permitivity within specimen

The boundary in this case is any change in relative permitivity (Commonly known as Dielctric Constant) o f the material.



Measurement Technique

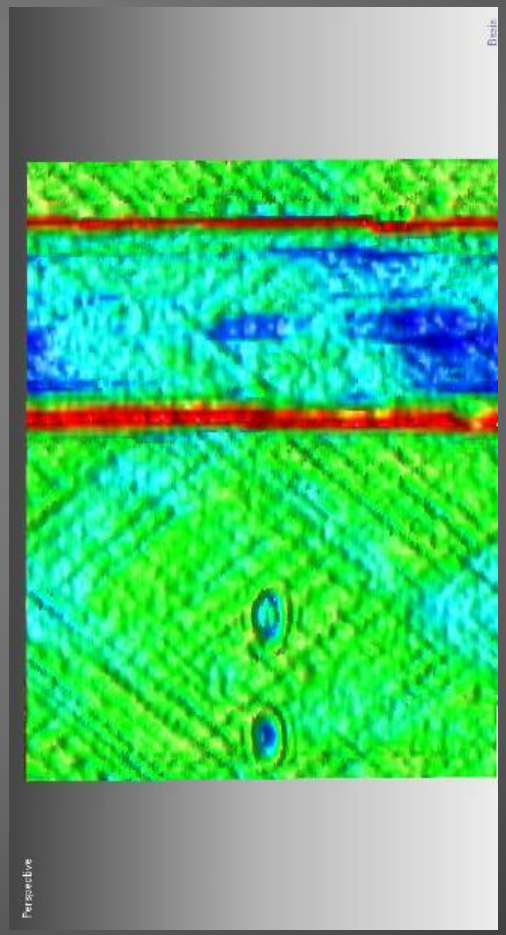
The reflected energy is measured and creates a resulting output voltage signal



Data Collection

The resulting voltage is sampled at discreet locations across sample to create an image

Image Creation



MW Inspection Overview

- Multiple generations of equipment in the field
- Mechanical inspection devices for:
  - HDPE butt fusion and electrofusion joints
  - HDPE, FRP pipes and vessels (up to 12 feet in diameter)
  - Rubber expansion joints
  - Fully battery operated and bluetooth data transfer inspection equipment
- Microwave Inspection accepted as a new technique in ASNT
- ASTM Standards under development
- Microwave represented in ASME BPVC working groups on HDPE

Detectable Defect Types

- Disbonds & Lack of Fusion in HDPE Butt Fusion and Electrofusion Thermal Welds
- Foreign Material Inclusions
- Voids
- Moisture or other liquid contamination
- Mechanical damage
- Physical changes due to chemical attack

Current Uses

- Fiberglass Tanks and Pipes
  - Dow
  - Bayer
  - Borouge
  - Shell
- Fiberglass Armor
  - US Army (SBIR)
  - Kazak
- Reinforced Rubber Expansion Joints
  - Exelon
  - PSEG
  - FENOC
  - Wolf Creek
- Ceramic Materials
  - US Air Force (SBIR)
- HDPE Butt Fusion Joints
  - Axiall

Work In Progress

- Enhanced imaging techniques using Narrow Band Synthetic Aperture Focusing Techniques (SAFT)
  - Allow specific depth location

  Transition to Wide Band SAFT
  - Provide for 3D imaging (holographic) techniques

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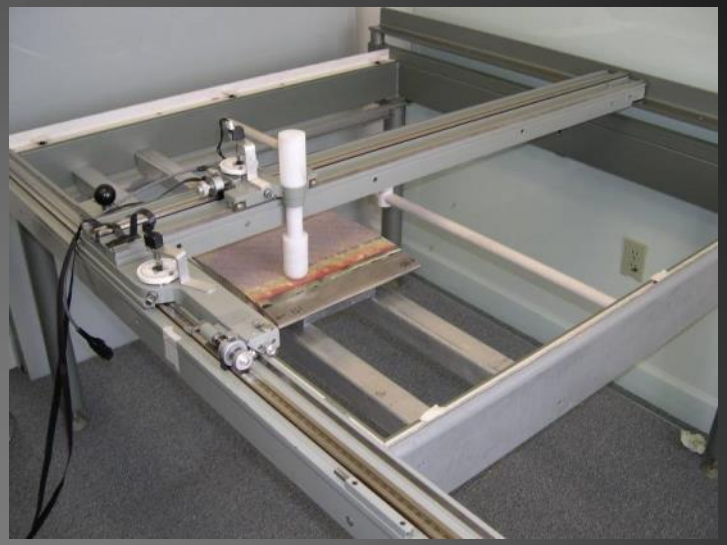
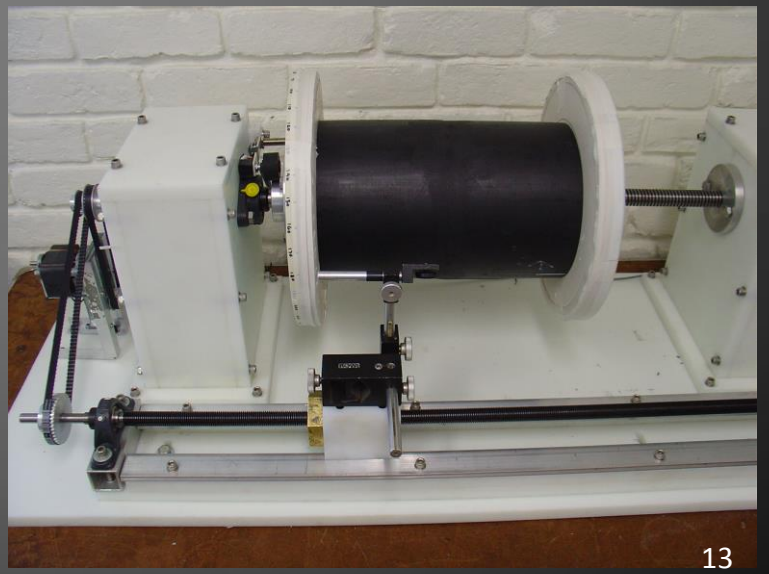
FIRST GENERATION LAB EQUIPMENT

Laboratory Scan Table

Basic Equipment Setup



Laboratory Scan Lathe



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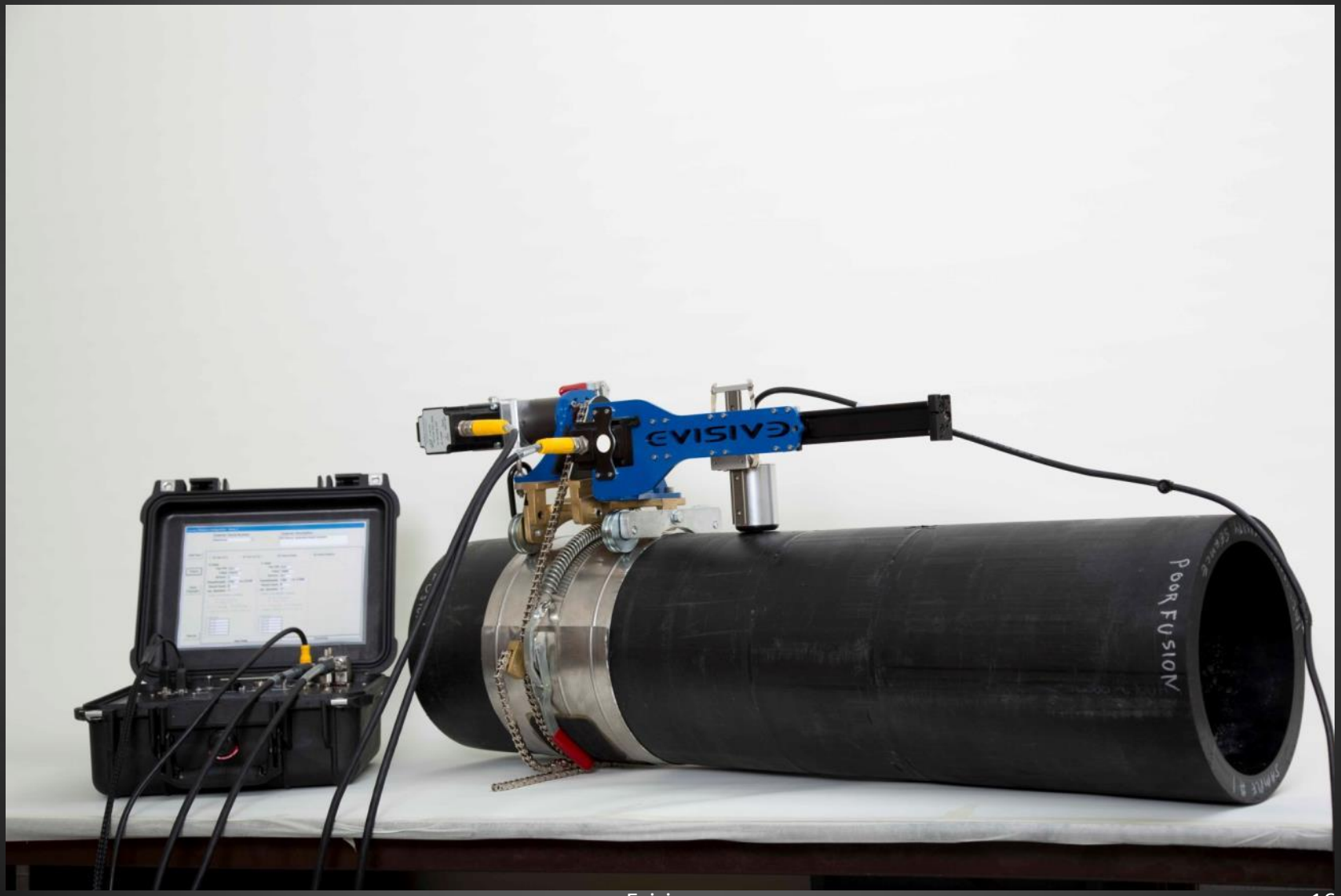
NEW GENERATION FIELD EQUIPMENT

Blue Tooth Hand Held

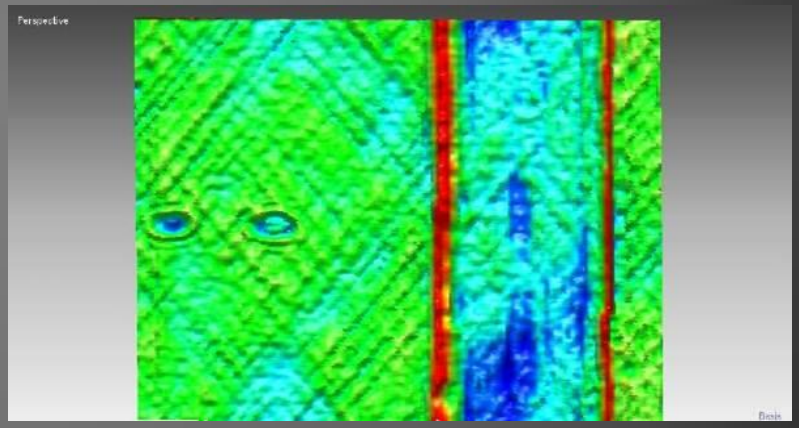
Pipe Scanner



Pipe with manufactured defects

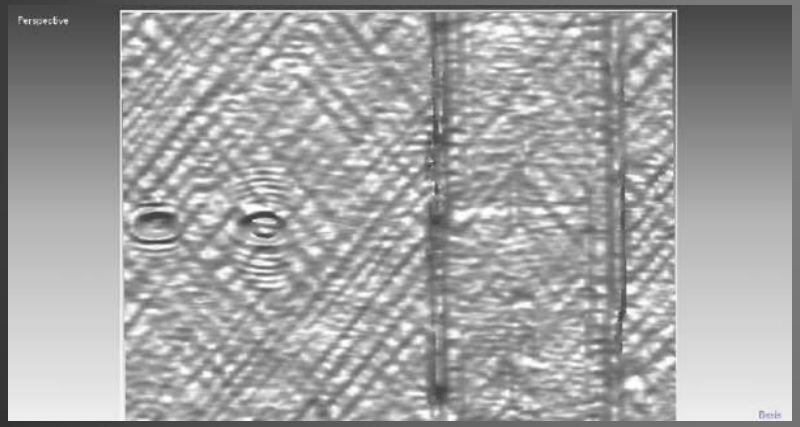
Pipe with erosion defects and insufficient glue

Inspection image of pipe

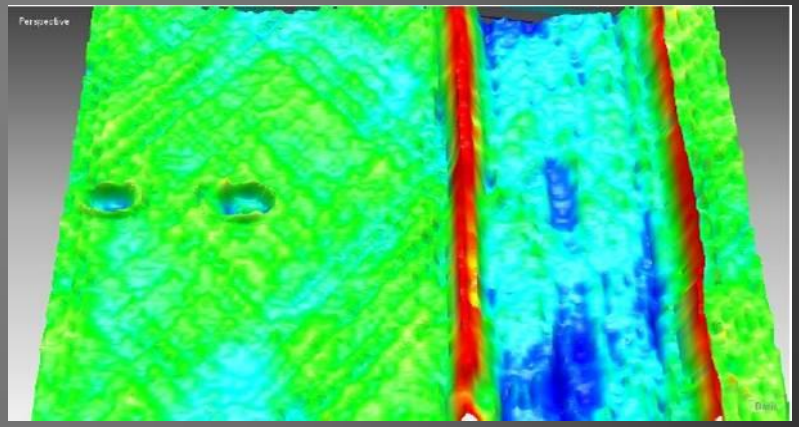


Pipe with manufactured defects

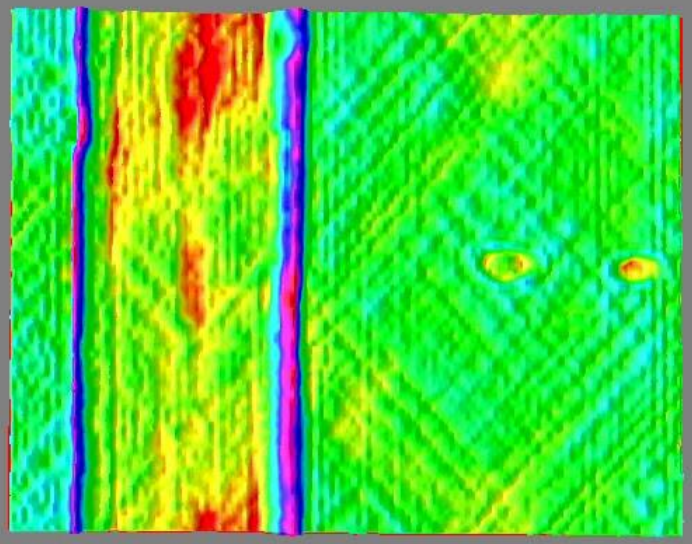
Gray scale image showing interference pattern at erosion hole



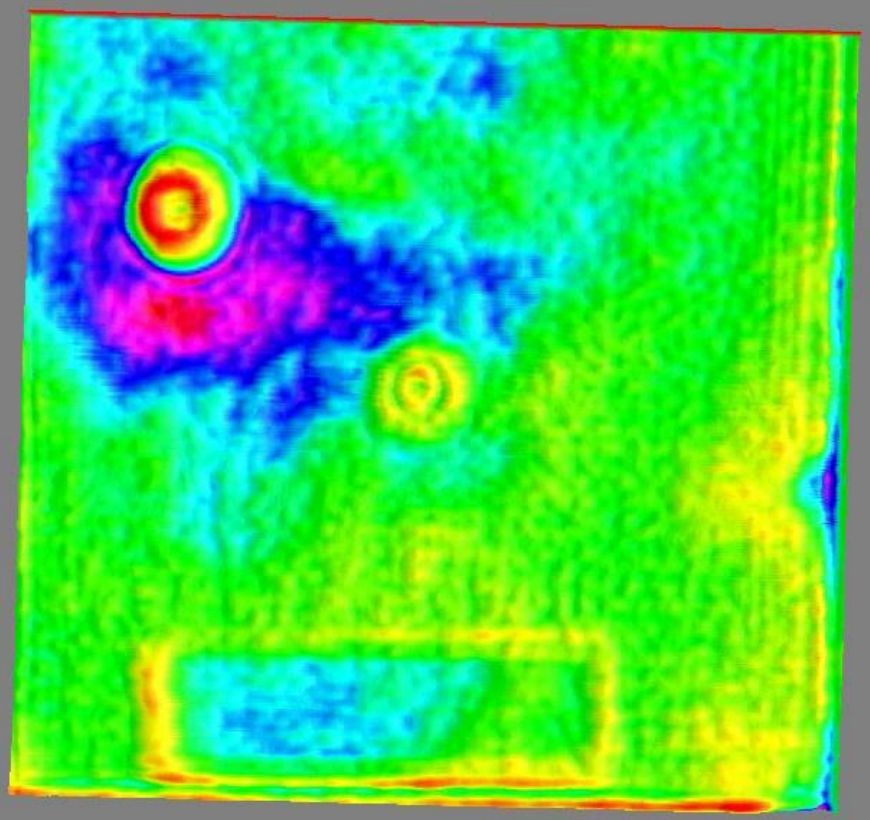
3D rendering of pipe



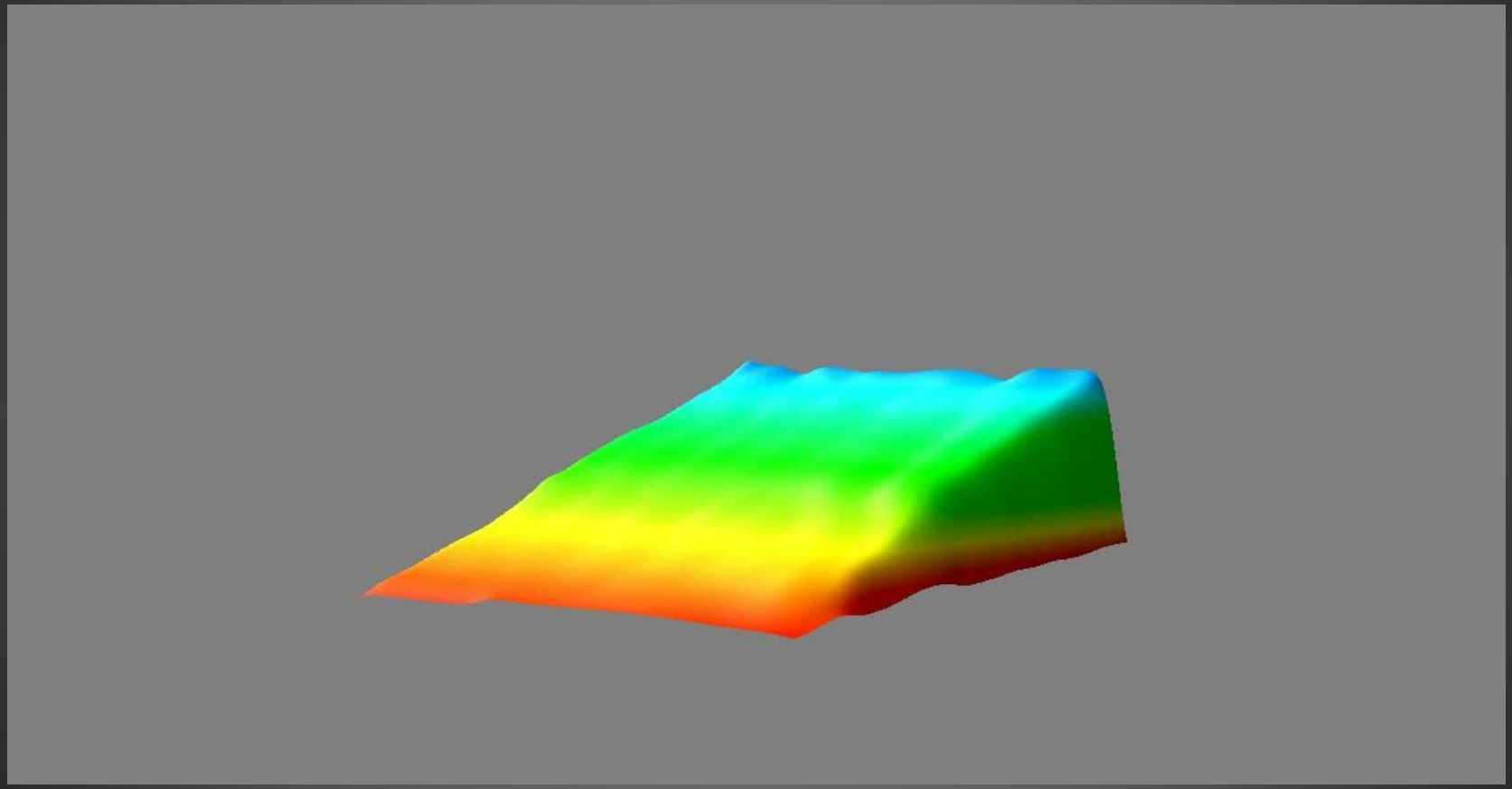
3D Rotated view of part



Fiberglass Panel



Thickness determination



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MICROWAVE SCANNING NDT

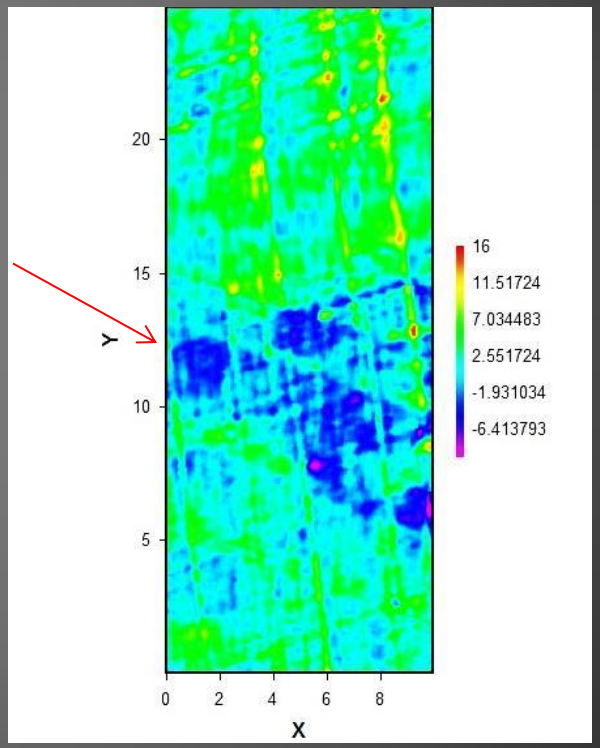
MICROWAVE INSPECTION OF GFR

Overloaded section of fiberglass boom

Boom section

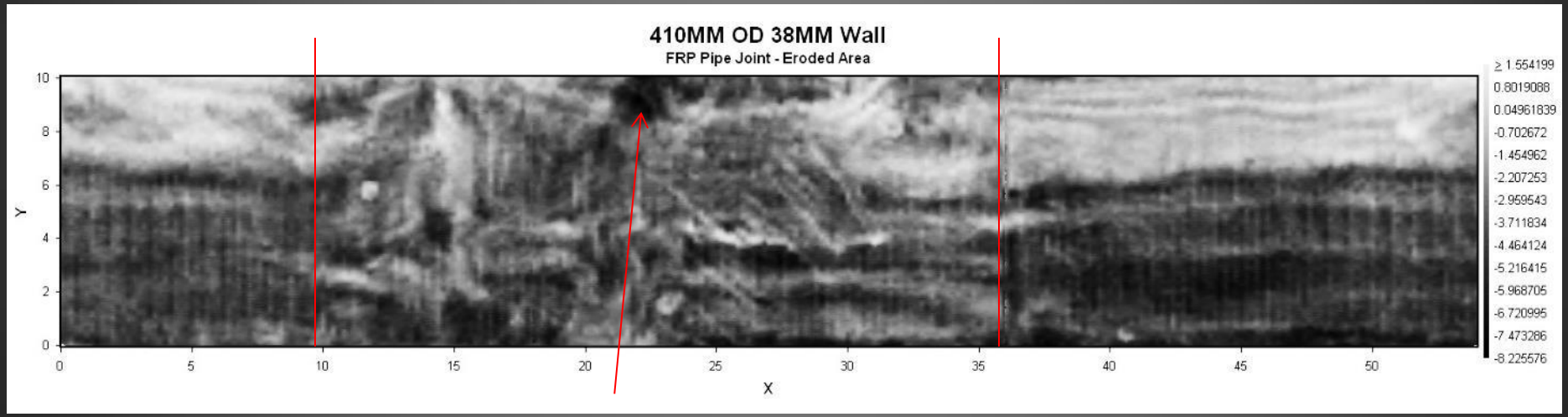
Delamination

Inspection image



Internal erosion of pipe

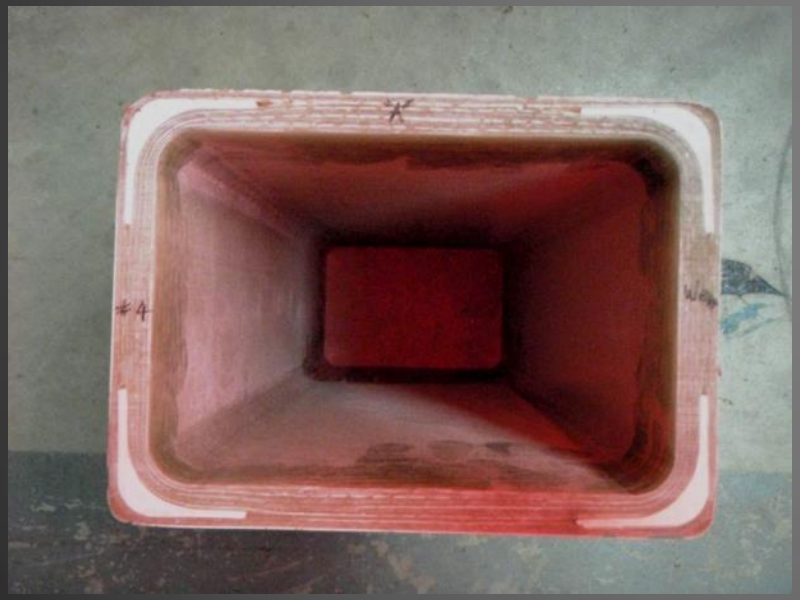
Displaced structure caused by
washout of resin matrix



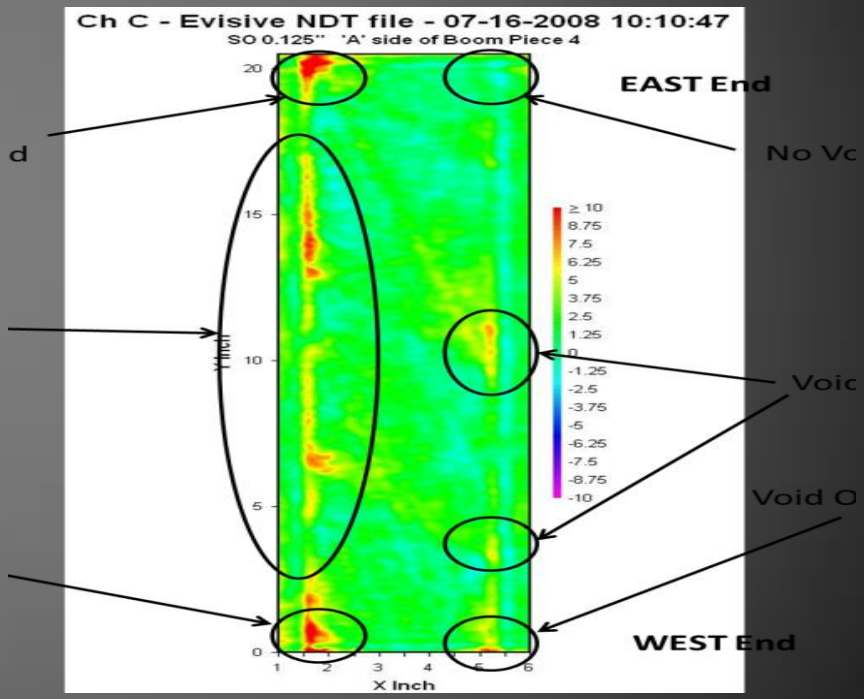
Localized Pit

Voiding at manufacture

Boom with voiding



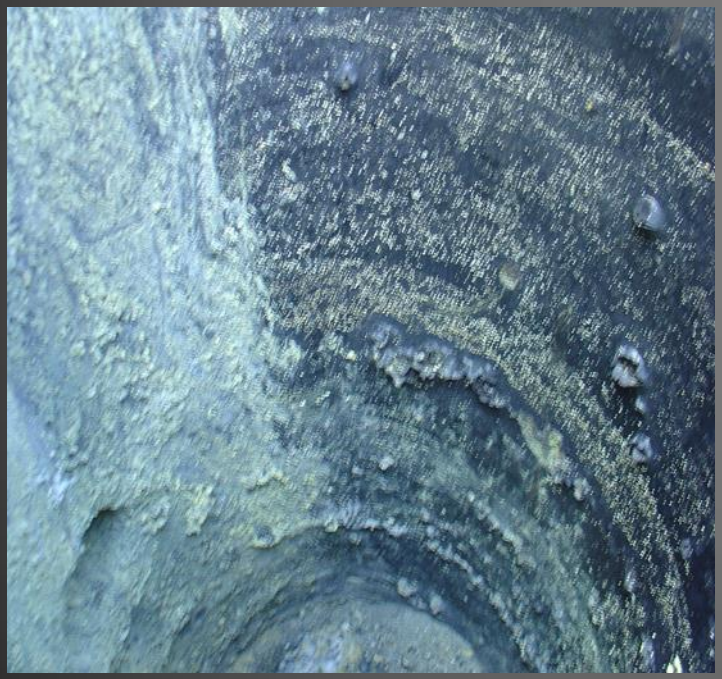
Inspection image of boom



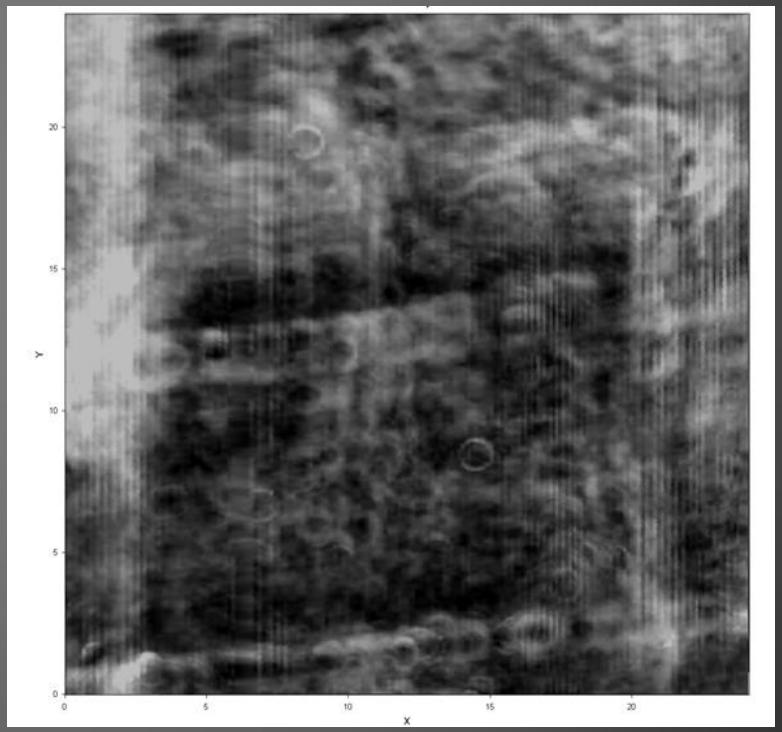
Voiding identified in inspection image

Internal pipe hydrolysis

Picture of pipe ID



Inspection image of pipe ID

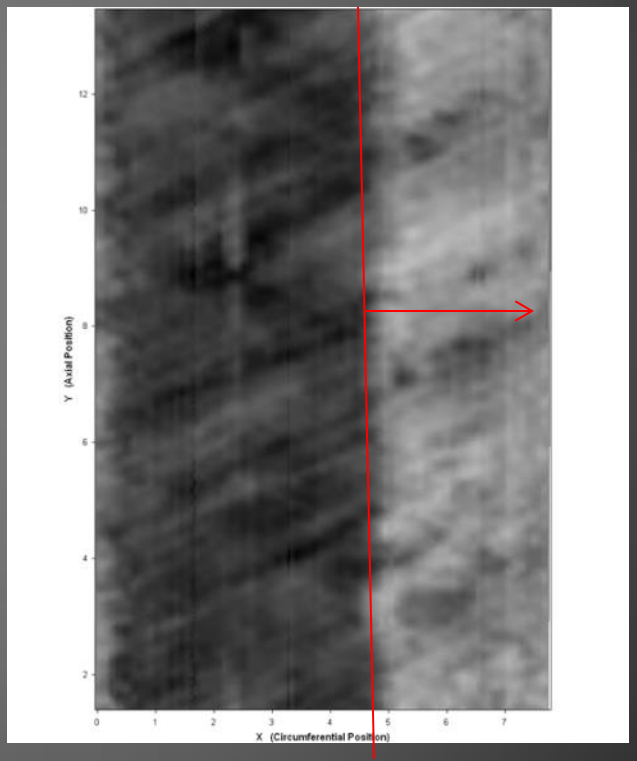


Internal blistering identified in image

Environmental degradation of furan pipe

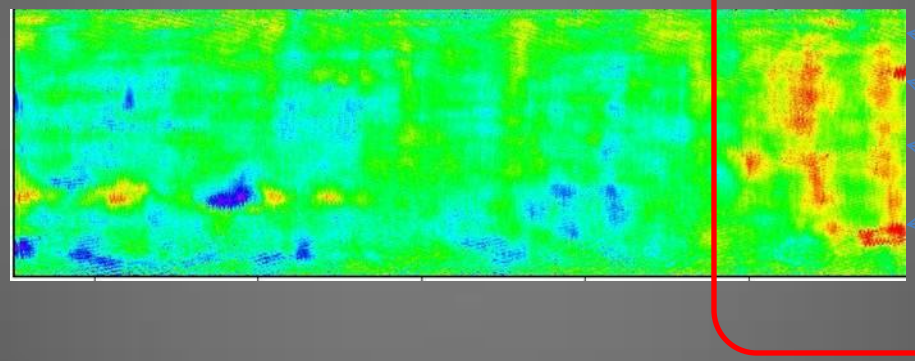
Photo showing chemical attack

Inspection image of chemical attack



Degraded resin to right of line

Resin poor areas of pultruded panel



Tensile test results (Pounds load to failure)

A	1816
B	1217
C	1597
D	1114

Panel with various types of fod

Image focus changes based on relative position of the end of the antenna with respect to the material surface

Metal, paper, cloth FOD

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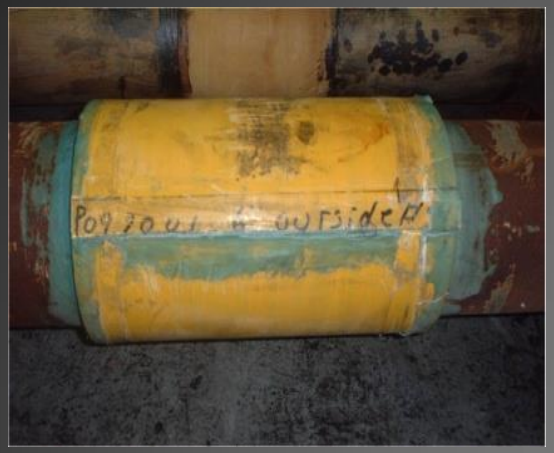
INSPECTION OF STEEL PIPE CORROSION BENEATH FIBERGLASS OVERWRAP

Corrosion Beneath Fiberglass Overwrap

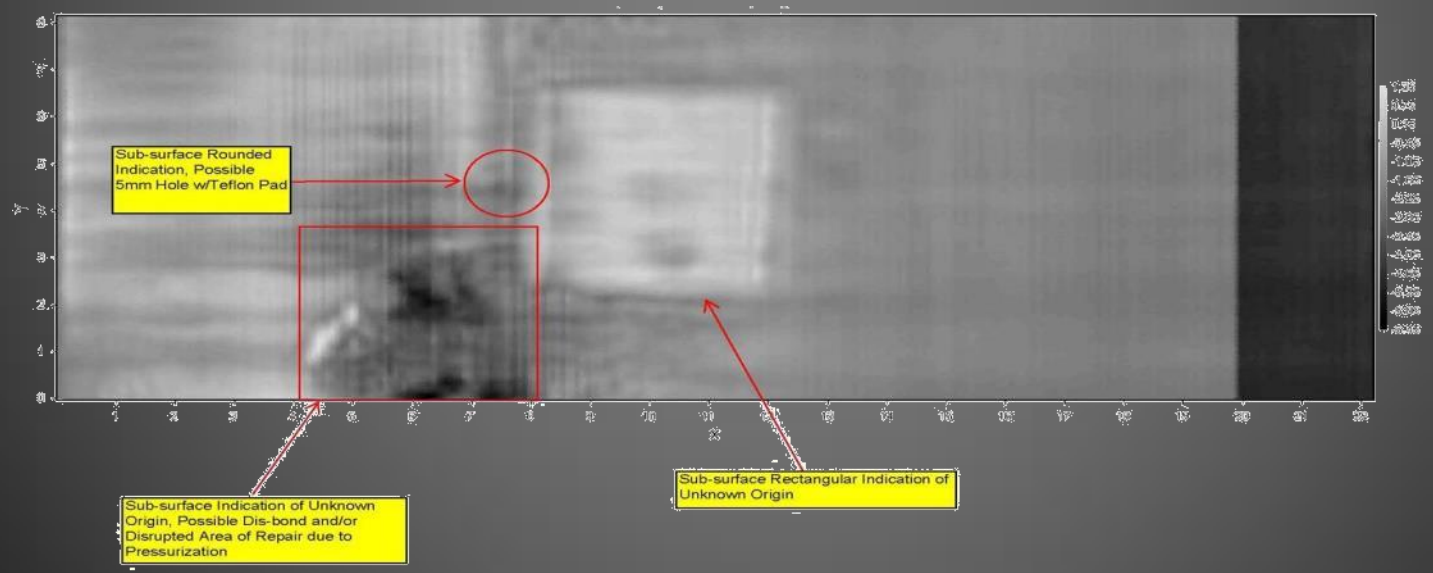
- In service inspection of steel pipe corrosion under insulation or overwraps.
- Condition monitoring of pipe over time

Pipe Wrap with Artificial Defects



The wrap is hard fiber reinforced layer with mastic matrix and interlayer fill.

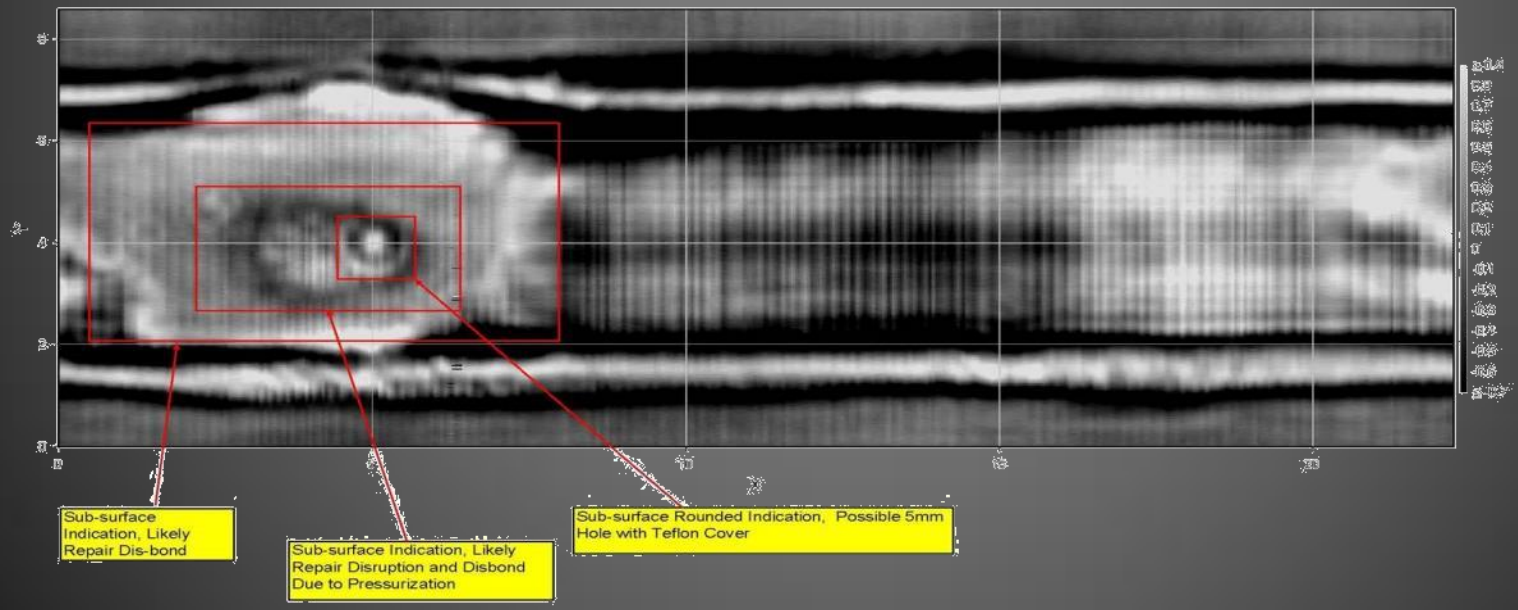
Scan image shows features in pipe surface, at pipe to wrap interface and in pipe wrap. Indications inclued artificial and unintended features.



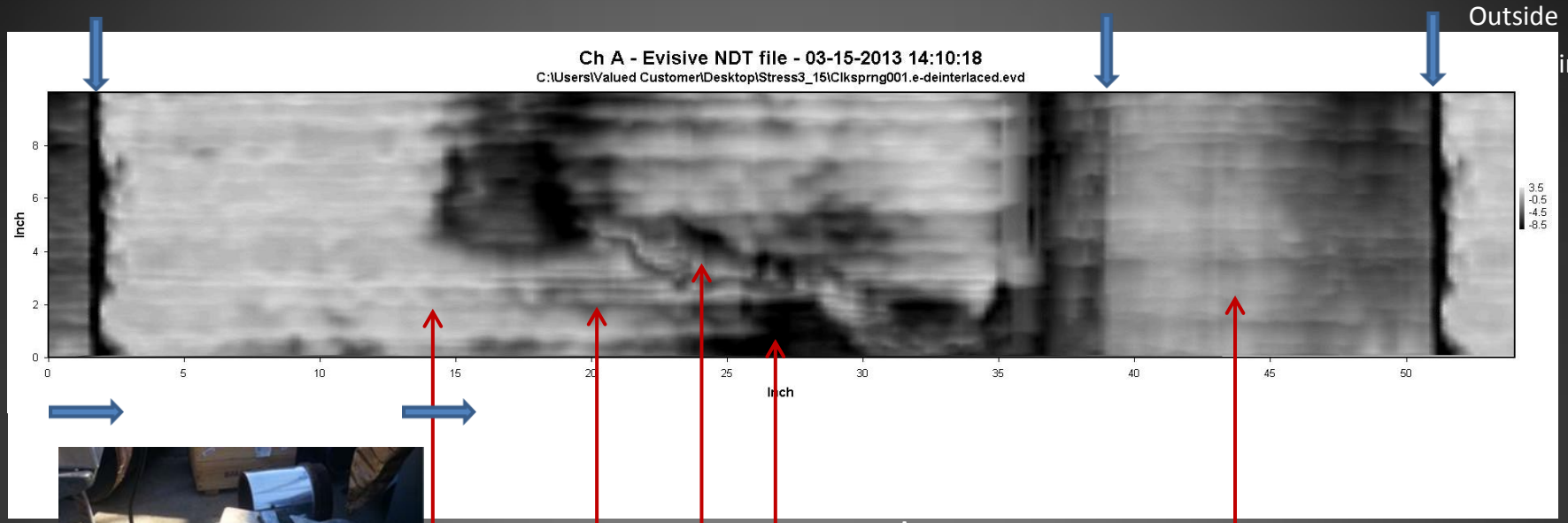
Pipe Wrap with Artificial Defects

Pipe wrap with artificial defects. The wrap is flexible fiber material with a resin matrix.

Microwave interference scan of pipe wrap showing features in pipe surface, at pipe to interface and in pipe wrap volume. Indications include artificial and unintended features.



Clockspring Inspection

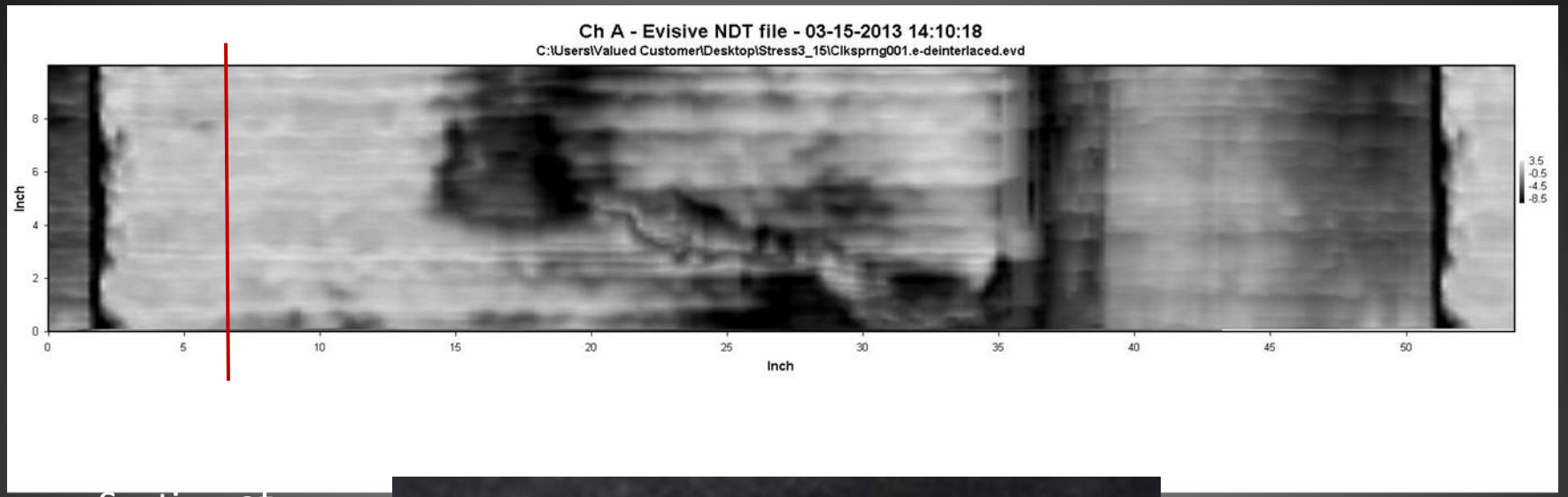


Crack

Strong indication, likely disbond at metal surface

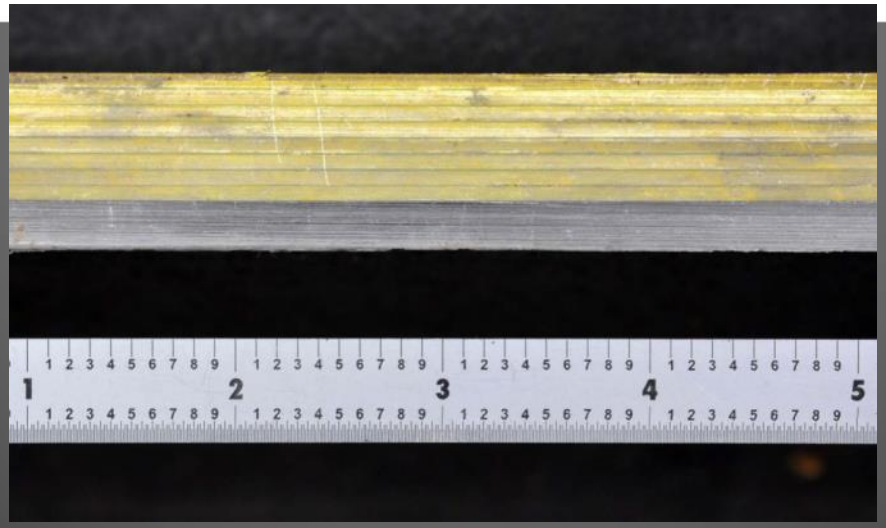
Good bond / whole area

Clockspring inspection



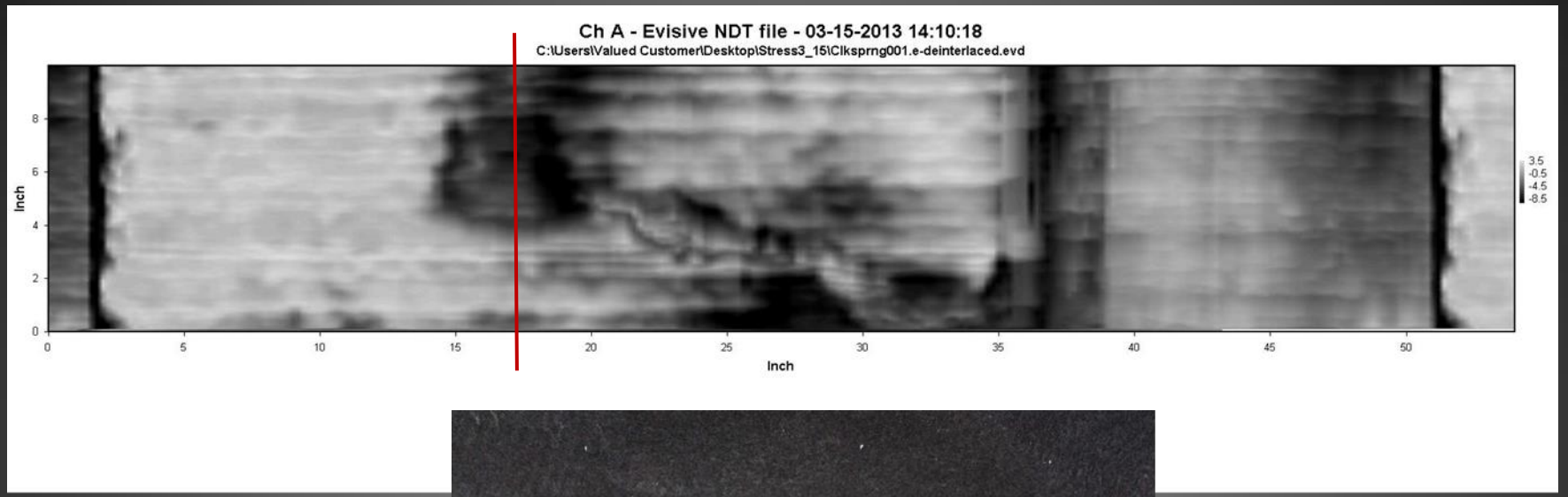
Section at

x = 8 in.

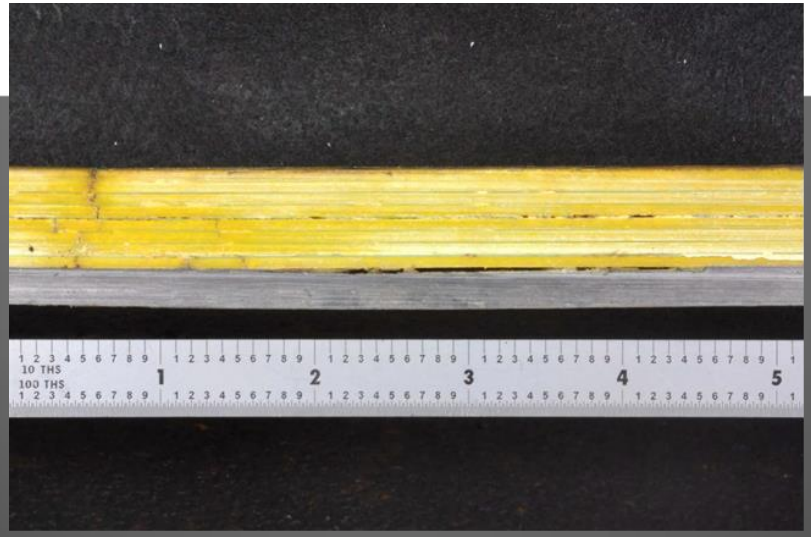


Good Bond

Clockspring inspection



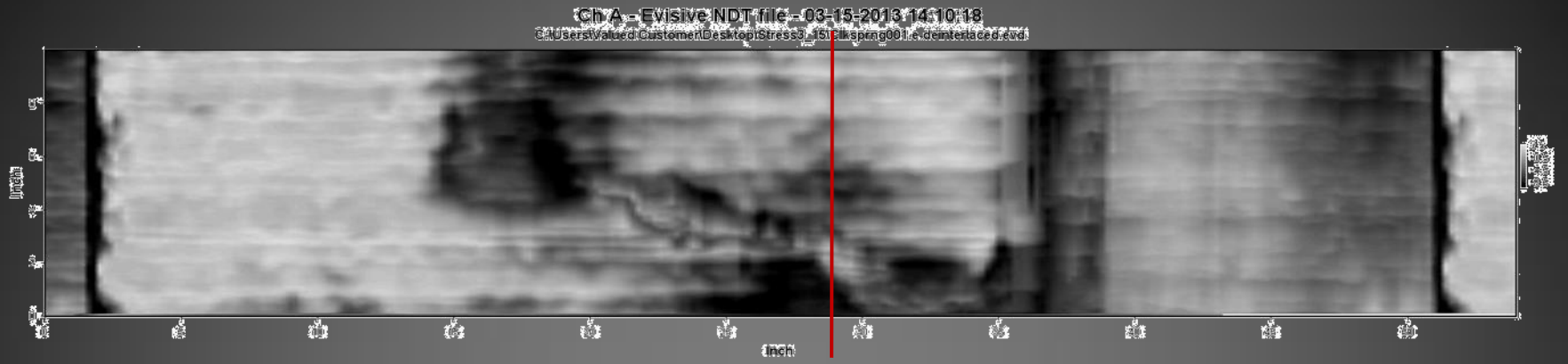
x = 18 in.



Corrosion/

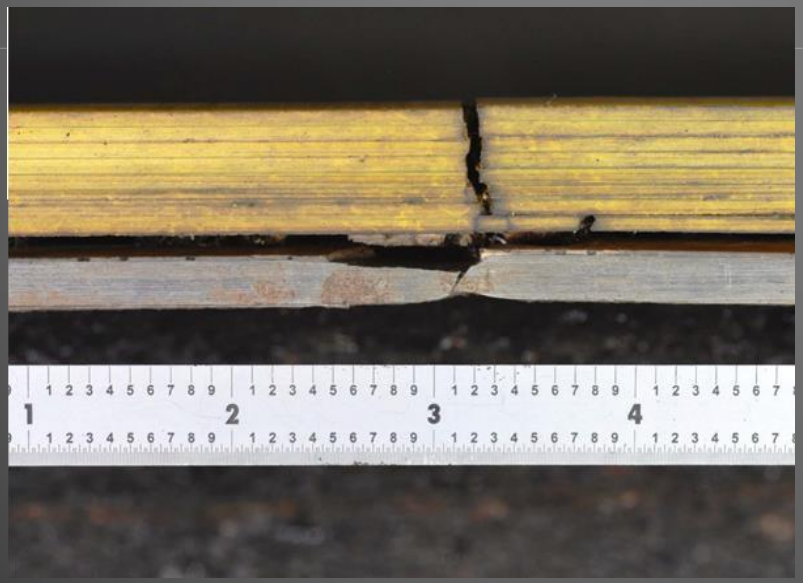
Delamination at pipe surface

Clockspring inspection



Section at

x = 29 in.



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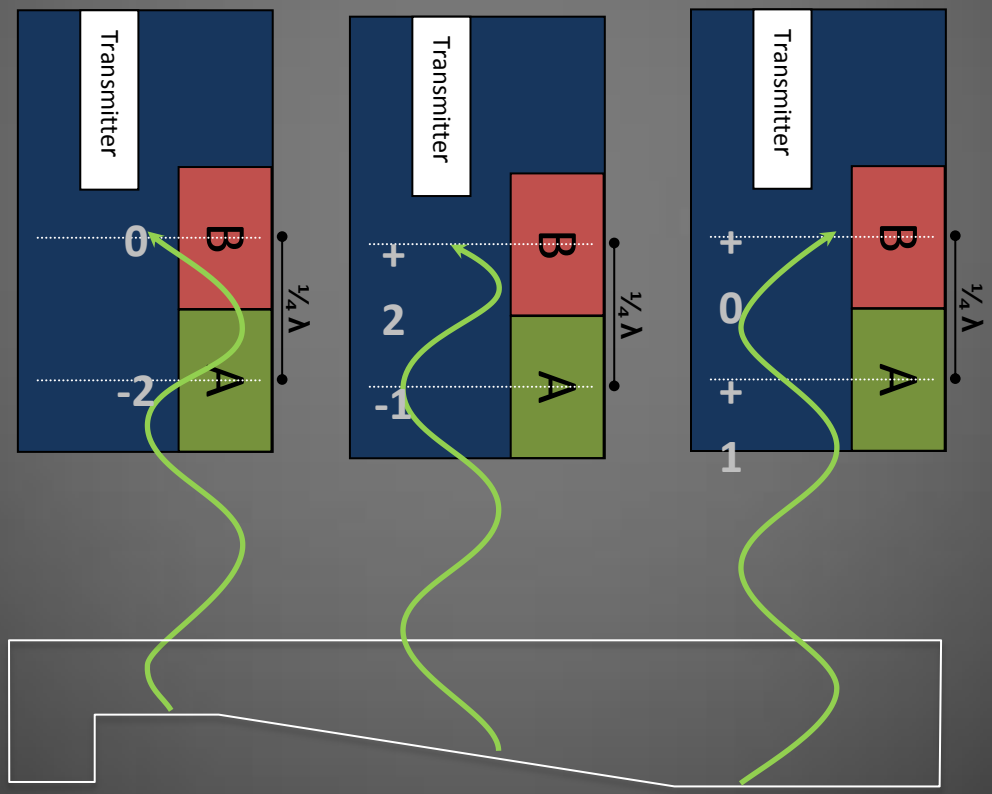
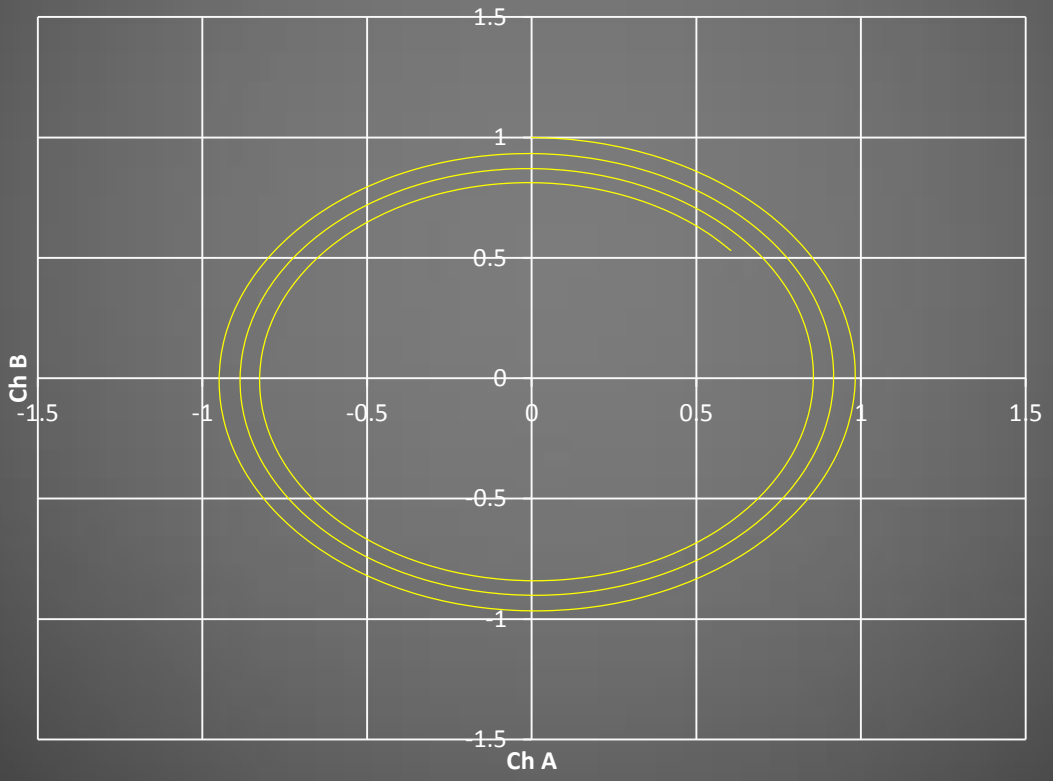
THICKNESS MEASUREMENT

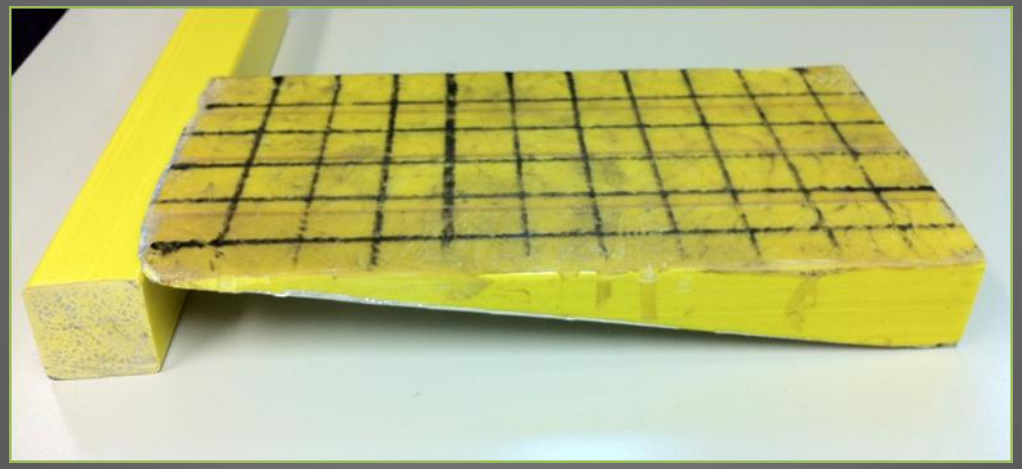
Thickness Measurement



Phase Plot

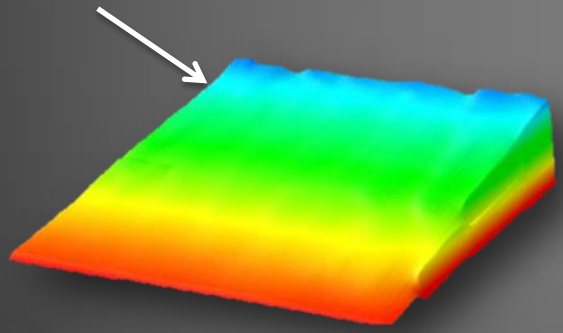


Calibration Panel

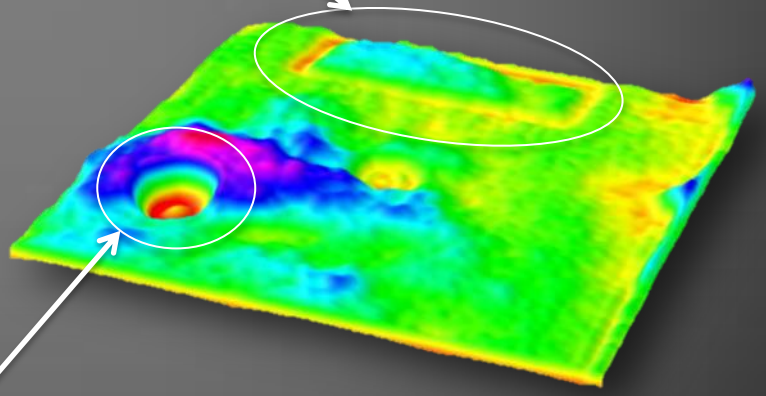


Phase & Magnitude Application

Wedge used to correlate thickness to color

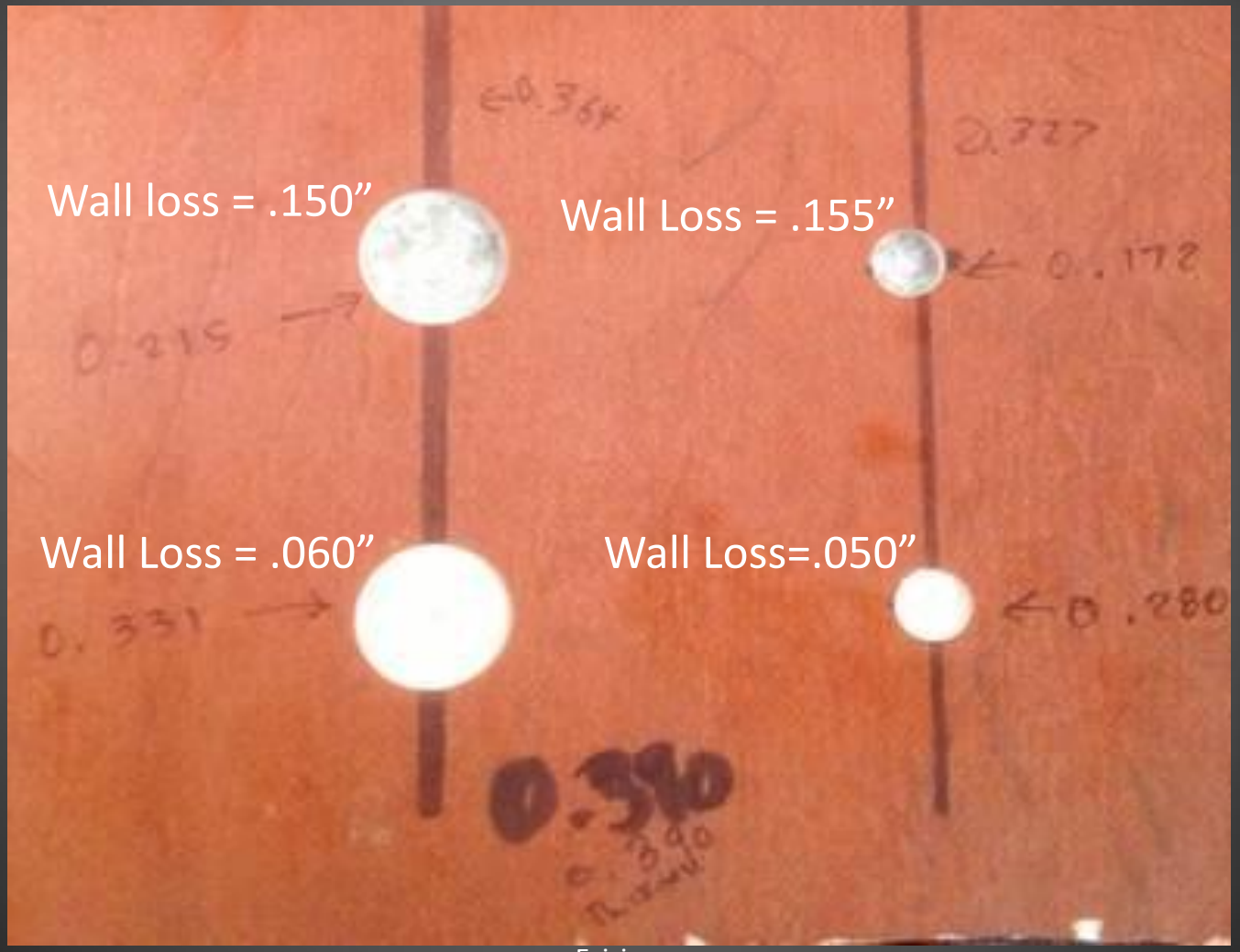


Thicker area



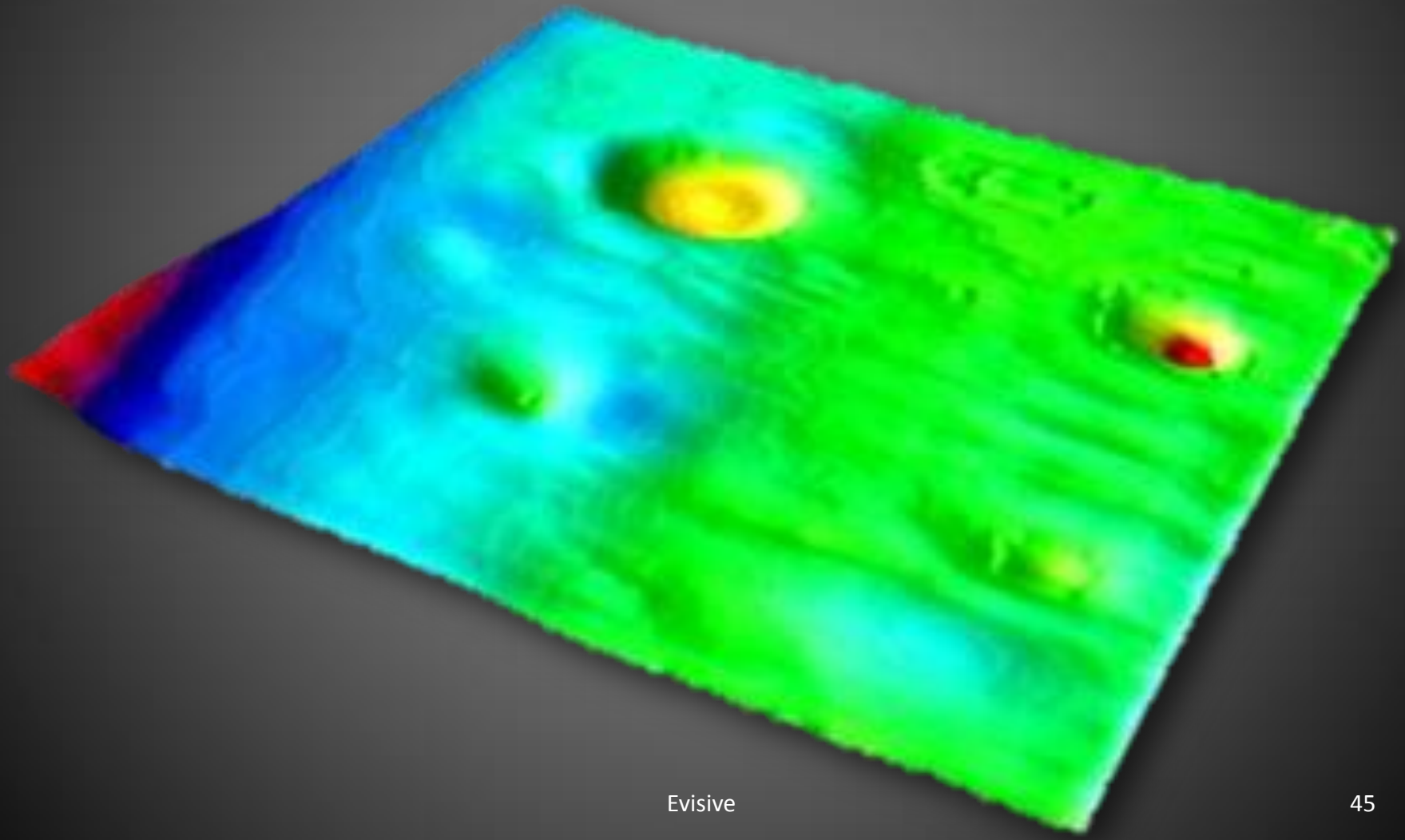
Area with wall loss

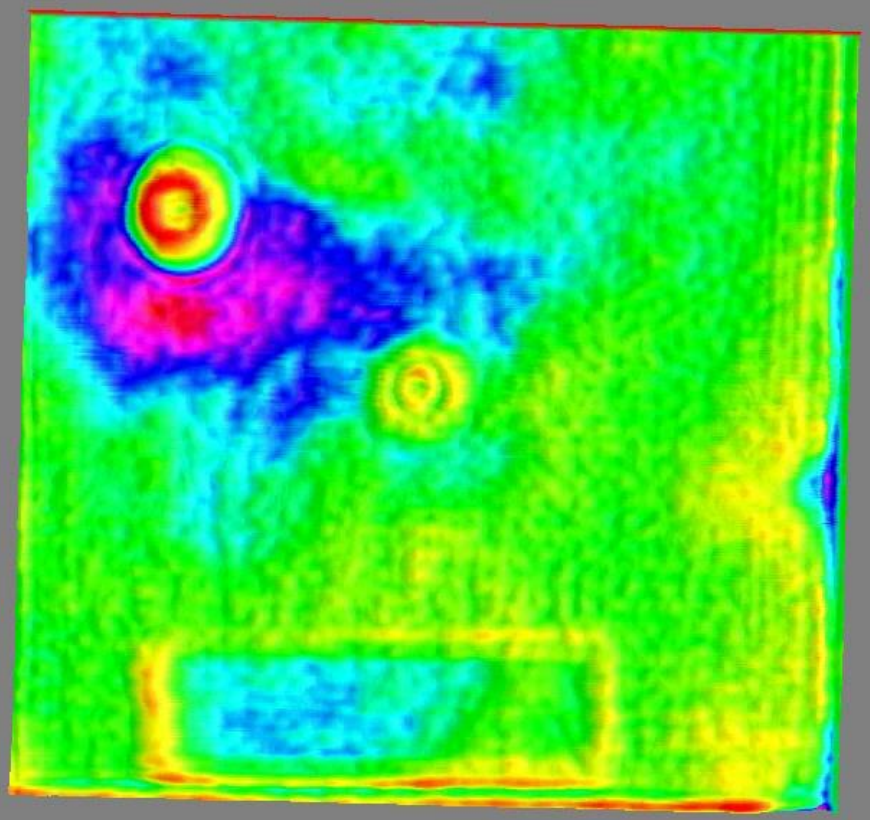
Fiberglass Panel



Inspection Image

3D Representation





QUESTIONS?

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