به نام خدا

مرکز دانلود رایگان
مهندسی متالورژی و مواد

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TECHNOLOGY

Senior Welding Inspection

NDT & Visual Inspection

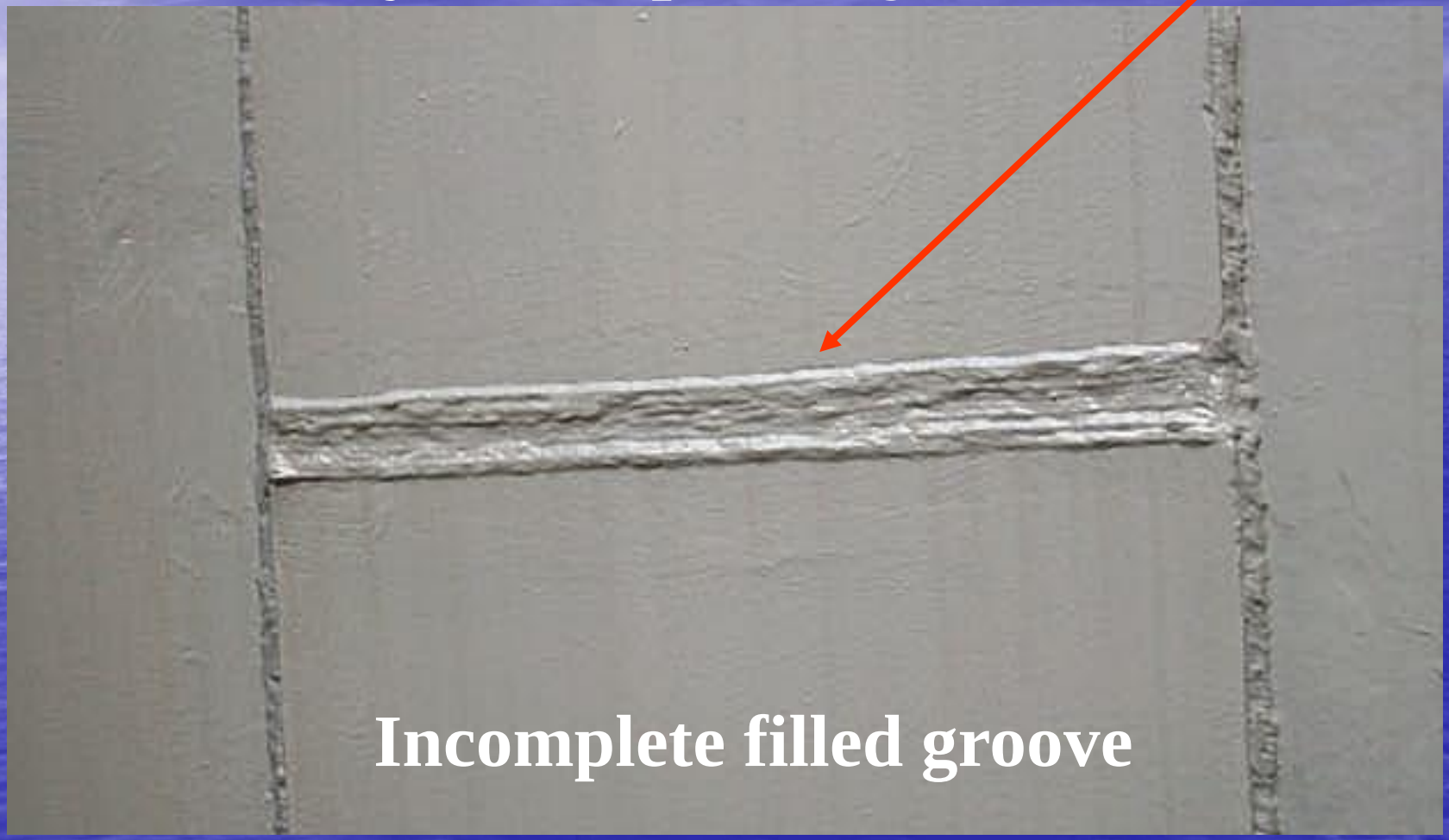
Course Reference WIS 10

TECHNOLOGY

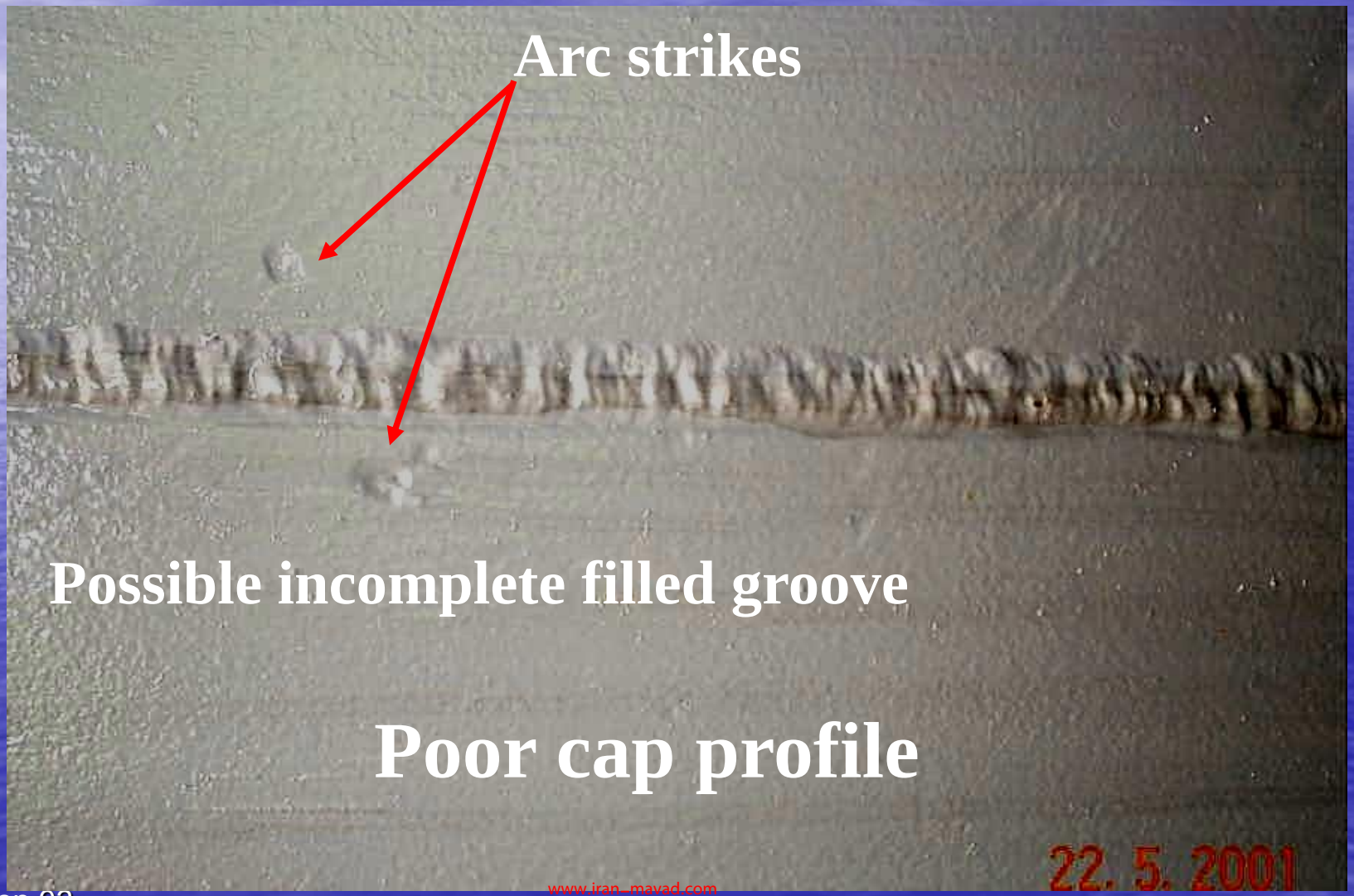
Basically a revision area

TECHNOLOGY

Would you accept or reject this weld?



Incomplete filled groove



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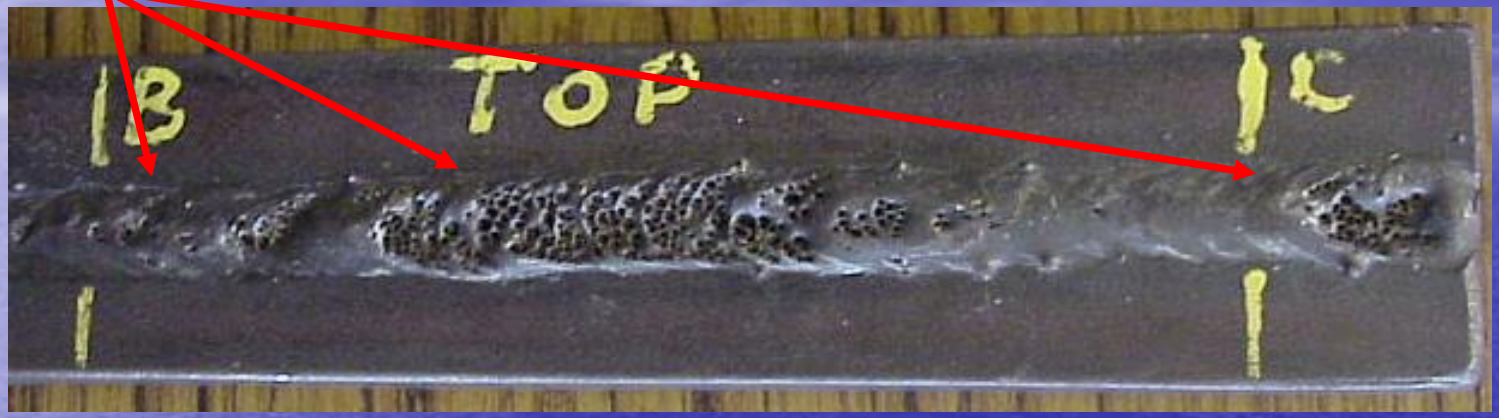
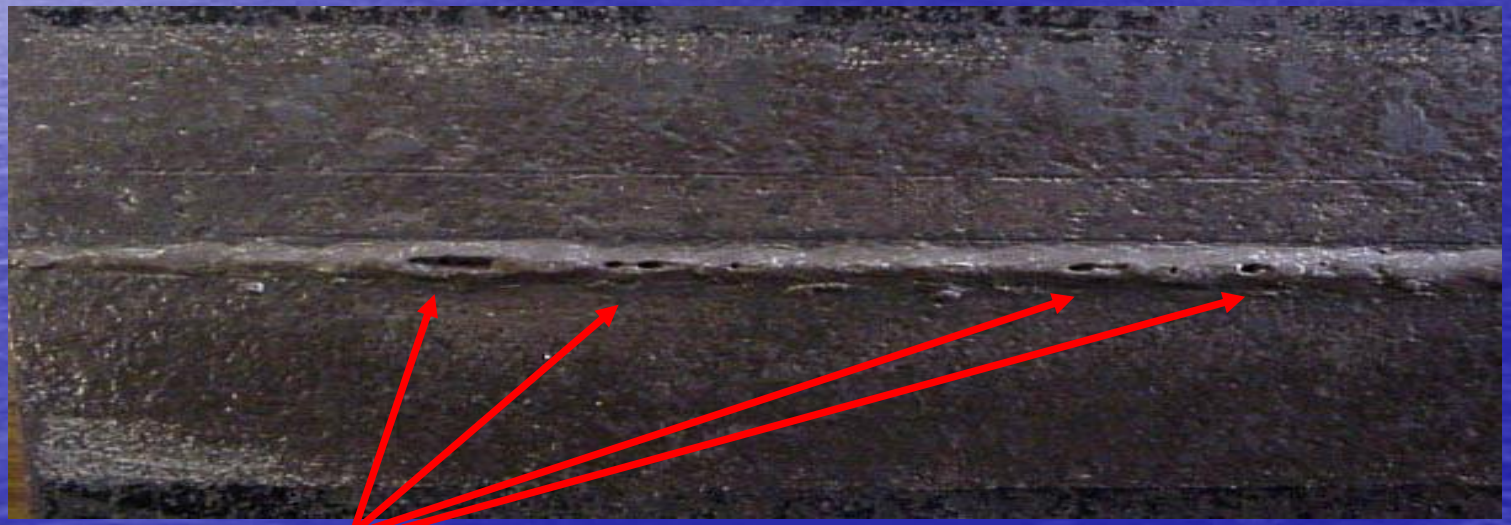
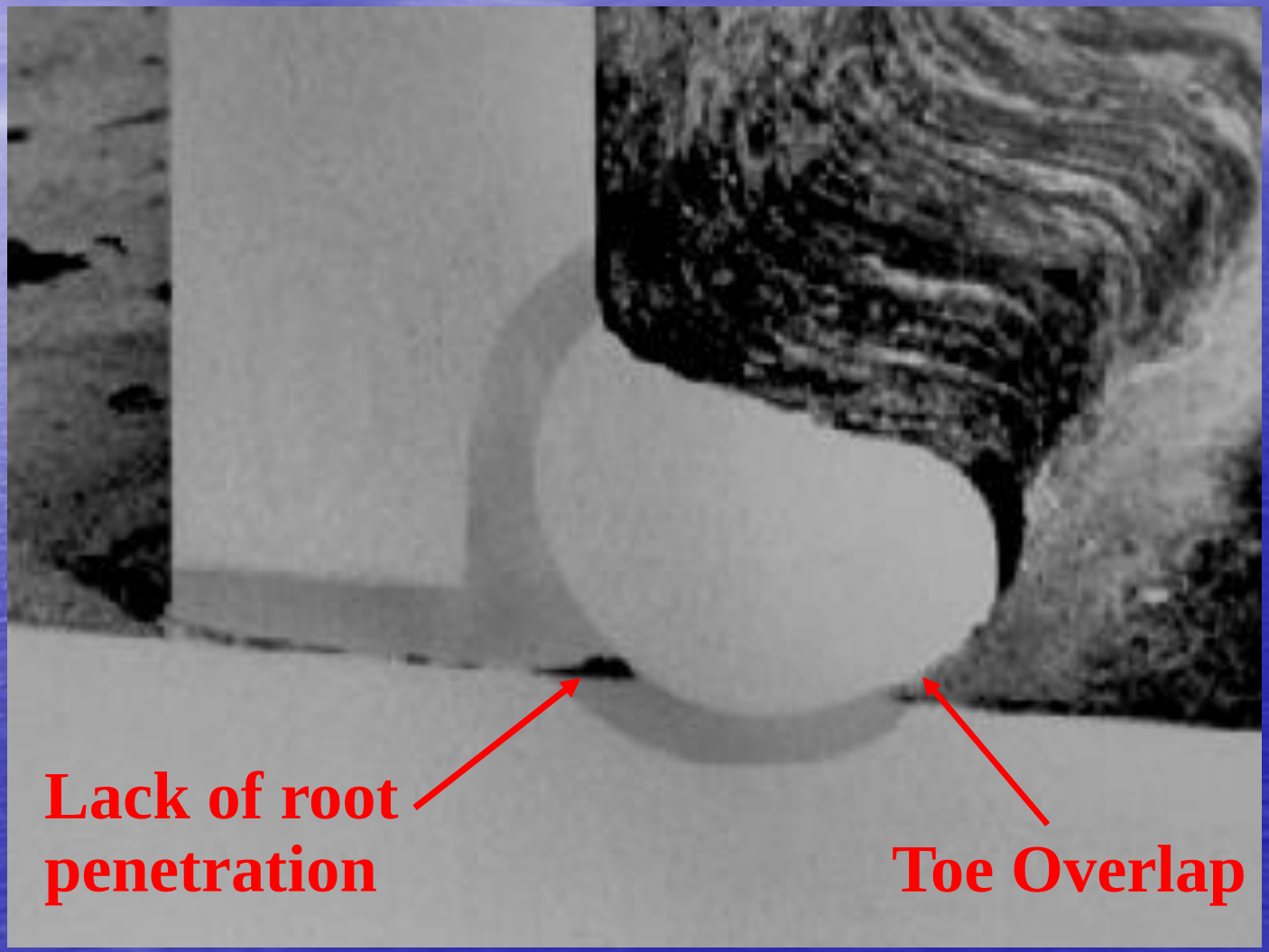
Porosity





Root piping (hollow bead)



Lack of root fusion

Lack of root Penetration

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Poor stop/starts

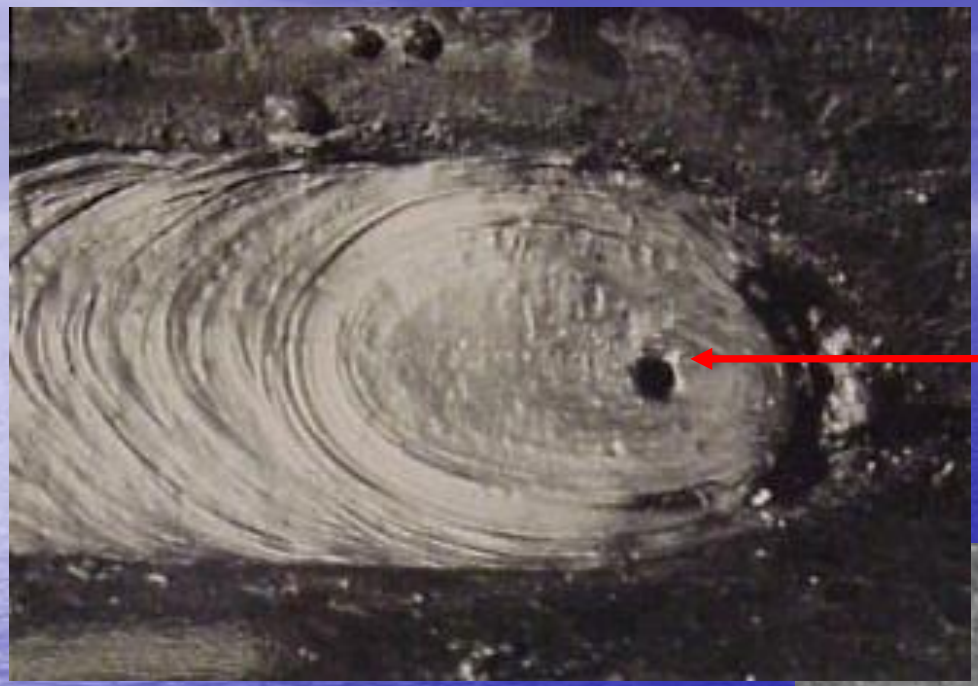
Cap undercut

TECHNOLOGY

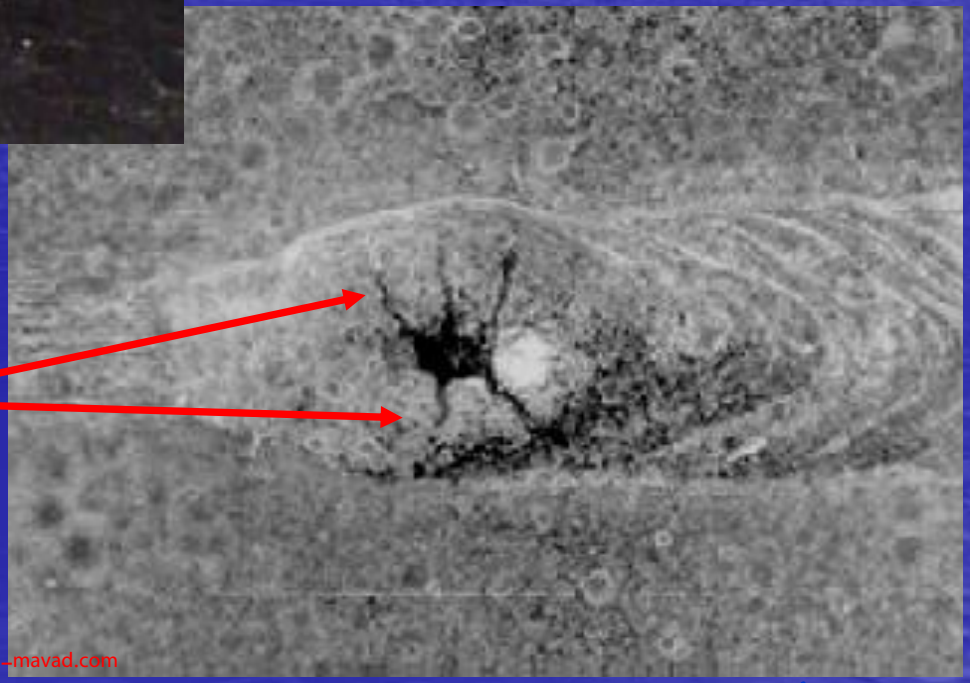
Concave Root

TECHNOLOGY

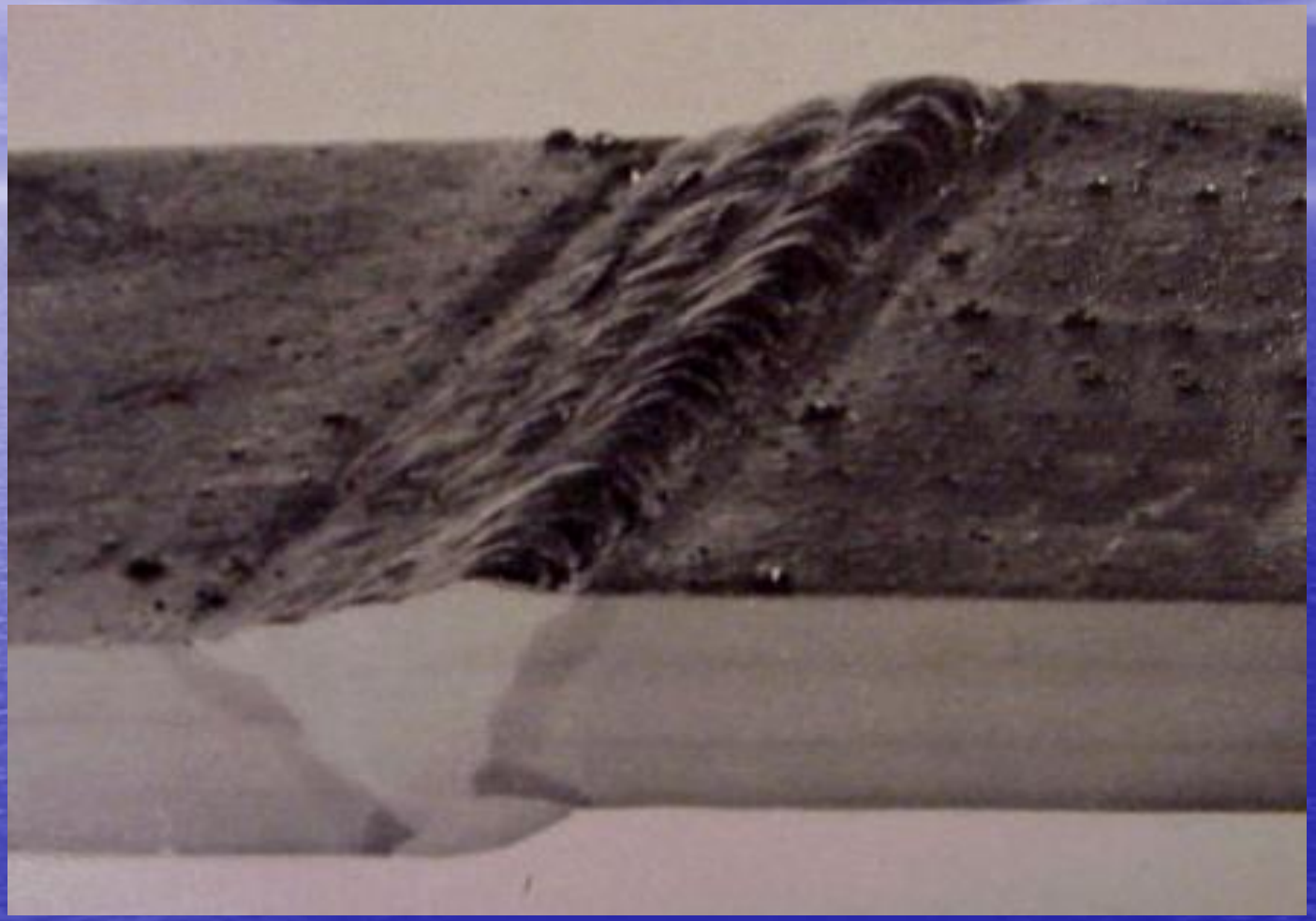
Burn Through



Crater pipe

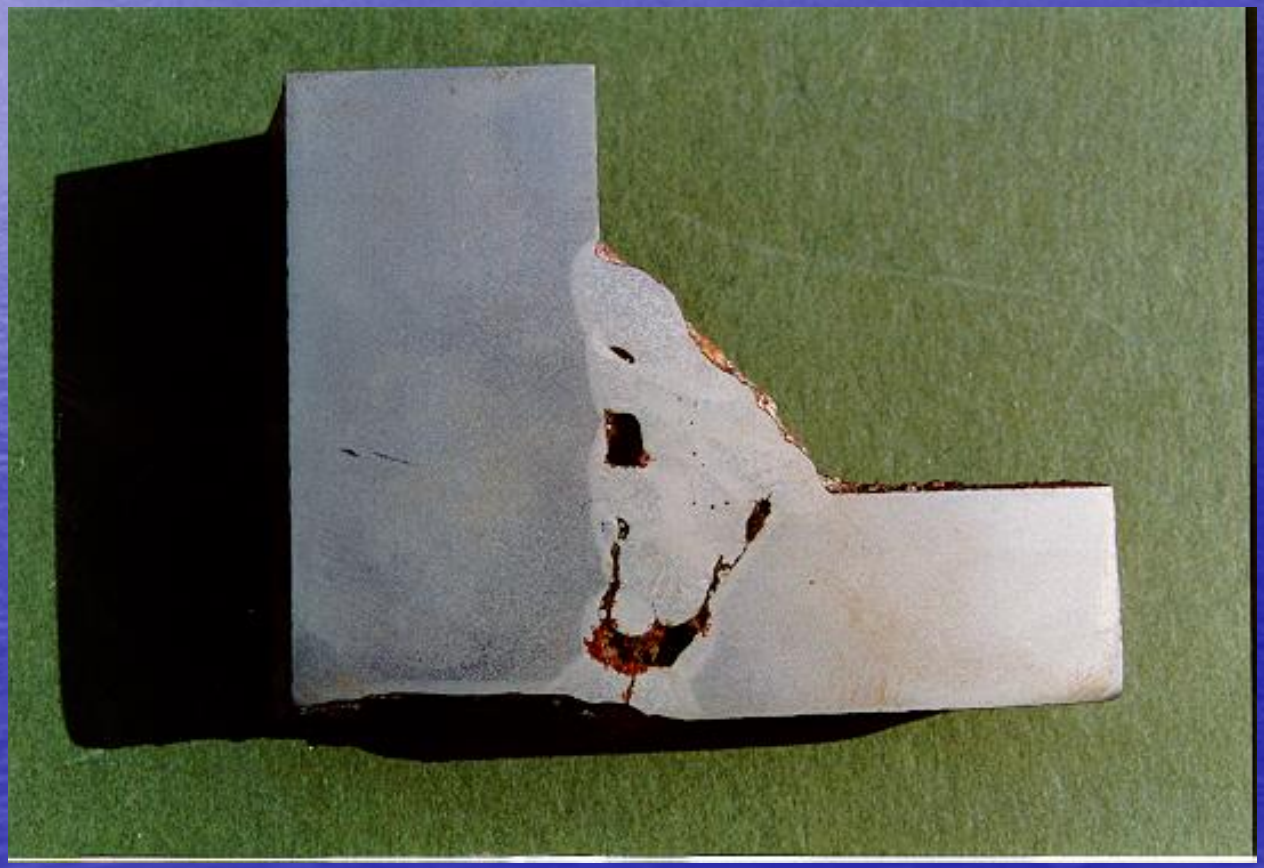


Crater cracks



Linear Misalignment

WHAT WOULD A VISUAL INSPECTION OF THIS WELD REVEAL?



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SO:

HOW USEFUL IS VISUAL INSPECTION OF WELDS?

There are 4 main things limiting its effectiveness:

What are they?

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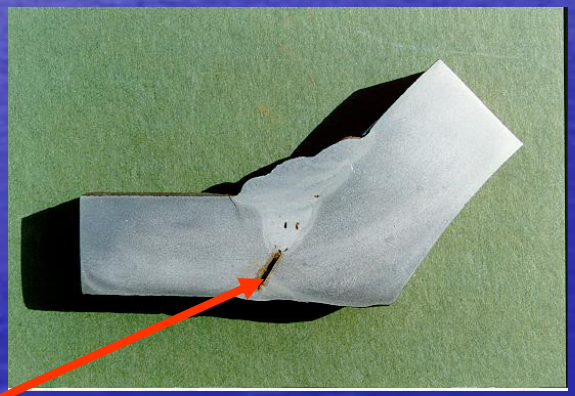
THE EFFECTIVENESS OF VISUAL WELD EXAMINATION IS LIMITED BY:

1. Different codes and standards

BS 5289



2. The nature of weld defects themselves: (they are not all on the surface)

3.Problems with interpretation (people see things differently)

What's No. 4?

Clue

M.S.Rogers

CLUE

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4. VISUAL INSPECTION DOES NOT ALWAYS REVEAL ALL SURFACE DEFECTS

IT'S NOT AS SENSITIVE AS NDT

TECHNOLOGY

The four basic methods

- Magnetic particle inspection (MT)
- Dye penetrant inspection (PT)
- Radiographic inspection (RT)
- Ultrasonic inspection (UT)

- Surface and sub-surface detection
- This detection method uses high frequency sound waves, typically above 2MHz to pass through a material
- A probe is used which contains a piezo electric crystal to transmit and receive ultrasonic pulses and display the signals on a cathode ray tube or digital display
- The actual display relates to the time taken for the ultrasonic pulses to travel the distance to the interface and back
- An interface could be the back of a plate material or a defect
- For ultrasound to enter a material a couplant must be introduced between the probe and specimen

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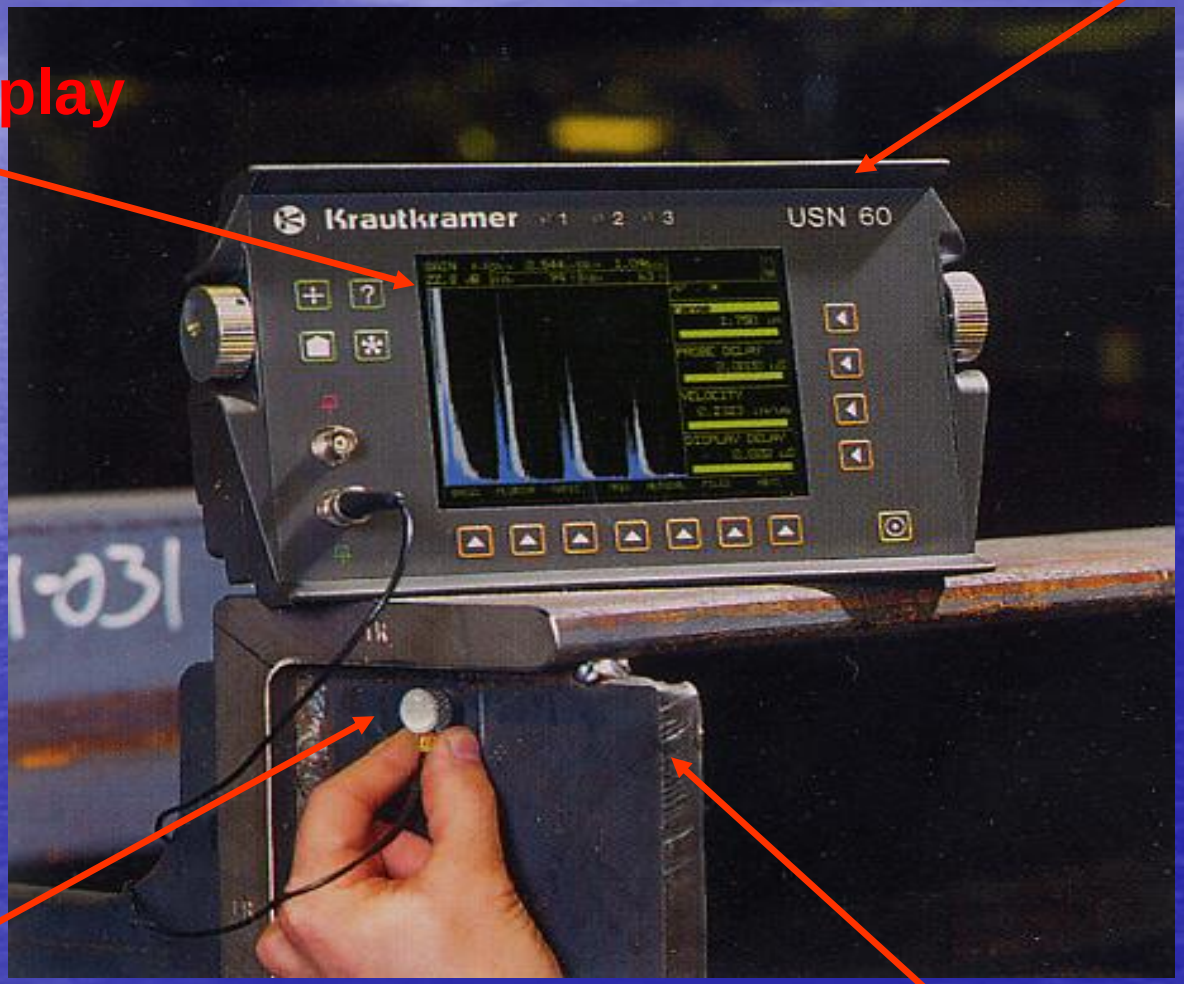
Pulse echo signals
A scan Display

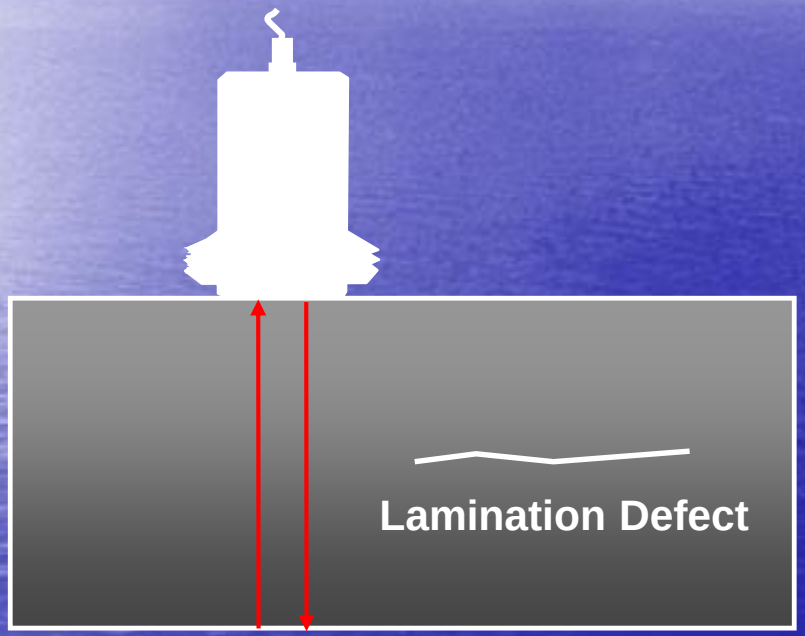
UT Set, Digital

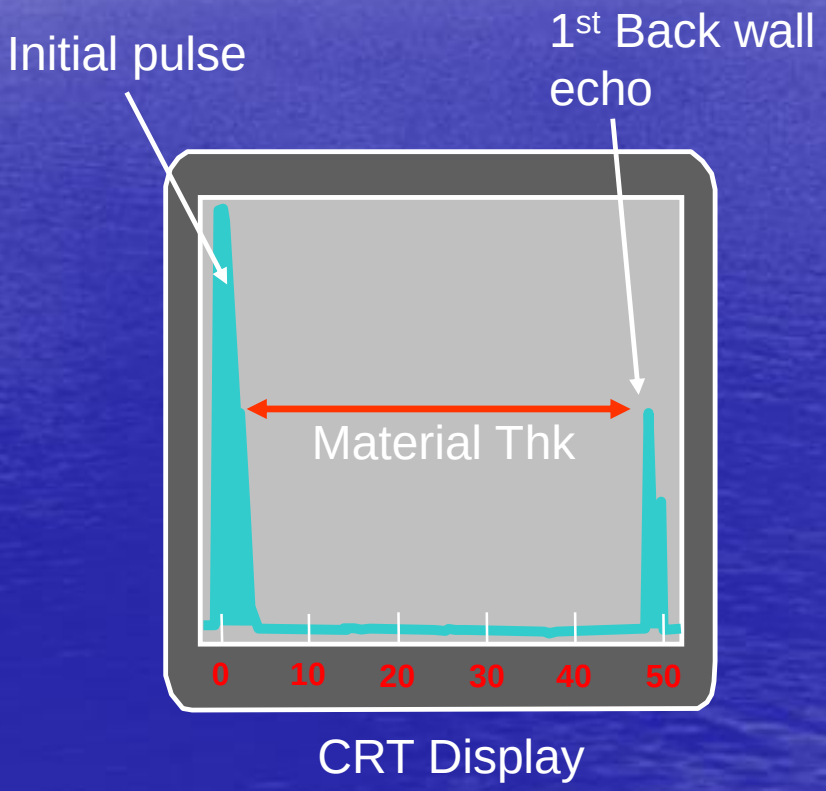


Compression probe

Thickness checking the material

Ultrasonic testing is a good technique for the detection of plate laminations and thickness surveys





CRT Display

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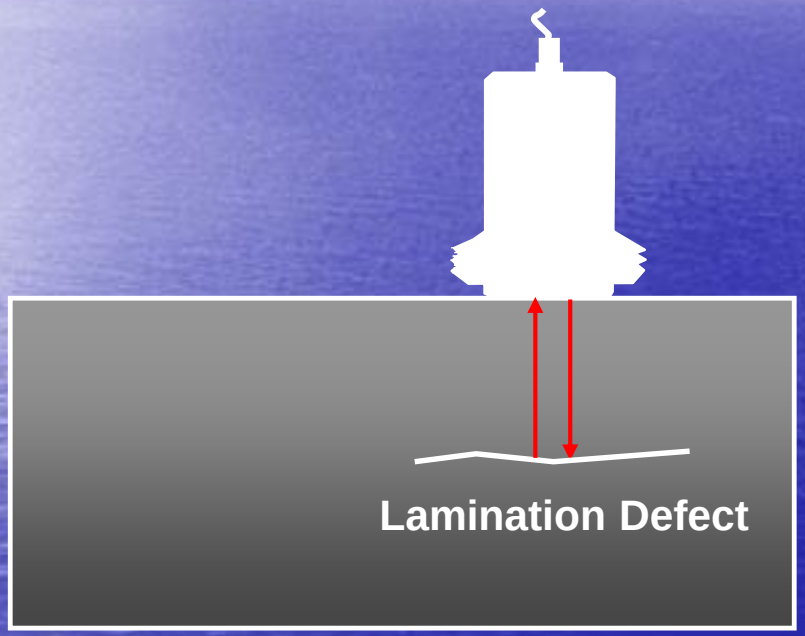
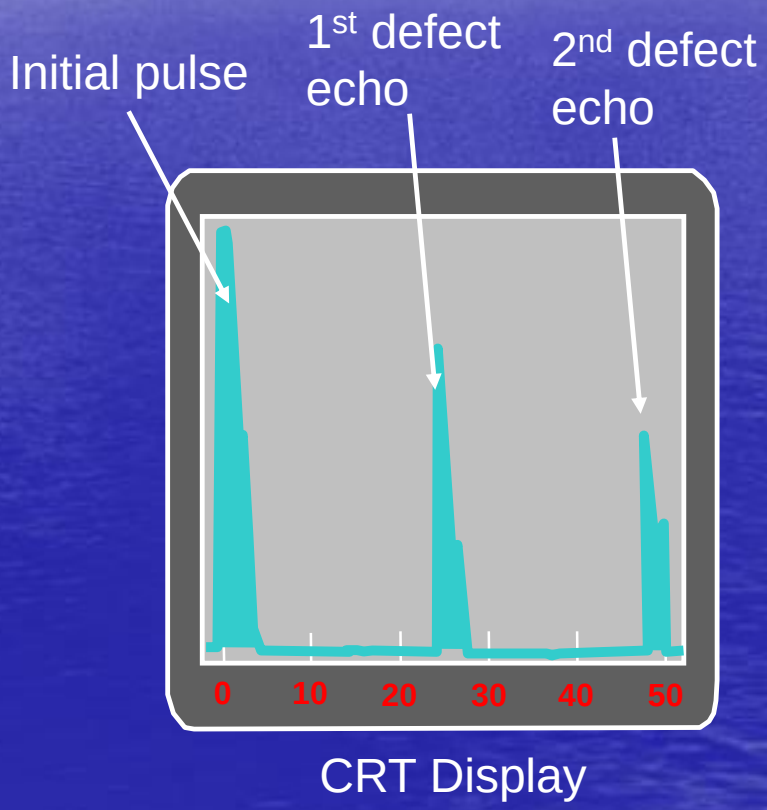
Ultrasonic testing is a good technique for the detection of plate laminations and thickness surveys





CRT Display

Lamination detected using a compression probe

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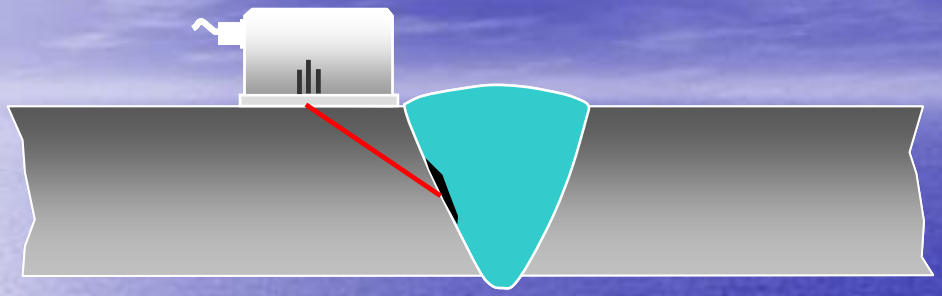
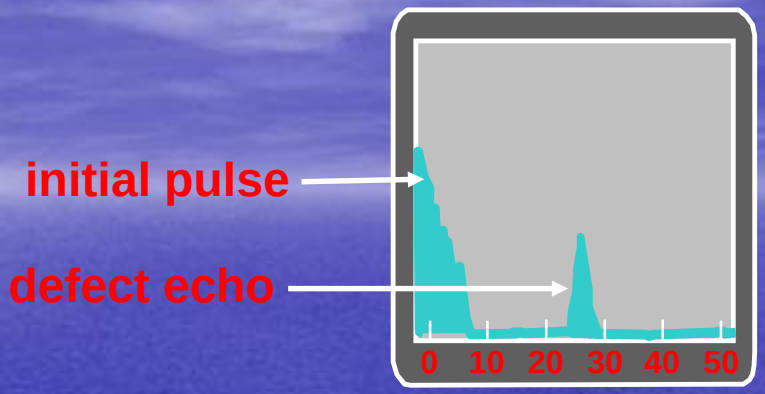
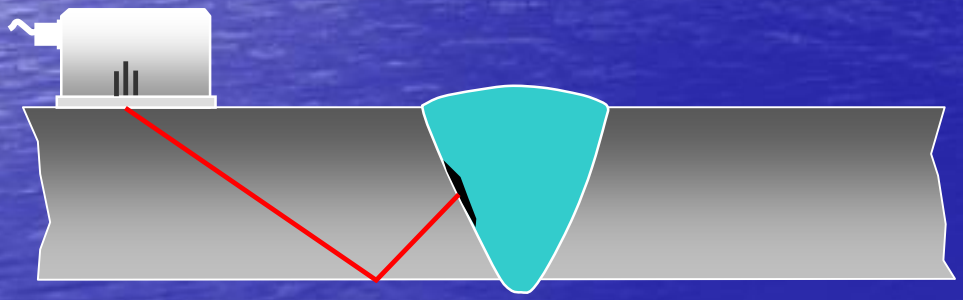


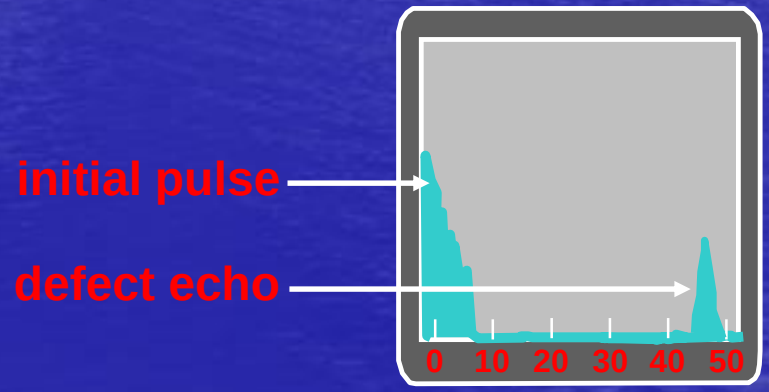
½ Skip



CRT Display



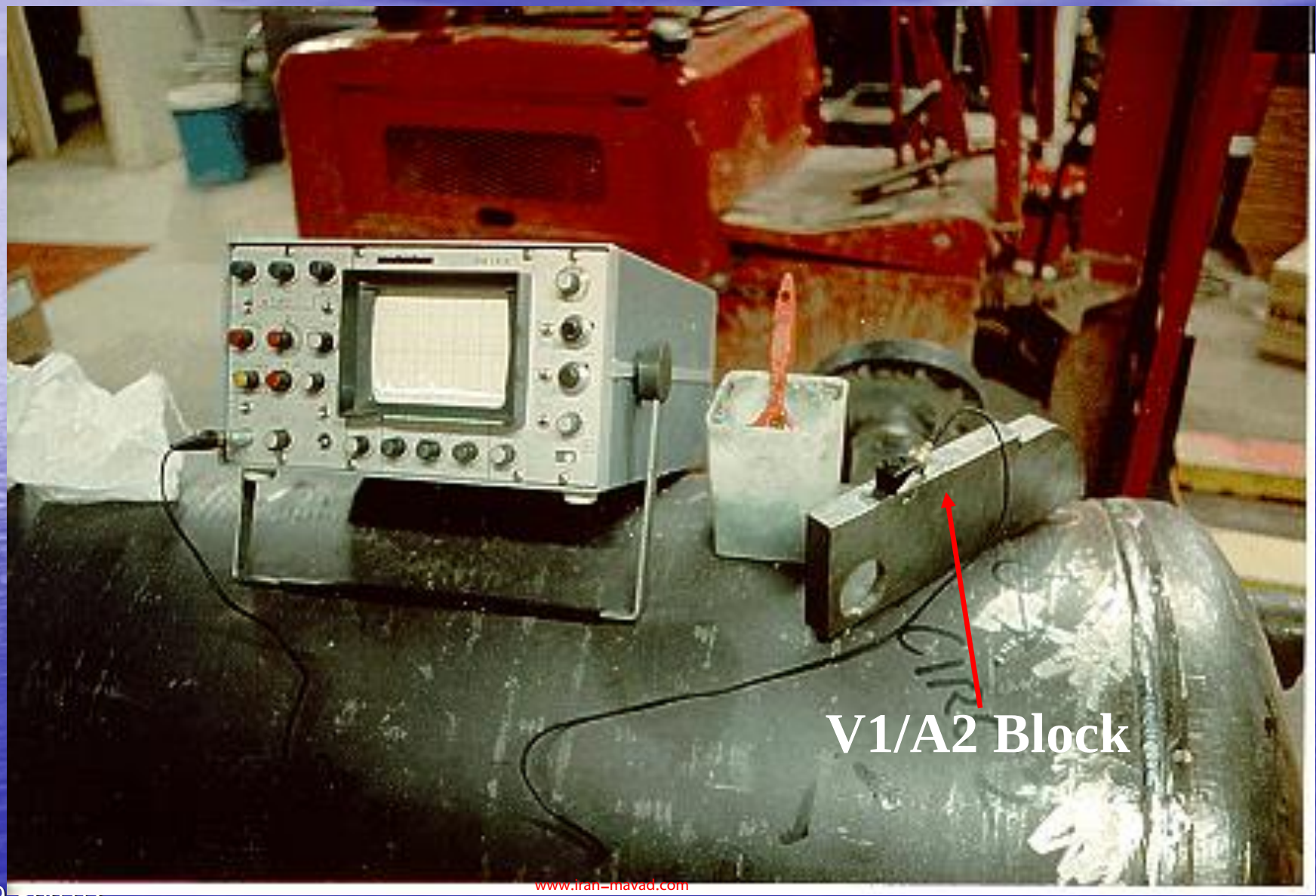
Full Skip

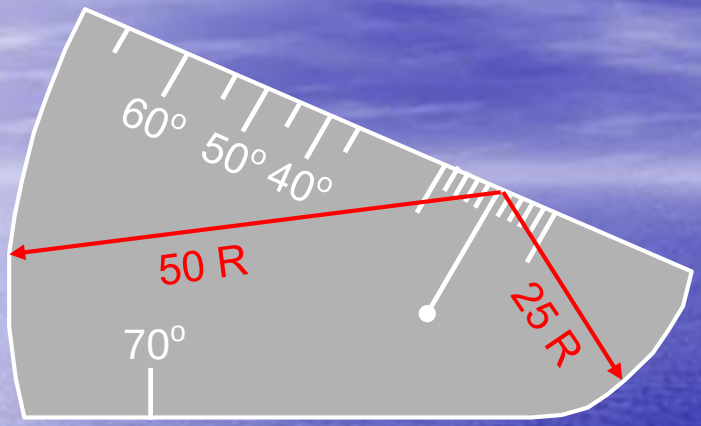


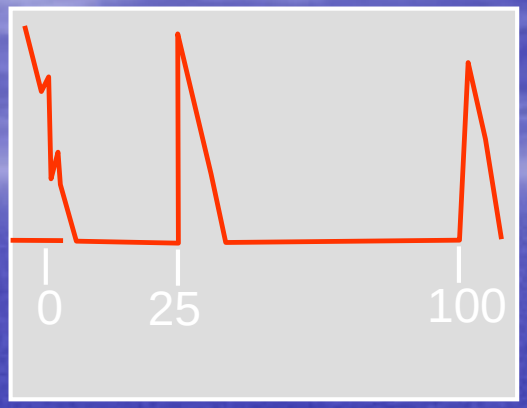
CRT Display

TECHNOLOGY

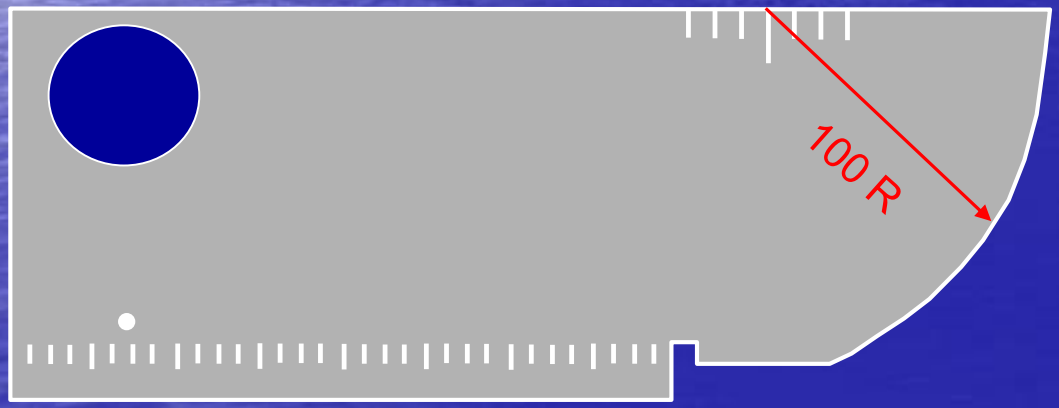
M.S.Rogers

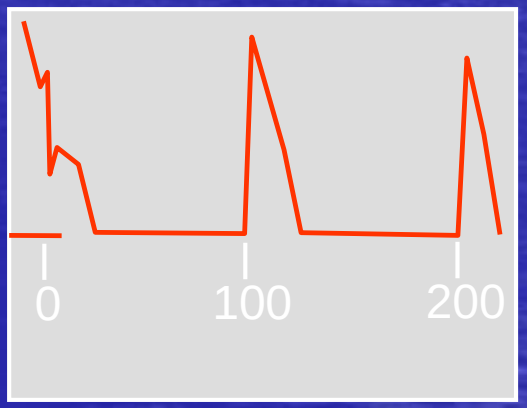






V2 (A4) Block Thickness 12 or 20mm





V1 (A2) Block Thickness 25mm

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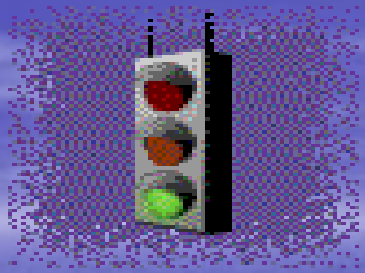
Advantages



Disadvantages

- Rapid results
- Both surface and sub-surface detection
- Safe
- Capable of measuring the depth of defects
- May be battery powered
- Portable

- Trained and skilled operator required
- Requires high operator skill
- Good surface finish required
- Defect identification
- Couplant may contaminate
- No permanent record

Remember in the CSWIP 3.2 Senior Welding Inspectors examination your are required to comment on three NDT reports

- Time allowed 1 hour for three reports
- 1 UT, 1 RT and 1 MT or PT reports

TECHNOLOGY

Instructions

1. Check each report number against the numbers on the report given.
2. You are required to scrutinise the attached report and submit written comments on the technical accuracy of each report.
3. For the purpose of this test the standards/codes/specifications have been deliberately omitted, therefore you are NOT required to accept or reject the weld, this is not part of the test.
4. The section headed ACTION, for the purpose of these reports, should contain any instructions that may be necessary to correct a faulty application of a NDT technique

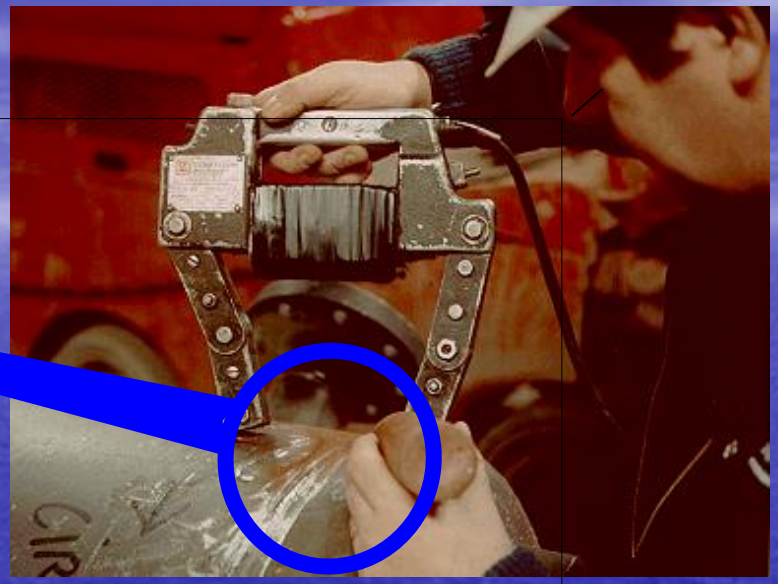
NOTE YOU MUST CLARIFY ALL STATEMENTS

- Client/location
- Item number
- Weld identification
- Specifications/procedures
- Operators name/signature/position
- Date of test
- Equipment used including serial numbers
- Inspection sensitivities dB etc
- Surface conditions
- Attenuation checks/calibrations
- Weld geometry as welded etc
- Test limitations
- Details of any flaws/sizes/sizing methods
- Report numbers

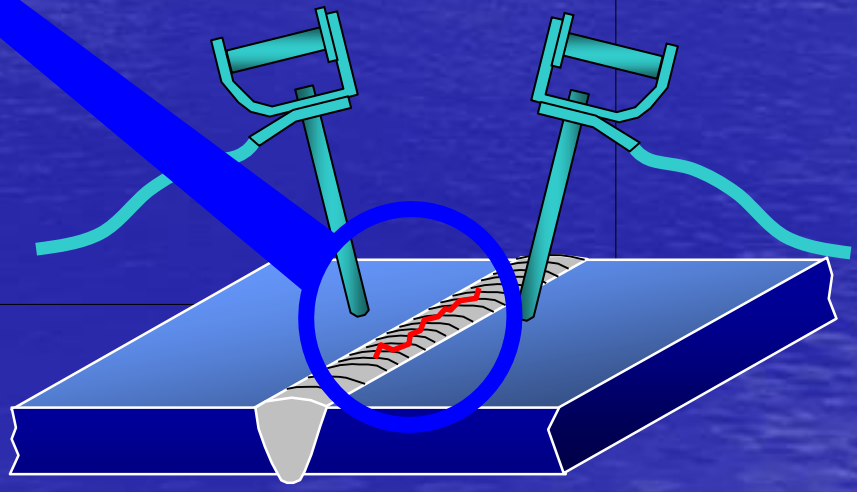
- Surface and slight sub-surface detection
- Relies on magnetization of component being tested
- Ferro-magnetic materials only can be tested
- A magnetic field is introduced into a specimen being tested
- Methods of applying a magnetic field, yoke, permanent magnet, prods and flexible cables.
- Fine particles of iron powder are applied to the test area
- Any defect which interrupts the magnetic field, will create a leakage field, which attracts the particles
- Any defect will show up as either a dark indication or in the case of fluorescent particles under UV-A light a green/yellow indication

TECHNOLOGY

Collection of ink particles due to leakage field



Electro-magnet (yoke) DC or AC



Prods DC or AC

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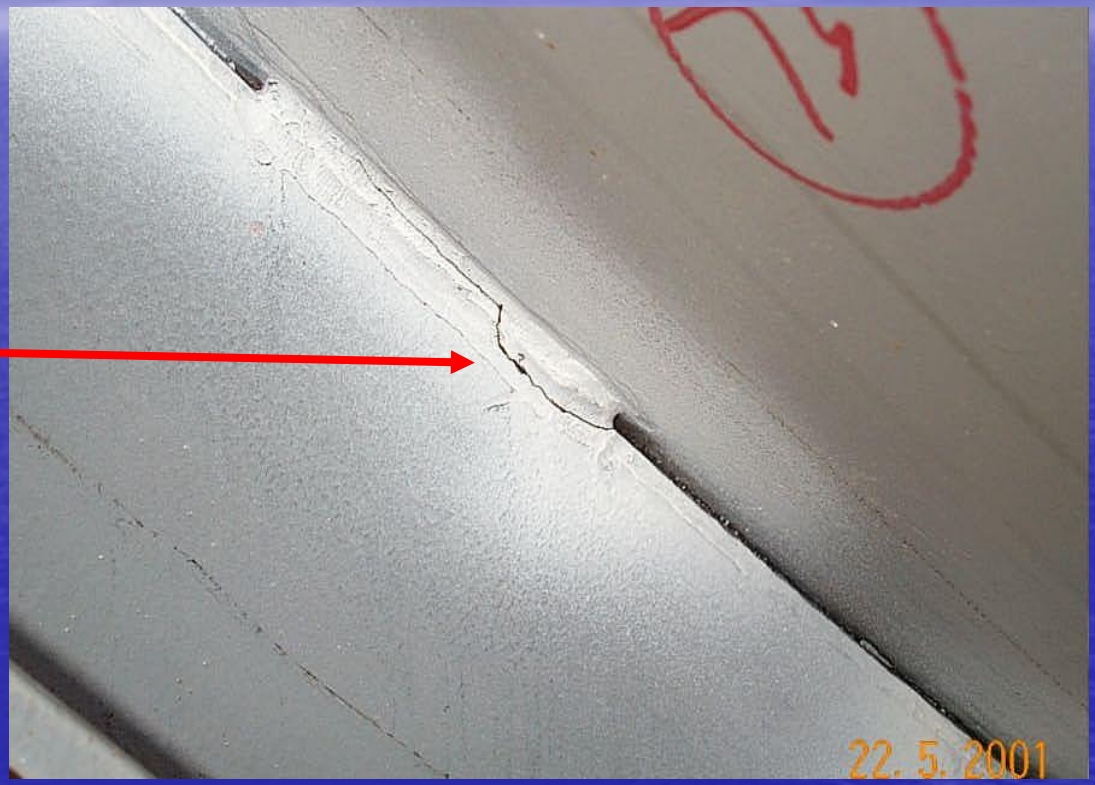
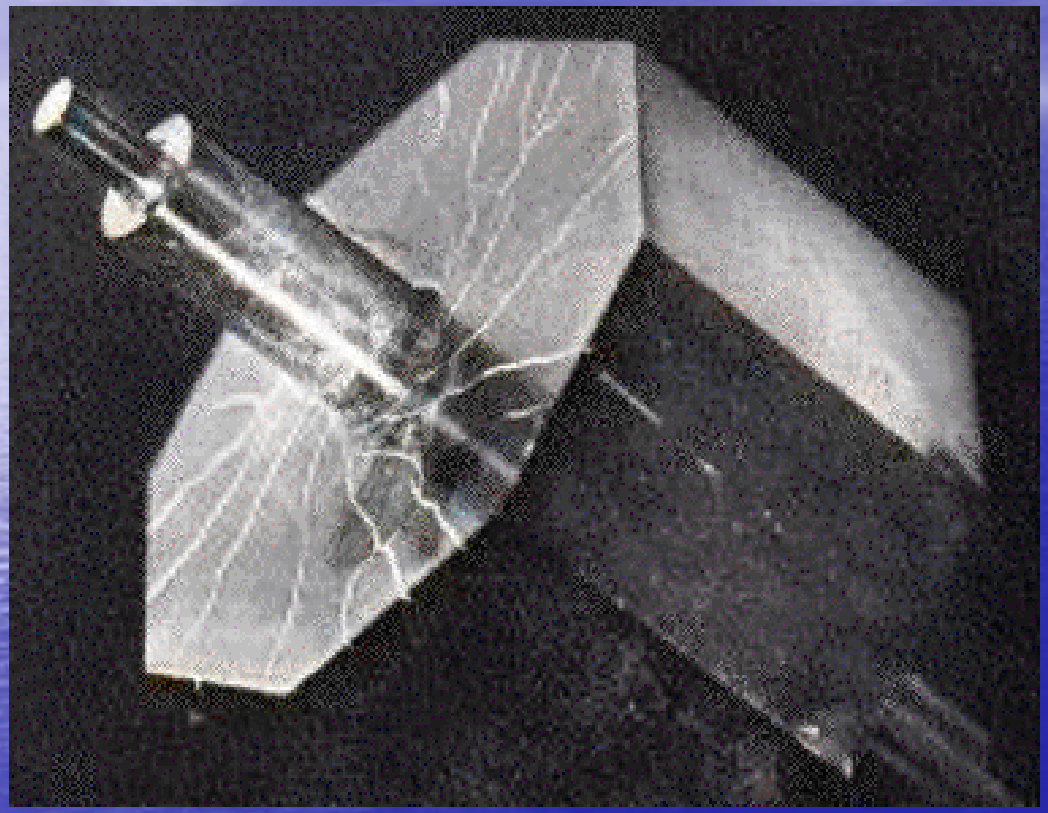
A crack like indication





Alternatively to contrast inks, fluorescent inks may be used for greater sensitivity. These inks require a UV-A light source and a darkened viewing area to inspect the component

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Typical sequence of operations to inspect a weld

- Clean area to be tested
- Apply contrast paint
- Apply magnetisism to the component
- Apply ferro-magnetic ink to the component during magnatising
- Iterpret the test area
- Post clean and de-magnatise if required

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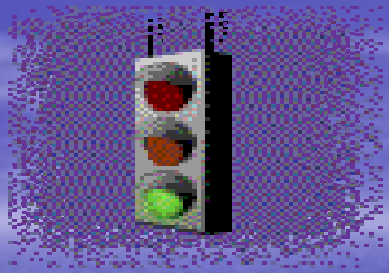
Advantages



- Simple to use
- Inexpensive
- Rapid results
- Little surface preparation required
- More sensitive than visual inspection

Disadvantages

- Surface or slight sub-surface detection only
- Magnetic materials only
- No indication of defects depths
- Only suitable for linear defects
- Detection is required in two directions

- Client/location
- Item number
- Weld identification
- Specifications/procedures
- Operators name/signature
- Date of test
- Equipment used including serial numbers
- Current used and type e.g AC or DC
- Inspection sensitivities pentameters etc
- Surface conditions
- Consumables, ink, contrast paints etc.
- Weld geometry as welded etc
- Test limitations
- Viewing conditions, details of any flaws present.
- Report numbers

TECHNOLOGY

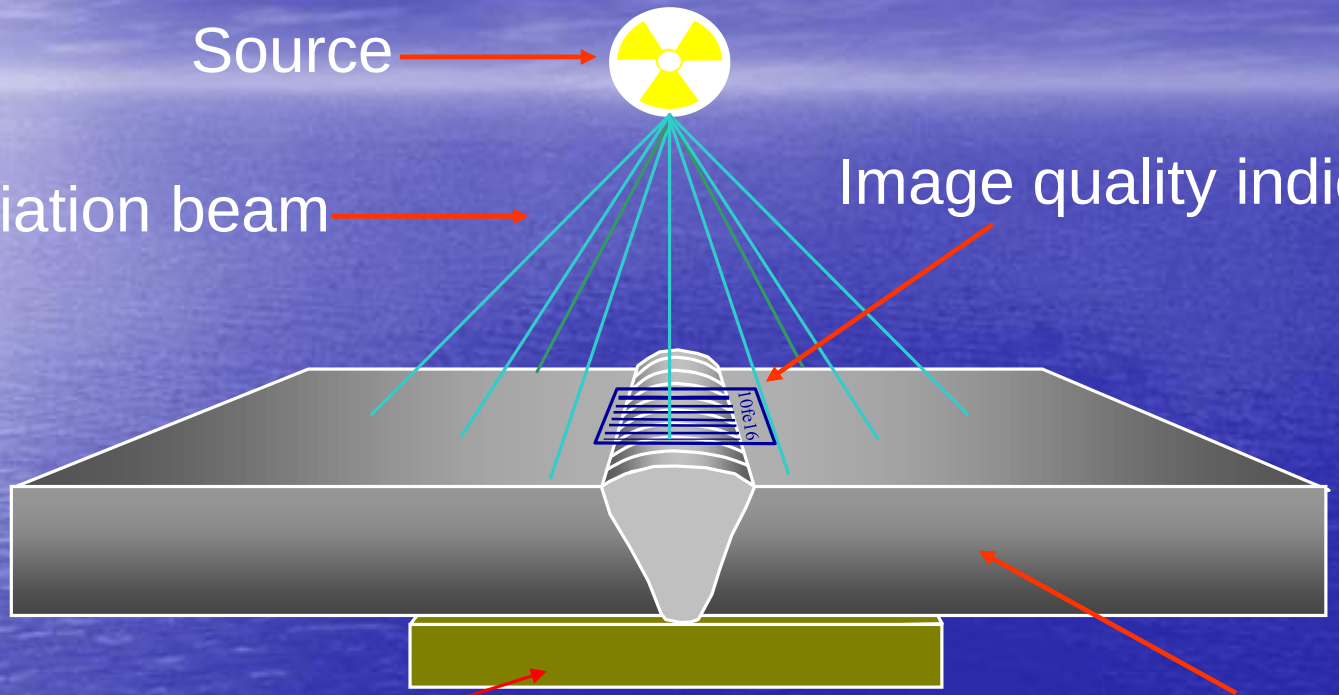
- **The principles of radiography**
- X or Gamma radiation is imposed upon a test object
- Radiation is transmitted to varying degrees dependant upon the density of the material through which it is travelling
- Thinner areas and materials of a less density show as darker areas on the radiograph
- Thicker areas and materials of a greater density show as lighter areas on a radiograph
- Applicable to metals,non-metals and composites

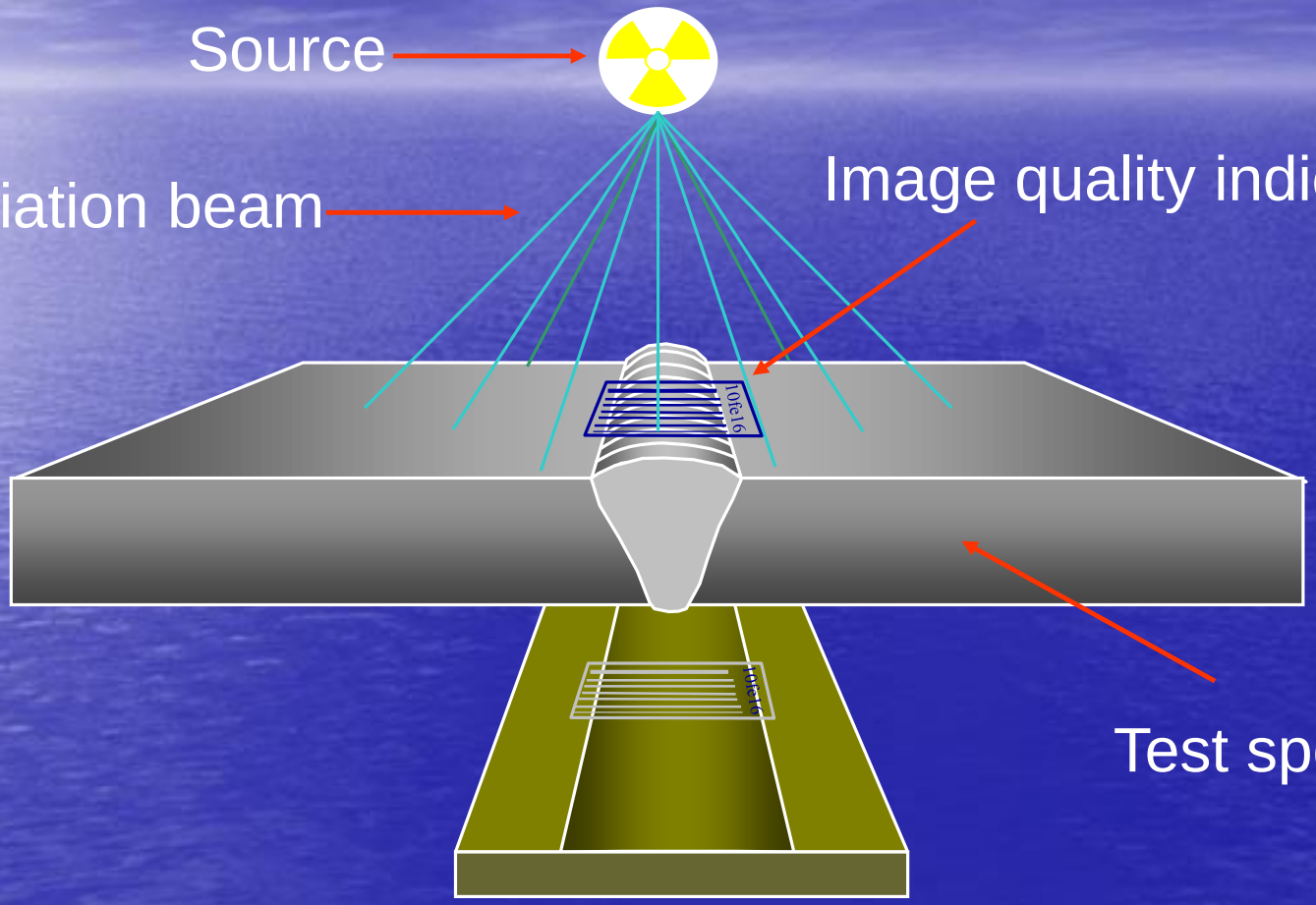
X - Rays

Electrically generated

Gamma Rays

Generated by the decay of unstable atoms

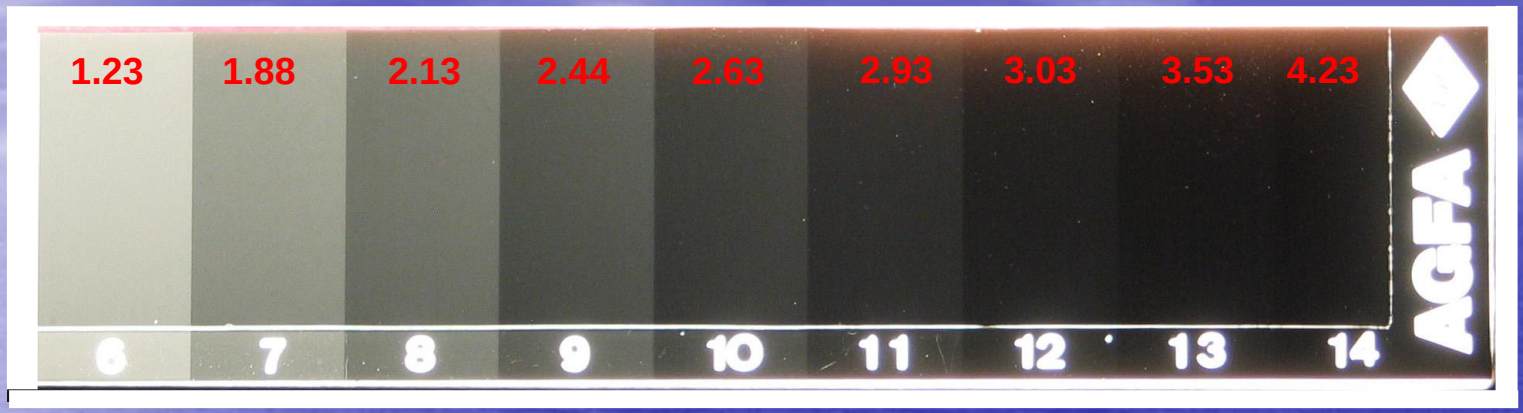




Radiographic film with latent image after exposure

TECHNOLOGY

- **Density** - relates to the degree of darkness
- **Contrast** - relates to the degree of difference
- **Definition** - relates to the degree of sharpness
- **Sensitivity** - relates to the overall quality of the radiograph



Density Strip

- Density is measured by a densitometer
- A densitometer should be calibrated using a density strip

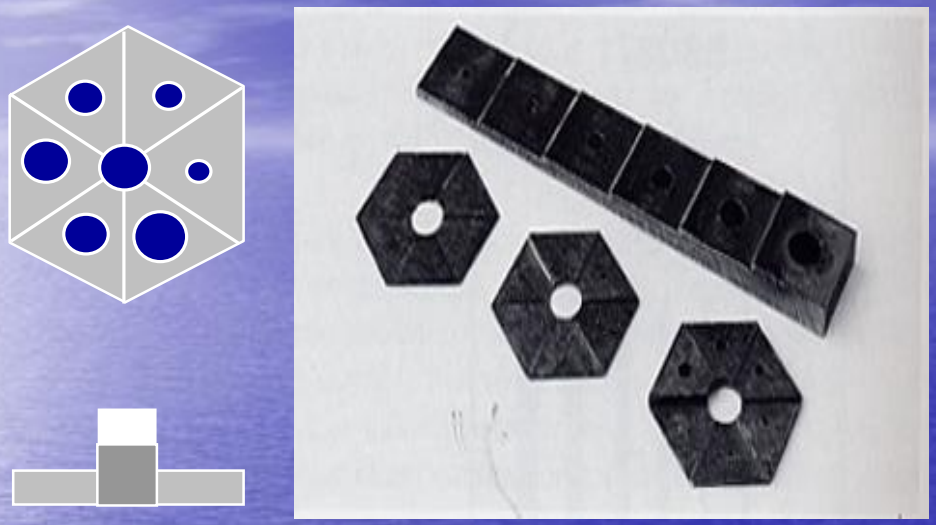
Densitometer

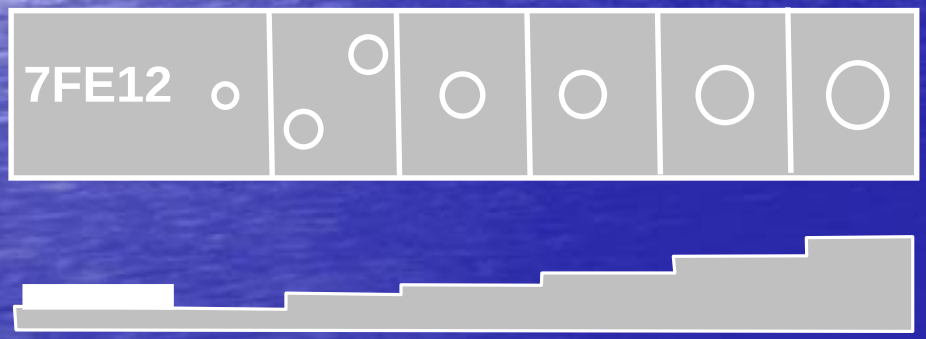
- IQI's / Penetrameters are used to measure radiographic sensitivity and the quality of the radiographic technique used They are not used to measure the size of defects detected
- Standards for IQI's include:

  BS 3971

  BS EN 462

  DIN 62





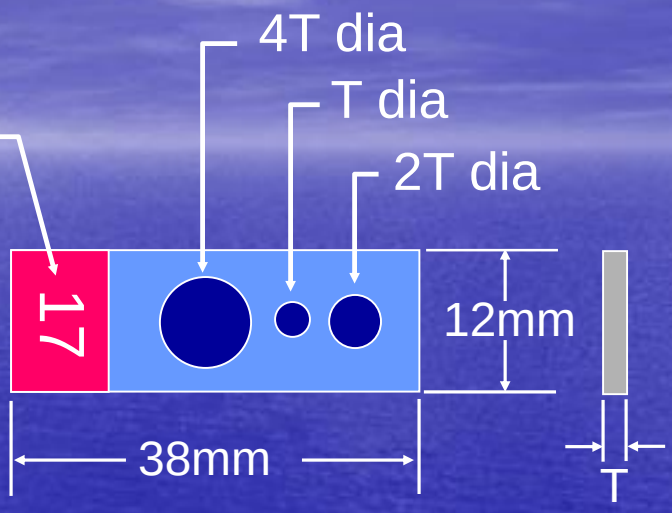
Step / Hole type IQI

Wire type IQI

TECHNOLOGY

Penetrmeter Design

Minimum Penetrmeter Thickness	0.12mm
Minimum Diameter for 1T Hole	0.25mm
Minimum Diameter for 2T Hole	0.50mm
Minimum Diameter for 4T Hole	1.00mm



IQI Sensitivity

1 Hole visible = 4T

2 Holes visible = 3T

3 Holes visible = 2T

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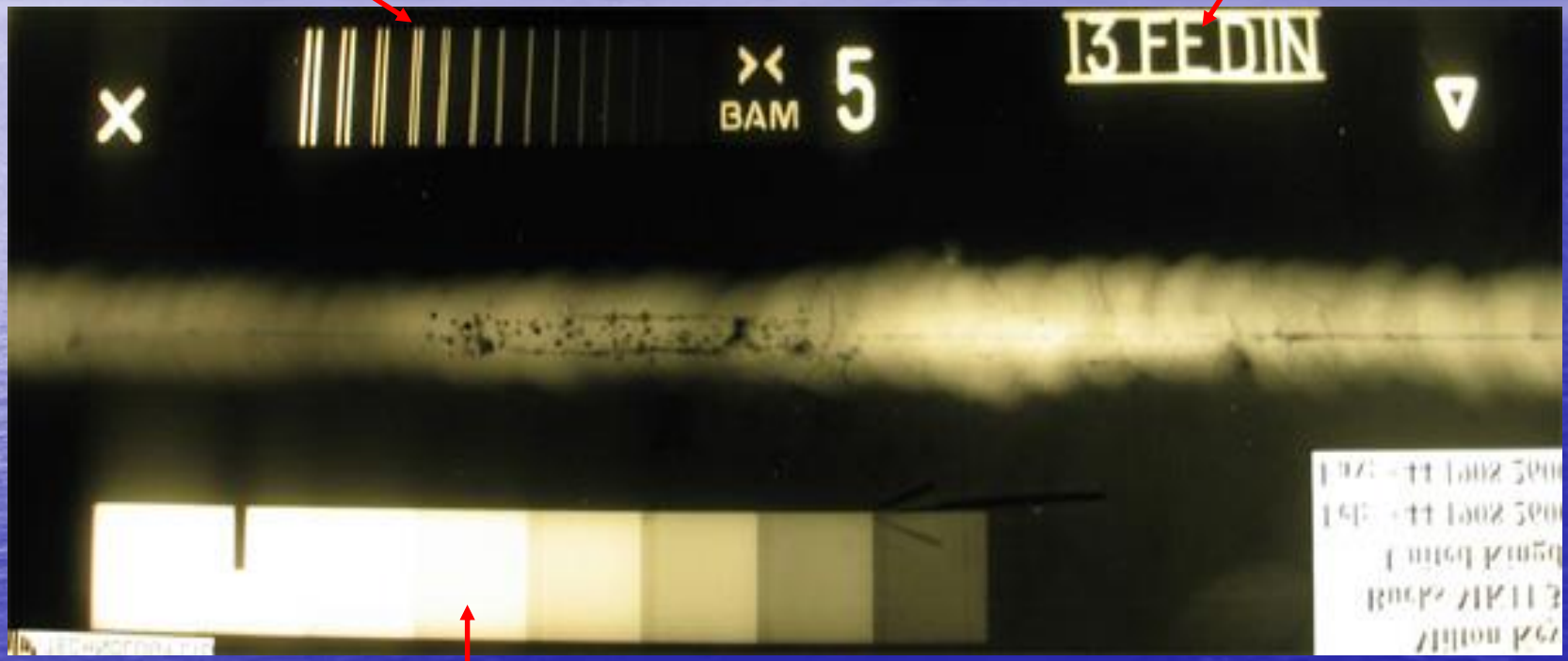
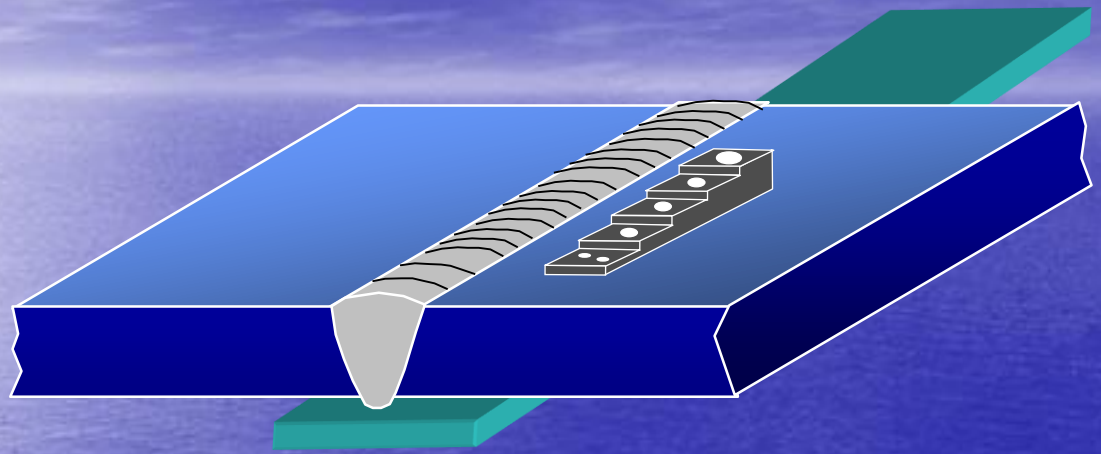
Duplex type IQI

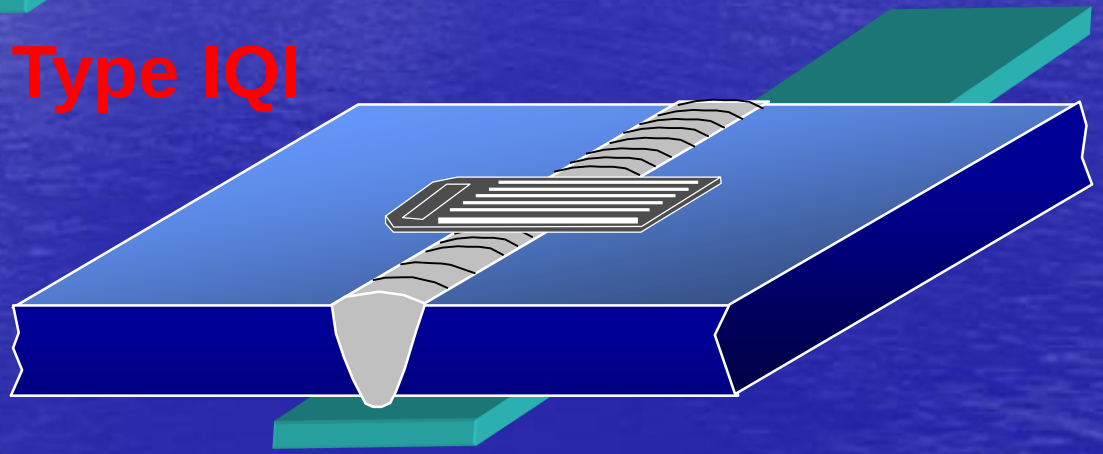
Wire type IQI



Step/Hole type IQI



Step/Hole Type IQI



Wire Type IQI

- Ideally IQI should be placed on the source side
- IQI sensitivity is calculated from the following formula

$$\text{Sensitivity \%} = \frac{\text{Thickness of thinnest step/wire visible}}{\text{Object Thickness}} \times 100$$

As a rough guide sensitivity = 2.0% or better.

Image Quality Indicators

Thickness (mm)	BS 3971						DIN 54 109			BS EN 462-2				BS EN 462-1			
	STEP			WIRE			WIRE (DIN 62)			STEP/HOLE				WIRE			
	1-6	7-12	13-18	4-10	9-15	15-21	1-7	6-12	10-16	H 1	H 5	H 9	H 13	W 1	W 6	W 10	W 13
0.050																	7
0.063				7													6
0.08				6													5
0.10				5					7							7	4
0.125	6			4					6	6						6	3
0.15																	
0.16	5			3					5	5						5	2
0.20	4			2	7				4	4						4	1
0.25	3			1	6			7	3	3					7	3	
0.30																	
0.32	2				5			6	2	2	6				6	2	
0.35																	
0.40	1				4			5	1	1	5				5	1	
0.50		6			3			4			4				4		
0.60																	
0.63		5			2			3			3				3		
0.75																	
0.80		4			1	7	7	2			2	6		7	2		
0.90																	
1.00		3				6	6	1			1	5		6	1		
1.20																	
1.25		2				5	5					4		5			
1.50		1				4											
1.60							4					3		4			
1.80						3											
2.00			6			2	3					2	6	3			
2.50			5			1	2					1	5	2			
3.00																	
3.20			4				1						4	1			
4.00			3										3				
5.00			2										2				
6.30			1										1				

TECHNOLOGY

A Radiograph of a 16mm thick butt weld is viewed under the correct conditions, 5 wires visible on the radiograph IQI pack 6-12 Din 62, what is the IQI sensitivity?

$$\text{Sensitivity} = \frac{\text{Thickness of thinnest wire visible}}{\text{Total weld thickness}} \times 100$$

$$\text{Sensitivity} = \frac{0.4}{16} \times 100$$

Sensitivity = 2.5 %

Using the same IQI pack 6-12 Din 62, How many IQI wires must be visible to give an IQI sensitivity of 2 %

Thickness of thinnest wire visible =

$$\frac{\text{Sensitivity}}{100} \times \text{Total weld thickness}$$

$$= \frac{2.0}{100} \times 16$$

= 0.32 6 wires visible

- Single Wall Single Image (SWSI)

  - film inside, source outside

- Single Wall Single Image (SWSI) panoramic

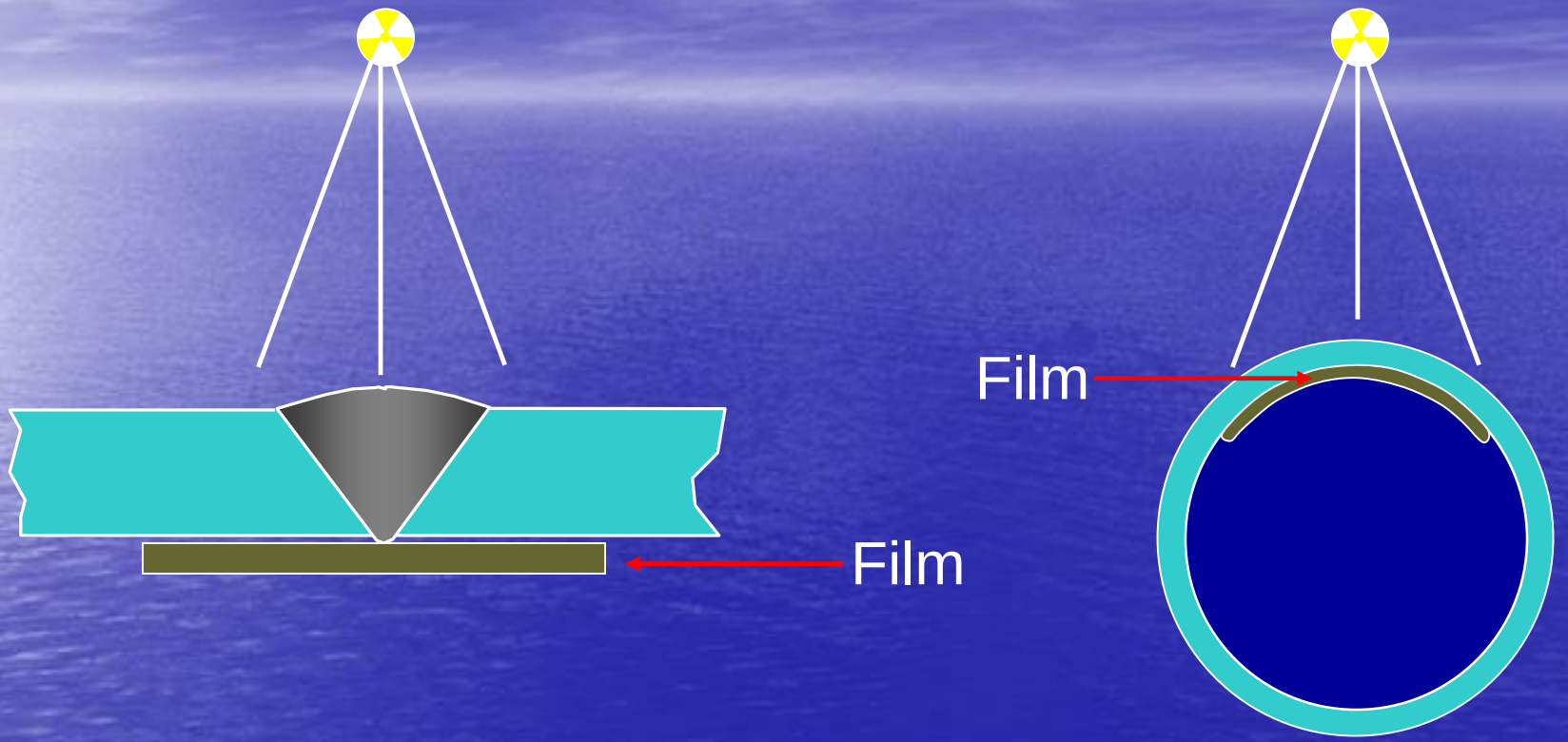
  - film outside, source inside (internal exposure)

- Double Wall Single Image (DWSI)

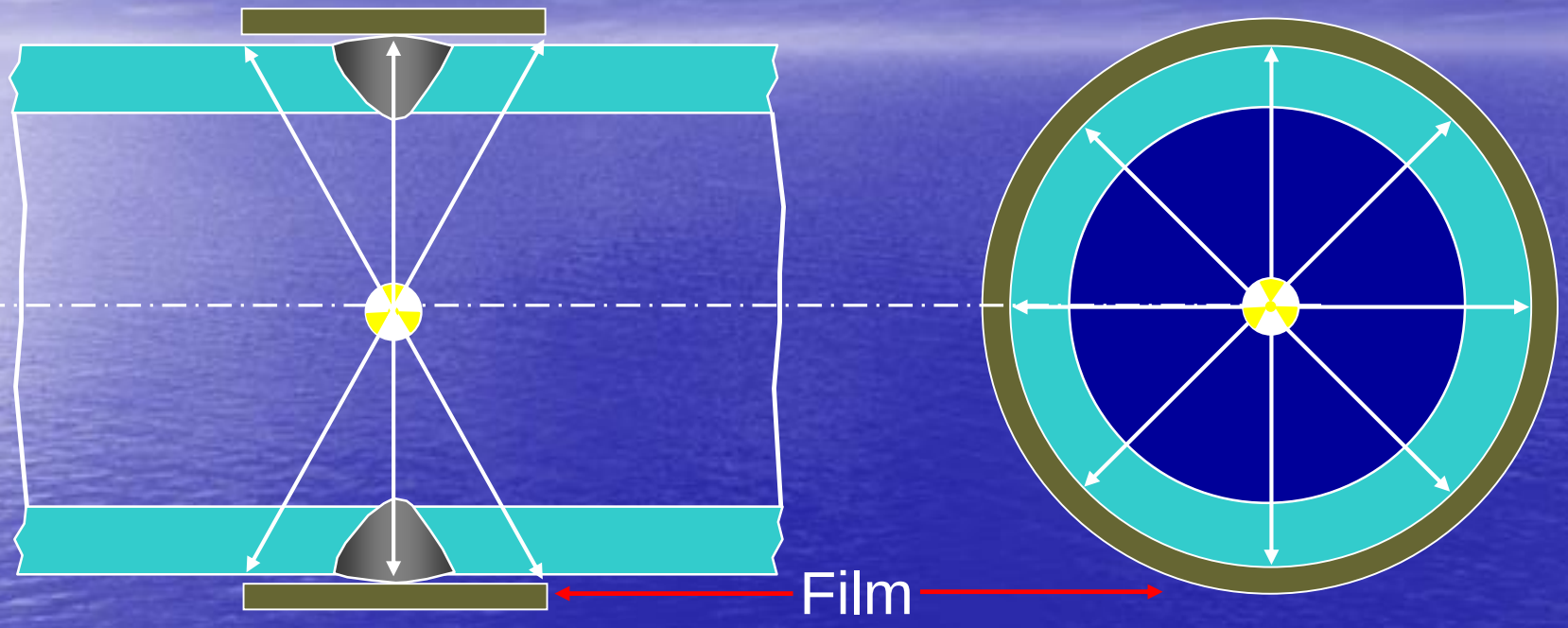
  - film outside, source outside (external exposure)

- Double Wall Double Image (DWDI)

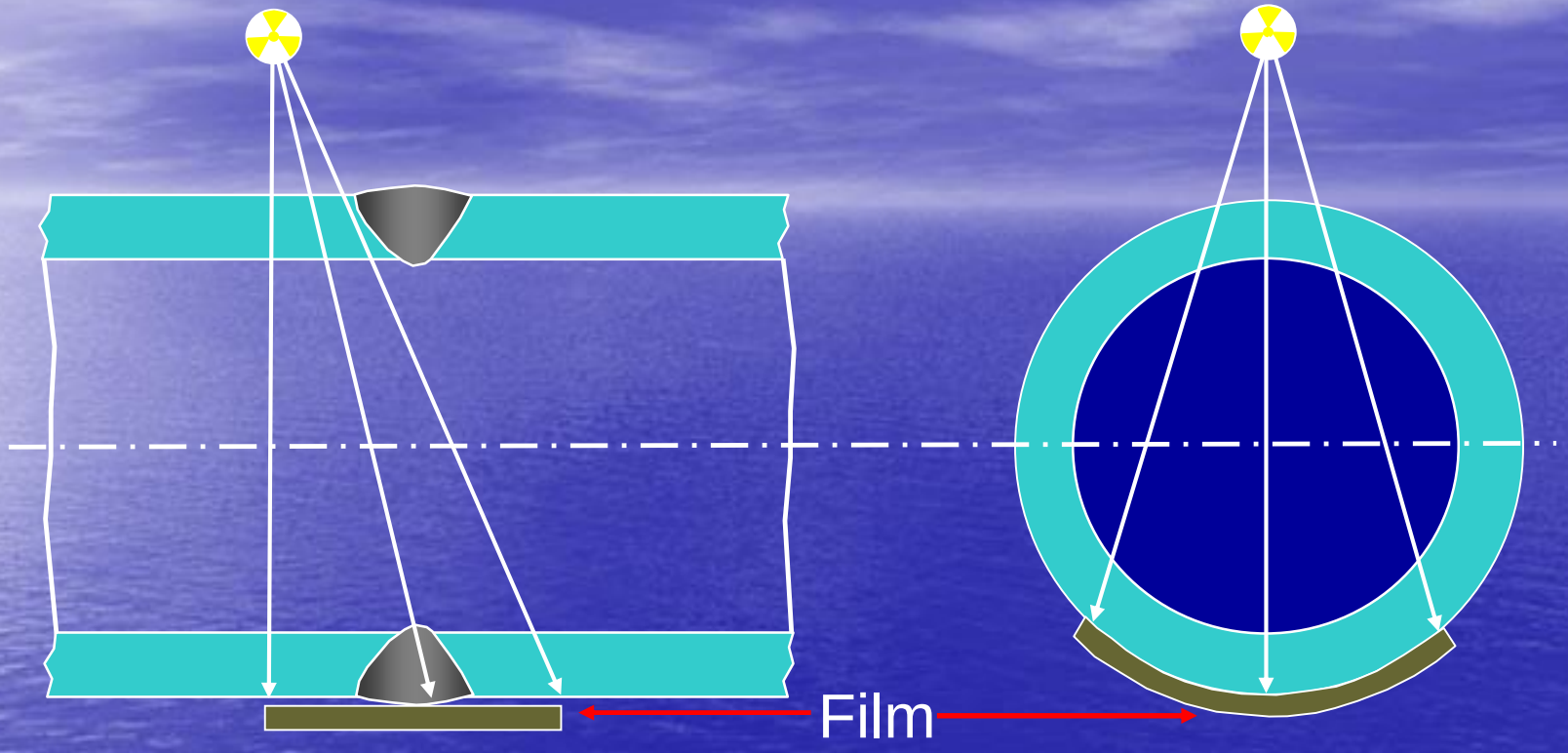
  - film outside, source outside (elliptical exposure)



- IQI's should be placed source side



- IQI's are placed on the film side
- Source inside film outside (single exposure)

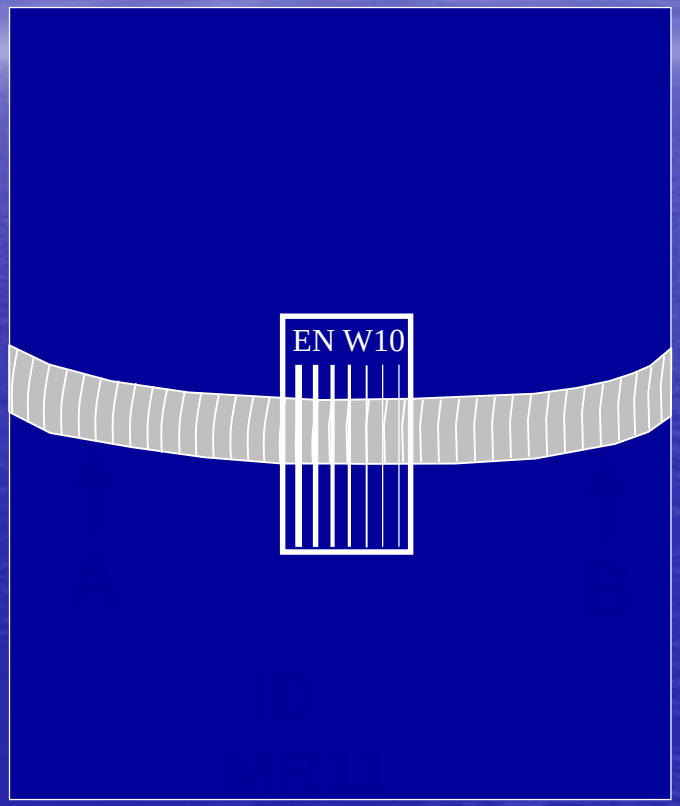


- IQI's are placed on the film side
- Source outside film outside (multiple exposure)
- This technique is intended for pipe diameters over 100mm

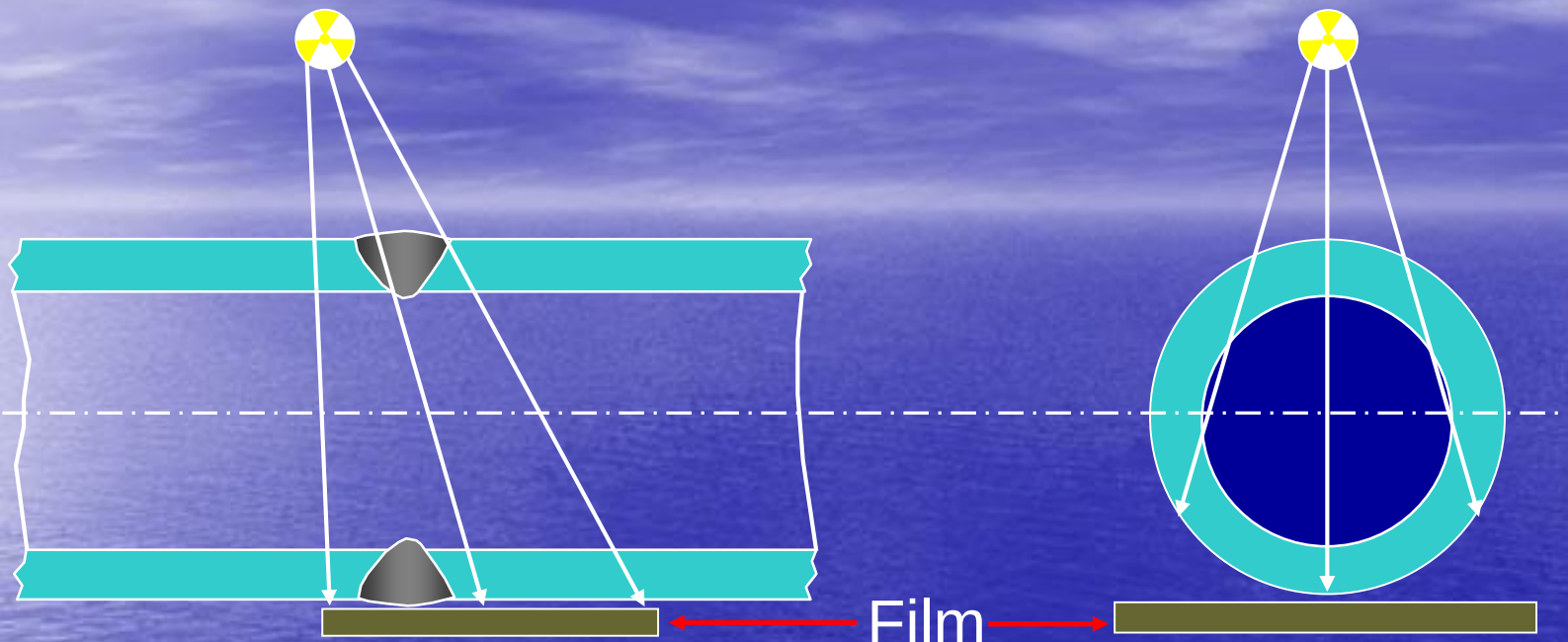
TECHNOLOGY

Identification

- Unique identification
- IQI placing
- Pitch marks indicating readable film length



Radiograph

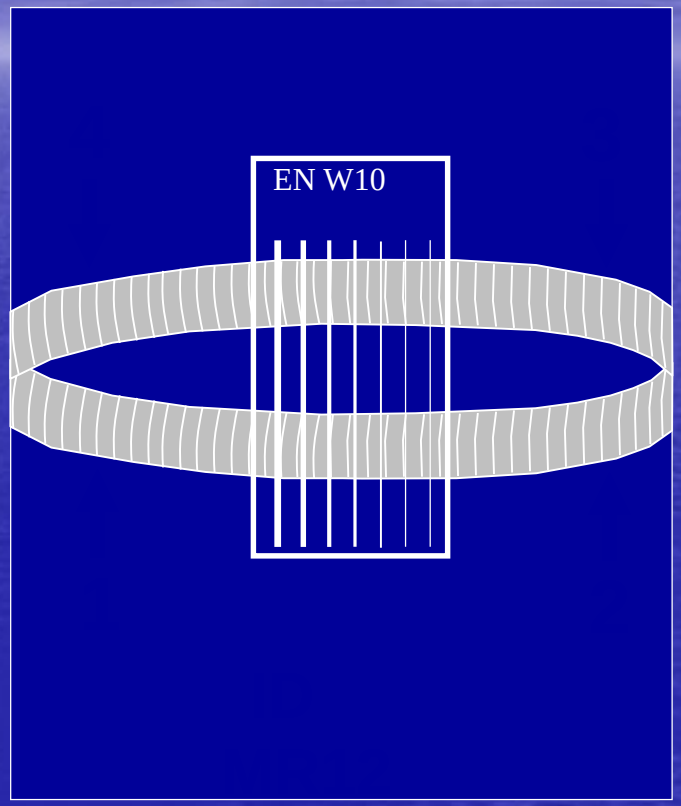


- IQI's are placed on the source or film side
- Source outside film outside (multiple exposure)
- A minimum of two exposures
- This technique is intended for pipe diameters less than 100mm

TECHNOLOGY

Identification

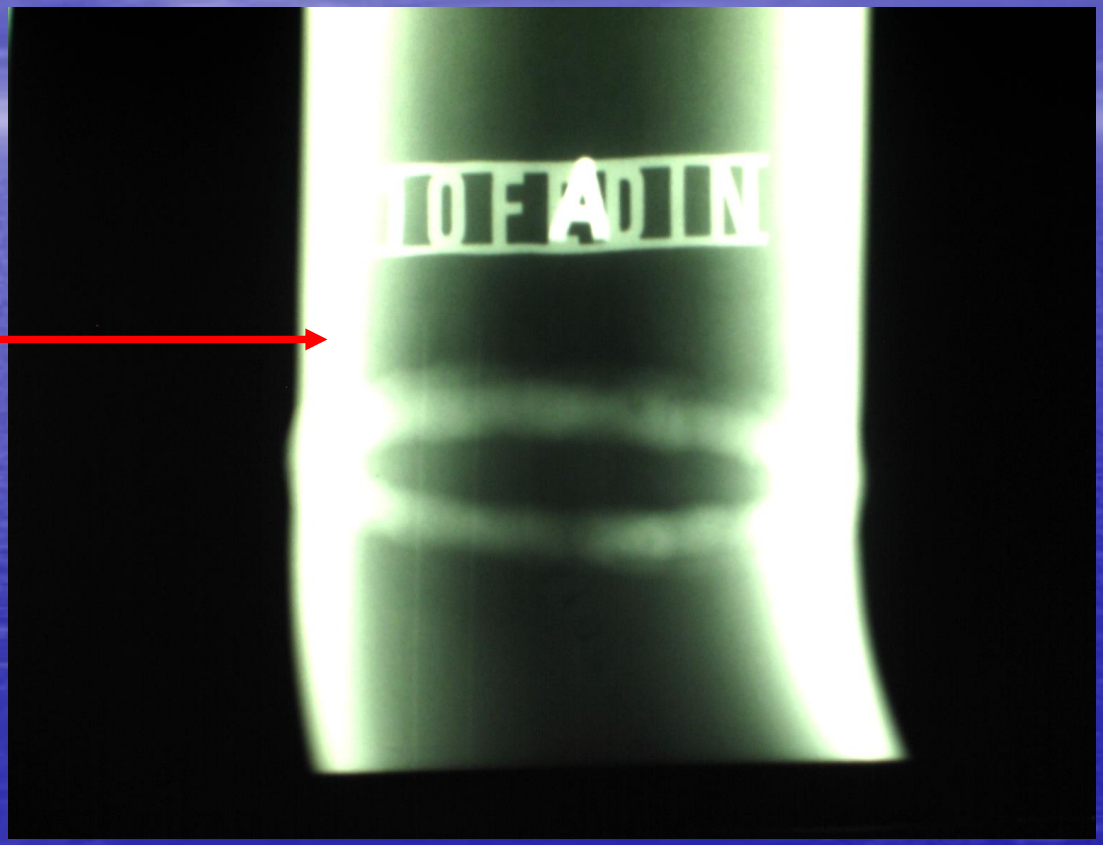
- Unique identification
- IQI placing
- Pitch marks indicating readable film length



Shot A Radiograph

TECHNOLOGY

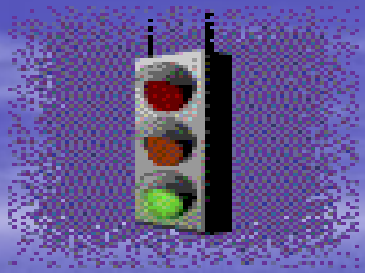
Elliptical exposure



When calculating the IQI sensitivity, take two wall thickness

TECHNOLOGY

Advantages



- Permanent record
- Little surface preparation
- Defect identification
- No material type limitation
- Not so reliant upon operator skill
- Thin materials

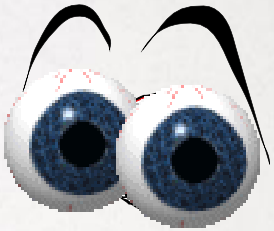
Disadvantages

- Expensive consumables
- Bulky equipment
- Harmful radiation
- Defect require significant depth in relation to the radiation beam
- Slow results
- Very little indication of depths

- Client/location
- Item number
- Weld identification
- Specifications/procedures
- Operators name/signature
- Date of test
- Details of equipment used manual external, battery internal crawler) including manufactures name and serial numbers
- Tube current and voltage used if applicable
- Source type/strength if applicable
- Exposure times
- Inspection sensitivities IQI and density

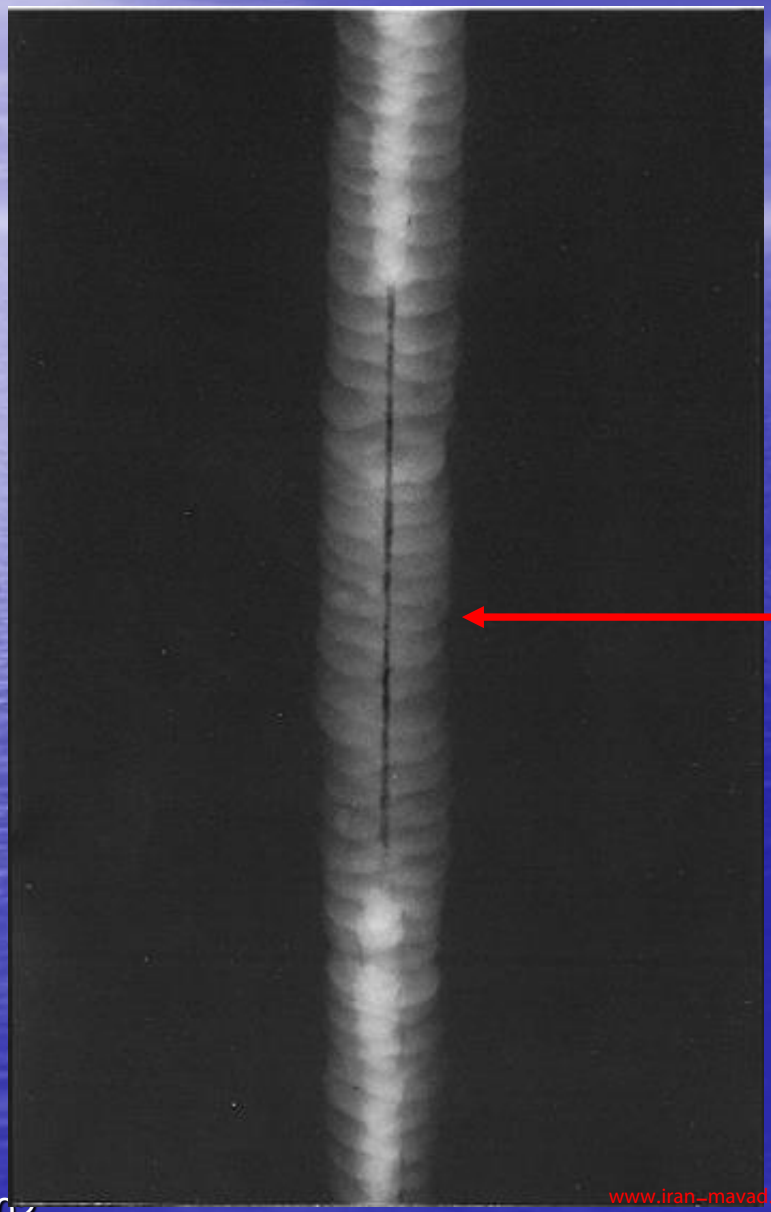
- Surface conditions
- Geometry set-up FFD, OFD, Source/focal spot size
- Technique used
- Weld geometry as welded etc
- Test limitations
- Details of any flaws present.
- Film and screen types.
- Processing details, manual or automatic
- Report numbers

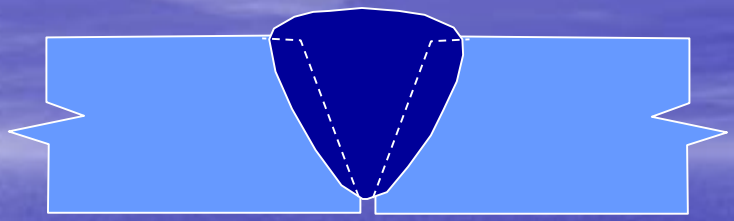
TECHNOLOGY



Basically a revision area

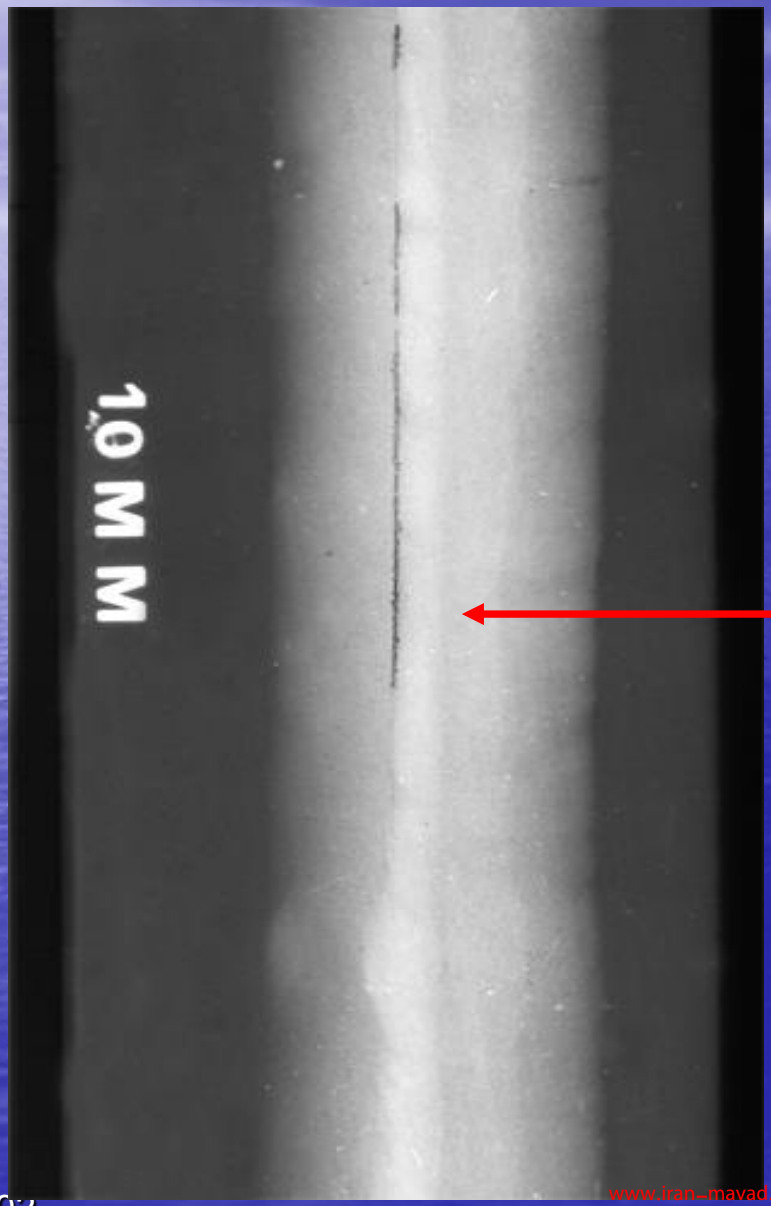
TECHNOLOGY

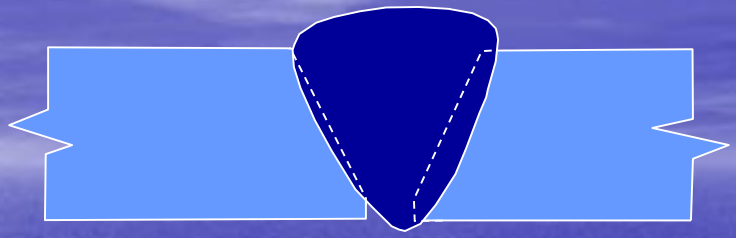




Lack of root penetration

What's the defect?

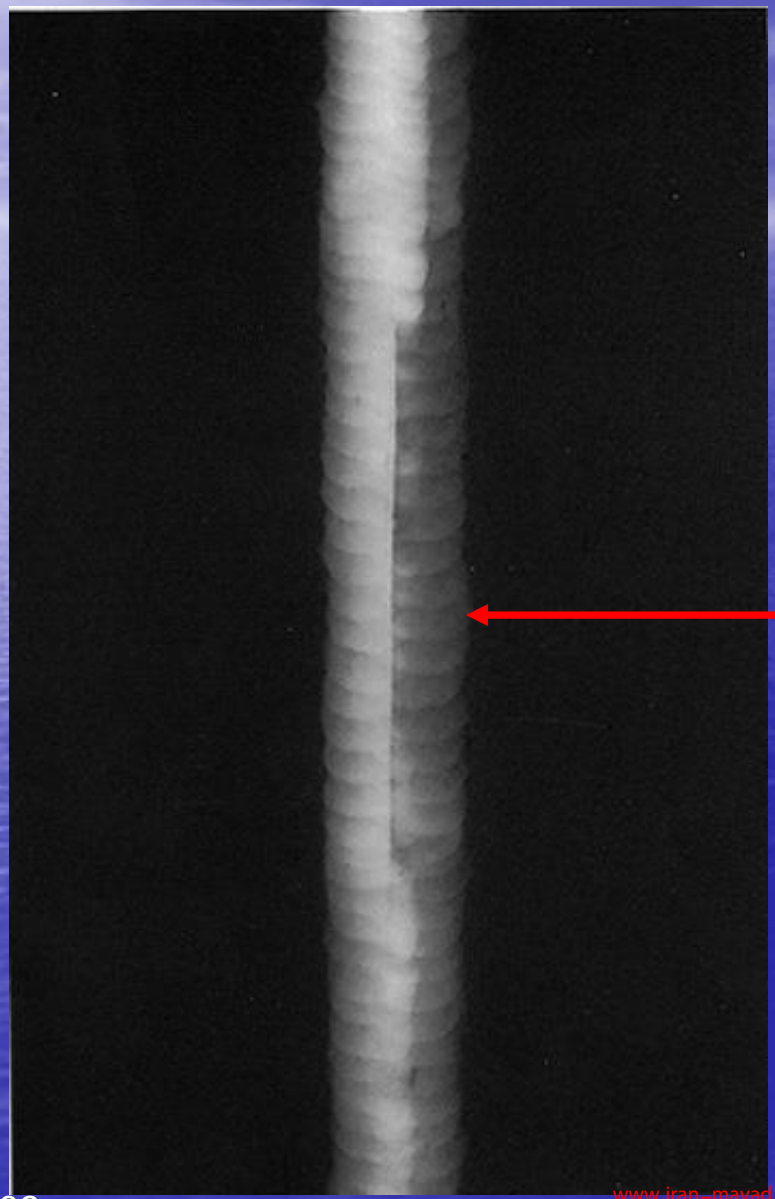


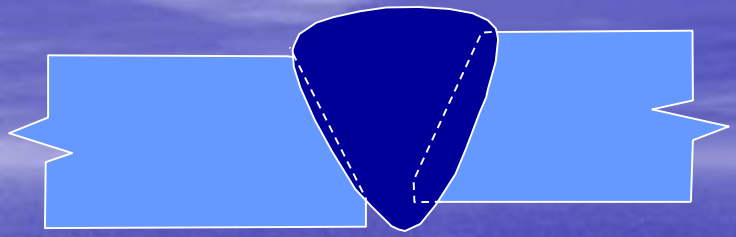


Lack of root Fusion

What's the defect?

TECHNOLOGY

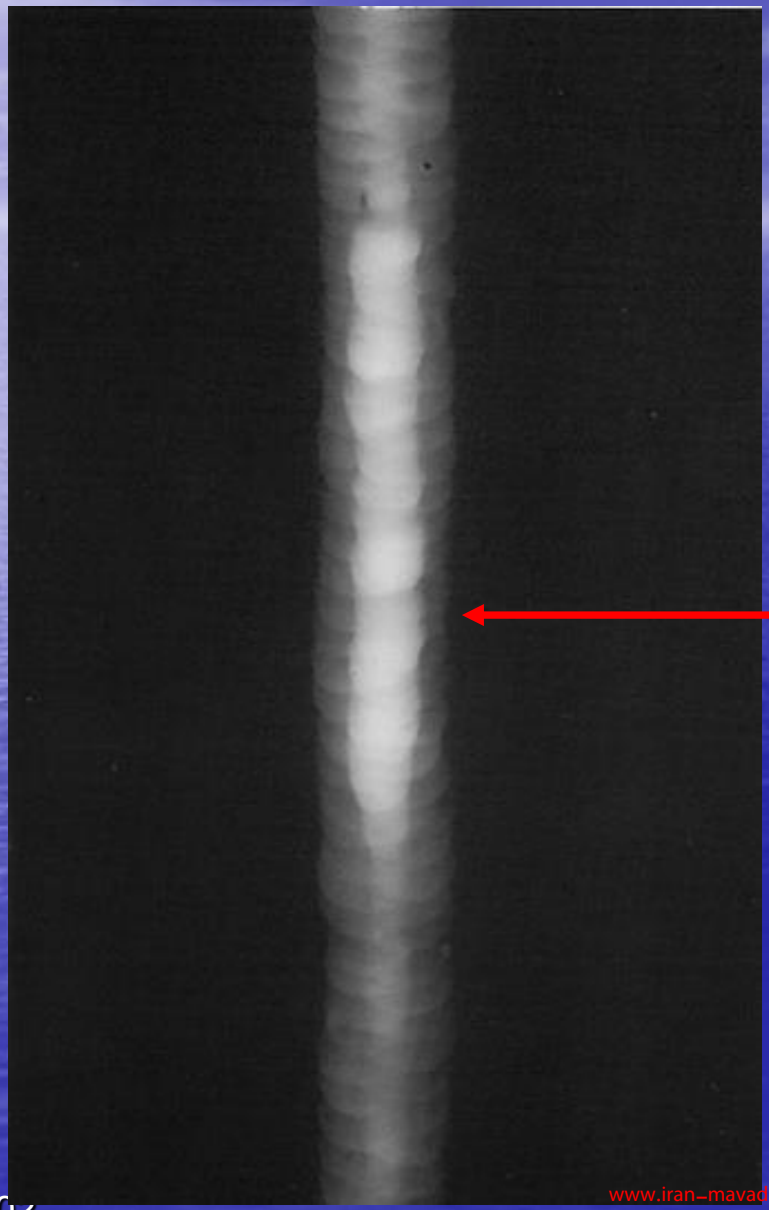


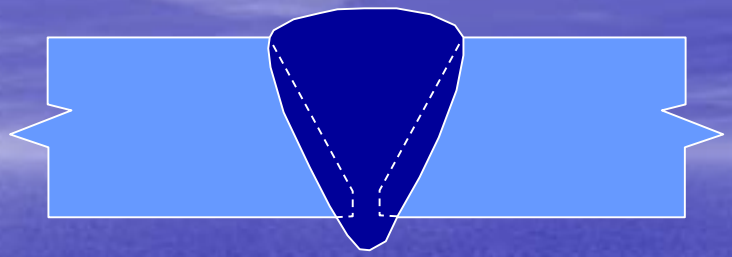


Lack of root fusion with misalignment

What's the defect?

TECHNOLOGY

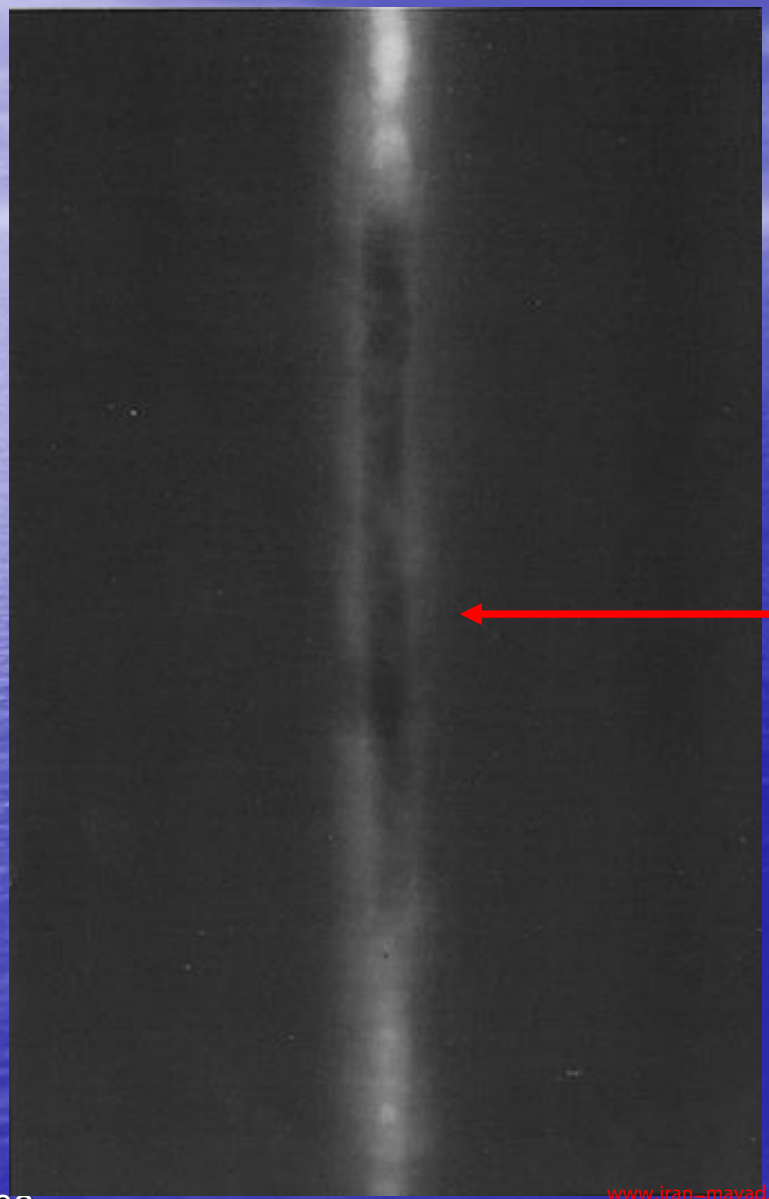


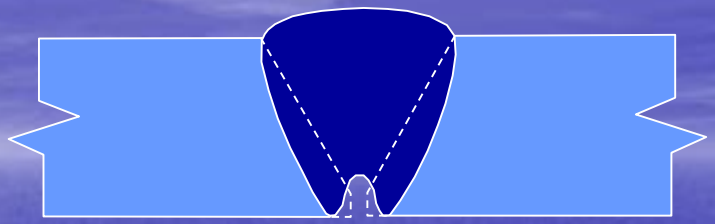


Excessive root penetration

What's the defect?

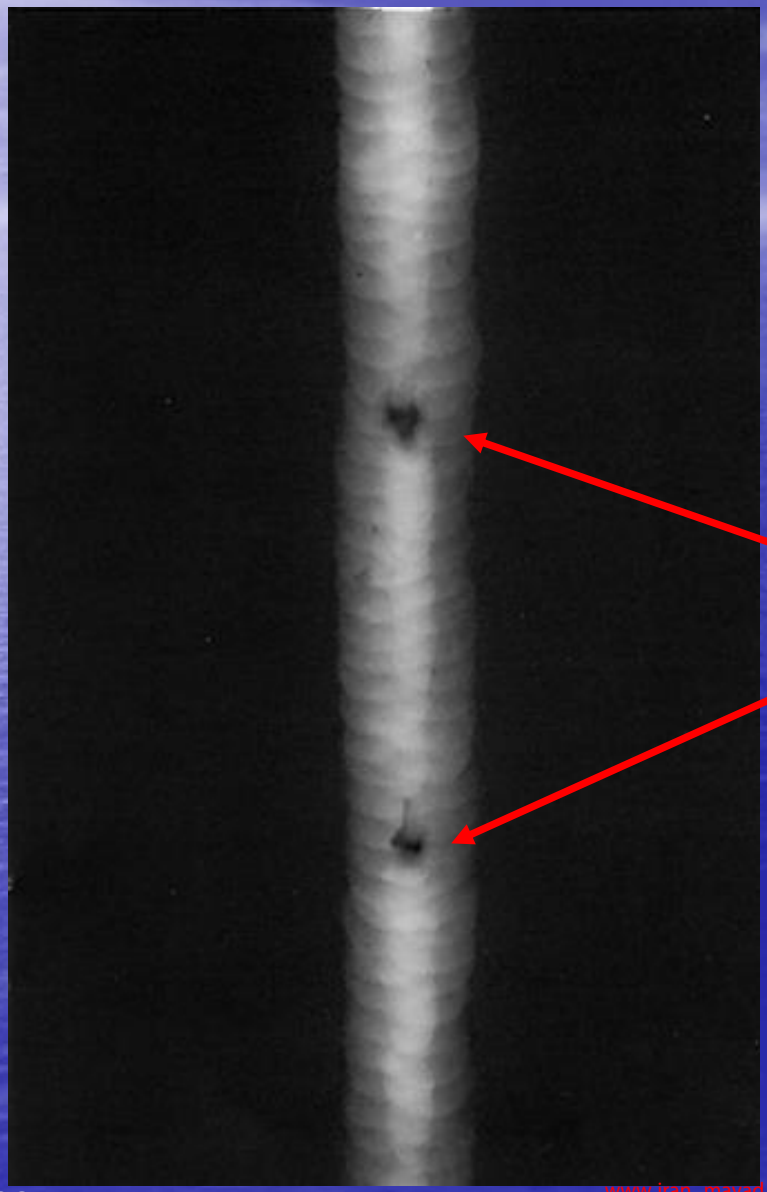
TECHNOLOGY

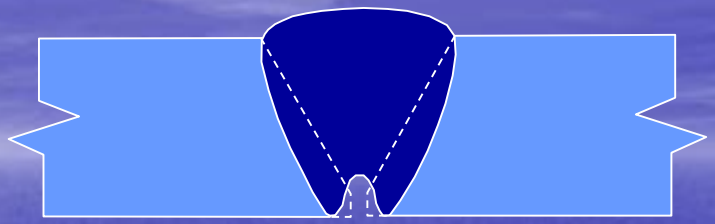




Concave root

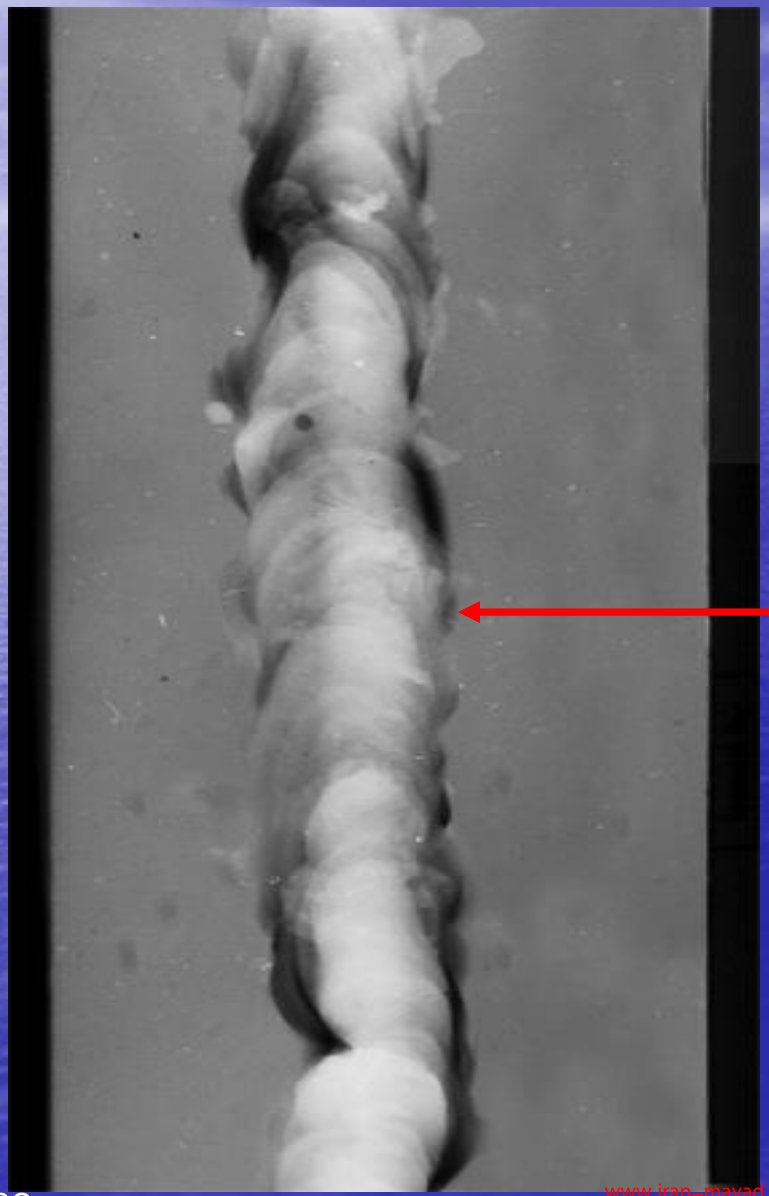
What's the defect?

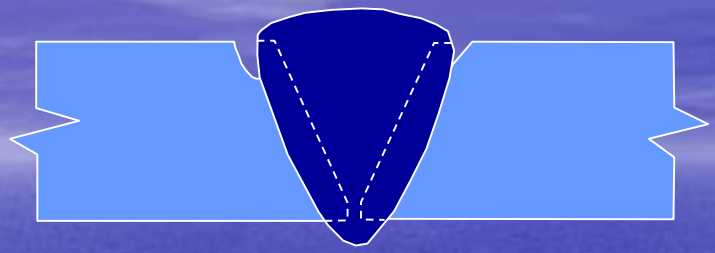




Burn through

What's the defects?

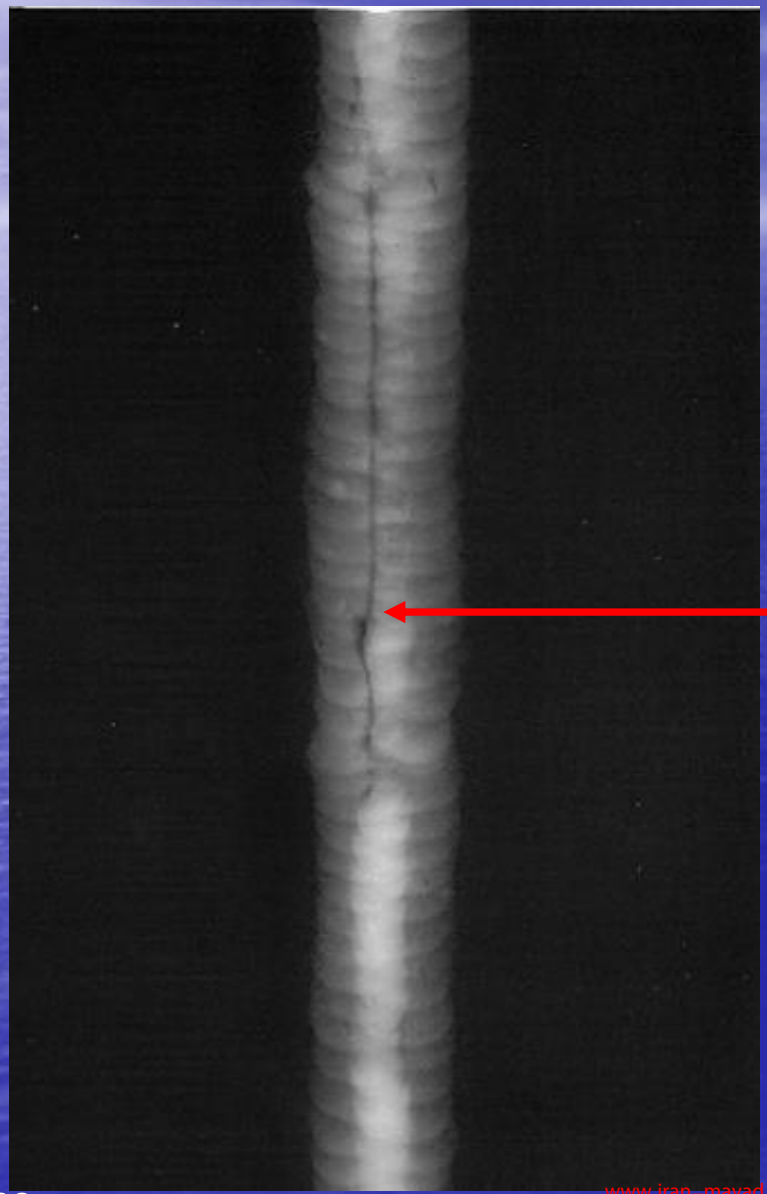


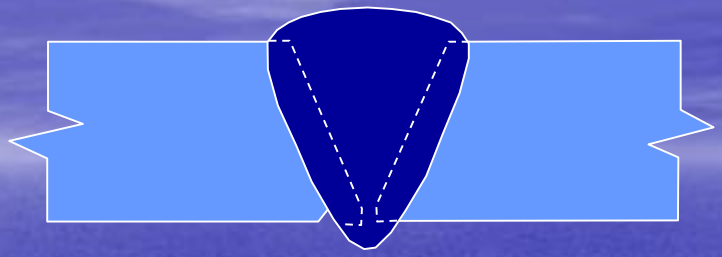


Cap undercut

What's the defect?

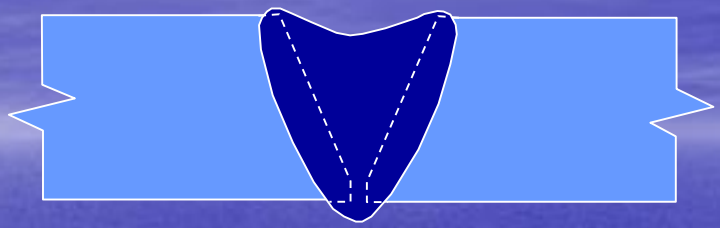
TECHNOLOGY





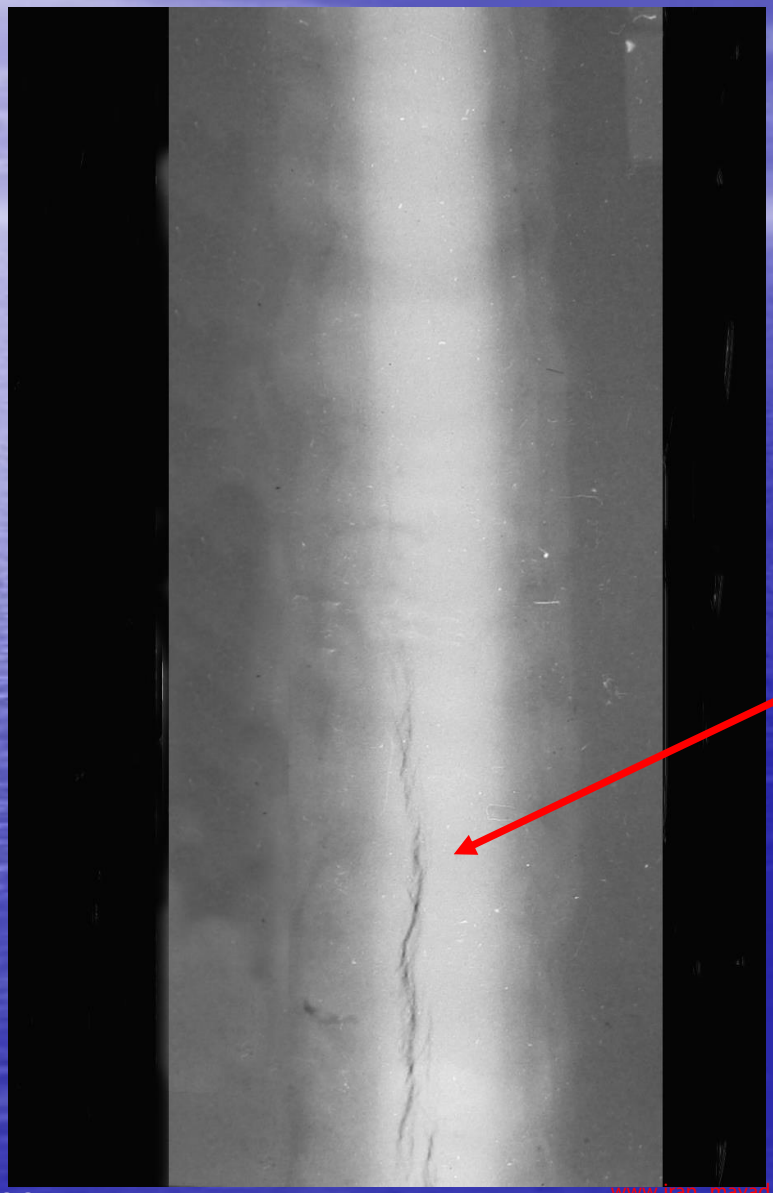
Root undercut

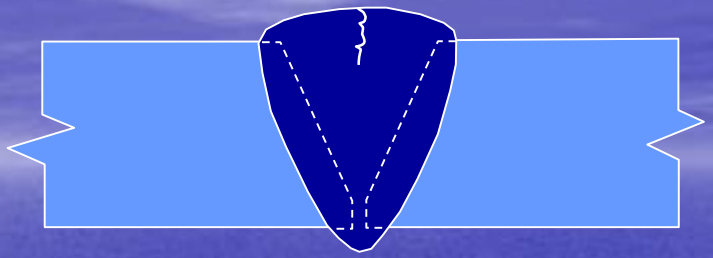
What's the defect?



Incomplete filled groove

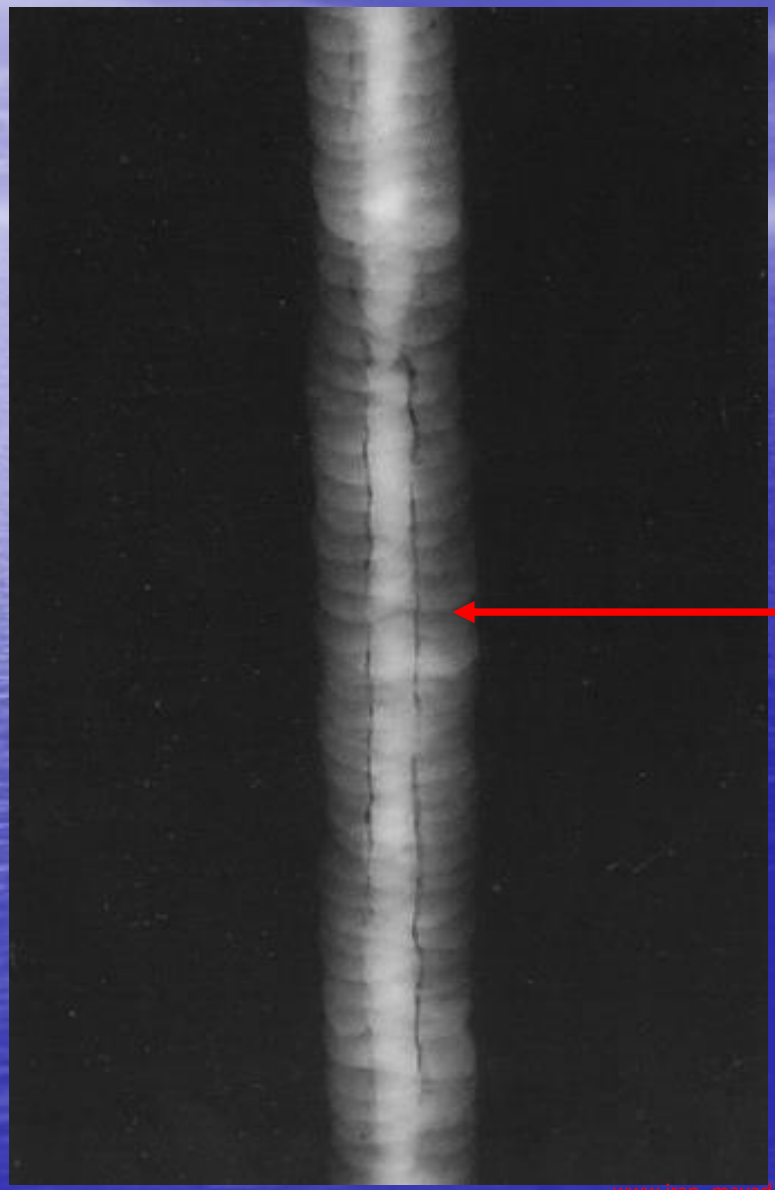
What's the defect?

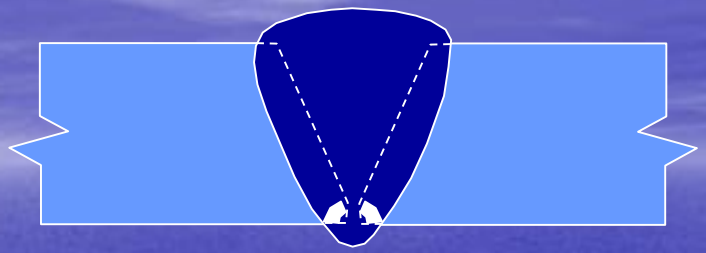




Longitudinal crack

What's the defect?

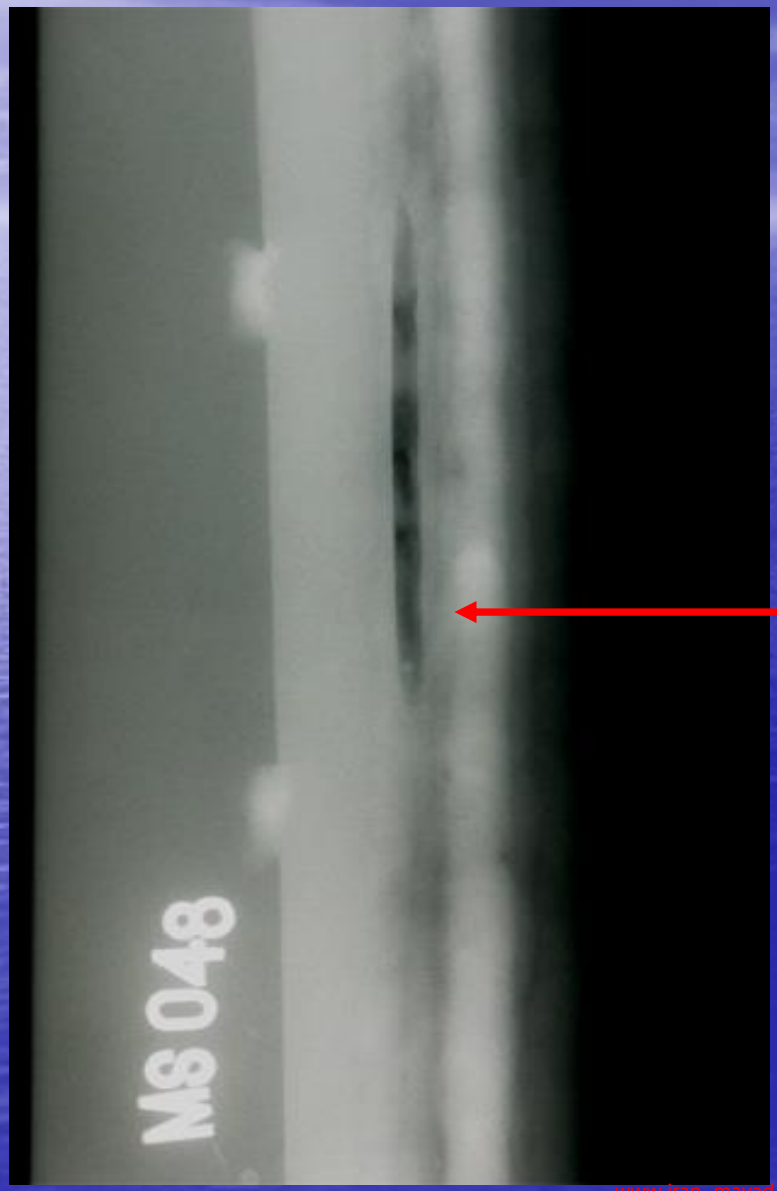


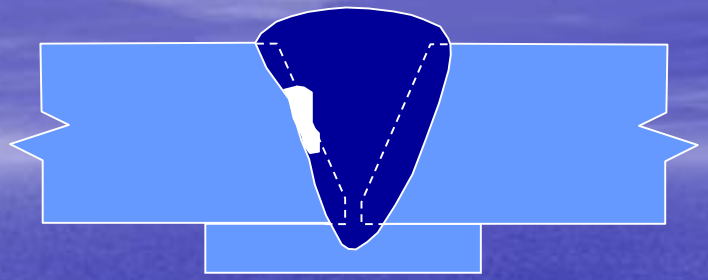


Elongated slag lines

What's the defect?

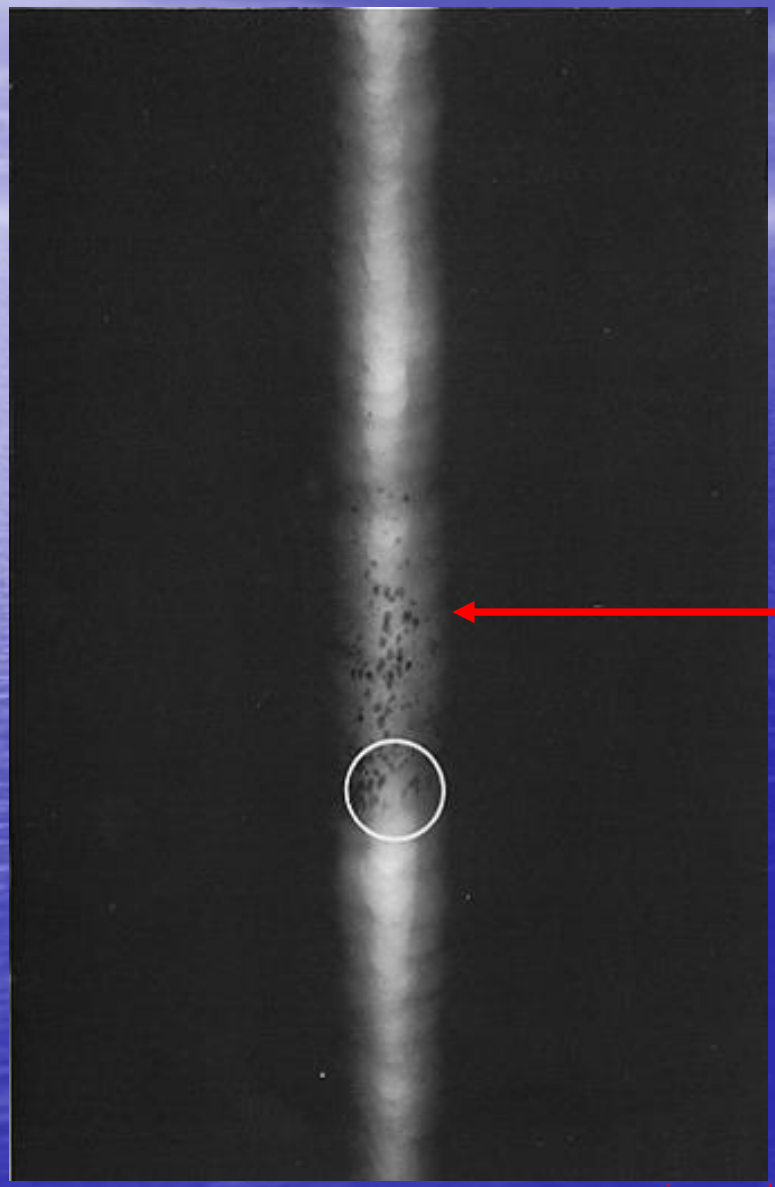
TECHNOLOGY

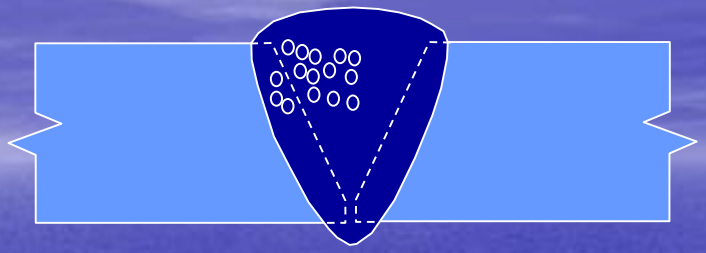




Lack of sidewall fusion + slag

What's the defect?

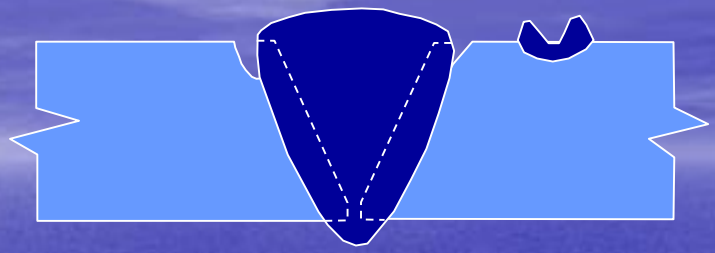




Cluster porosity

What's the defect?

TECHNOLOGY

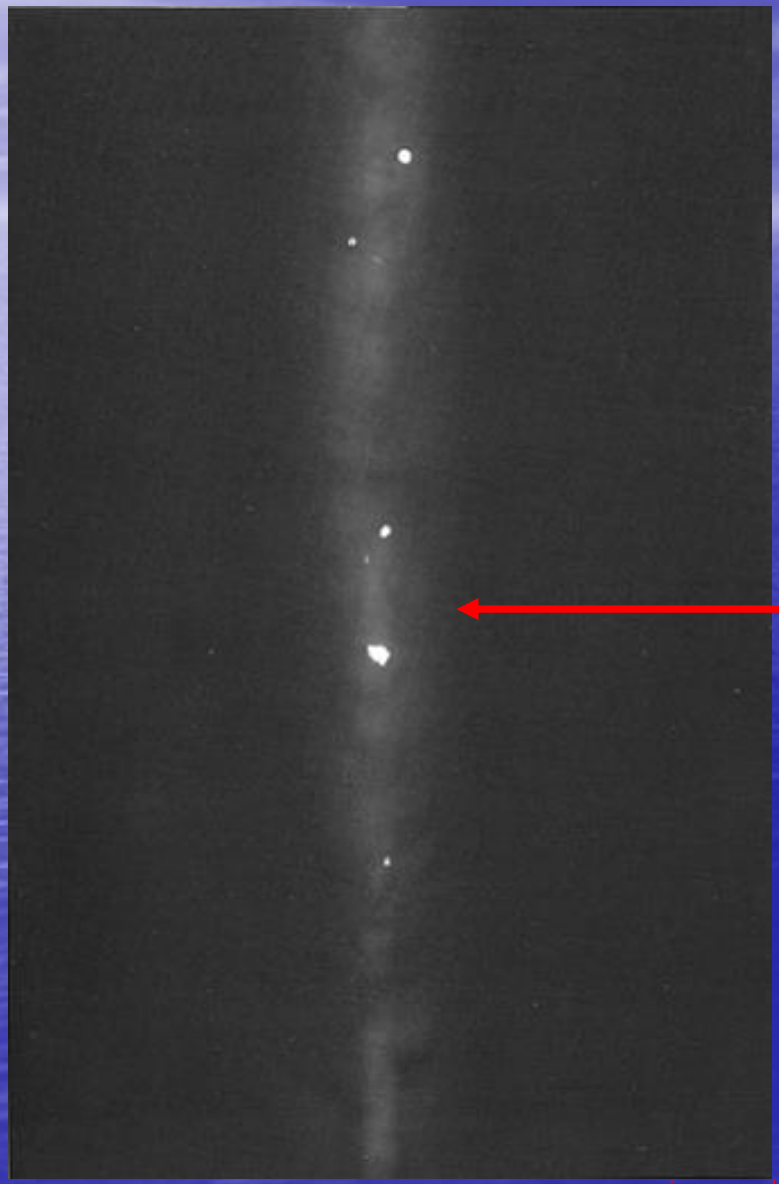


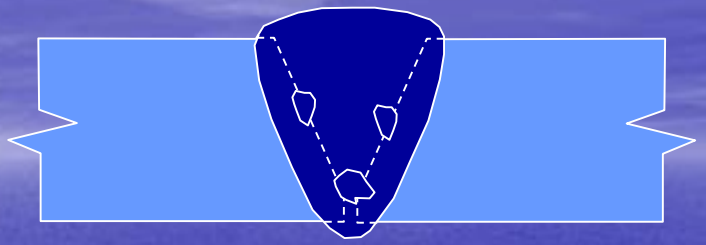
Cap undercut

Arc strike

What's the defects?

TECHNOLOGY





Tungsten inclusions

What's the defects?

TWI

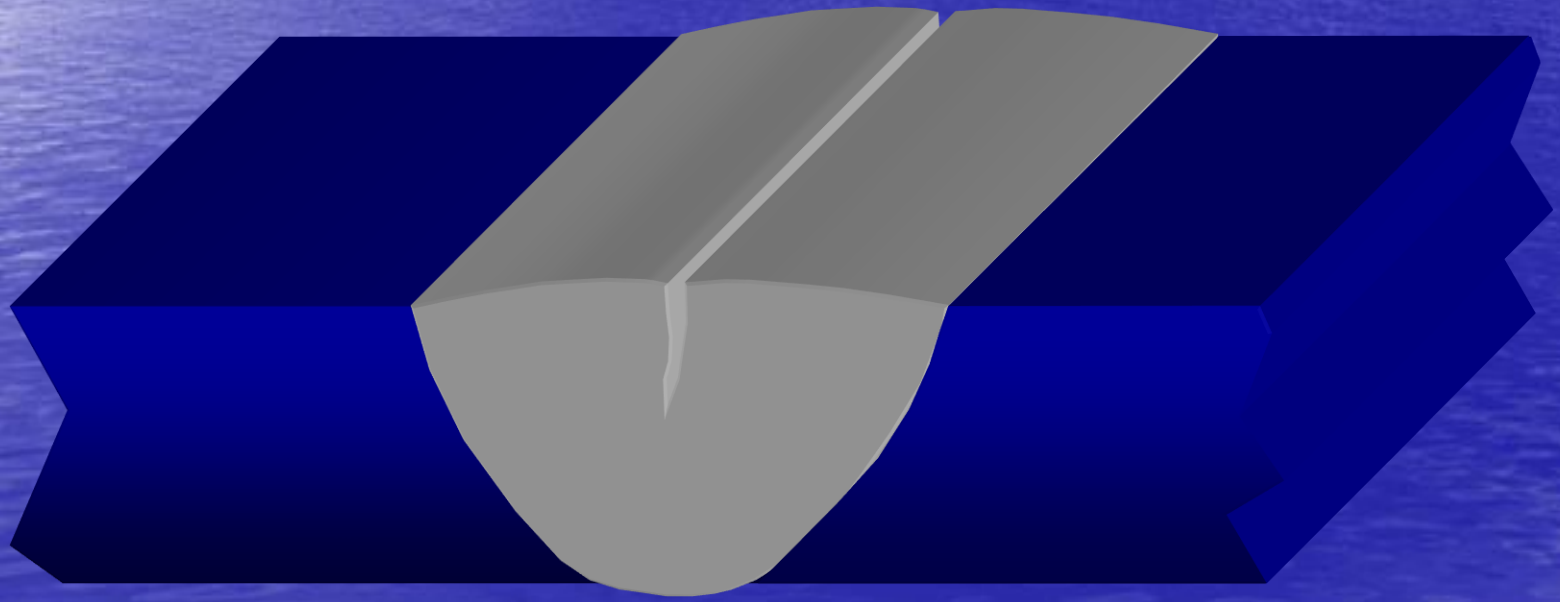
TECHNOLOGY

- Surface breaking defects only detected
- This test method uses the forces of capillary action to detect surface breaking defects
- The only limitation on the material type is the material can not be porous
- Penetrants are available in many different types
- Water washable contrast
- Solvent removable contrast
- Water washable fluorescent
- Solvent removable fluorescent
- Post-emulsifiable fluorescent

TECHNOLOGY

Step 1. Pre-Cleaning

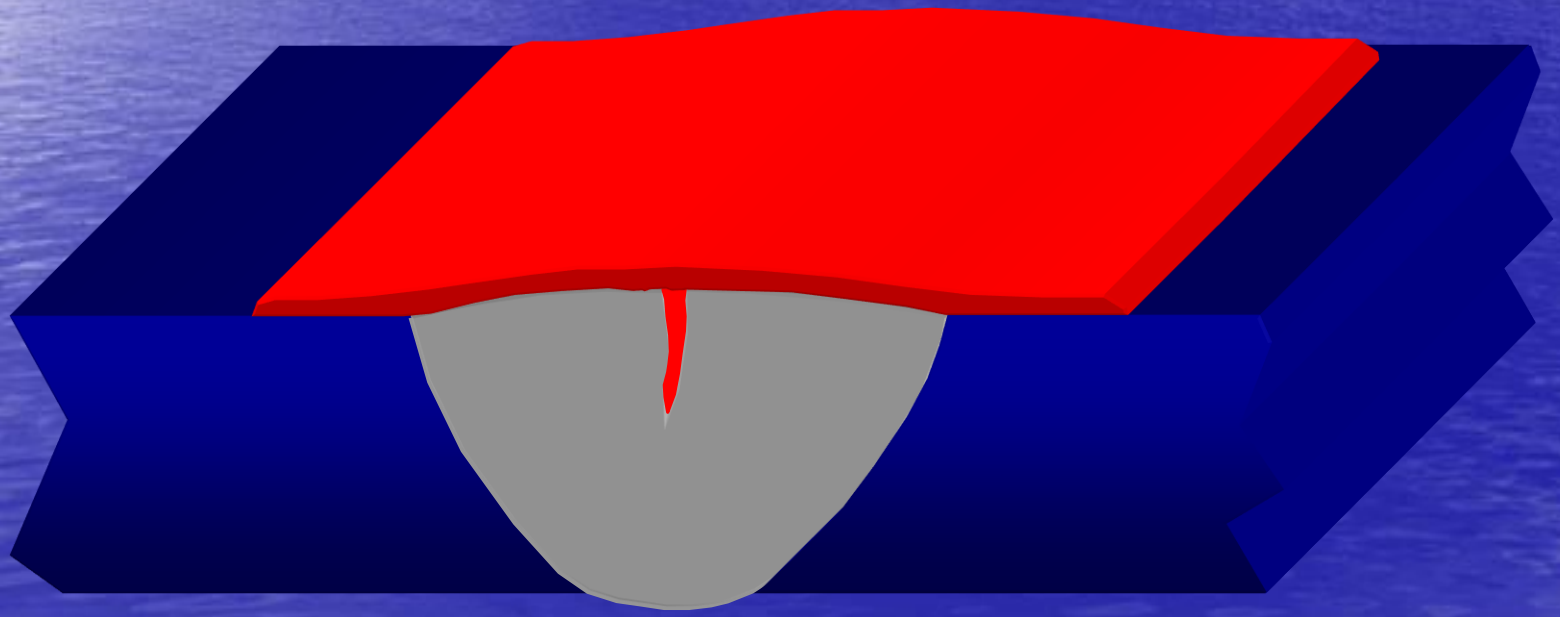
Ensure surface is very Clean normally with the use of a solvent



TECHNOLOGY

Step 2. Apply penetrant

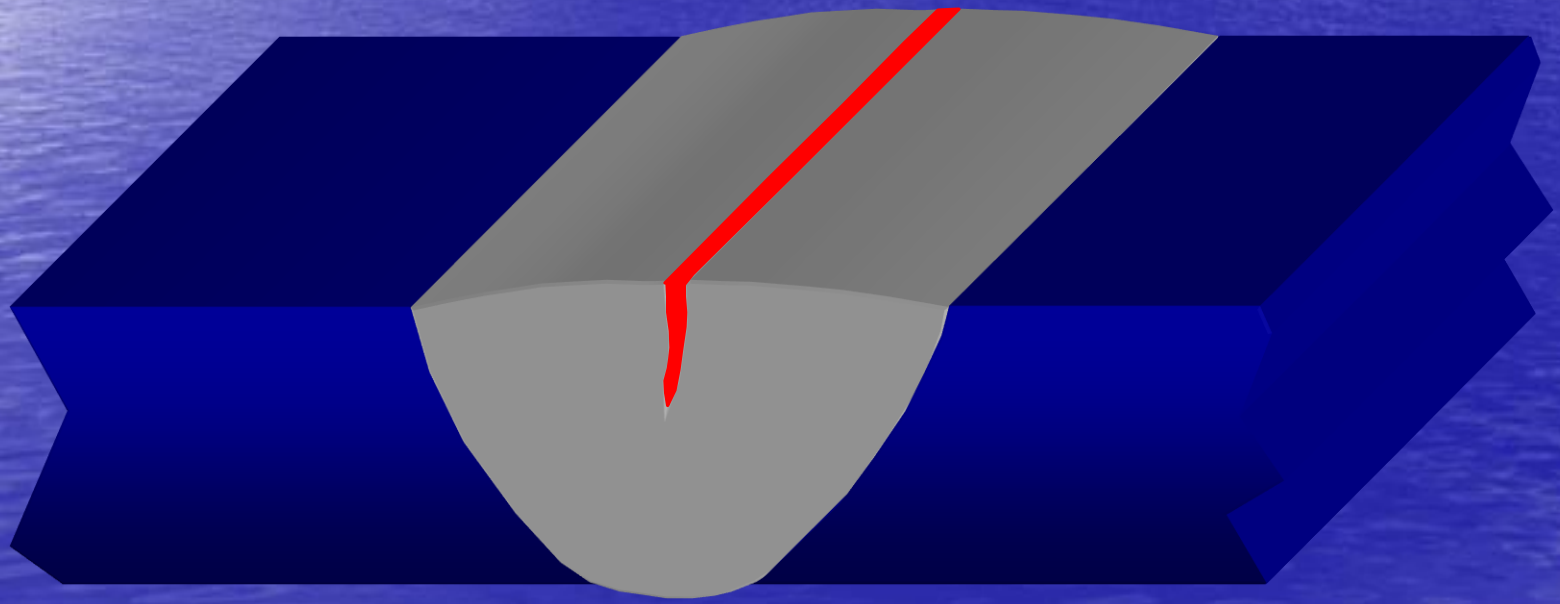
After the application of the penetrant the penetrant is normally left on the components surface for approximately 15 minutes (dwell time). The penetrant enters any defects that may be present by capillary action



TECHNOLOGY

Step 3. Clean off penetrant

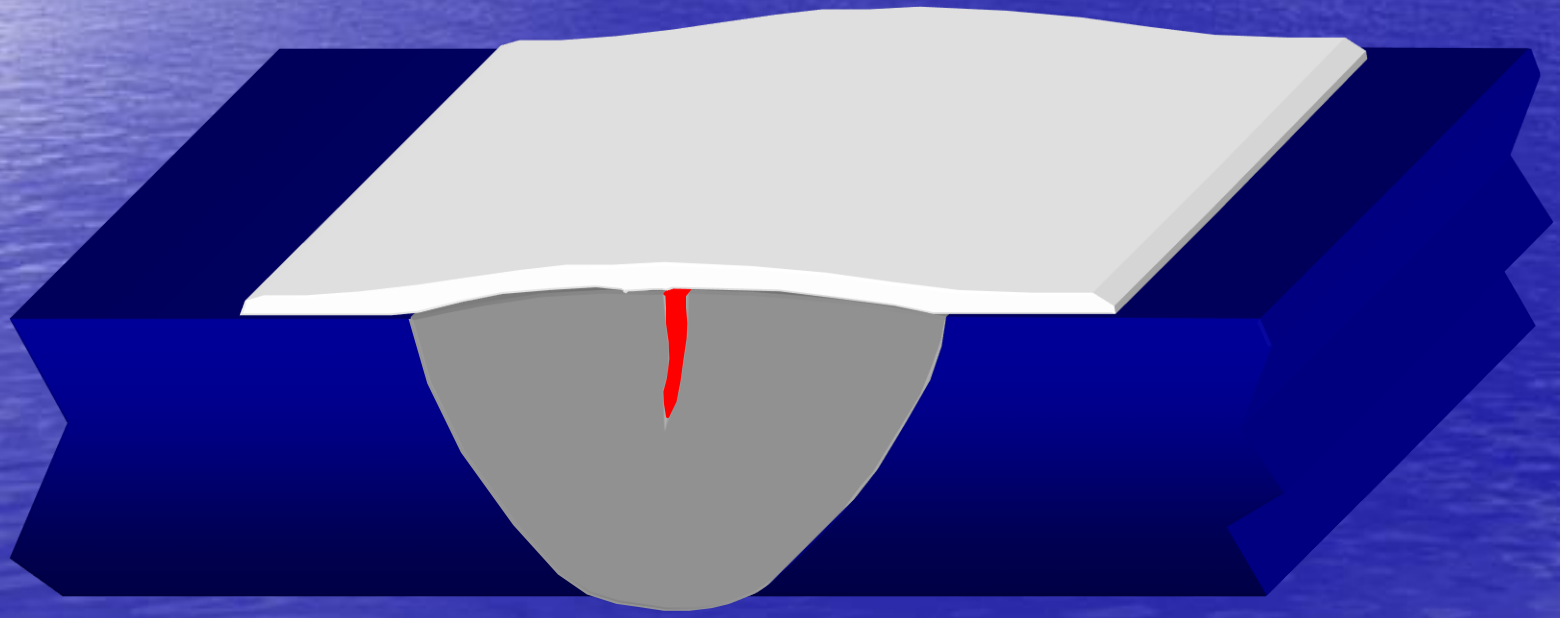
After sufficient penetration time (dwell time) has be given the penetrant is removed, care must be taken not to wash any penetrant out off any defects present



TECHNOLOGY

Step 3. Apply developer

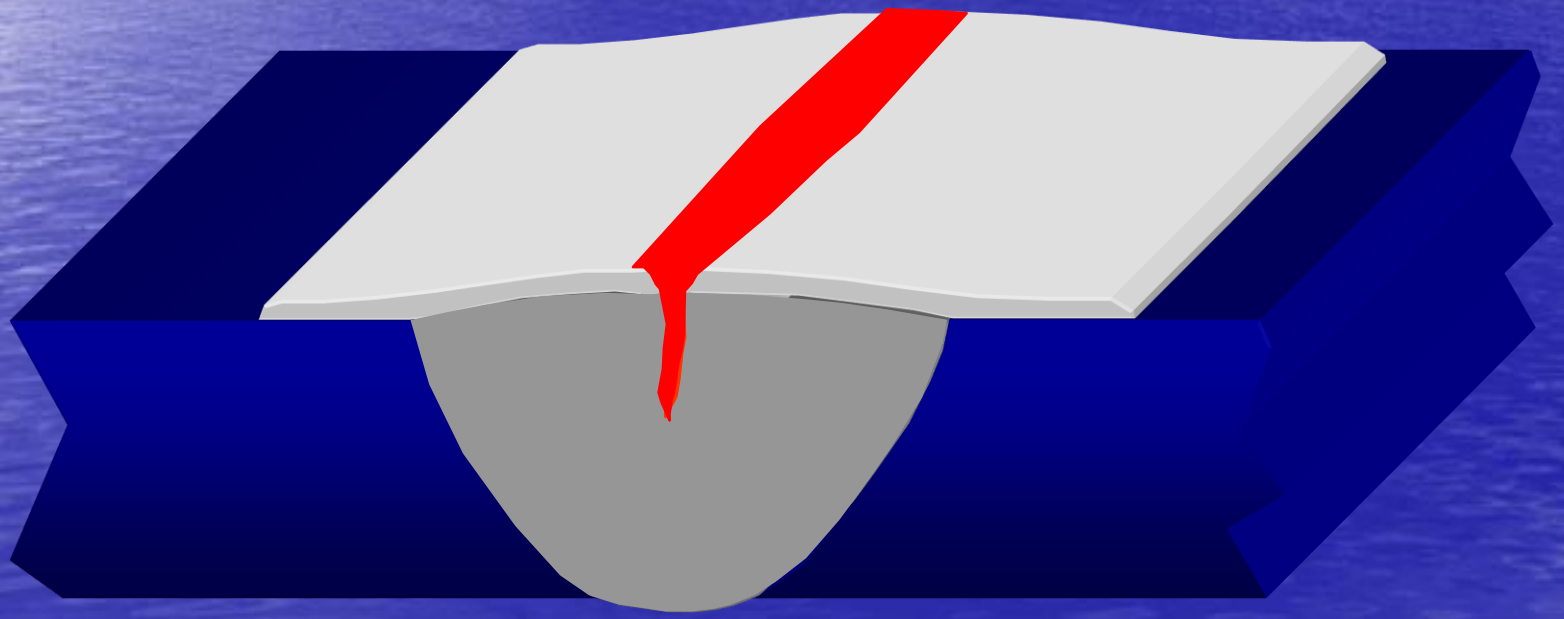
After the penetrant has be cleaned sufficiently a thin even layer of developer is applied. The developer acts as a contrast against the penetrant and allows for reverse capillary action to take place



TECHNOLOGY

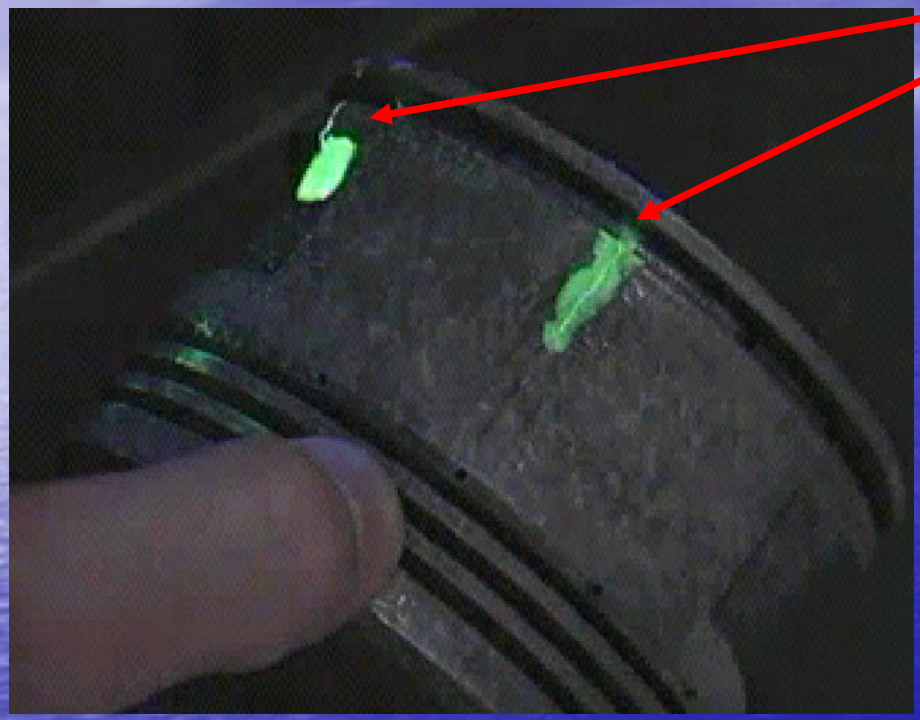
Step 4. Inspection / development time

Inspection should take place immediately after the developer has been applied any defects present will show as a bleed out during development time.



TECHNOLOGY

Fluorescent Penetrant



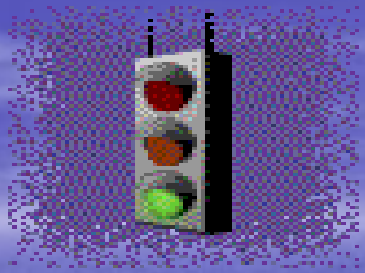
Bleed out viewed under a UV-A light source

Bleed out viewed under white light

Colour contrast Penetrant

TECHNOLOGY

Advantages



Disadvantages

- Simple to use
- Inexpensive
- Quick results
- Can be used on any non-porous material
- More sensitive than visual inspection
- Low operator skill required

- Surface breaking defects only
- Little indication of defects depths
- Penetrant may contaminate components
- Surface preparation critical
- Post cleaning may be required

- Client/location
- Item number
- Weld identification
- Specifications/procedures
- Operators name/signature
- Date of test
- Lighting conditions
- Method of pre-cleaning
- Surface conditions
- Consumables, penetrant, developer and removers
- Both dwell and development times
- Weld geometry as welded etc
- Test limitations
- Details of any flaws present.
- Report numbers

TECHNOLOGY

QU 1. Name four NDT methods

QU 2. State the two radiation types used in industrial radiography and state advantages of each.

QU 3. Give the advantages and disadvantages of radiography and conventional ultrasonic inspection.

QU 4. Give the main disadvantages of magnetic particle inspection and give at least three methods of applying magnetisium to a component.

QU 5 State the main limitations of dye penetrant inspection.