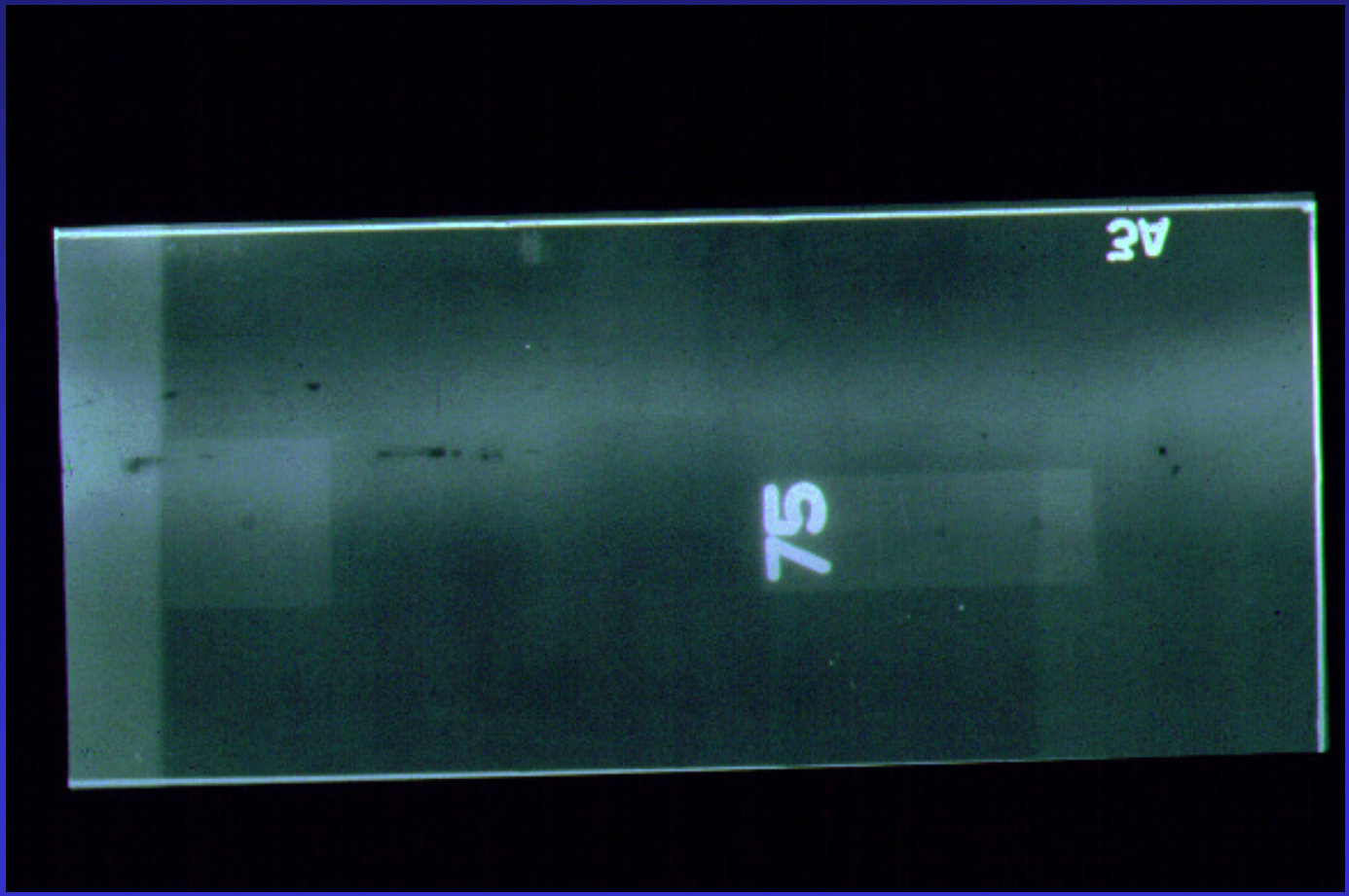
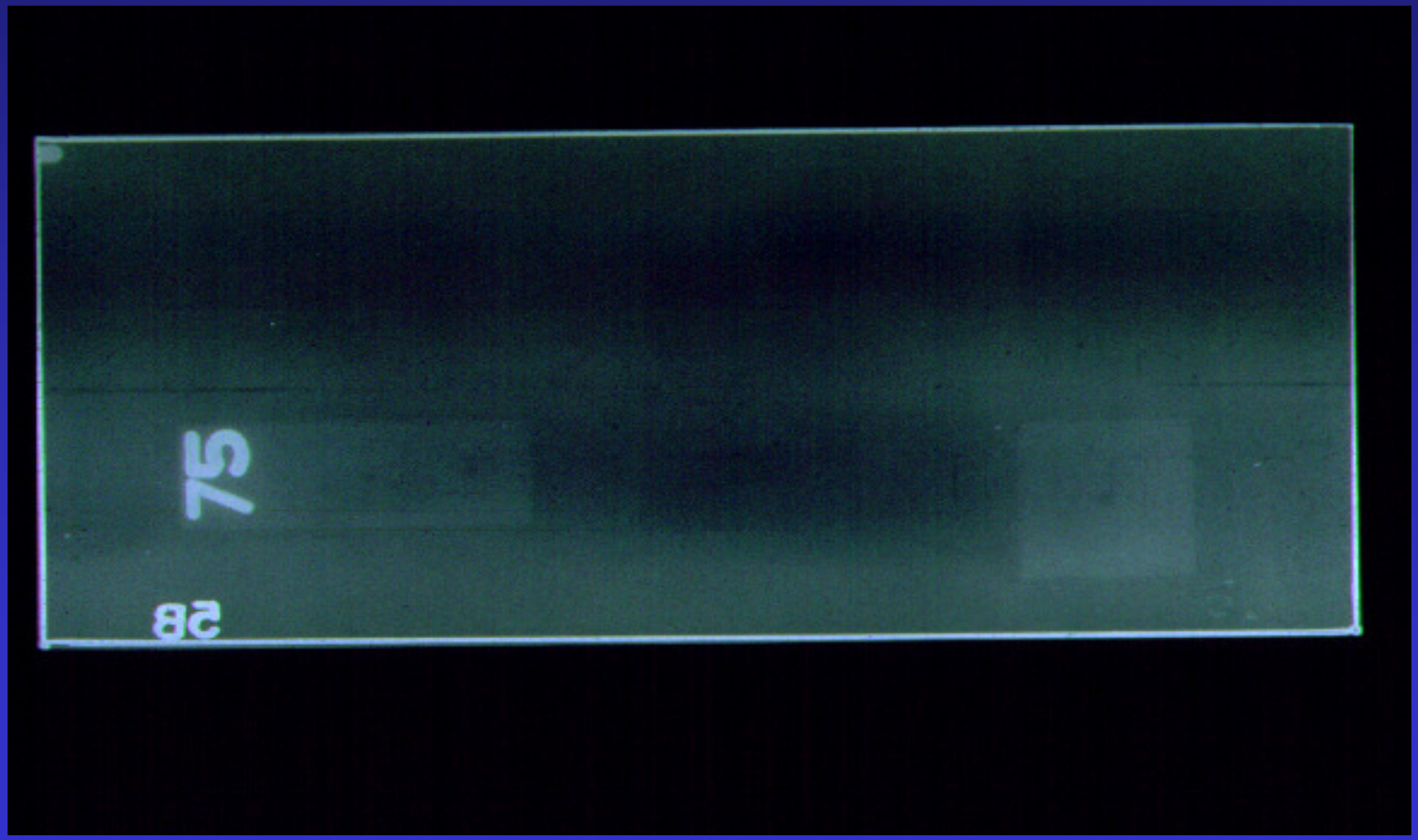
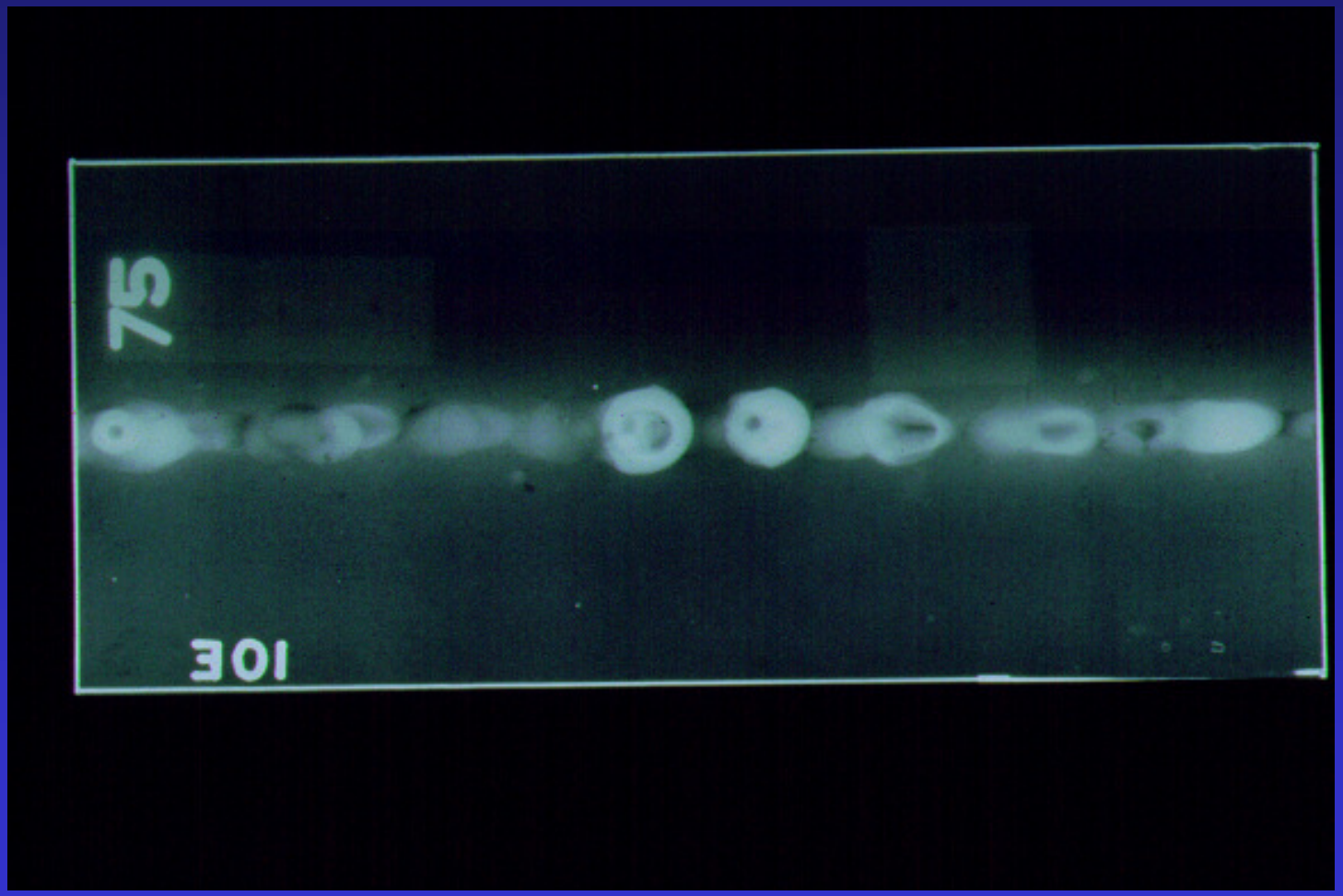
# POROSITY AND SLAG INCLUSION



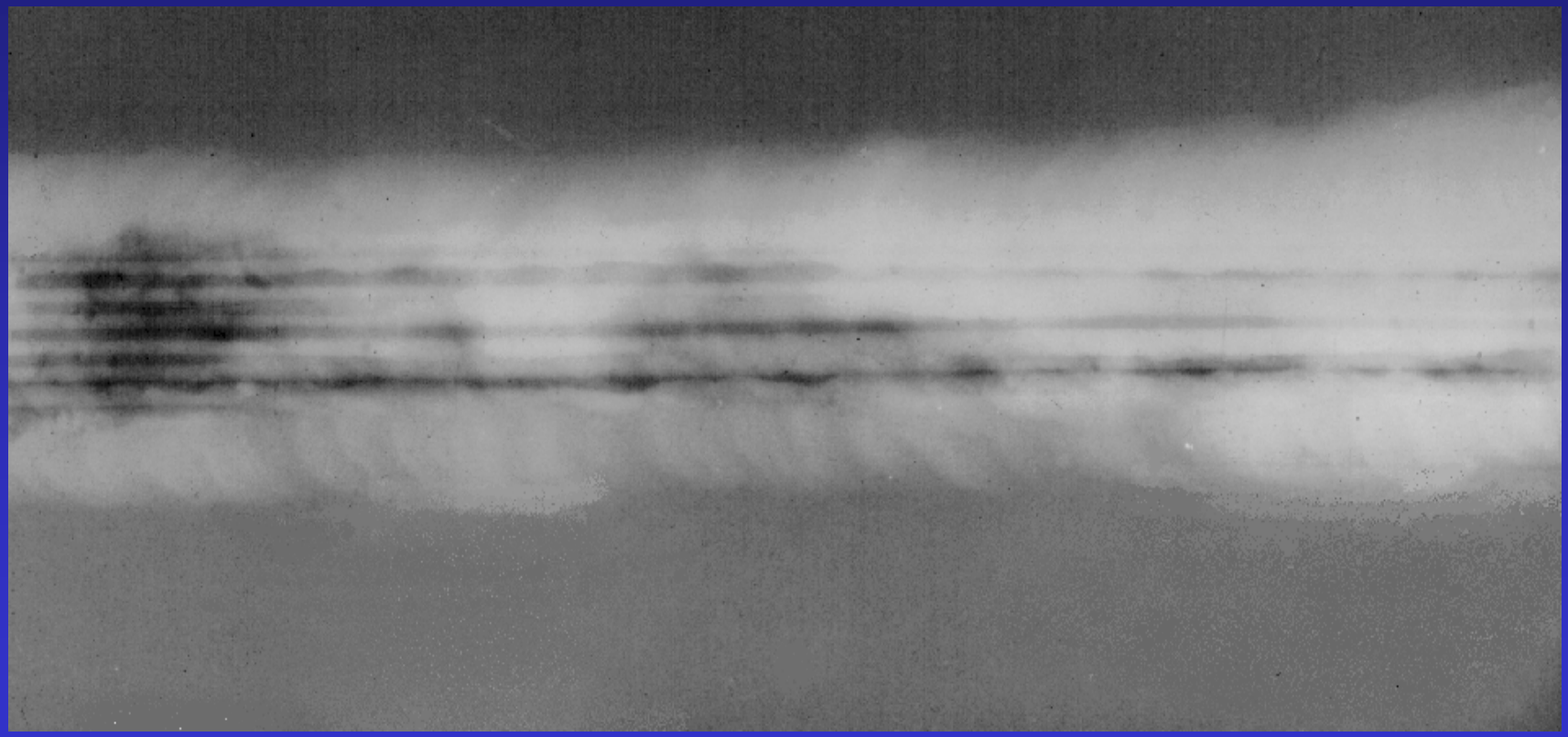
# INCOMPLETE PENETRATION(IP)



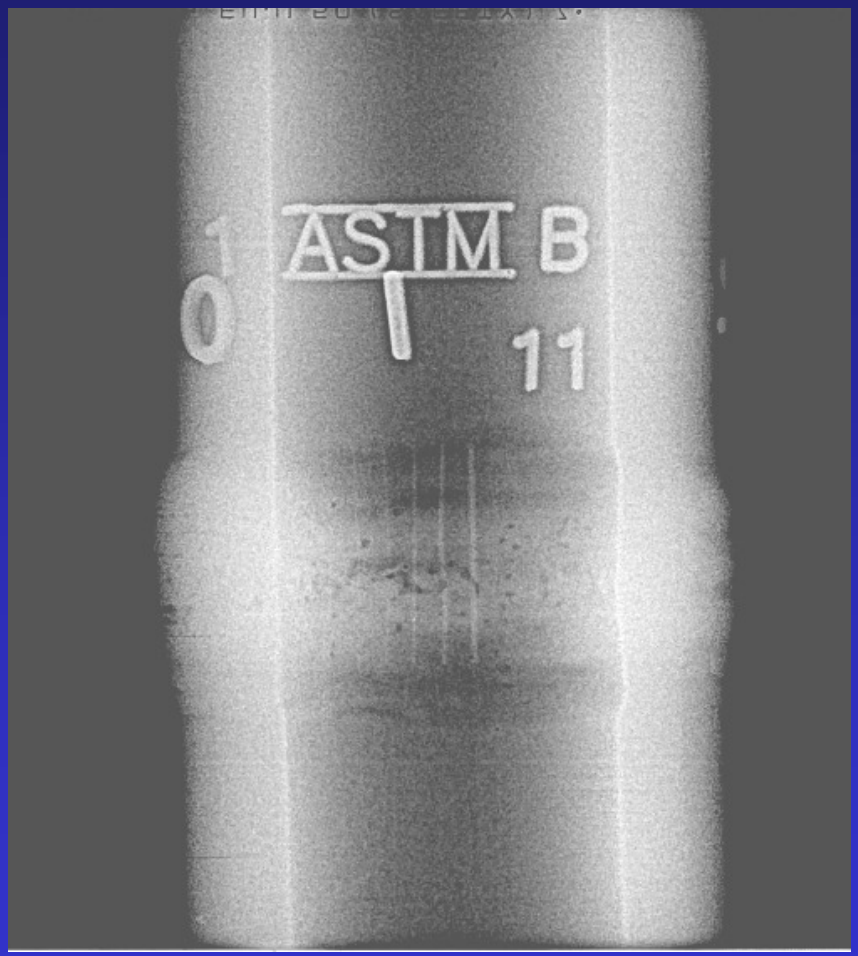
# EXCESSIVE PENETRATION WITH IP AND INSIDE UNDERCUT



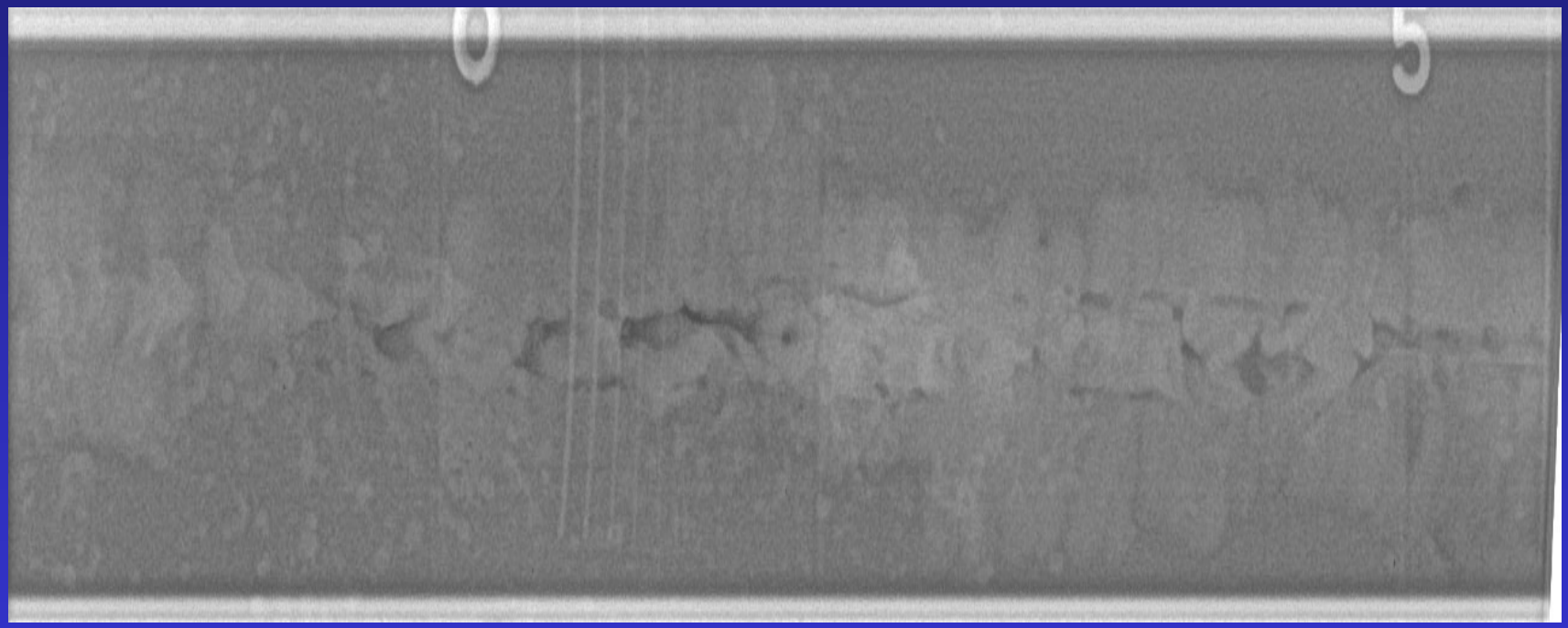
# SLUG WELD
# (WELDING RODS)



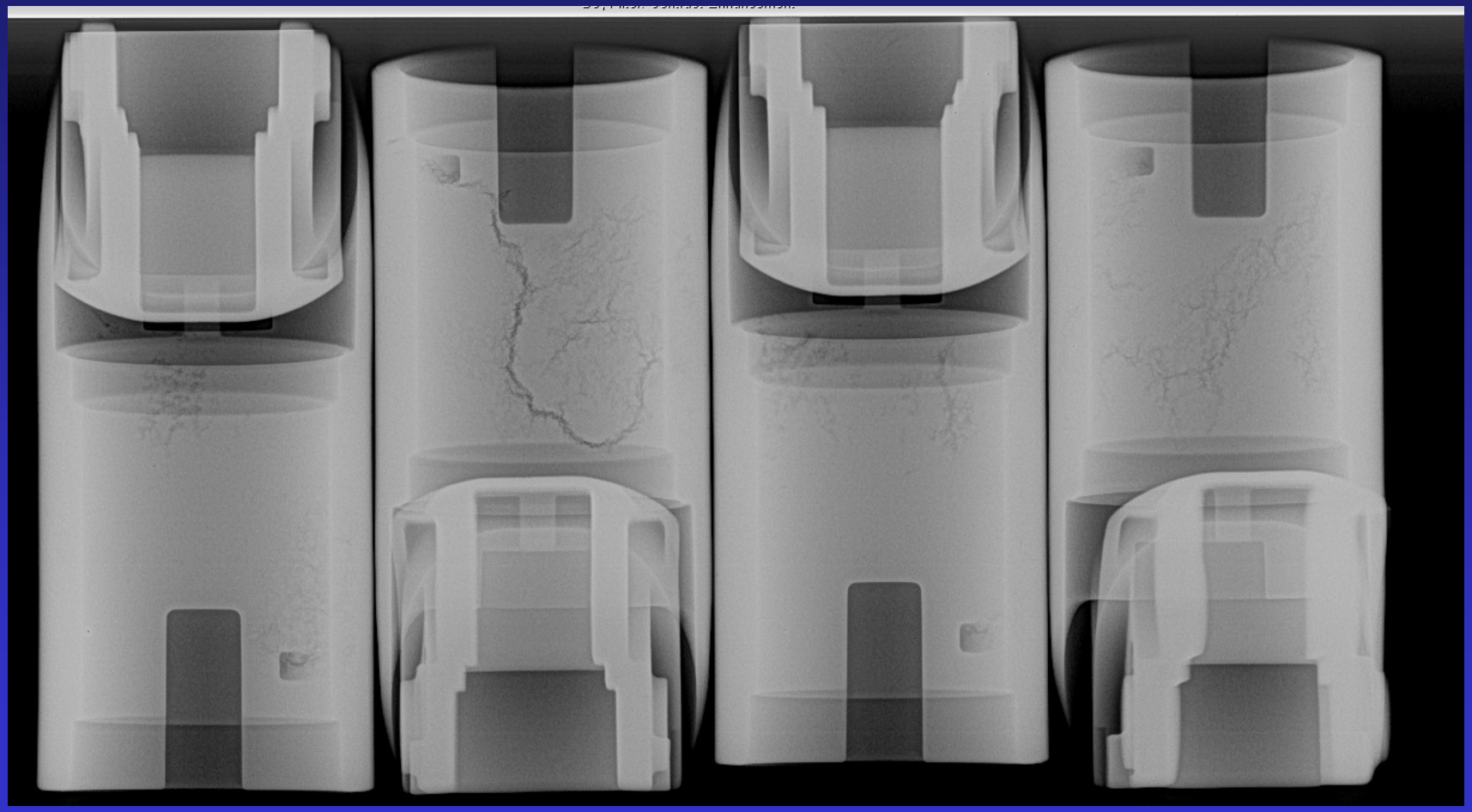
# Porosity/Slag



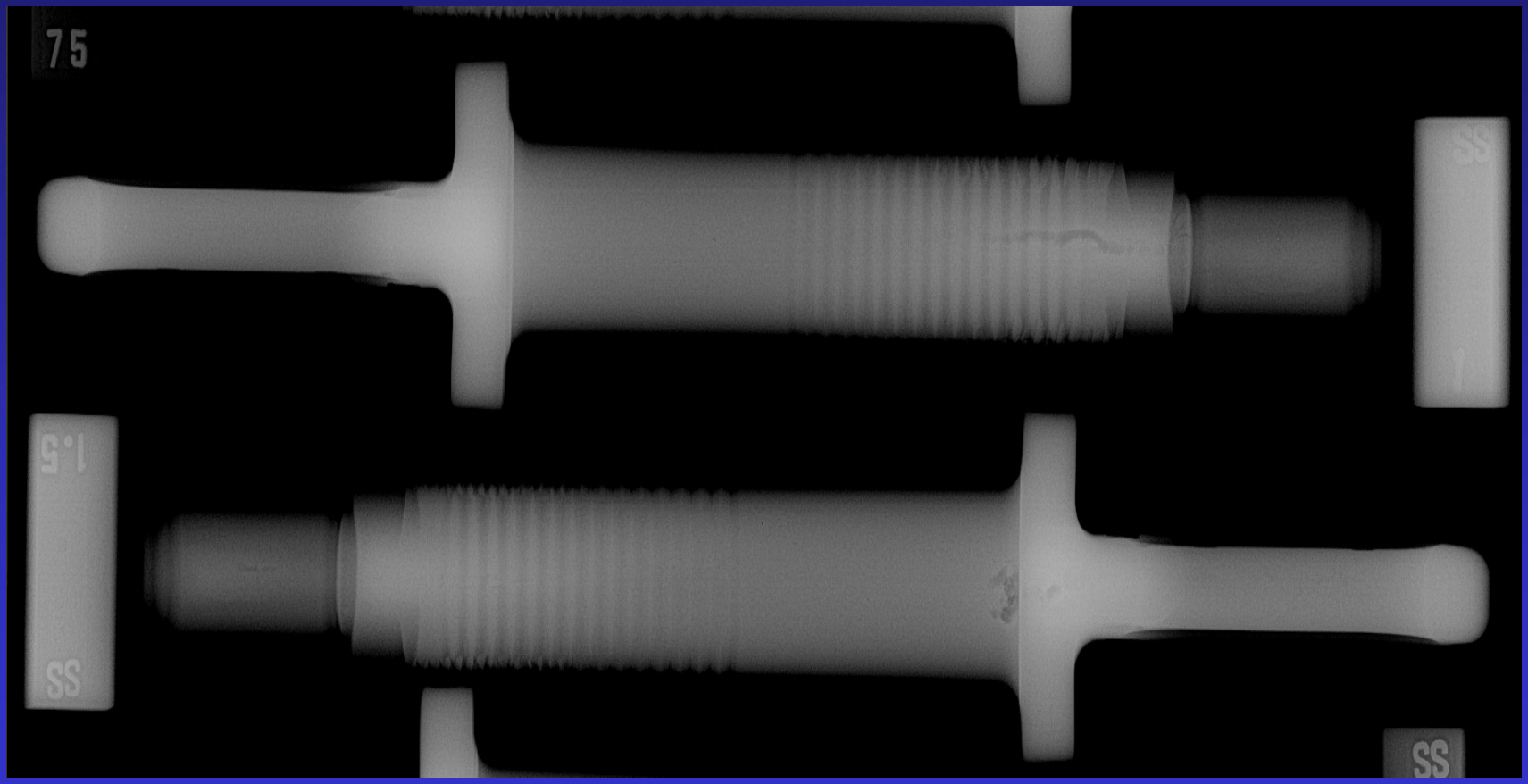
# Lack of Fusion



# Casting Shrink



# Casting Shrink



# *ADVANTAGES OF RT*

- Permanent record
- Volumetric - internal, structural conditions
- Examination of complex geometry's possible

# *LIMITATIONS OF RT*

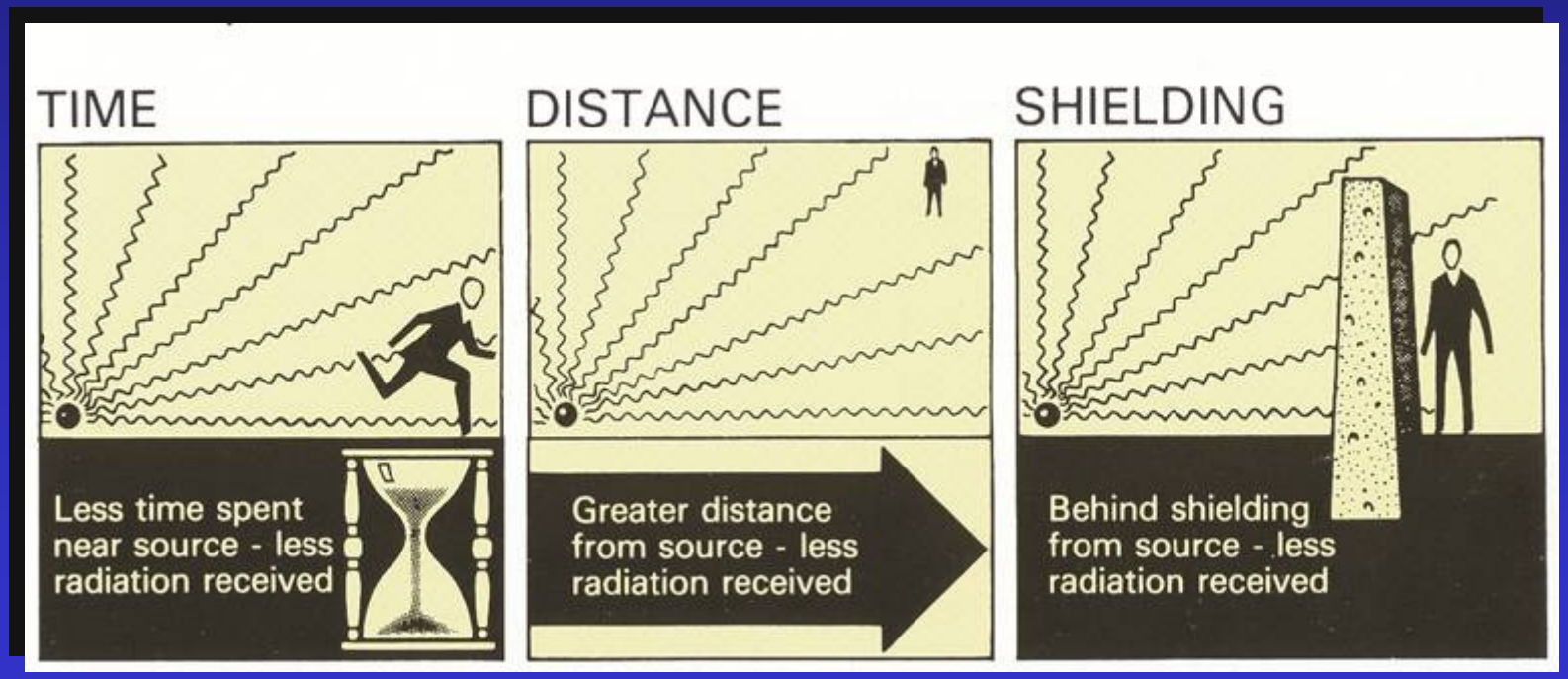
- Two sides must be accessible
- Planar discontinuities difficult to detect
- Safety hazard
- Expensive
- Part thickness limitations
- Time consuming

# Radiation Safety

Use of radiation sources in industrial radiography is heavily regulated by state and federal organizations due to potential public and personal risks.

# Radiation Safety (cont.)

**There are three means of protection to help reduce exposure to radiation:**



# Radiation Safety (cont.)

**Technicians who work with radiation must wear monitoring devices that keep track of their total absorption, and alert them when they are in a high radiation area.**

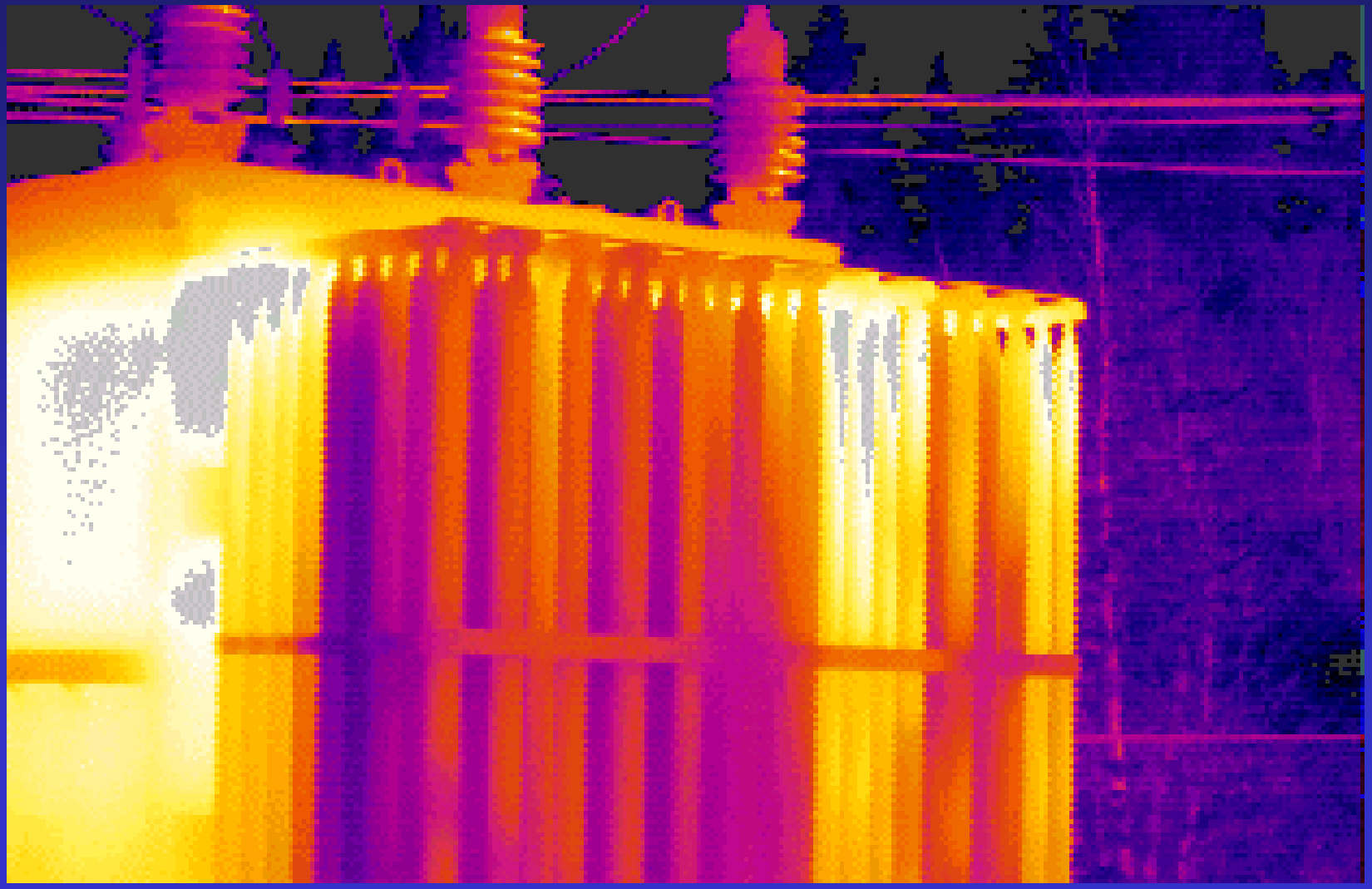
Survey Meter

Pocket Dosimeter

Radiation Alarm

Radiation Badge

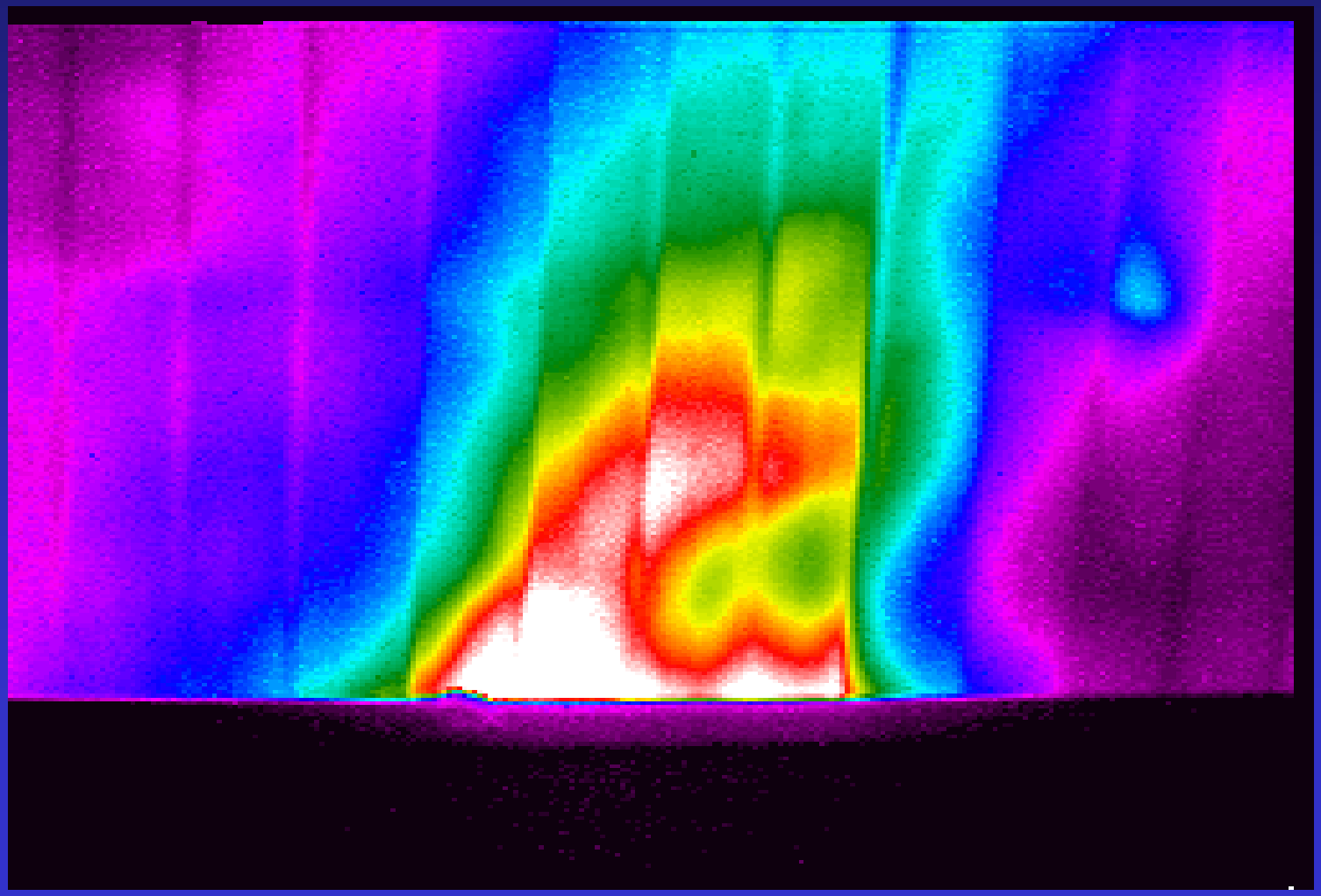
# FLUID THEROMOGRAM
# INSULTATING OILS IN THE TRANSFORMER BREAKING DOWN RAPIDLY



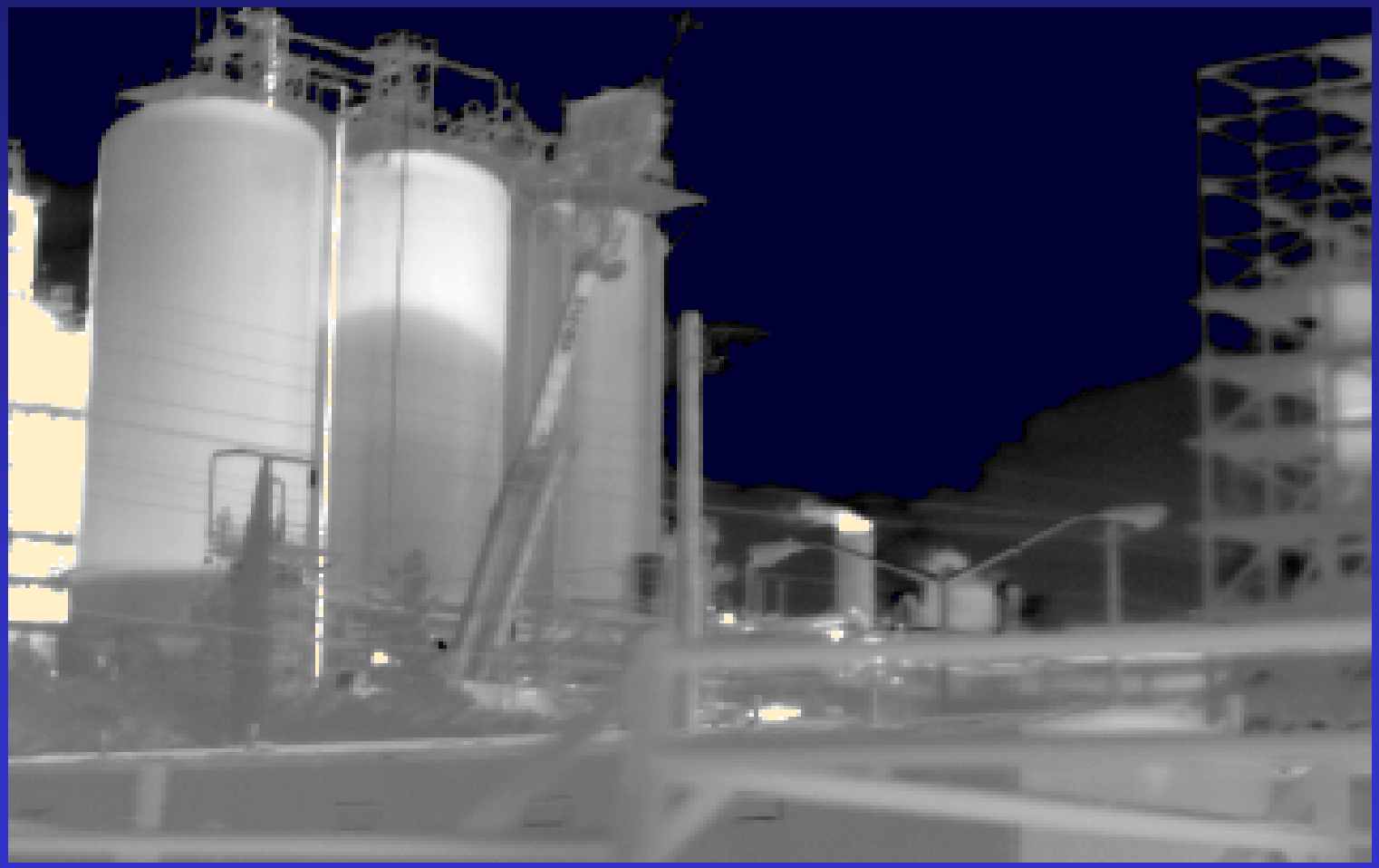
# RESISTANCE HEATING SHOWS THE TEMPERATURES SEEN ON THE OUTSIDE OF THE TANK ARE TOO COOL TO THE TEMPERATURE INSIDE

# STEAM TRAPS AND LINES PHOTOGRAPH

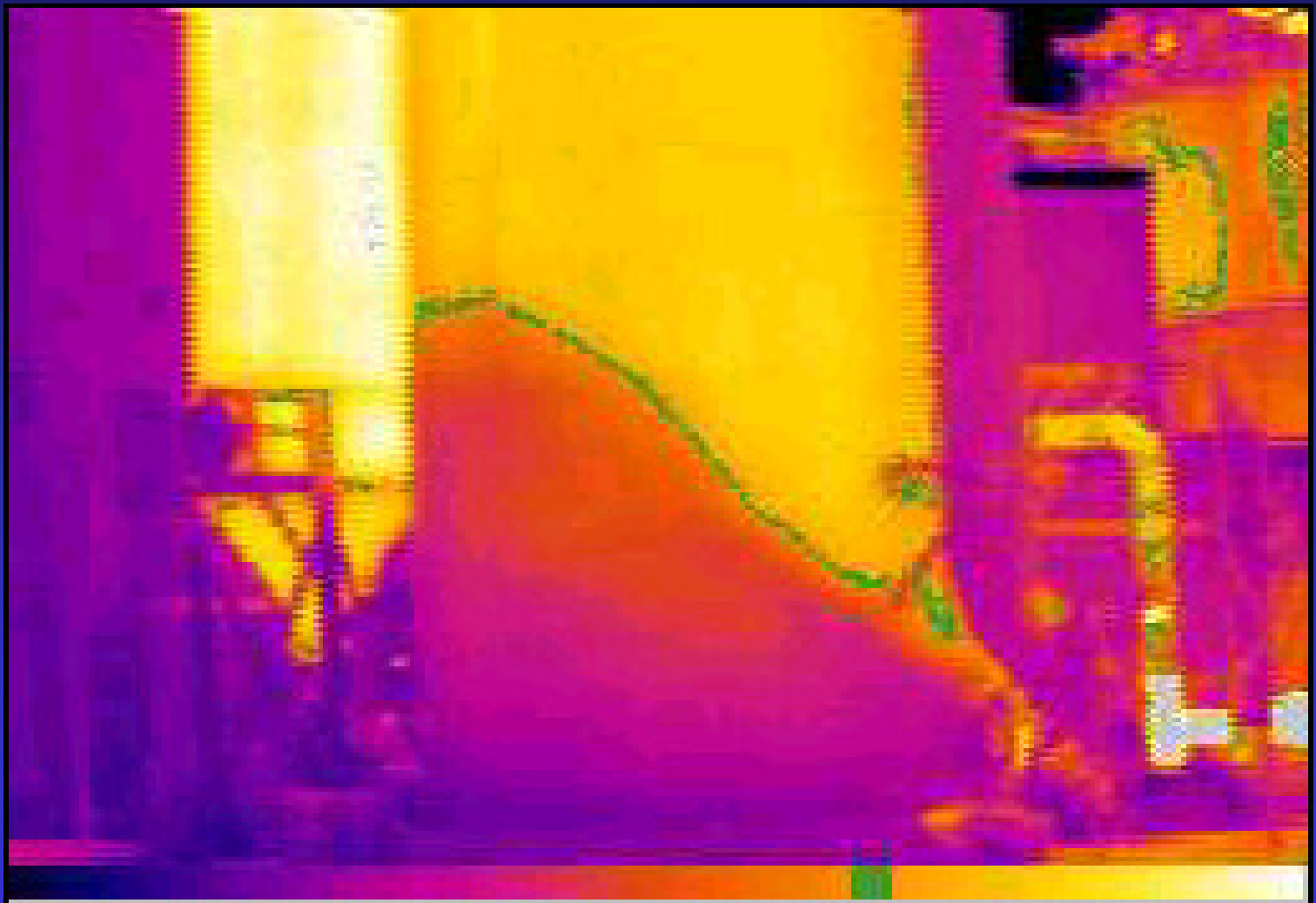
# THERMOGRAPH SHOWING PROBLEM WITH REFRACTORY



# FLUID LEVELS IN TANK CLEARLY VISIBLE IN LATE EVENING OR EARLY MORNING



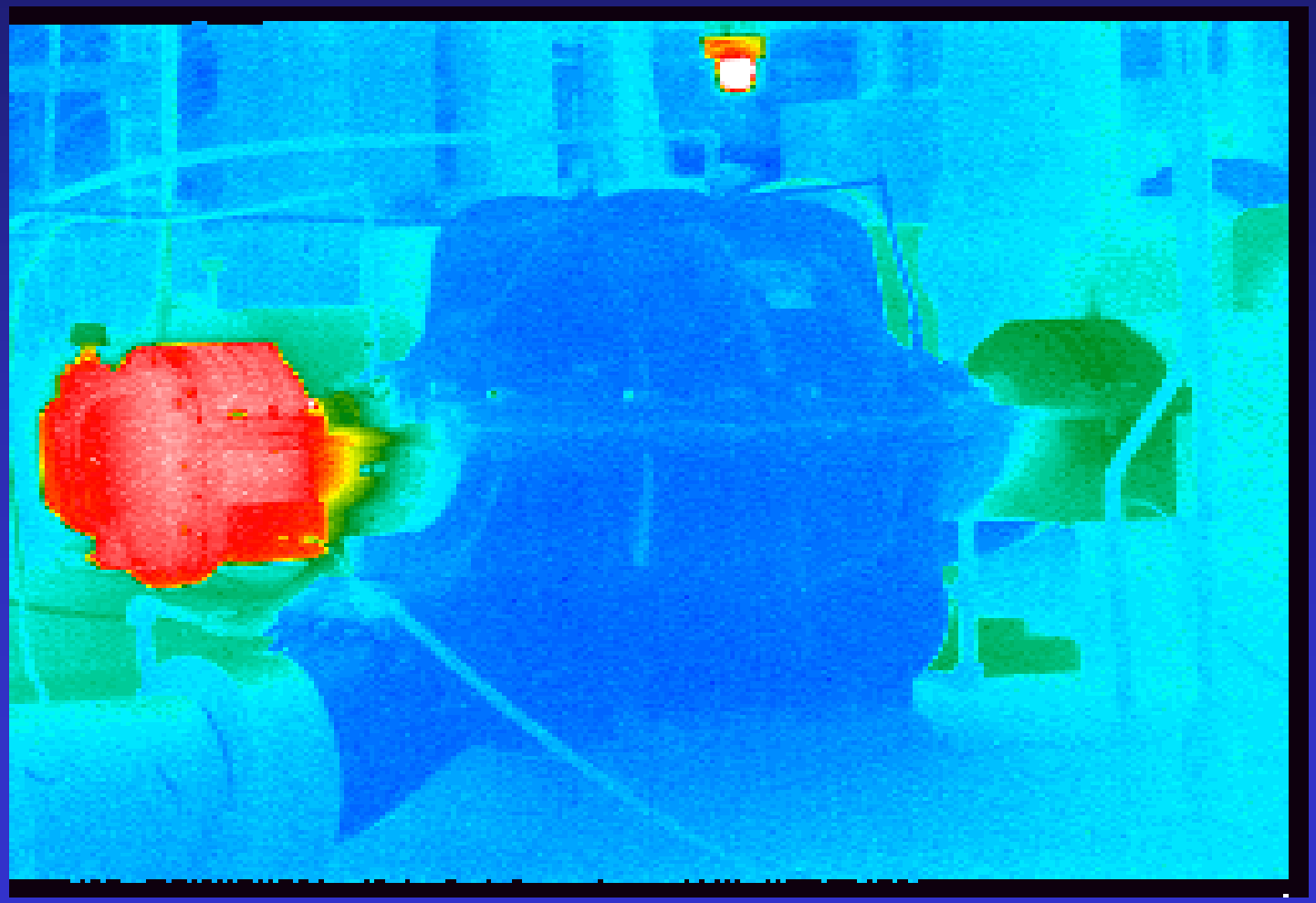
# FLOATING MATERIAL SUCH AS WAXES HAS A HIGHER THERMAL CAPACTANCE WHICH CAN USUALLY BE DISTINGUISHED FROM LIQUID



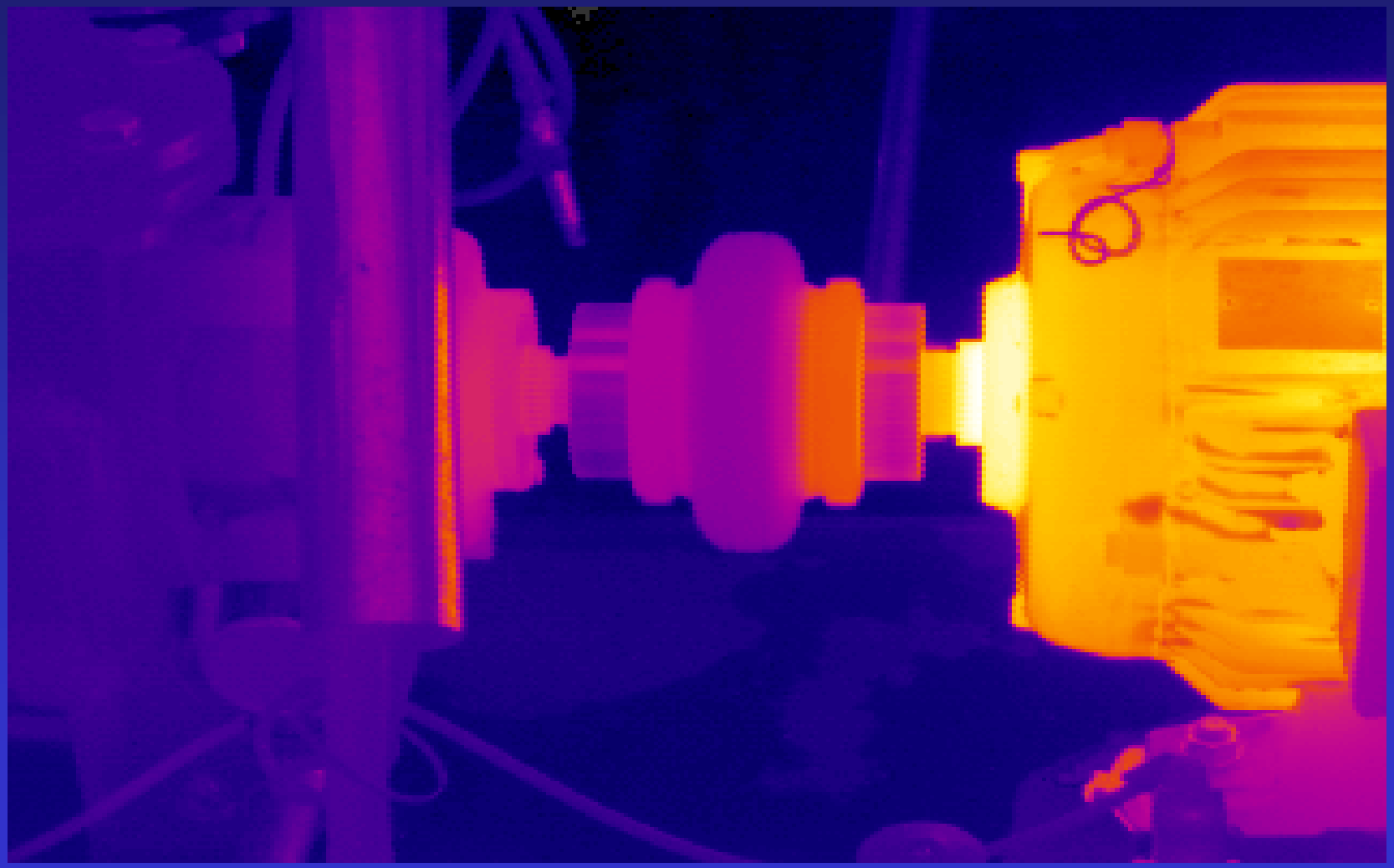
SludgeIR.jpg

# MECHANICAL INSPECTION

# OVERHEATING OF THE BEARING DUE TO LACK OF LUBRICATION



# DEGRADATION OF BEARING OVER A PERIOD OF TIME DUE TO MISALIGNMENT



# ADVANTAGES

- Inspection technique that is highly effective and very easy to use
- A inspection tool that can create a thermal image of grading heat transfer with great detail
- Thermal mapping of complex industrial machines
- Provide information about operation and/ or the internal integrity of a component.

# LIMITATION

- Only the surface of an object can be seen thermally
- Surfaces may be so thermally reflecting that may require preparation with a high-emissive coating.
- In order to resolve the thermal imager the internal temperature may have to be increased.
- This is a surface inspection, even through subsurface may influence the surface thermal image, this is not a volumetric inspection method.

# Advanced NDT Methods

- Direct Digital RT
- Ground Penetrating Radar
- Phased Array UT
- Creaform Laser Measurement
- RAT Rope Access Technology

# Digital Radiography (‘DR’)

- Digital Radiography is a filmless system where a digital image is captured by a device used to record and make available as a digital file that can be viewed, interpreted and recorded.
  - Most common detectors
    - Amorphous Silicon
    - Linear Diode Array

- Acuren primarily uses Amorphous Silicon detectors for its portable DR services.

# Acuren's Portable DR Systems

- Portable
  - Full system in single pelican case
  - Lightweight
  - Hand carried
  - Lends well to rope access

- Simple
  - Direct connection to laptop
  - No film processing
  - Instant evaluation/image
  - Instant/better image enhancement
  - Instant/easier archiving

# Why use Digital Radiography?

- Safety/ ALARA (As Low As Reasonably Achievable)
  - Drastically reduced shot times reduce exposure
  - Reduced barricade size (SCAR/ Pulsed X-Ray)
  - Lower source strength required

- Quality Assurance / Quality Control
  - Excellent image quality (higher probability of detection than CR)
  - Image portability
  - Software supplied for 3rd party review
  - ASTM E 2339-04 (DICONDE) compliant
  - Comparative analysis facilitated with computer software
  - Image enhancement / wall thickness and defect measurement tools
  - Remote data analysis

# Why use Digital Radiography?

- Environmental
  - Exceeds requirements of ISO 14001
  - No chemicals used
  - No heavy metals

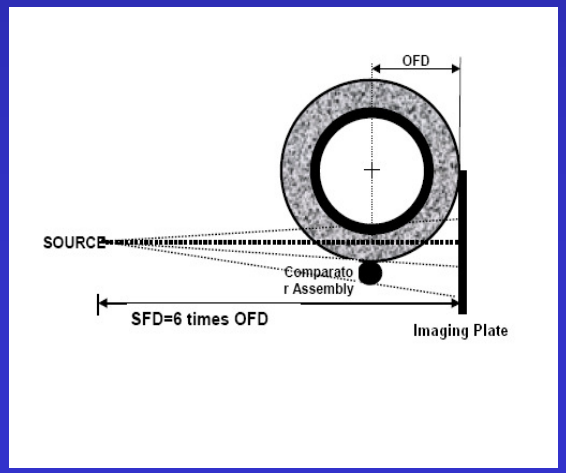
- Productivity
  - High speed image capture (34 second max exposure)
  - Reduced barricade set-up / protection time
  - Fewer re-shots
  - No darkroom / processing time
  - Computer assisted image assessment

# Sample Applications

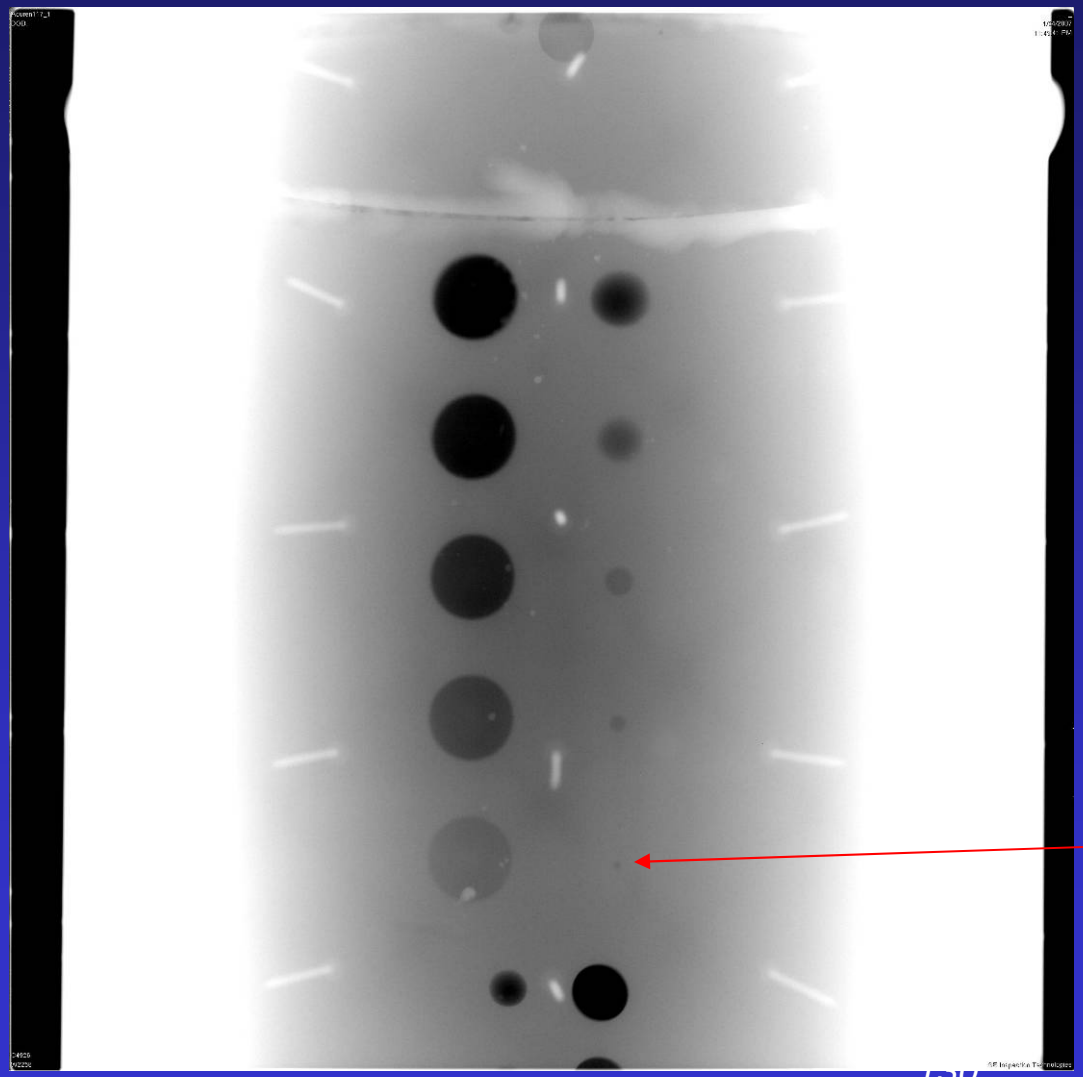
- DR is ideally suited for the following applications
  - Valves – many densities and thicknesses - single shot, internal verifications
  - Jacketed piping – one shot to grade internal / external on both pipes
  - CUI – no stripping, high speed
  - Long runs of pipe – 50ft/hr semi-auto system
  - Touch-points (saddles, supports, etc.)
  - Boiler tubes (thinning, scale, fatigue cracking)
  - Flow accelerated corrosion – heavy wall, large diameter
  - Concrete inspection (core and in-situ)
  - Vessel inspection
  - Weld inspection (ASME V, Article II, Appendix IX)
  - Fire water systems

# Portable DR - Semi-Automated System

- Fixed positioning for high production rates
- Capable of achieving 50 ft/hr



# Small Defect Recognition and Assessment



Greater Sensitivity:

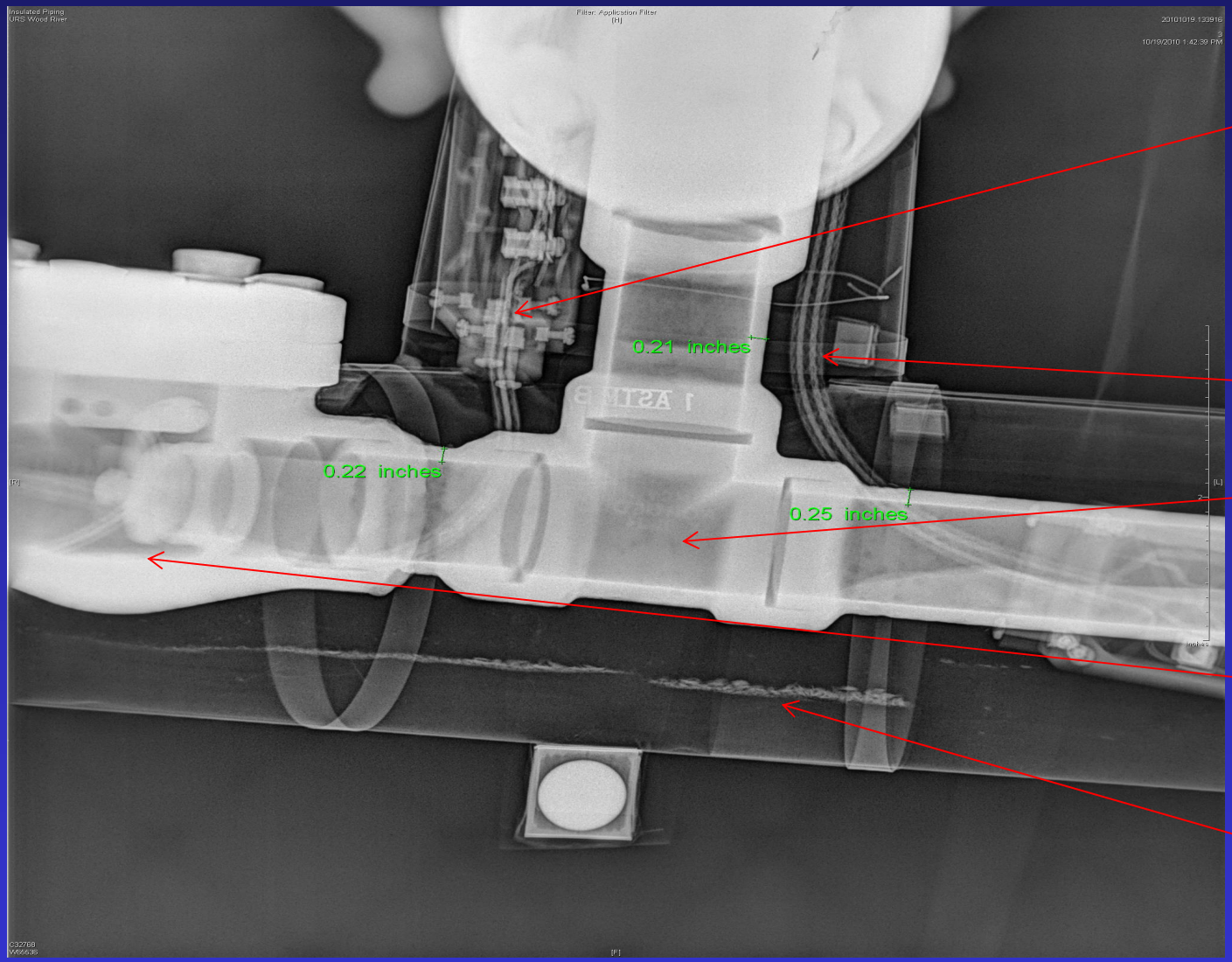
- Film: greater than 4%
- CR: ~ 2% - 4%
- DR: greater than 1%*

*Amorphous silicon plate

Small Defect Recognition

- 1/16” diameter
- 15% (0.056”) deep

# Evaluation



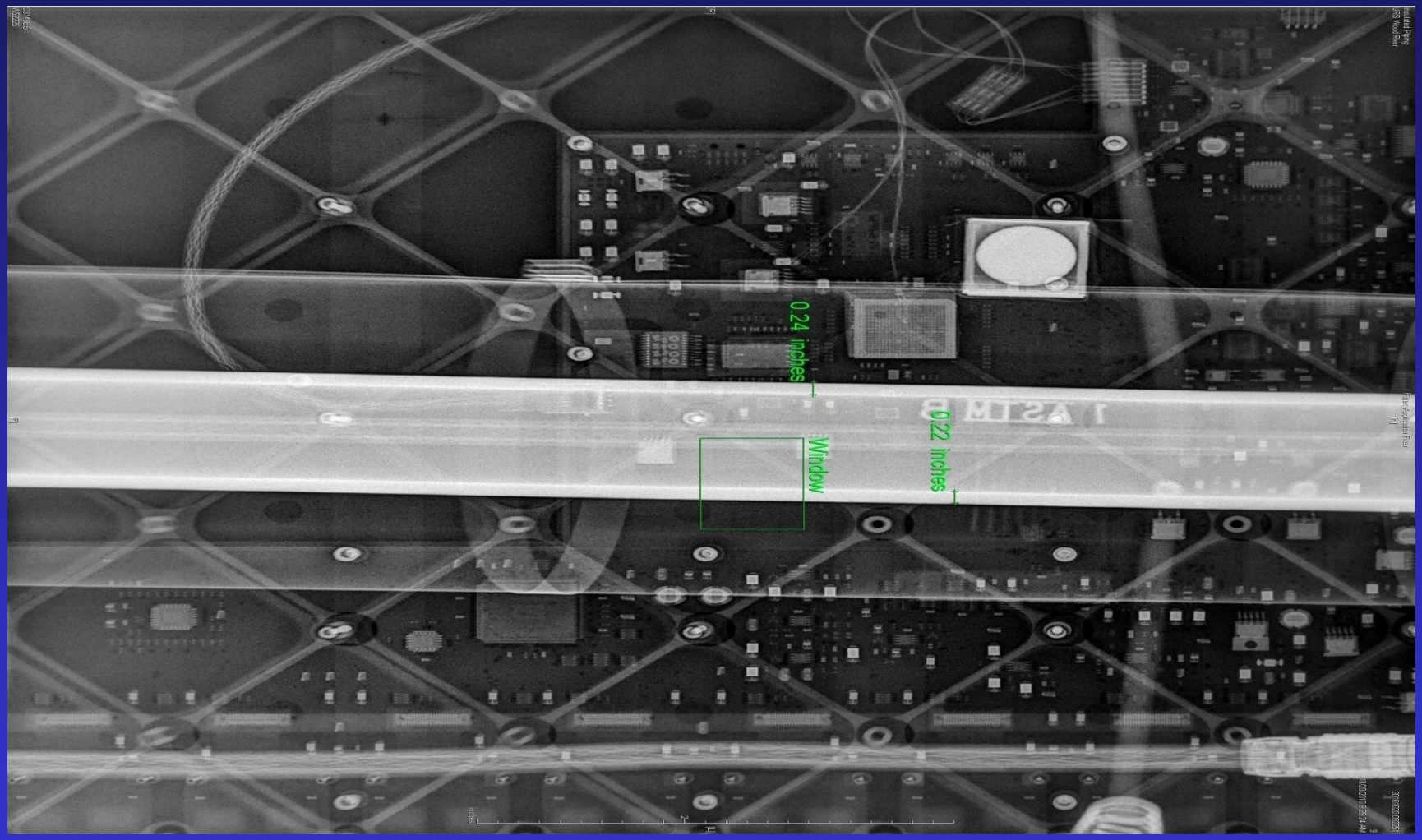

Inspection of heat tracing leads

pitting

Deposit build- up

Moisture/ scale

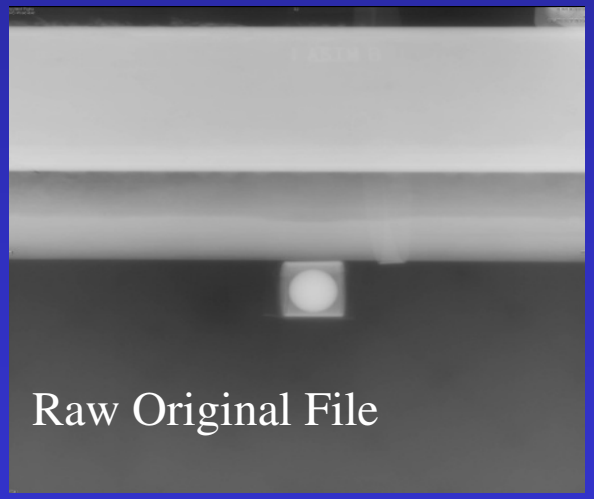
# Versatility

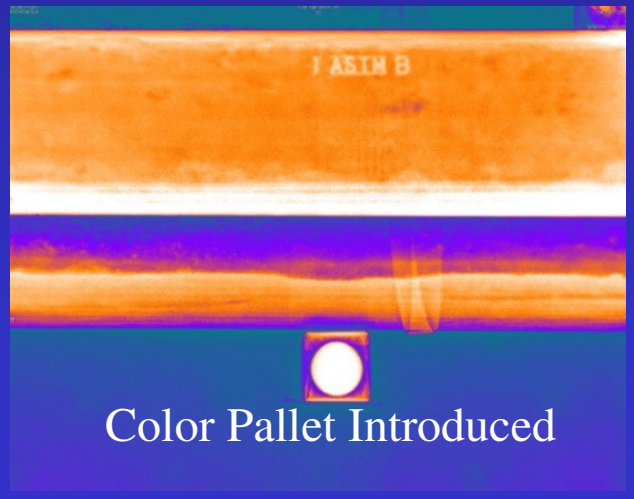



Radiograph through obstruction

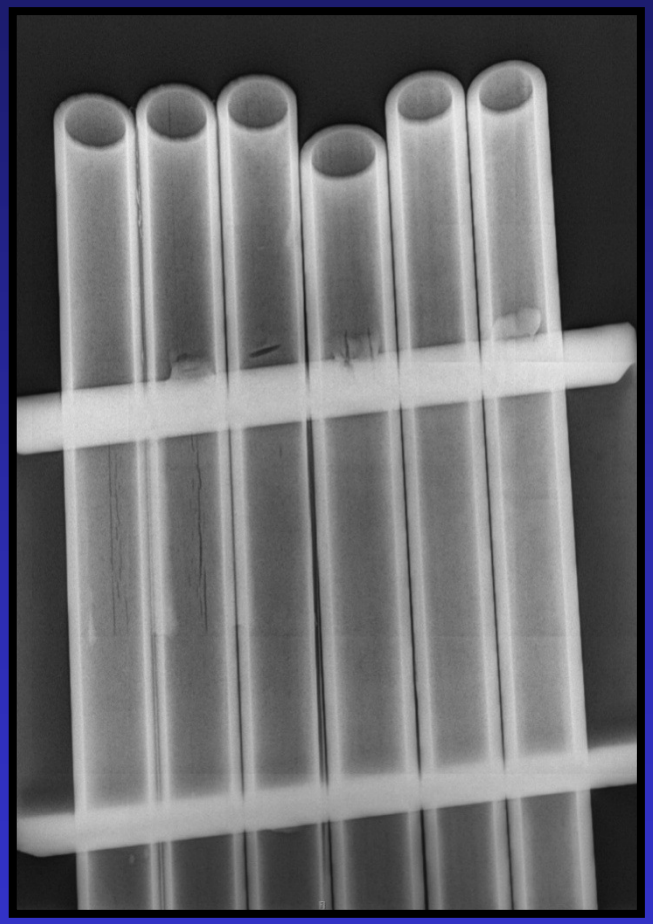
# Image Review

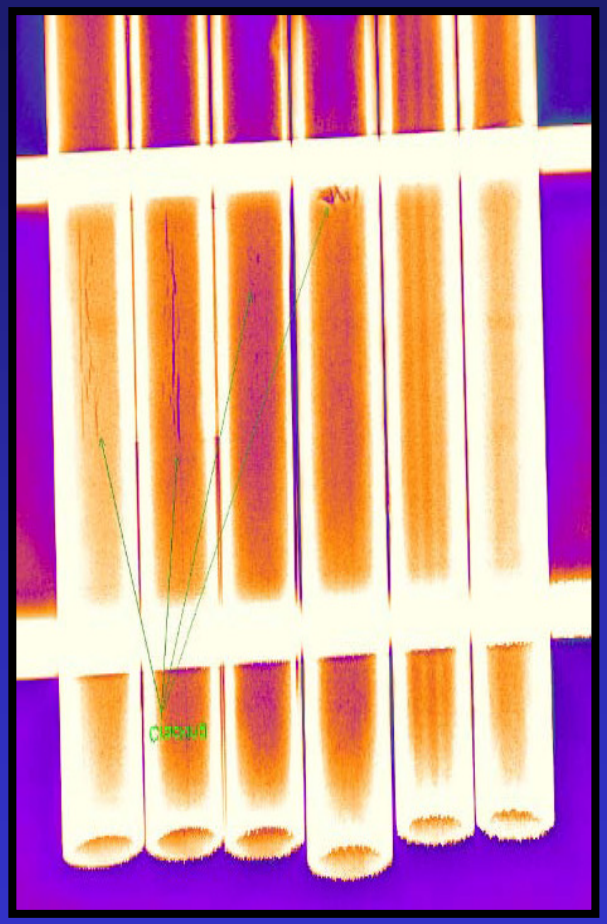
- The human *eye* can distinguish between 200 and 256 *shades of grey* with training.
- Introduction of color expands the number of shades the human eye can distinguish to more than 2.4 million
- Advanced software allows for a more comprehensive detailed review of acquired radiographs by introducing a color pallet





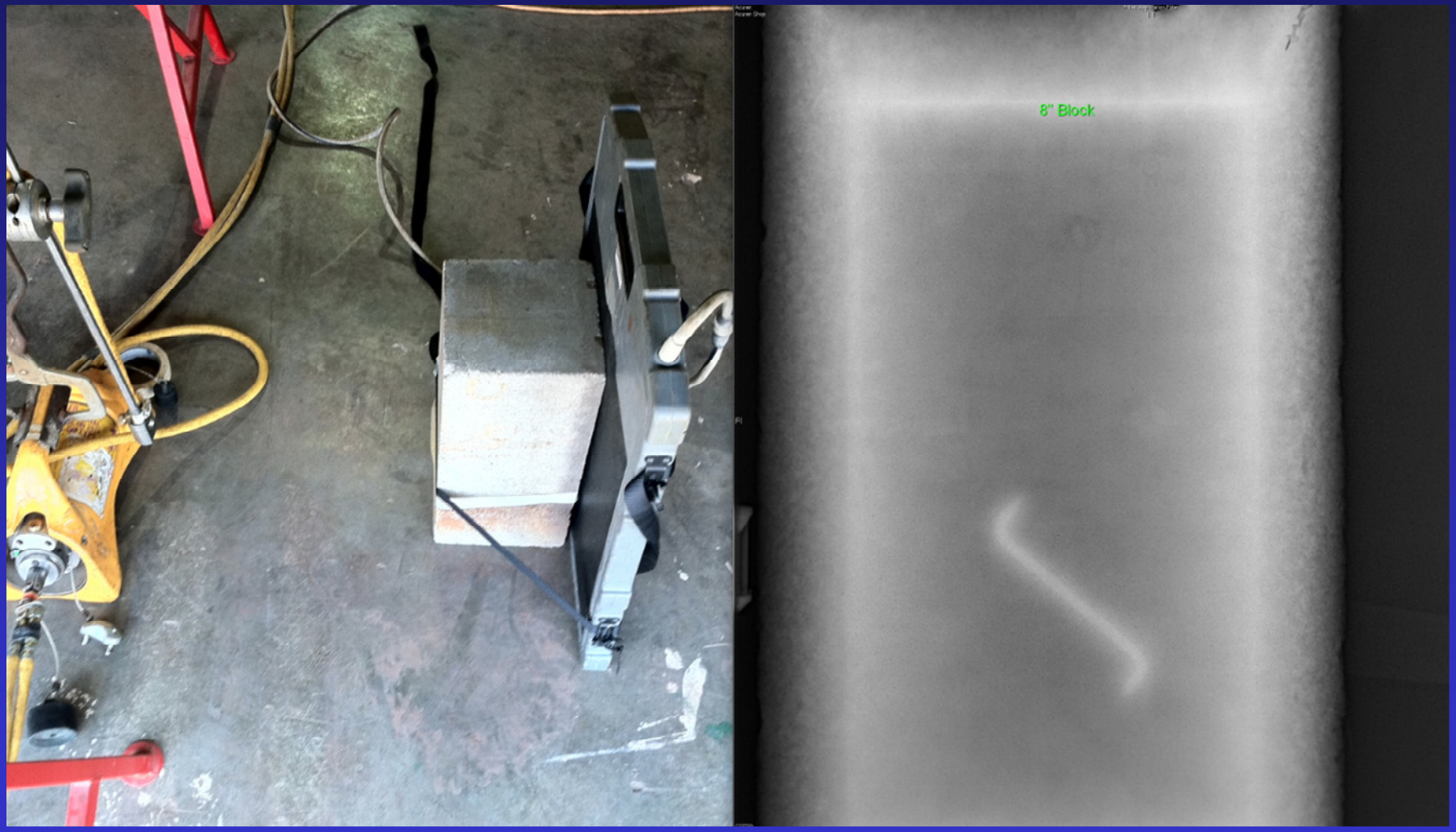
# Boiler Tubes





Thermal Fatigue cracking behind “buckstay” channels
Shot with 8 curies of Se (SCAR camera), 28 second

# Radiograph through concrete

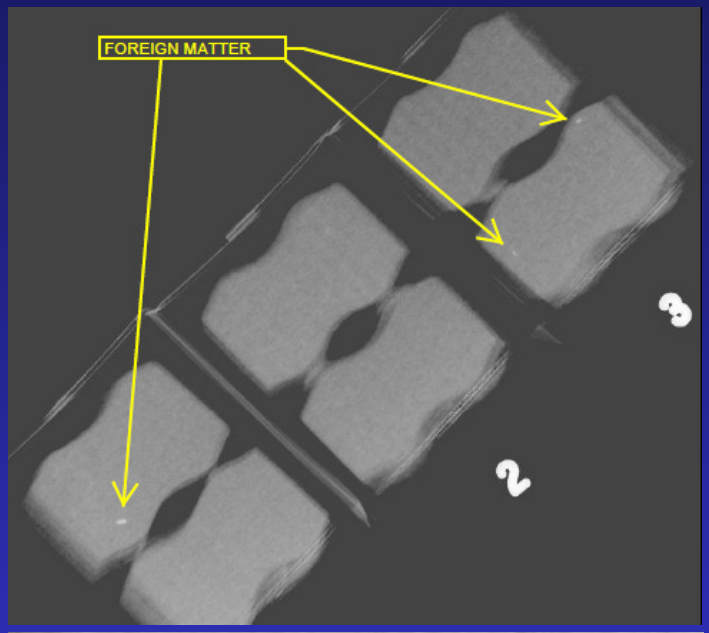


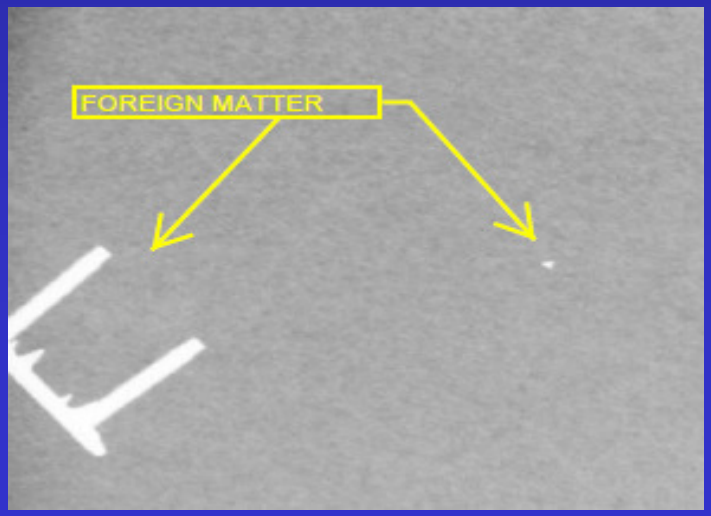

7 ¼” concrete block – shot with 30 curie Ir source
20 second exposure

# Case Study: Foreign Material in Mfg

Problem:

- Manufacturing facility had failure of gears on assembly line process
- Metallic foreign material fell into batter to make sponges
- Customer needed way to rapidly identify whether product was defective or safe to sell




Solution:

- Use of DR application with 80

# Case Study: Water Wall Rebuild

Problem:

- Inspection of 1700 welds (A/B shot = 3400 images) as part of Recovery Boiler wall replacement
  - 2.5” to 3” tubes composite stainless over carbon
- Needed quality of film with production of CR
  - Film / CR would require more shot windows, longer shot windows and all other trades to stop production
- Minimize boiler downtime

Solution:

- Use of AcuView solution (low-energy radiography paired with Digital Radiography)
  - Utilized “Baby SCAR” system (13Ci Se75)
  - Reduced exclusion zone to ~13’ inside boiler and 17’ outside boiler
  - 3 - 15 second exposures per image (13 days total for project)

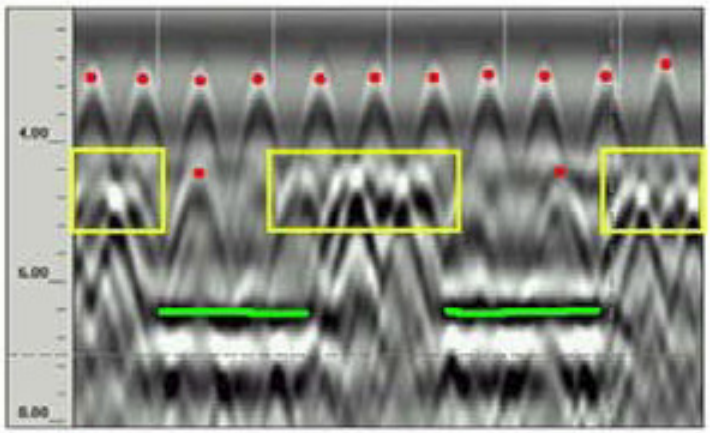
# Case Study: Water Wall Rebuild Cont.

Benefits

- No disruption to welders – using low-energy radiography allowed Acuren crews to work alongside Boilermakers
- ***Elimination of shot windows shortened overall duration of project by ~7 days*** No lag time between inspection and identification of problem
  - Identified porosity issue (53% reject rate) in first 4 hours of inspection due to liquid argon being drawn into pig rigs
  - Switched to gas, project reject rate <4%
  - ***DR saved ~ one day of welding (~300 welds) from having to be redone***

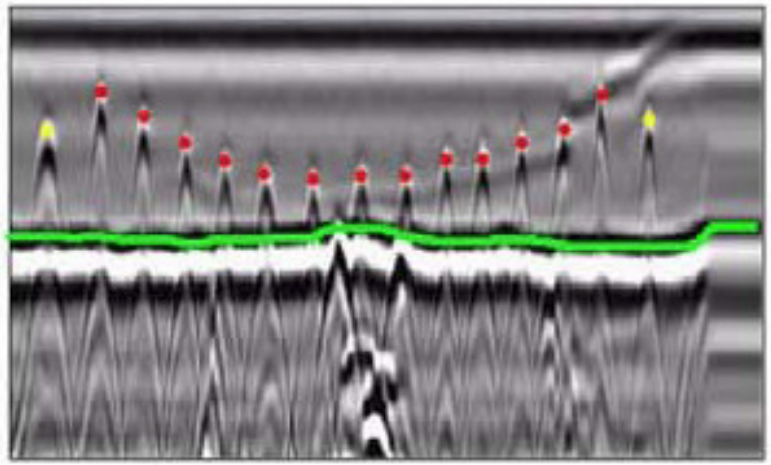
# Ground Penetrating Radar

# 2D GPR View




Rebar
Post tension cable cluster
Bottom of slab

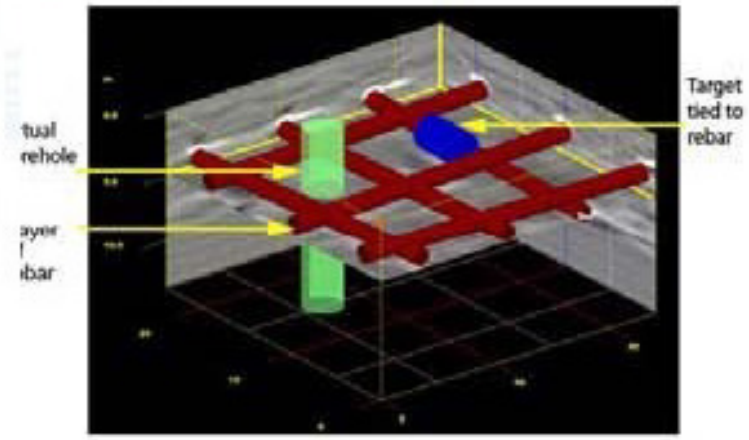
*Data shows a reinforced concrete deck with rebar, post tension clusters and a well-defined bottom of slab.*



Rebar
Post tension cable
Bottom of slab

*Data set shows a well-defined bottom of suspended concrete slab.*

# 3D GPR View

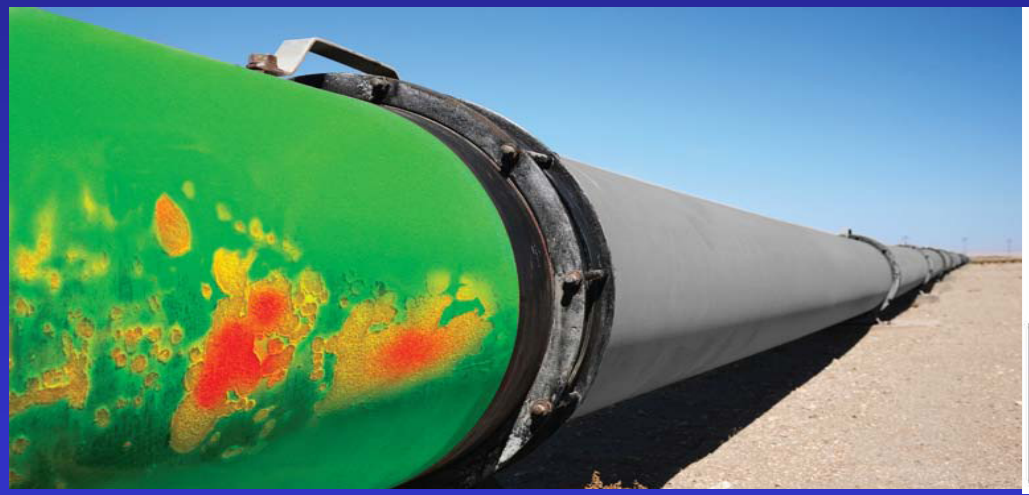


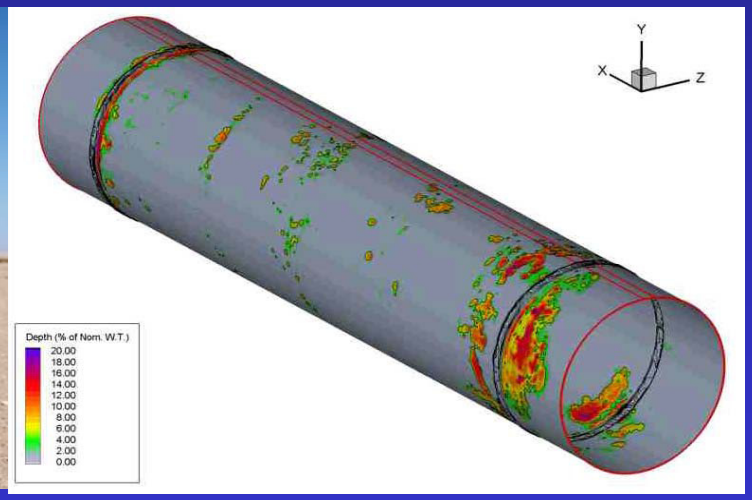

*3D data set (above) showing rebar mat 6 inches on center with a target (labeled in blue) attached to a piece of rebar. 3D data from field (left) - result showing rebar mat.*

# Acuren

## CreaForm

*Corrosion Mapping Tool*





# CreaForm Laser Corrosion Mapping

- The Handyscan 3D laser scanners can be carried on site very easily (**1-kg scanner and laptop only**).
- The scanning speed can be more than **10 times faster** than the pit gauge technique considering the time to setup, inspect, analyze and generate a report.
- The scanner is self-positioned to the pipe. **No need for encoders or bulky mechanical scanners** to reference the data.
- Resulting **dynamic link** between pipe and scanner preserves **accuracy** and **resolution** in any field vibrating environment.
- The quality of the acquired data can be **verified in real time** during the acquisition. The results are **generated in a few minutes**.
- Repeatability of results is ensured by scanner design and auto-generated reports (within a **± 50 micron accuracy**).
- **Inspector's skill level** has no impact on scanning process and analysis
- Follows code regulations **(ASME B31G code)**

# Complete Inspection Solution

- Handyscan 3D laser sc
- Pipecheck software
- Reference arrow
- Field Pack and laptop
- Carrying case
- OEM training course

# Work Experience

## Canadian Prairies Dig

# Work Experience

## Corroded Pipe on Bridge

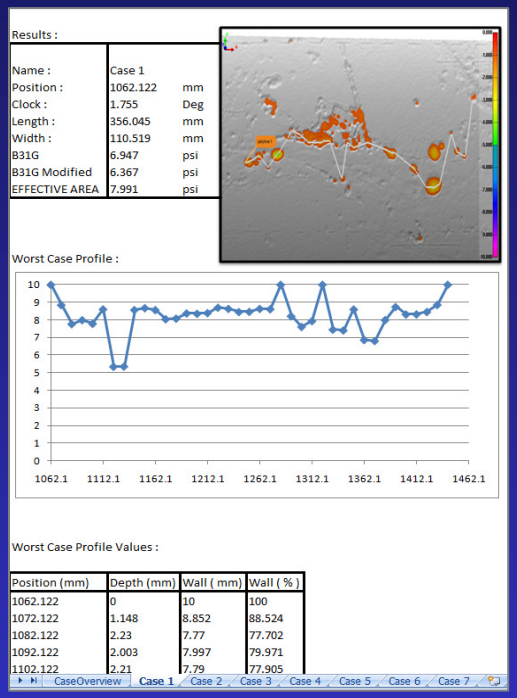
# Work Experience

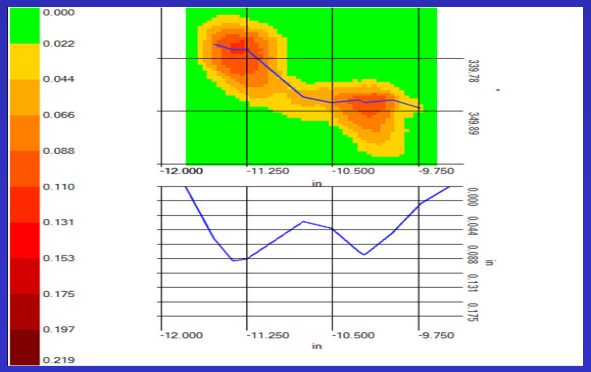
## Riser Examination

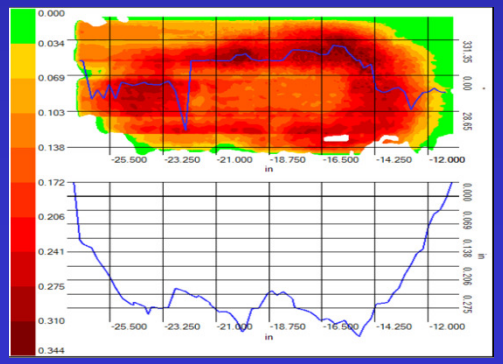
# Reporting/Results

## Auto-generated Excel report

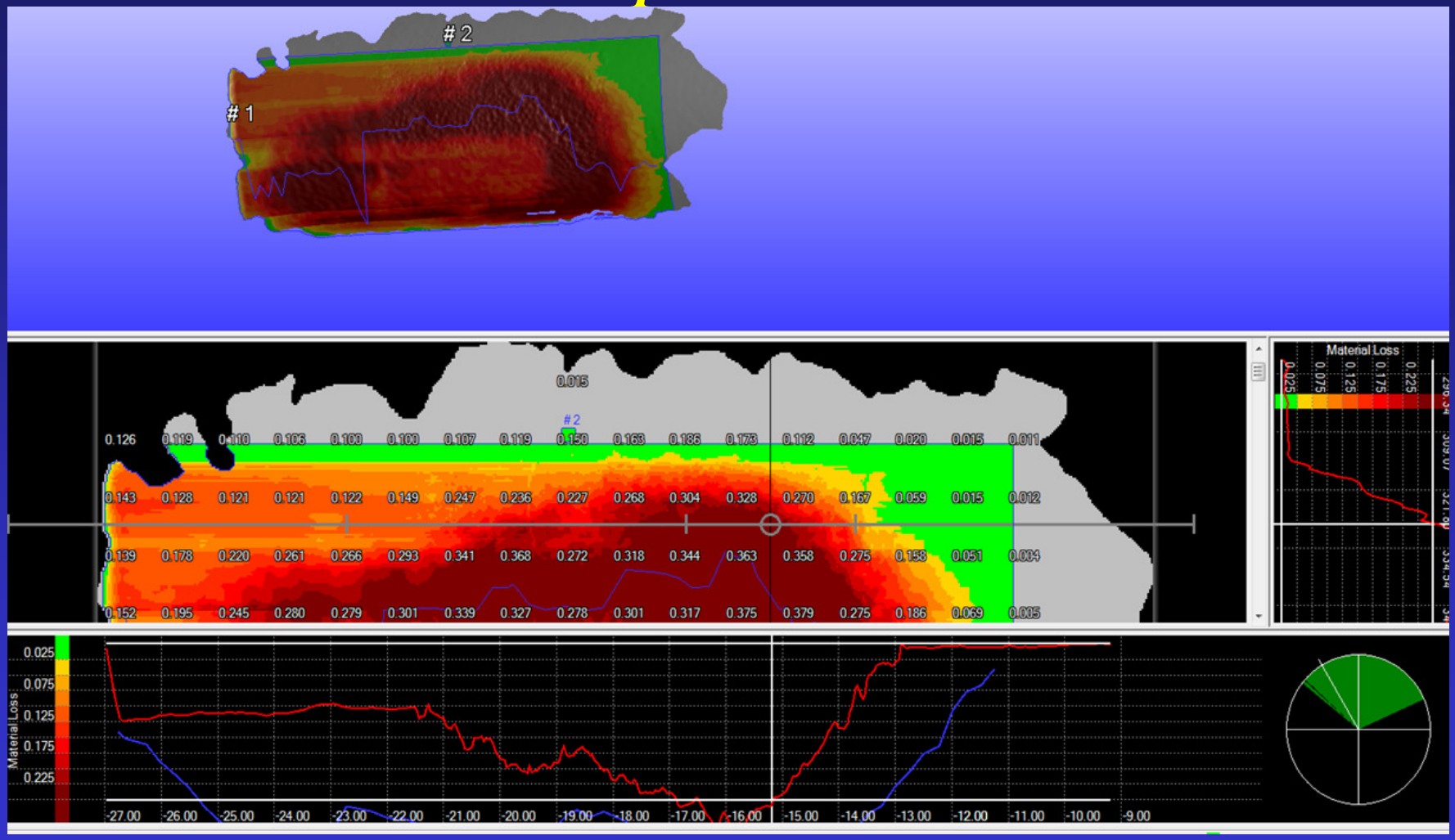
- Burst pressure (3 methods)
- Maximum depth
- Dimensions
- Position
- Color map
- River-bottom path overlay
- Worst case profile (pipe axis)
- Interaction rules applied



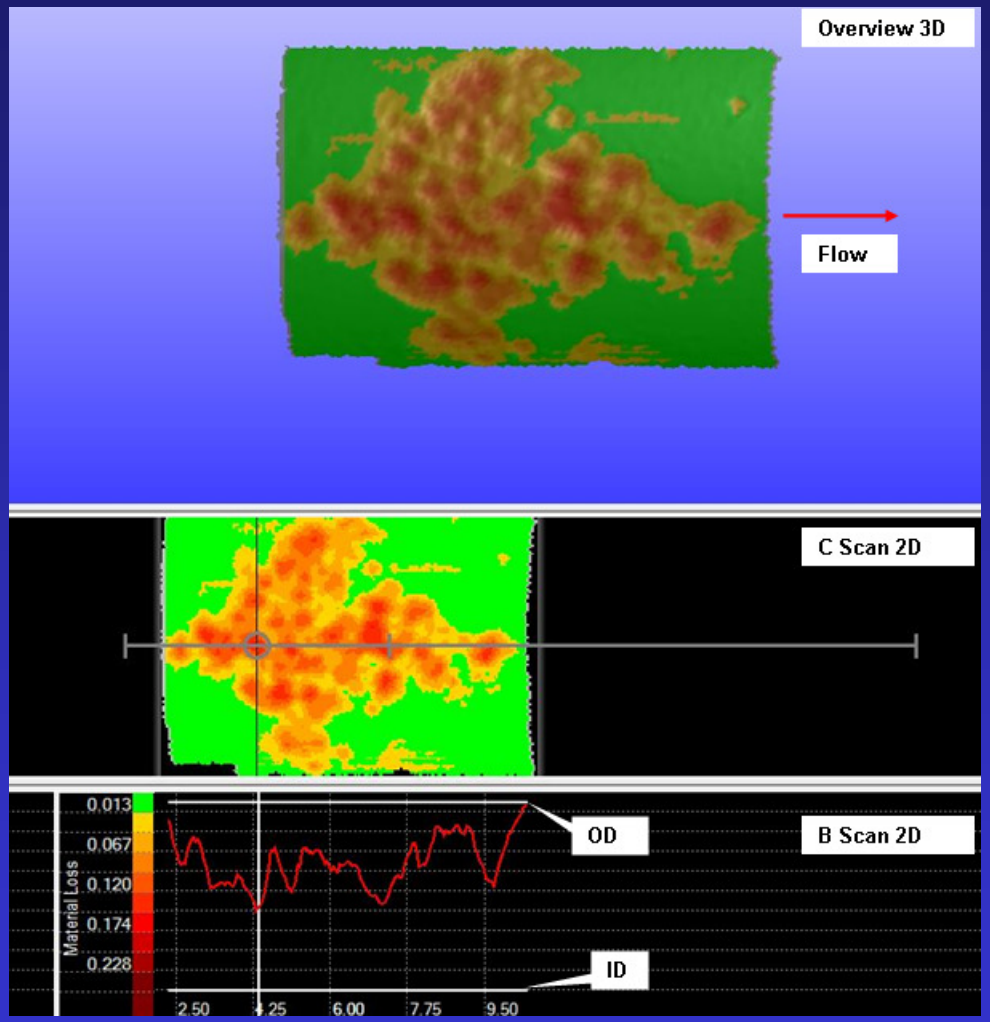



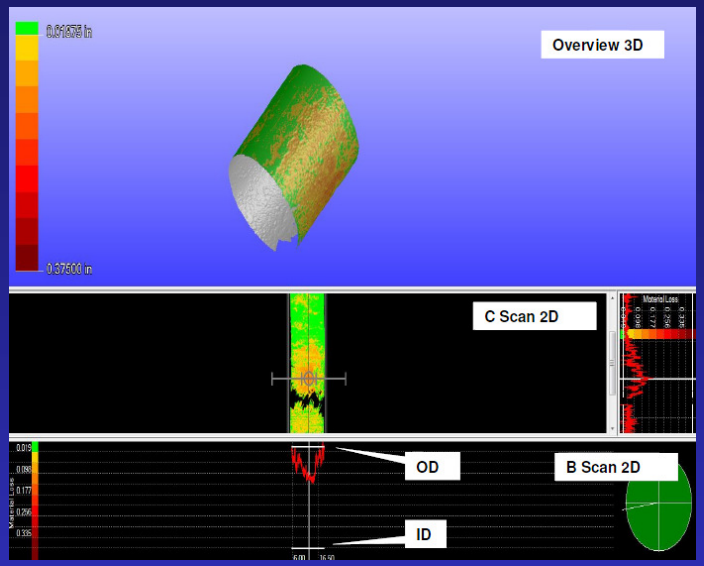


# Example – *Severely Corroded Pipe*

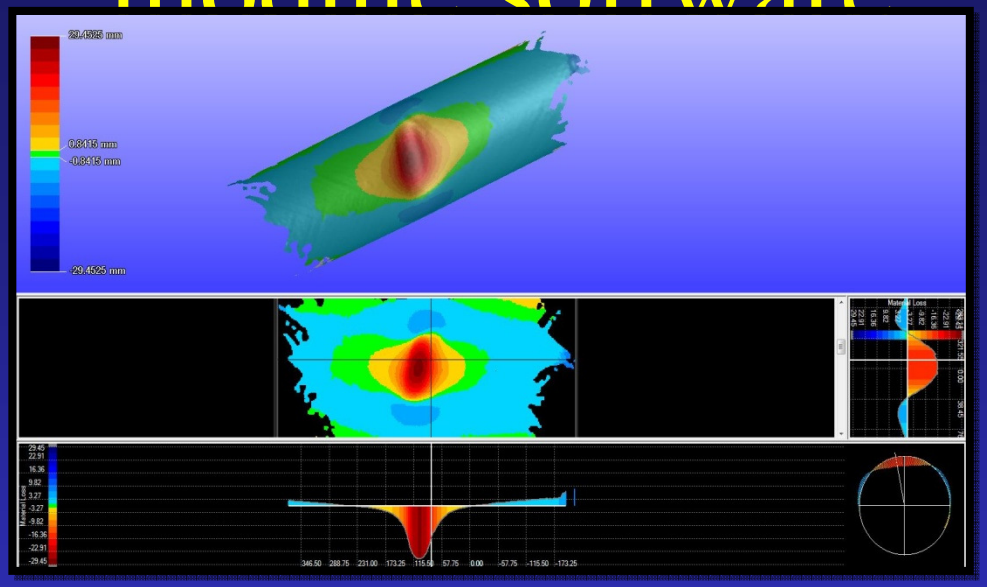


# Example – *Localized Corrosion*



# MECHANICAL DAMAGE module software




- Radius measurement.
- Maximum depth measurement using straight edge technique in both directions.
- Automatic maximum depth detection.
- Automatic creation of 2D cross-sections in both directions at maximum depth.
- Intuitive cross-section creation tool.
- 3D and 2D color mapping of damaged area.
- Visualization tool to increase dent shape understanding.
- Depth-over-diameter ratio.
- Maximum diameter at 90 degrees of the dent.
- Length and width measurement for each dent.
- Multiple dent analysis.

# ROPE ACCESS OVERVIEW

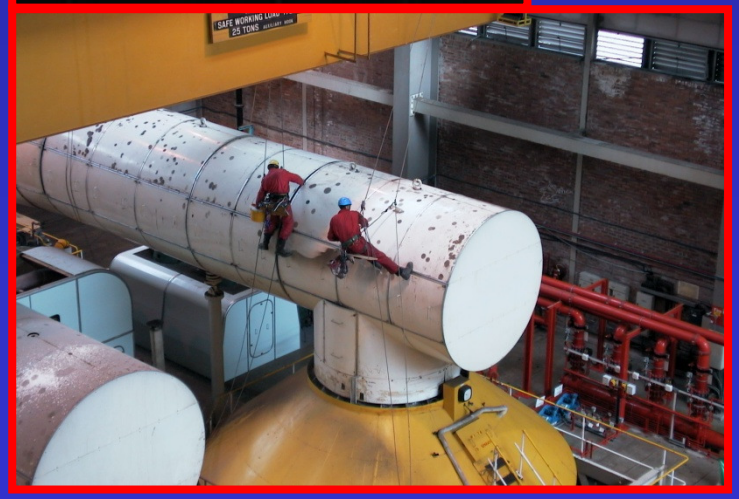
Over the last few years the implementation of a controlled Industrial Rope Access program has become an accepted tool in implementing a low risk strategy for working in high and difficult to access areas.

Rope Access is used for accessing and carrying out work in difficult to access areas that would otherwise absorb a disproportionate amount of money to complete using traditional access means

Rope access is a flexible alternative to scaffold, swing staging and personnel baskets.

# WHAT IS ROPE ACCESS ?

- Rope access is a twin line (rope) system of work positioning with a 100% redundancy factor
- Rope access uses Industrial climbing equipment
- Technicians both access the work site and perform the task



# Equipment: Harnesses

Multi-purpose harness w/chest ascender attached.

- ANSI Z359.1
- CSA Z259.10

Comfortable for suspension

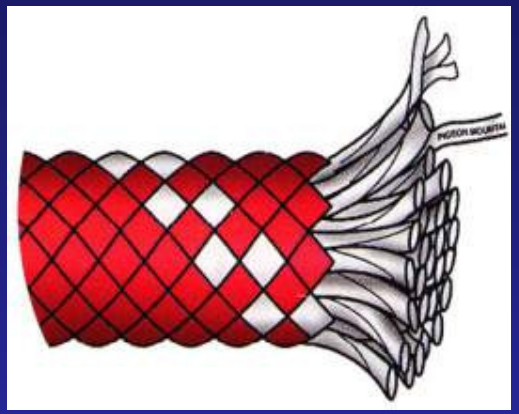
Durable for heavy work

Suitable for use in rope access and for fall protection

# Equipment: Ropes & Slings

Rope access ropes must be made of synthetic fibers (e.g. nylon and polyester) and be of “kern mantle” design.

- Composed of an inner core (kern) wrapped by a woven nylon sheath (mantle)
- Core provides the majority of the rope’s strength
- Sheath serves to protect the core

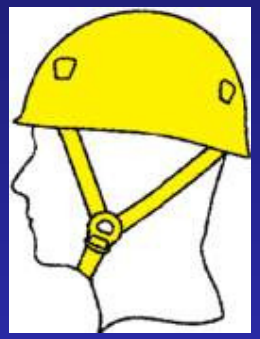


Many industrial sites require using wire rope slings for establishing anchor points.

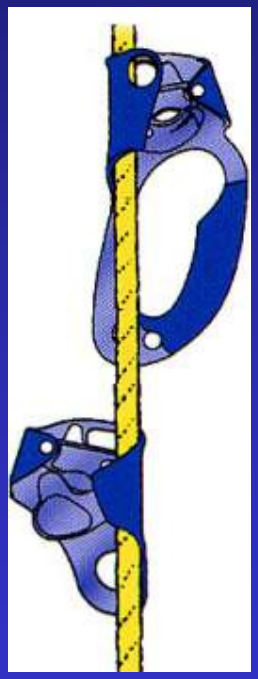
- Good resistance to damage from sharp edges, chemicals and heat
- Swages (ferrules) create soft eyes on either end, allowing the sling to be used end-to-end, in basket configuration, or choked (girth-hitched).

# Equipment: “Hardware”

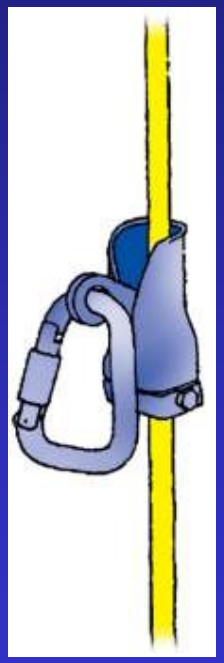
**Industrial Climbing Helmet**



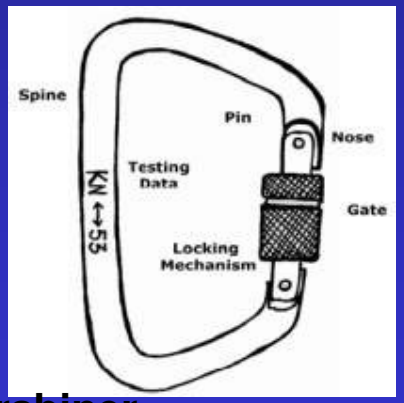
**Hand & Chest Ascender**



**Safety back up device**

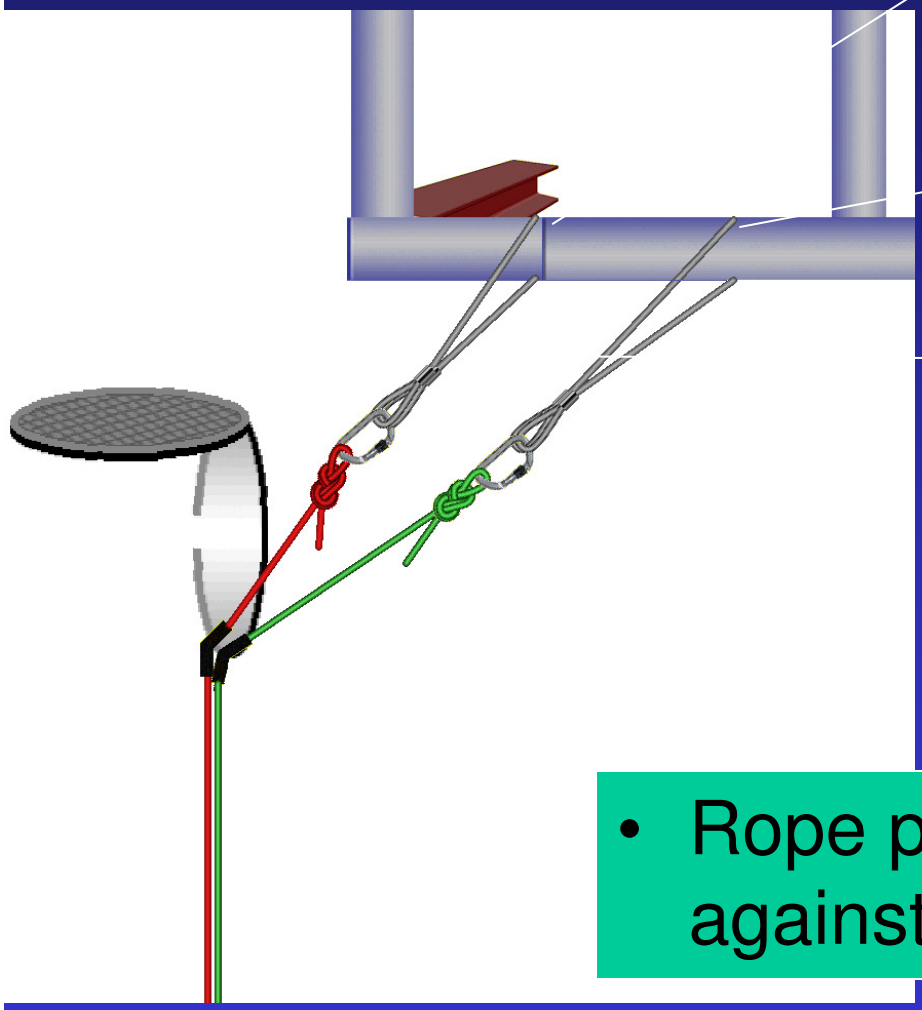


**ID & Stop Descenders**




**Carabiner**

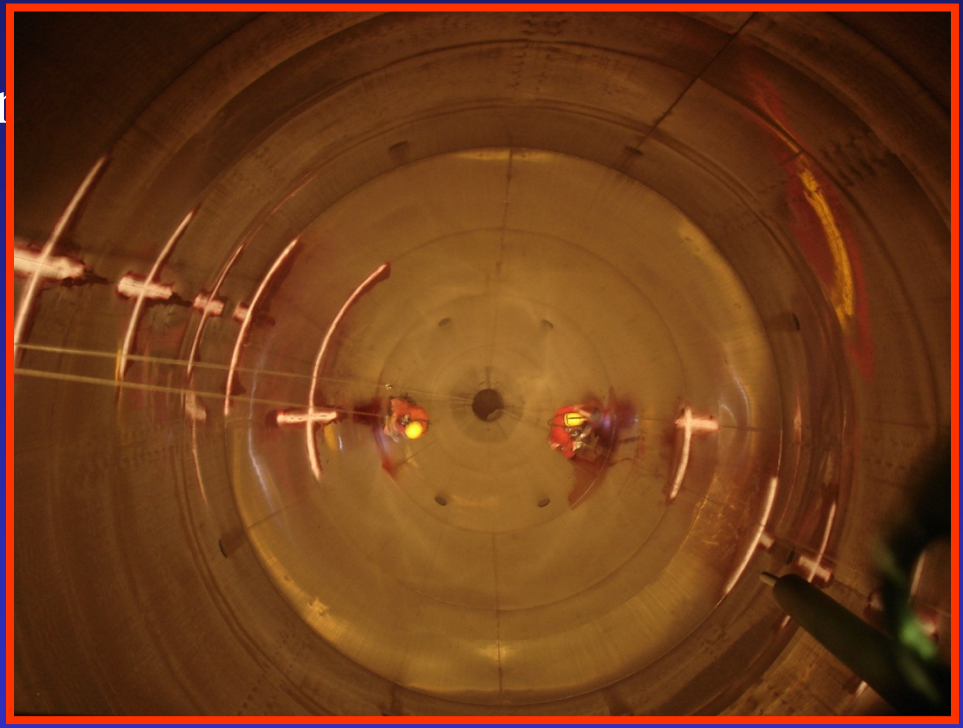
# Equipment: Anchor Rigging Example



- Two independent anchor systems 100% redundancy
- Wire slings for abrasion / temperature resistance
- Rope protection to protect ropes against abrasion and edges

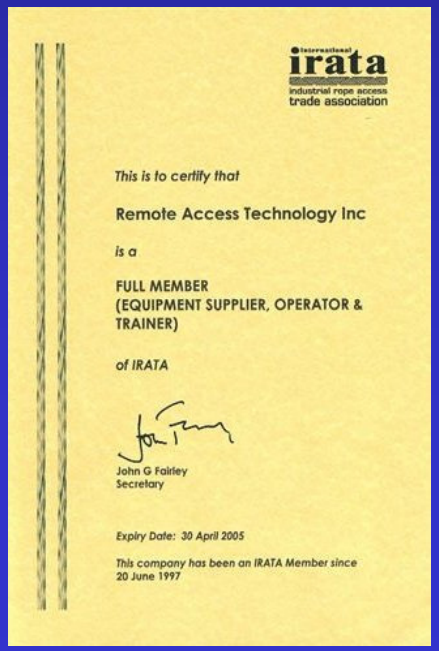
# THE BENEFITS OF ROPE ACCESS

- A rope access team will often accomplish tasks in hours which may take several days using conventional methods
- Rope access can put fewer people at risk for less time
- There is less interference with ongoing operations



# COMPLIANCE TO INTERNATIONAL STANDARDS

- The Industrial Rope Access Trade Association (IRATA) is established as the world's leading authority on industrial rope access.
- The association's aim is the national and international promotion and development of the safe system that it has pioneered over the last decade.
- IRATA aims to support its member companies and trained technicians and to ensure that they work in a safe and effective manner.



international irata industrial rope access trade association

*This is to certify that*

Remote Access Technology Inc

*is a*

FULL MEMBER
(EQUIPMENT SUPPLIER, OPERATOR & TRAINER)

*of IRATA*

John G Fairley
Secretary

*Expiry Date: 30 April 2005*

*This company has been an IRATA Member since 20 June 1997*

- IRATA ensures compliance by;
- Audits of company procedures for rope access work
- Audits of equipment regime for maintenance, inspection and logging of equipment
- Provision of independent assessment and certification of technicians
- Ensuring the level of safety supervision is of the highest quality through its rigorous level 3 training program and assessment criteria

# COMPLIANCE TO INTERNATIONAL STANDARDS

- 3.86 million hours worked around the world
- Incident rate 1.30 per 100000 hours worked
- Now more than 200 member companies
- Only five injuries officially classed as ‘Major.’
- **1 Fatality (July 2011 Under investigation)**

# Rope Access: System Hierarchy

Un regulated rope access companies

Unverified Training ??? Documentation ?

Processes?

Un regulated rope access schemes

SPRAT – SAIRAA – ARAA

Unverified voluntary guidance & associated Personnel certification schemes

Regulated rope access

IRATA

Comprehensive rope access system

3rd party audited 3rd party certification scheme & assessments

**RAT**, rope access meets and exceeds the SPRAT and IRATA standards

- RAT is regulated by IRATA for operations and training
- ISO QMS system
- Provincial Constructors Safety Assoc. certified AB NS NL*
- OSHA 30 supervisors for all teams in the USA

# SPRAT IRATA GAP

**SPRAT IRATA Organizational Review**

•Membership criteria

•Company Audits

•Accident and incident data

**RAT Position Organization perspective**

The lack of incident data collection and analysis compromises the safety claims made by the SPRAT rope access system - the lack of membership criteria / control and audit of the membership means RAT will not currently use the SPRAT system of work as a stand alone system to support our organization

**Technical review of SPRAT IRATA rope access Codes of Practice**

•Lack of appropriate supervision

•Lower levels of experience

•SPRAT allows single line use

•Lack of training criteria and control

•Entry to SPRAT 2 and 3 allows access for rope workers with no industrial experience

•Lack of advanced rigging in SPRAT

•No true independent assessment at L1

**RAT Position Training and Technical Perspective**

The practical & technical requirements for skills training and evaluation is lower for the SPRAT scheme in comparison to the IRATA system RAT will not currently use the SPRAT training / guidance and system of work as a stand alone as it would import risk into the rope access operations

# Trades and Qualifications

- Engineers
- Welders
- Asbestos Handlers
- Electricians
- Draftsmen
- Mechanical Engineers
- Civil Engineers
- Multi Disciplined NDT Inspectors
- Painters
- Jetting Operatives
- Insulators
- Brick Layers
- Pipe Fitters

# Benefits of Rope Access

- Why should I bring rope access to our plant, we have done it with scaffolding for years
  - Scaffolding has it's place, but generally it is a disproportionate cost to the value of the work being done.

# Cost Comparison 1

Project Scope
Inspect Five Coal Bunkers – Repair two Coal Bunkers

(Inspection, Sandblasting, Reinforcement Wire Repair, Gunite Application)

| Scaffolding Method | | Rope Access Method | |
|---|---|---|---|
| Scaffolding | $100,000 | Rigging | *included* |
| *(rental, install, removal, etc.)* | | | |
| *Project Work* | 35,000 | *Project Work* | |
| *TOTAL* | | $53,800 | |
| $135,000 | | *TOTAL* | |
| | | $53,800 | |
| Down Time (days) | 14 | Down Time (days) | 5 |

Summary

Selecting RAT saved the client over $80,000 and 9 days of down time.

# Cost Comparison 2

Project Scope
FGD Nozzle Cleaning

| Scaffolding Method | | Rope Access Method | |
|---|---|---|---|
| Scaffolding | $ 91,000 | Rigging | *included* |
| *(rental, install, removal, etc.)* | | | |
| *Project Work* | 30,000 | *Project Work* | |
| *TOTAL* | | *$51,000* | |
| $121,000 | | *TOTAL* | |
| | | *$51,000* | |
| Down Time (days) | 10 | Down Time (days) | 10 |

Summary

Selecting RAT provided cost savings to the client of $70,000.

# Cost Comparison 3

Project Scope
Boiler De-slag

| Scaffolding Method | | Rope Access Method | |
|---|---|---|---|
| Scaffolding | $150,000 | Rigging | *included* |
| *(rental, install, removal, etc.)* | | | |
| *Project Work* | *75,000* | *Project Work* | |
| *TOTAL* | | *$85,000* | |
| *$225,000* | | *TOTAL* | |
| | | *$85,000* | |
| Down Time (days) | 9 | Down Time (days) | 4 |

Summary

Selecting RAT saved the client over $140,000 and 5 days of down time.

# Understanding the overall cost

The overall time savings for the project will be 42% faster.

The overall project cost will be 60% less, not including down time.

# Pulp and Paper

- What is your safety record, do you have any lost time incidents? Our plant isn't like the others, we take safety seriously.
  - The safety of our industry has to be looked at from both the industry standard and as an individual company.
    - IRATA – is the only association that collects statistics from member companies.

# IFR - US

| Safety Performance | | | Incidents | | | |
|---|---|---|---|---|---|---|
| Year | TRIF | Total Hours | Loss Time | Medical | Restricted Work | Fatalities |
| 2008 | 0 | 49,432 | 0 | 0 | 0 | 0 |
| 2009 | 0 | 66,135 | 0 | 0 | 0 | 0 |
| 2010 | 0 | 92,597 | 0 | 0 | 0 | 0 |

Calculation : (# Recordable x 200,000)/Exposure Hours

No incidents are IRATA Reportable

# EMR

| EMR: US | |
|---|---|
| Year | EMR |
| 2009/10 | .87 |
| 2010/11 | .78 |
| 2011/12 | .75 |

# Sample Works – Pulp & Paper

| Client | Location / Site | Description |
|---|---|---|
| Northern Pulp | New Glasgow, NS | Black Liquor Tank Insp. |
| Northern Pulp | New Glasgow, NS | Economizer Insp. |
| Northern Pulp | New Glasgow, NS | Mechanical Repairs |
| Canfor Pulp | Prince George, BC | Bleach Tower Tile Insp. |
| Canfor Pulp | Prince George, BC | Support for 'Recovery A' |
| Canfor Pulp | Prince George, BC | Precipitator 'C' Insp. |
| Domtar | Kamloops, BC | Oxygen Reactor Internal Insp. |

# Sample Works – Pulp & Paper

| | | |
|---|---|---|
| Skookumchuck | Skookumchuck, BC | Black Liquor Tank Insp<br>Mechanical Repairs |
| DMI | Vancouver, BC | Digester Insp and Repairs<br>Impregnation Vessel Inspection |
| International Paper | Selma, Al | Maintenance and Repair |
| International Paper | Savannah | Tank Inspections |
| Howe Sound Pulp | Port Mellon, BC | Storage Tank Insp. |
| Mackenzie Pulp | MacKenzie, BC | Surge Tank Inspections |
| Verso Paper | Norway, MI | Vapor Trail Line, UT Inspection |
| Weyerhaeuser | New Bern, NC | Chip Silo Inspections |

# Sample Works - Electrical

Cable Pulling

Traywork

Ladder racking

Panel installation

Re Lamping

Replace/Repair/Renew lamps

Fire and gas detection systems

Installing

Replacing

Upgrading

Extending

Maintaining

Inspection

# Sample Works - Electrical

Hazardous Area ‘Ex’ inspections

Satellite Dish Installation — Installation of dishes and associated wiring

Lightning Conductors — Installation/repair of lightning conductors

Additional items

Deluge Testing, Replacements, Repairs

# General Photo’s

2006 6 2

# Installation of Acoustic Emission Wave Guides

# Cleaning FGD Nozzles

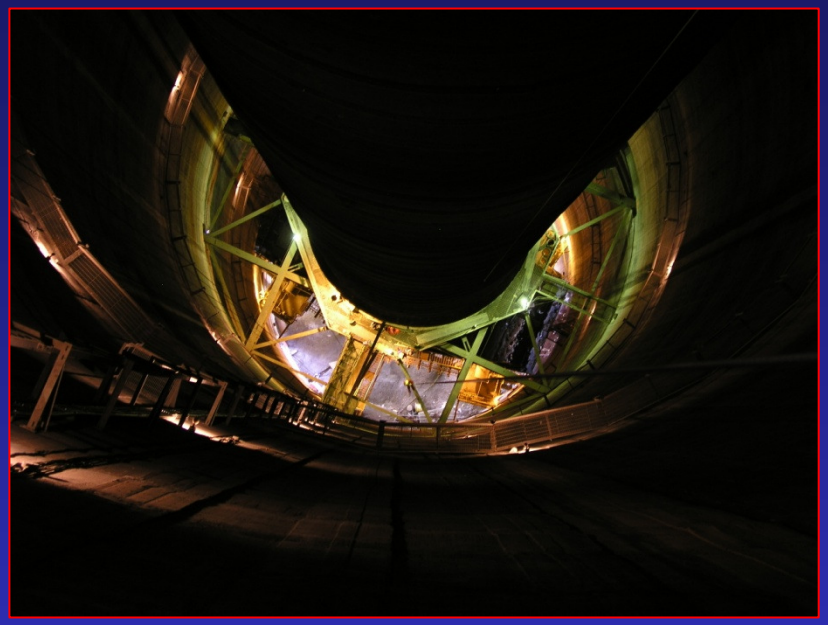
# Replacing FGD Piping

# Cladding Repairs

# SCR Inspection and Repair

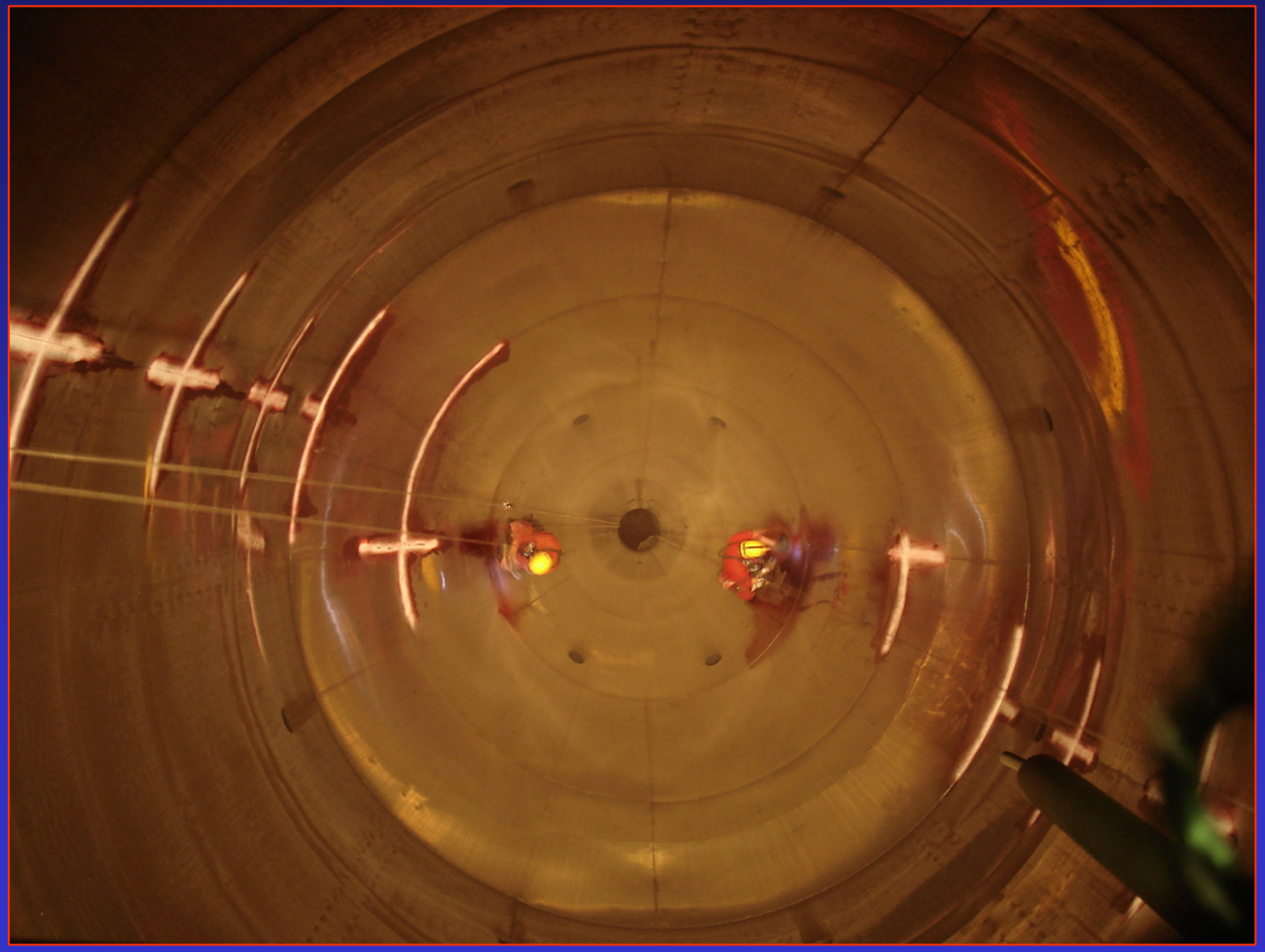
# SCR Repairs

# Stack Inspection/Repair



# Stack Repair

# Coal Silo Inspections



# Coal Bunker Inspection/Repair

# Boiler Inspections

# Boiler De-slagging

# Ceiling Fan Replacement Project

# Ceiling Fan Replacement Project

# Working in an IDLH Atmosphere

# QUESTIONS