Non-Destructive Testing

A welding inspector should have a working knowledge of NDT methods and their applications, advantages and disadvantages.

Four basic NDT methods

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

Dye Penetrant Inspection

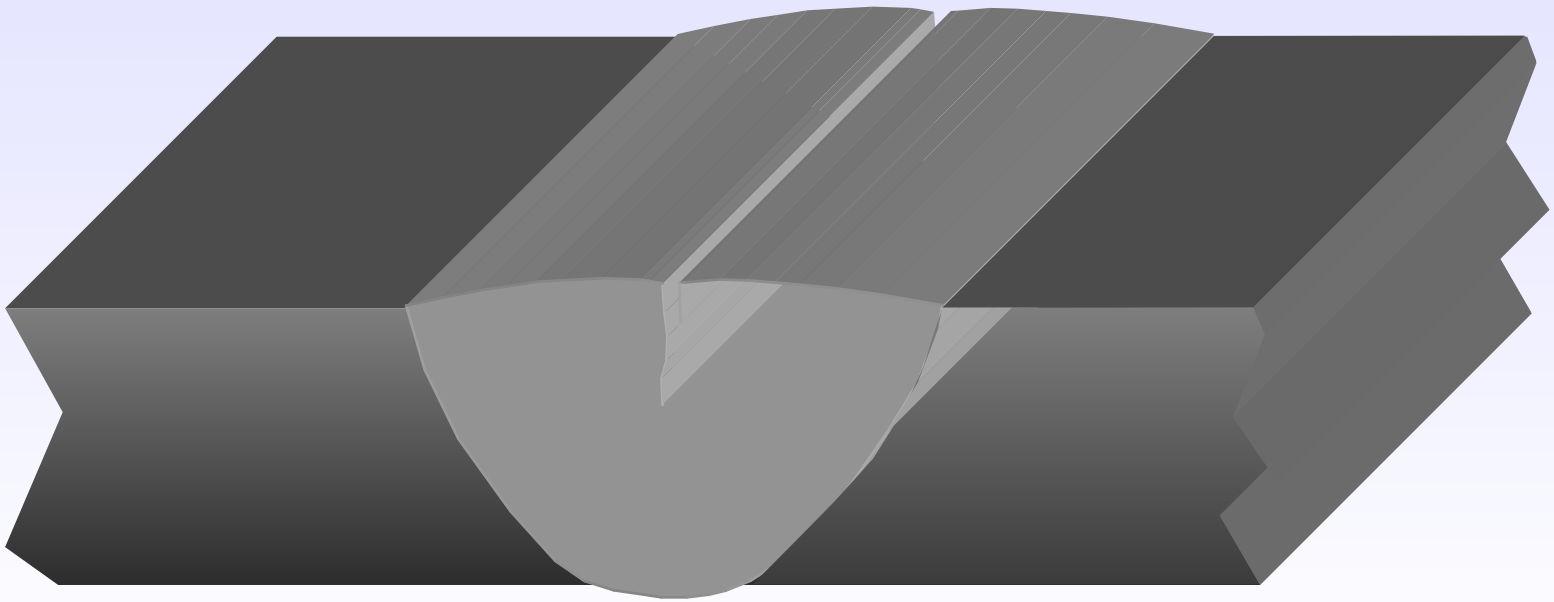
Dye Penetrant Inspection

- 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

Dye Penetrant Inspection

Step 1. Pre-Cleaning

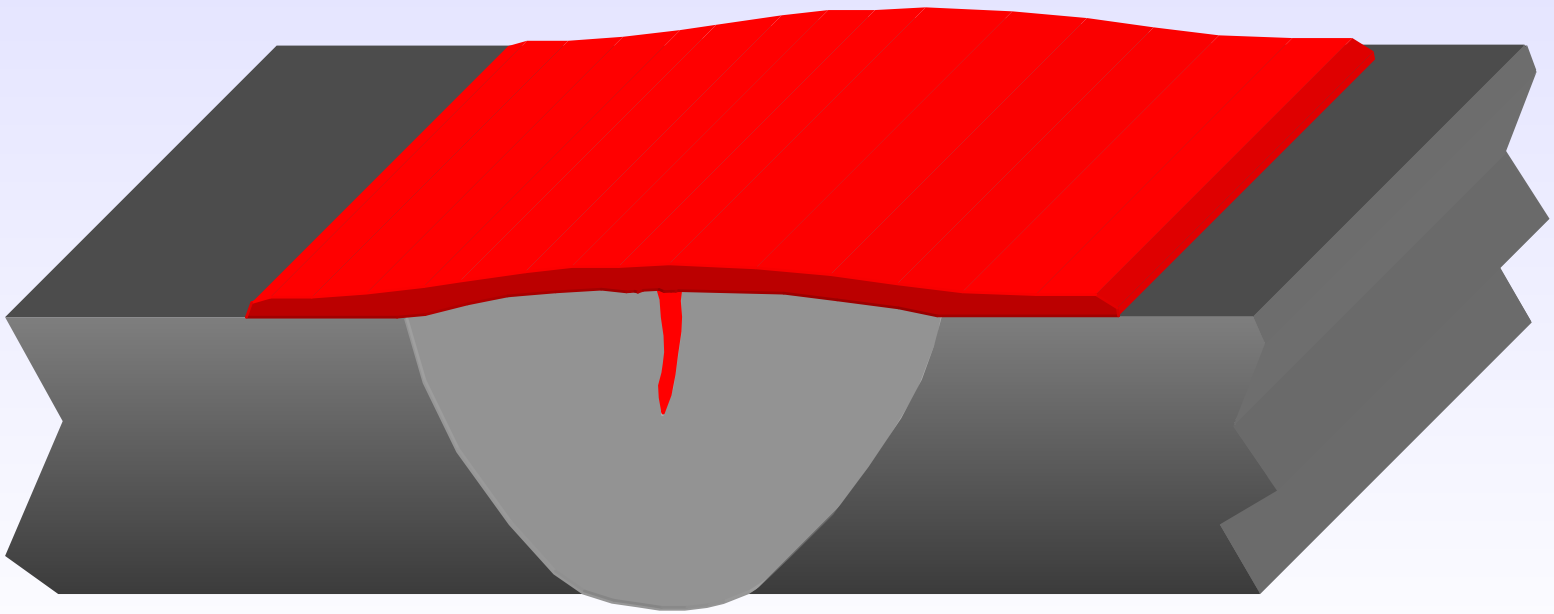
Ensure surface is very Clean normally with the use of a solvent



Dye Penetrant Inspection

Step 2. Apply penetrant

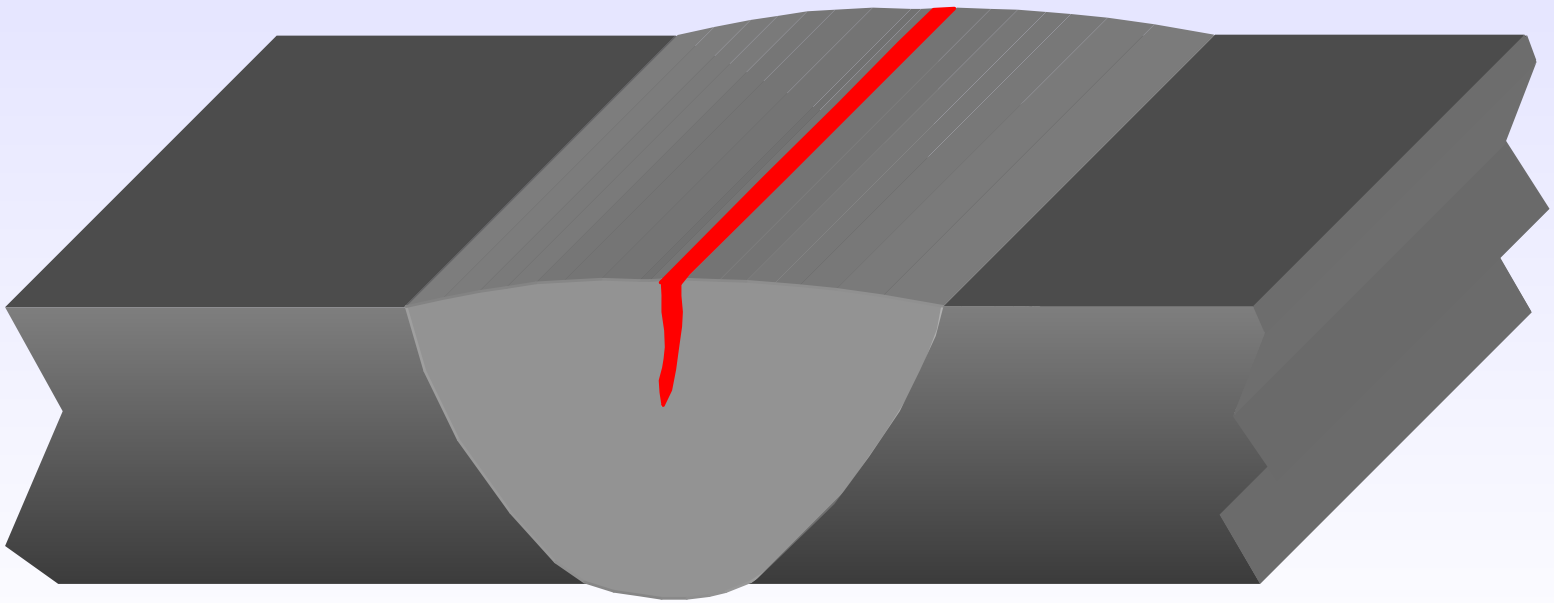
After the application of the penetrant the penetrant is normally left on the components surface for approximately 15 minutes (dwell time). The penetrant enters any defects that may be present by capillary action



Dye Penetrant Inspection

Step 3. Clean off penetrant

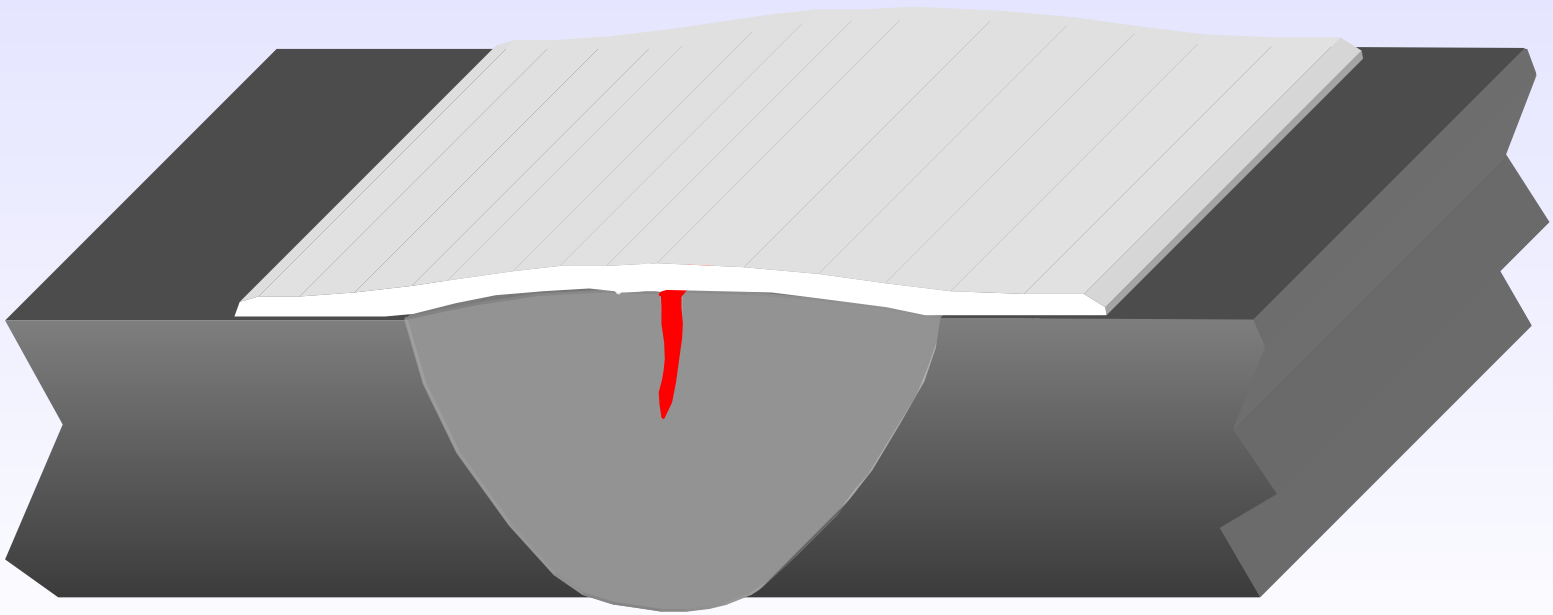
After sufficient penetration time (dwell time) has be given the penetrant is removed, care must be taken not to wash any penetrant out off any defects present



Dye Penetrant Inspection

Step 3. Apply developer

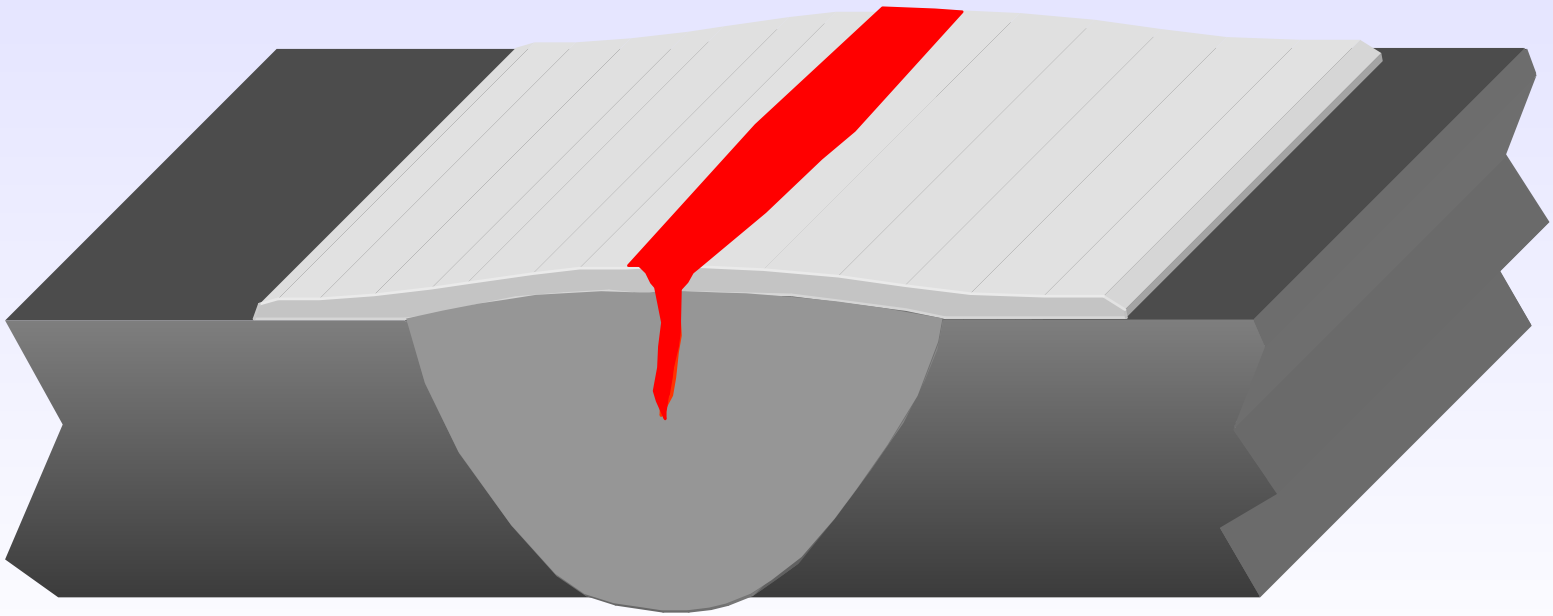
After the penetrant has be cleaned sufficiently a thin even layer of developer is applied. The developer acts as a contrast against the penetrant and allows for reverse capillary action to take place



Dye Penetrant Inspection

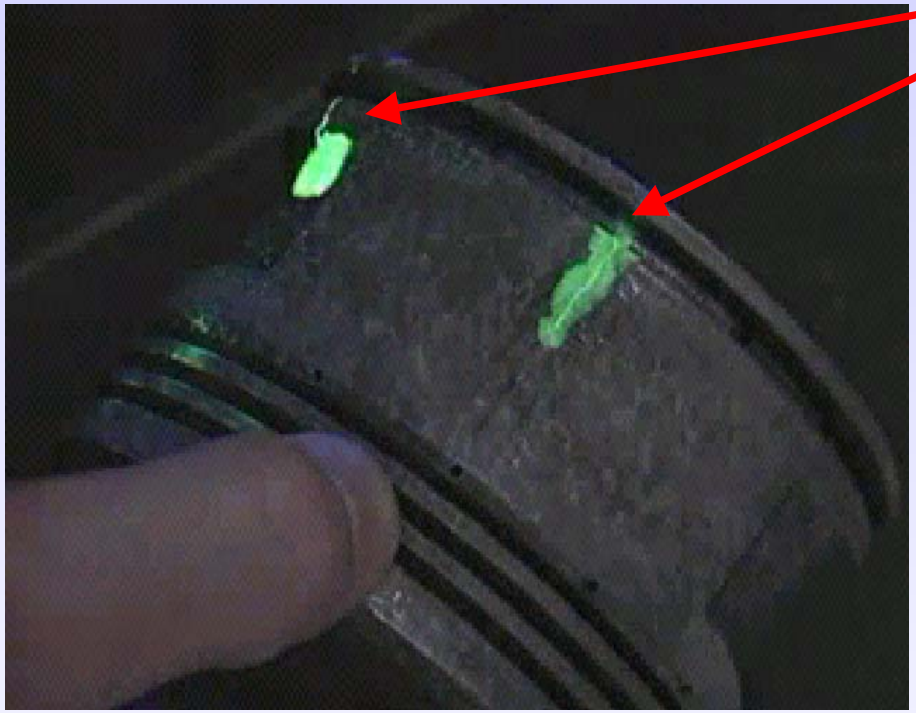
Step 4. Inspection / development time

Inspection should take place immediately after the developer has been applied any defects present will show as a bleed out during development time. After full inspection has been carried out post cleaning is generally required.



Dye Penetrant Inspection

Fluorescent Penetrant



Bleed out viewed under a UV-A light source

Bleed out viewed under white light

Colour contrast Penetrant

Dye Penetrant Inspection

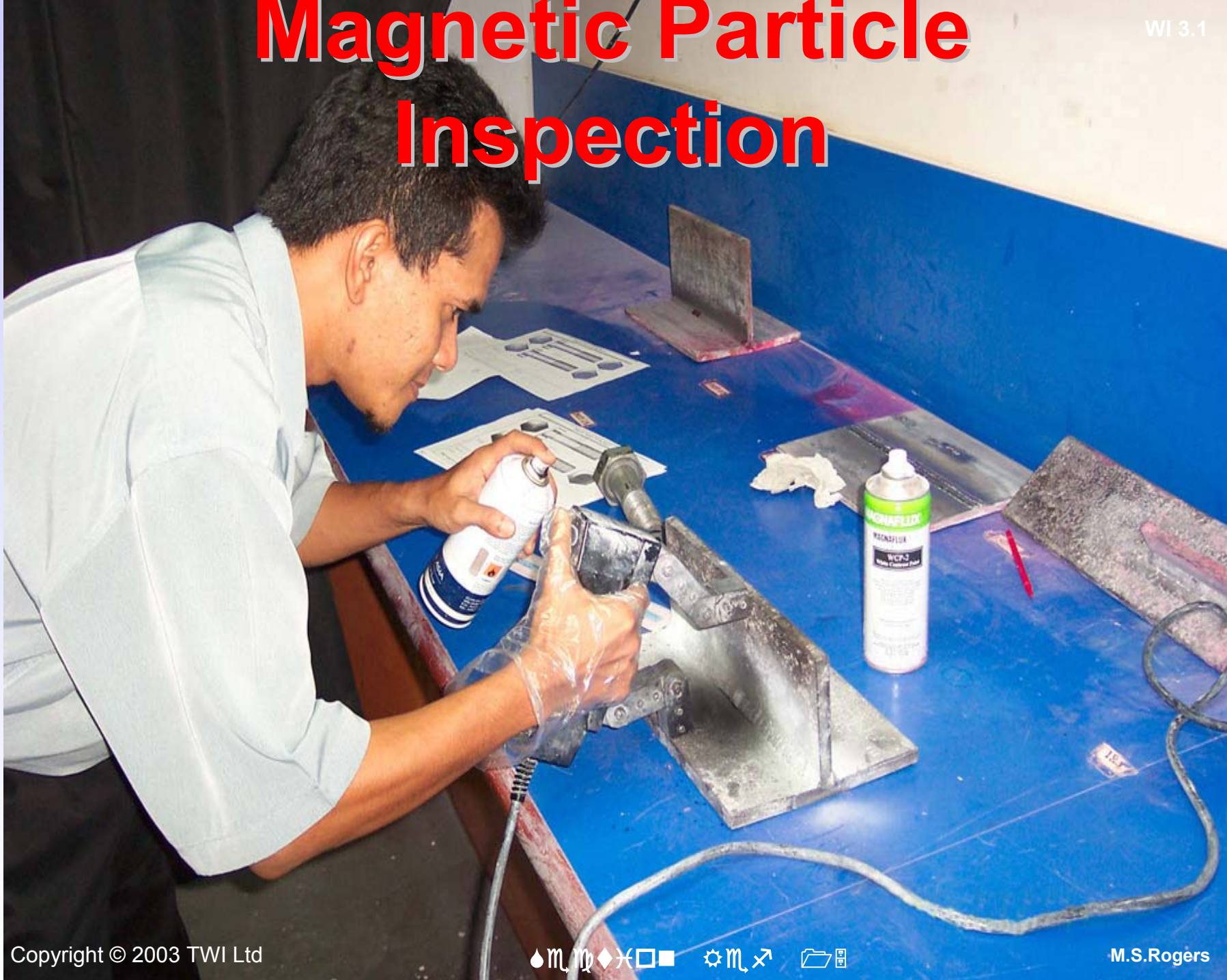
Advantages

- Simple to use
- Inexpensive
- Quick results
- Can be used on any non-porous material
- Portability
- Low operator skill required

Disadvantages

- Surface breaking defect only
- little indication of depths
- Penetrant may contaminate component
- Surface preparation critical
- Post cleaning required
- Potentially hazardous chemicals

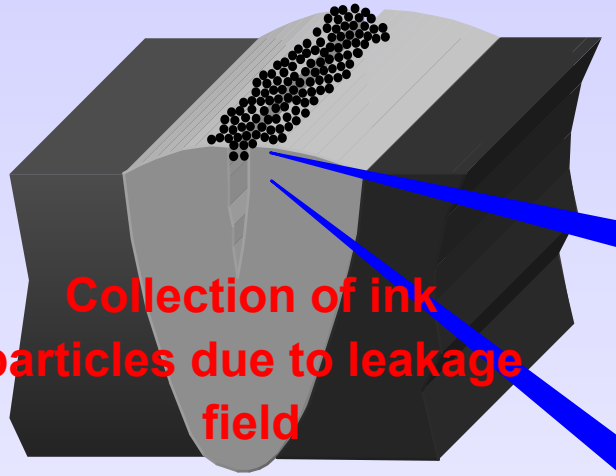
Magnetic Particle Inspection

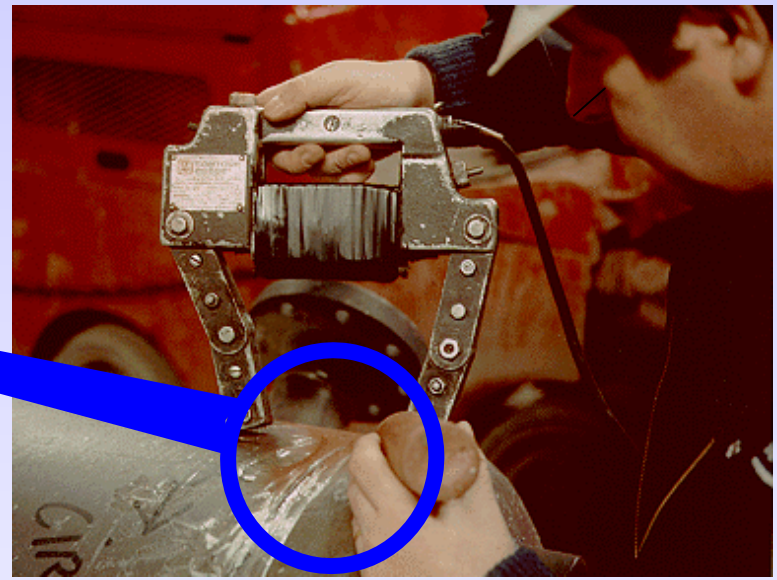


Magnetic Particle Inspection

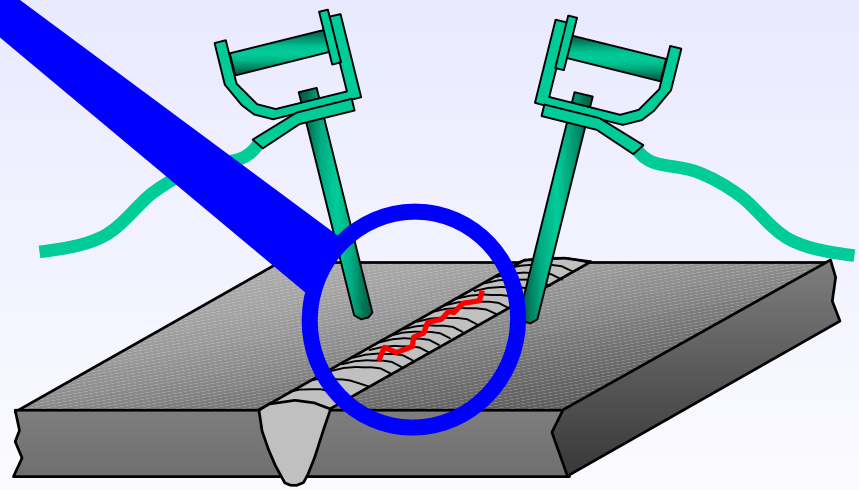
- Surface and slight sub-surface detection
- Relies on magnetization of component being tested
- Ferro-magnetic materials only can be tested
- A magnetic field is introduced into a specimen being tested
- Methods of applying a magnetic field, yoke, permanent magnet, prods and flexible cables.
- Fine 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

Magnetic Particle Inspection





Electro-magnet (yoke) DC or AC

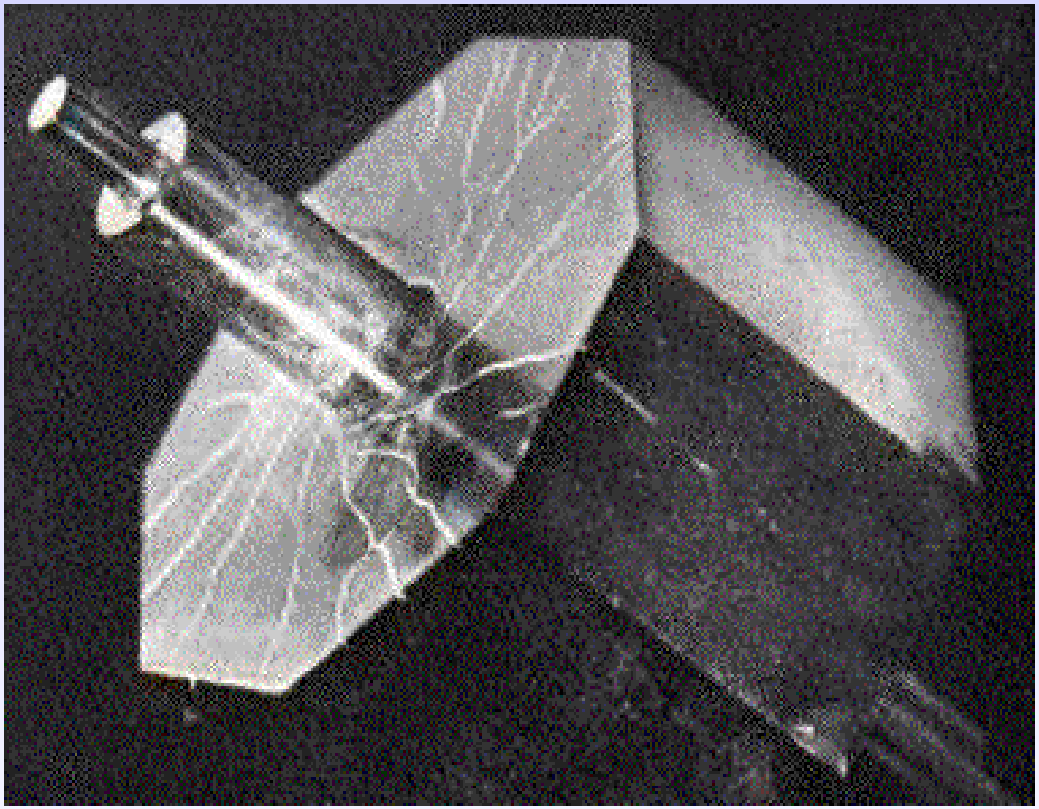


Prods DC or AC

Magnetic Particle Inspection

A crack like indication

Magnetic Particle Inspection



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

Magnetic Particle Inspection

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

Magnetic Particle Inspection

Advantages

- Simple to use
- Inexpensive
- Rapid results
- Little surface preparation required
- Possible to inspect through thin coatings

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

Ultrasonic Inspection

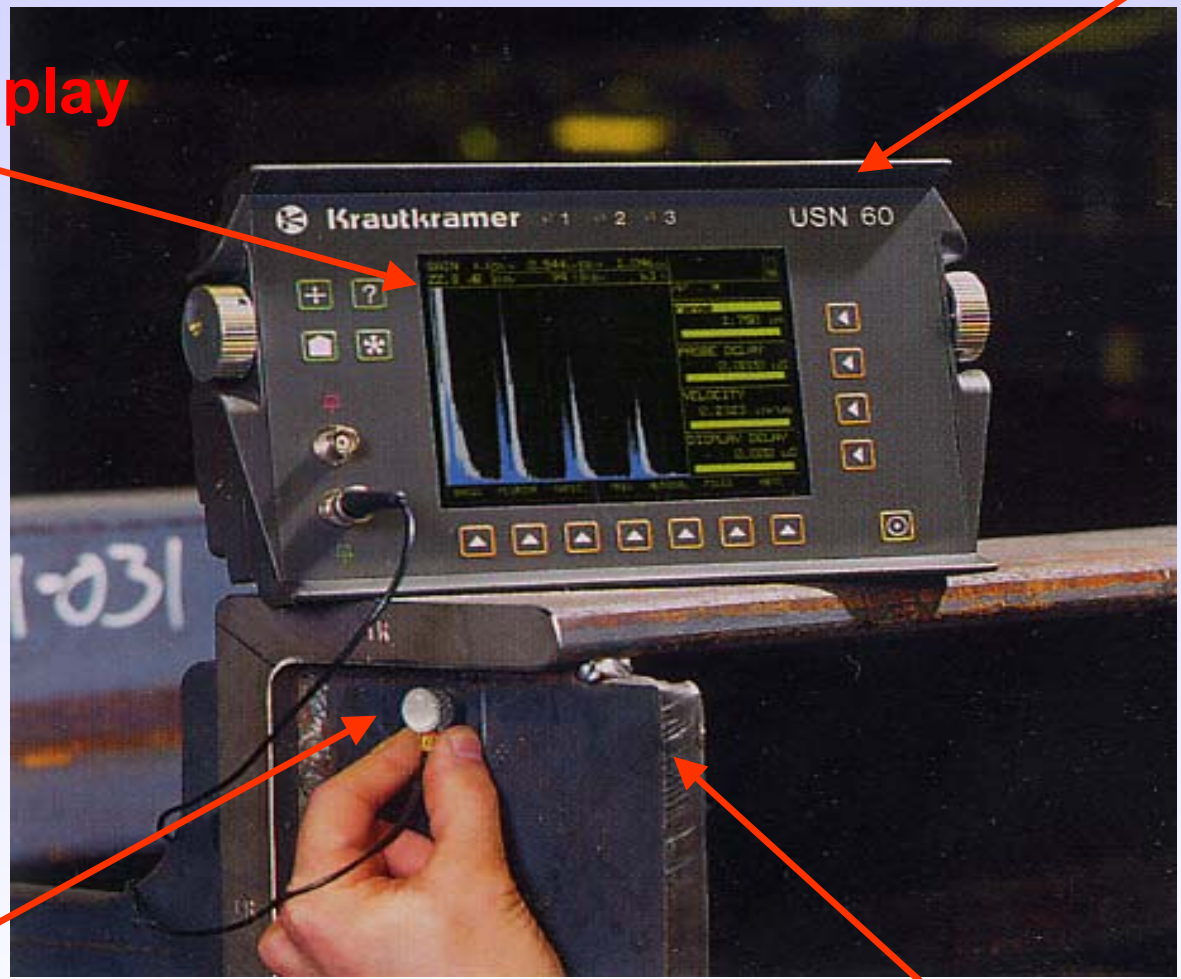
Ultrasonic Inspection

- 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

Ultrasonic Inspection

Pulse echo signals
A scan Display

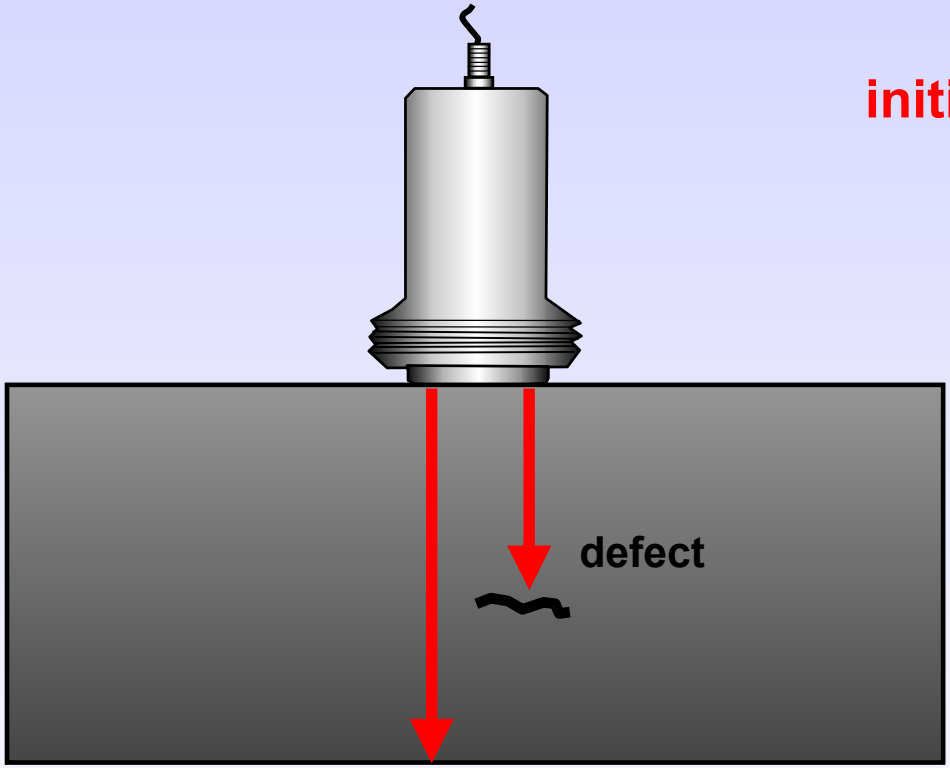
UT Set, Digital



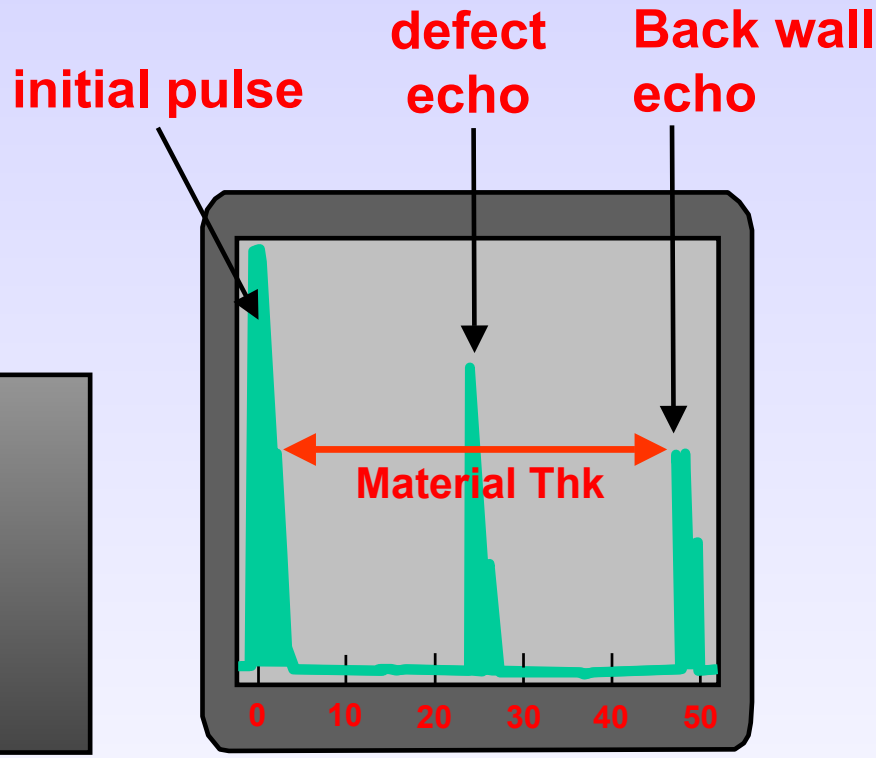
Compression probe

Thickness checking the material

Ultrasonic Inspection



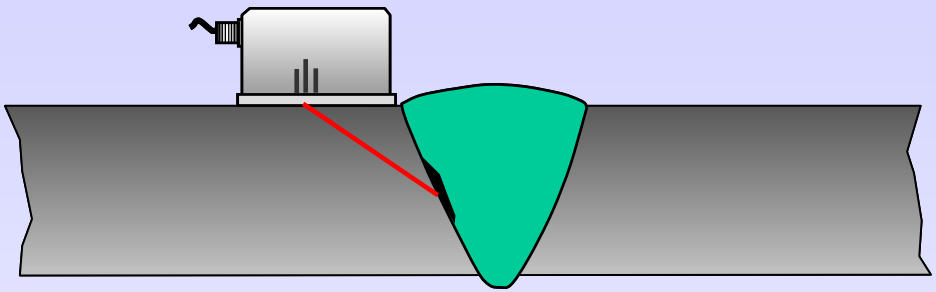
Compression Probe



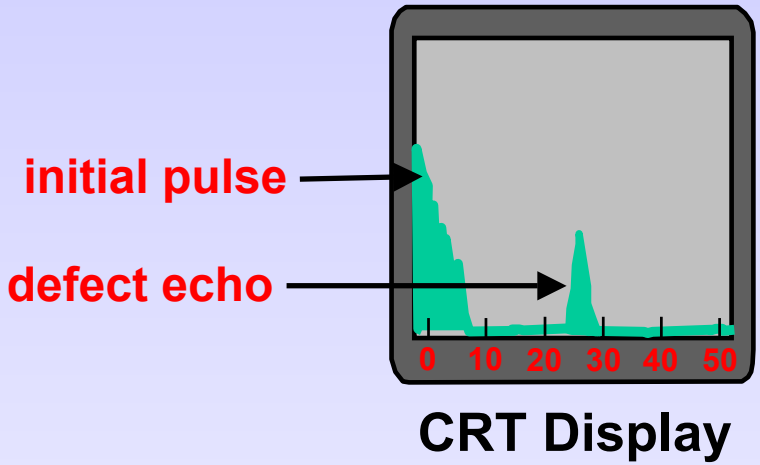
CRT Display

Ultrasonic Inspection

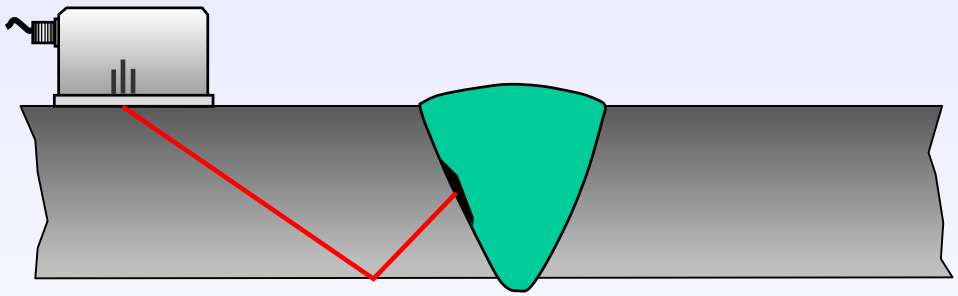
Ultrasonic Inspection



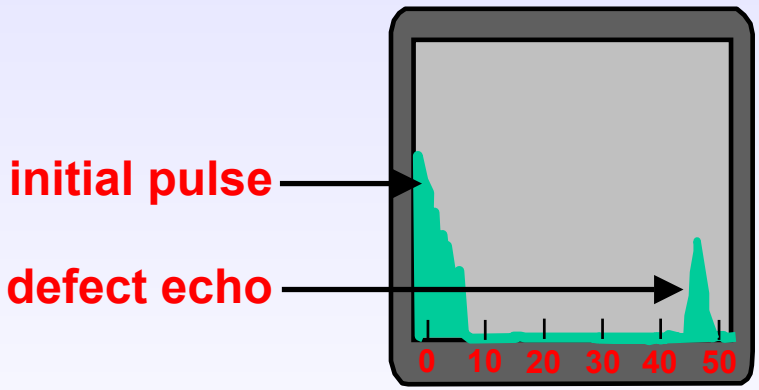
½ Skip



CRT Display



Full Skip



CRT Display

Ultrasonic Inspection

Advantages

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

Disadvantages

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

Any Questions

Radiographic Inspection

Radiographic Inspection

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

Radiographic Inspection

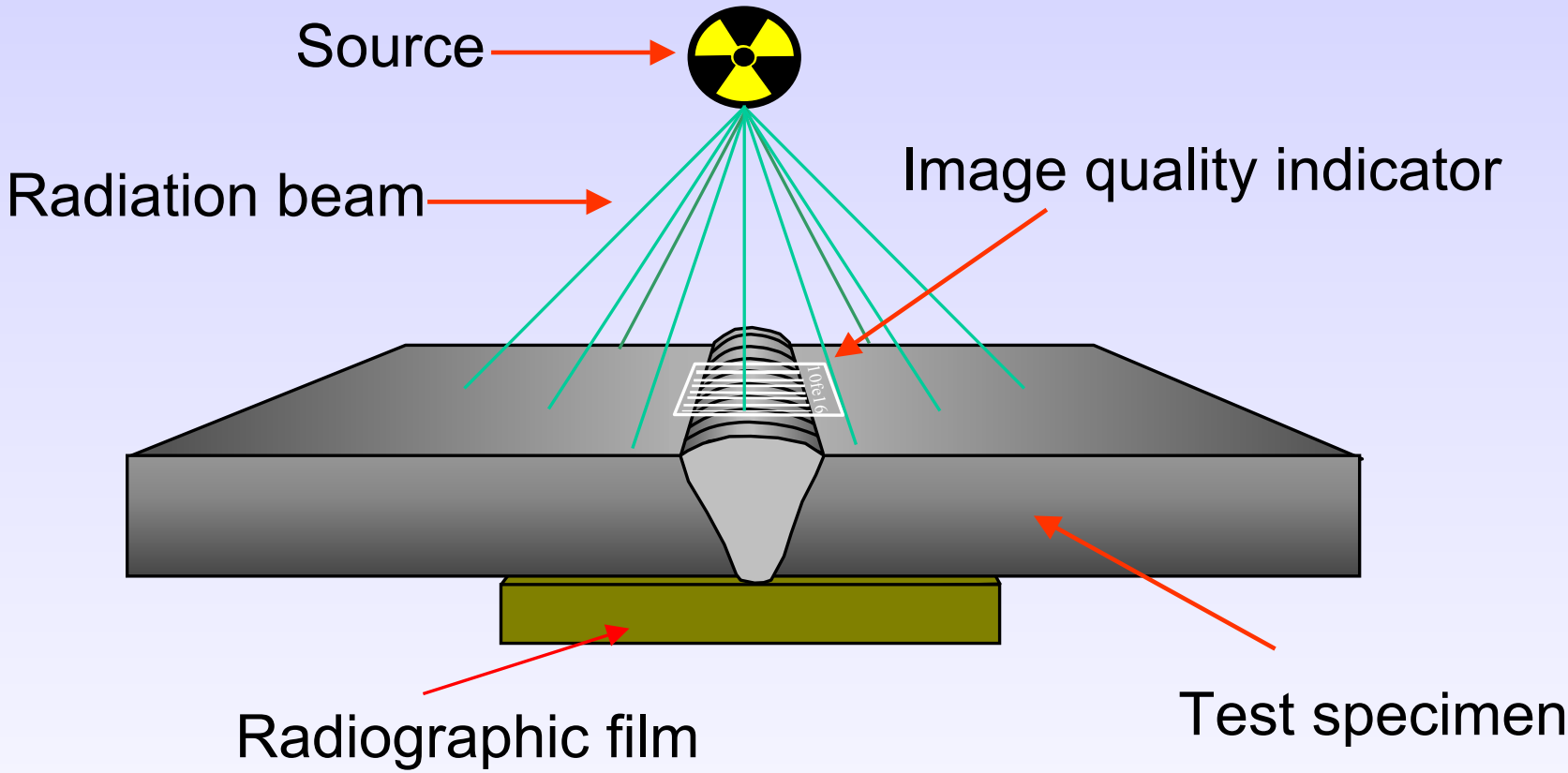
X - Rays

Electrically generated

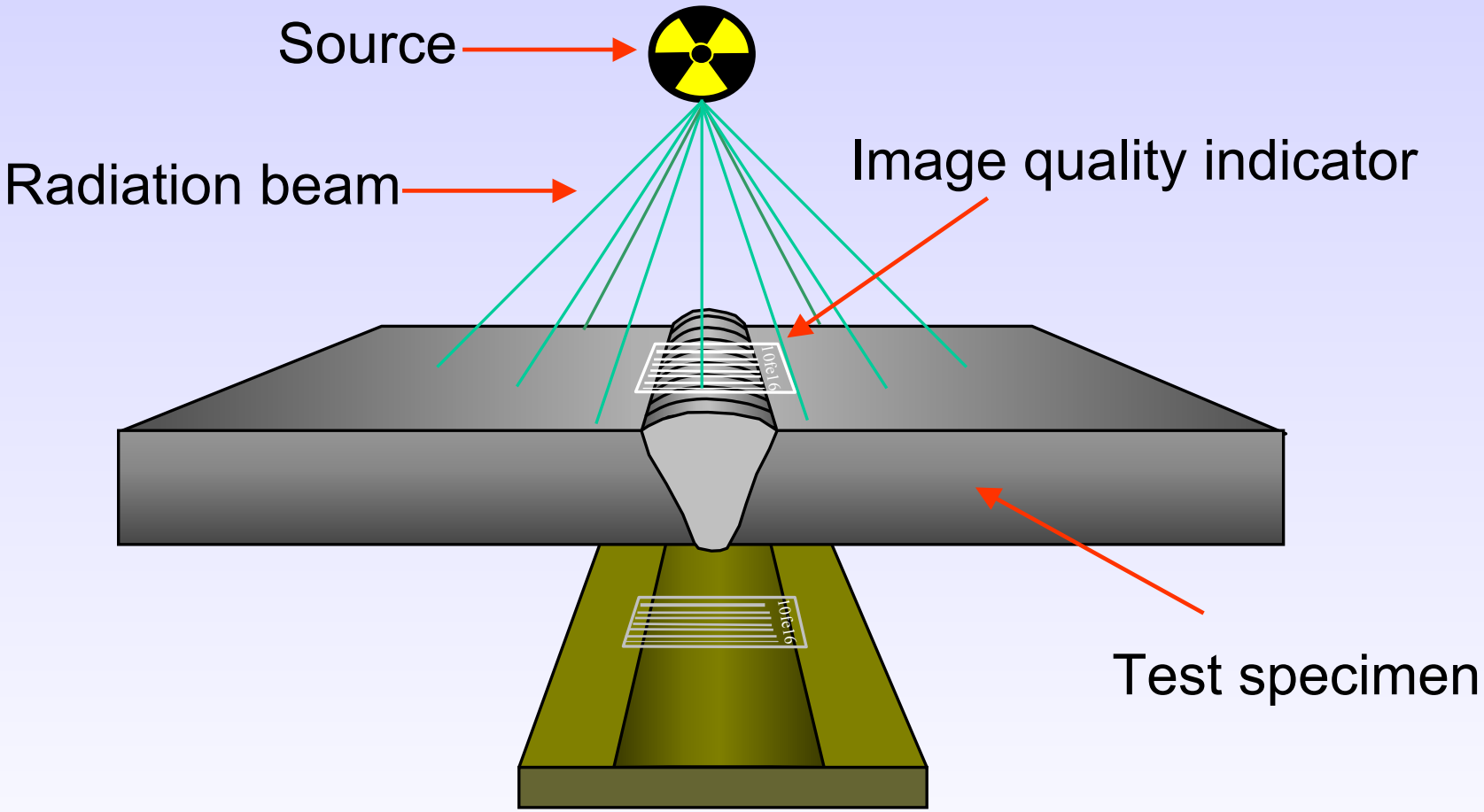
Gamma Rays

Generated by the decay of unstable atoms

Radiographic Inspection



Radiographic Inspection



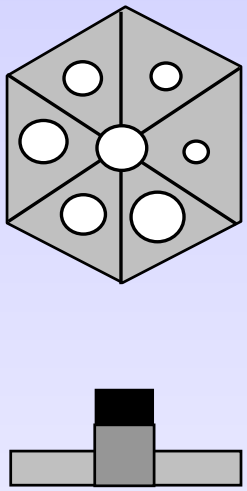
Radiographic film with latent image after exposure

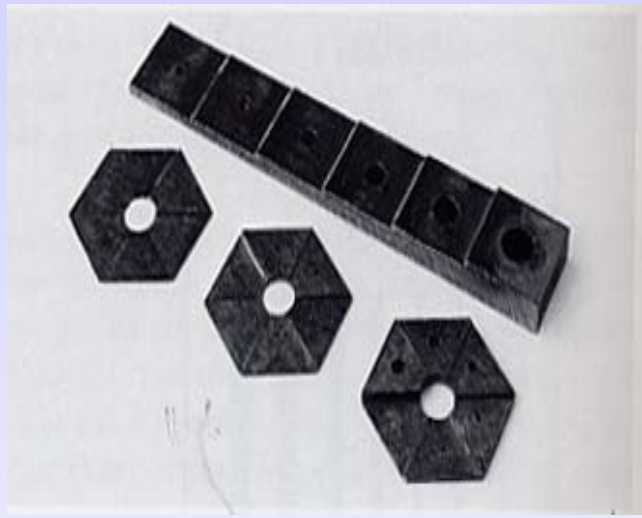
Radiographic Quality

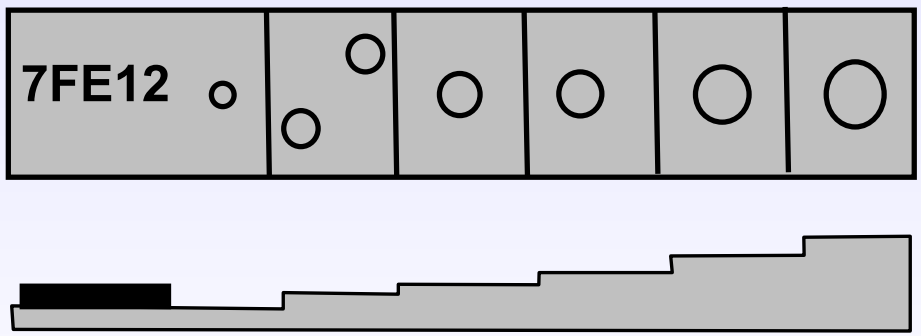
- **Density** - relates to the degree of darkness

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

Radiographic Sensitivity



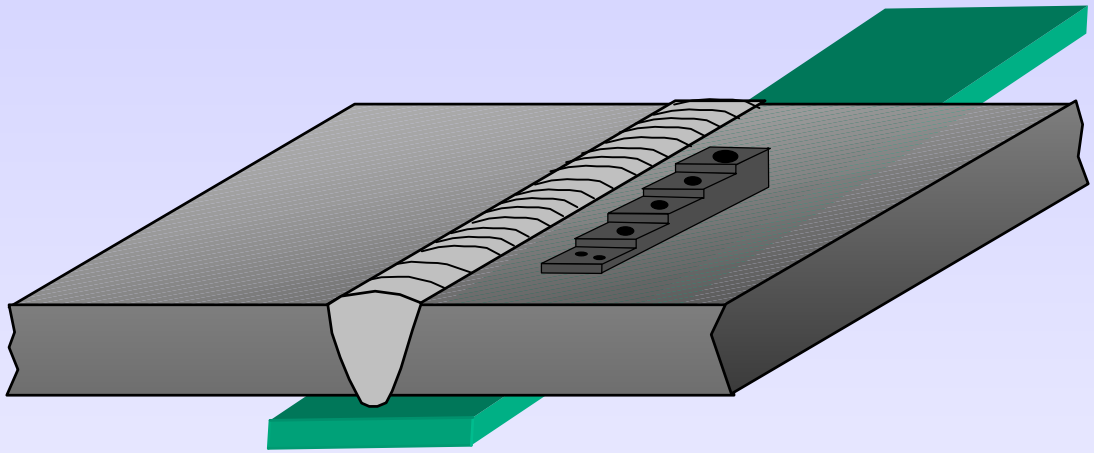




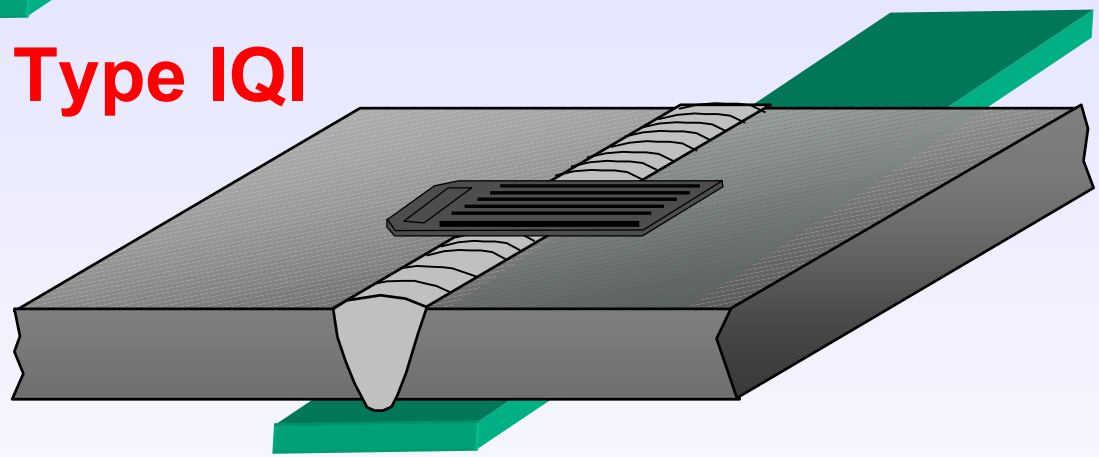
Step / Hole type IQI

Wire type IQI

Image Quality Indicators



Step/Hole Type IQI



Wire Type IQI

Radiographic Techniques

- Single Wall Single Image (SWSI)

  - film inside, source outside

- Single Wall Single Image (SWSI) panoramic

  - film outside, source inside (internal exposure)

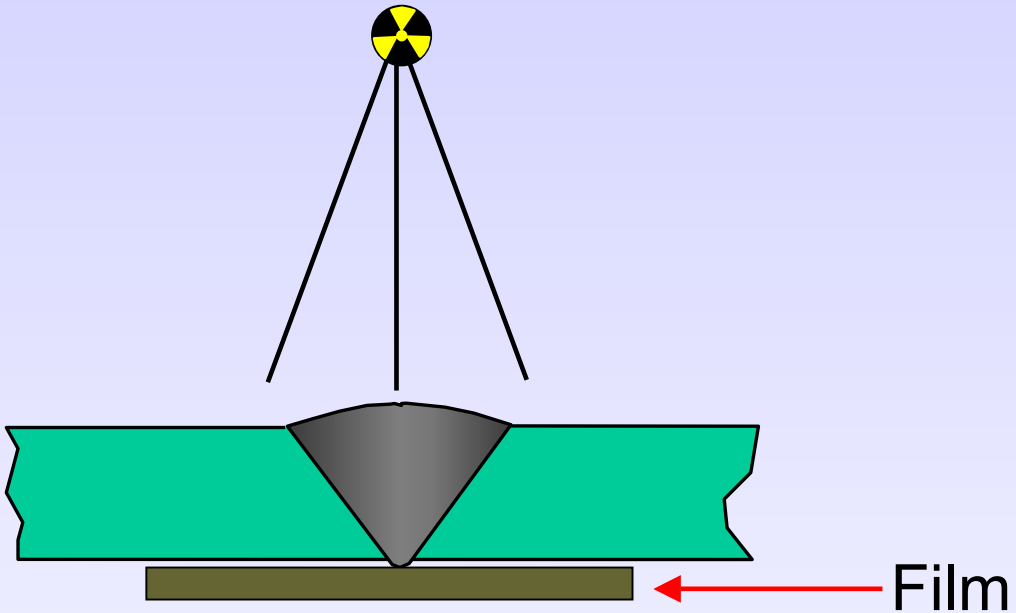
- Double Wall Single Image (DWSI)

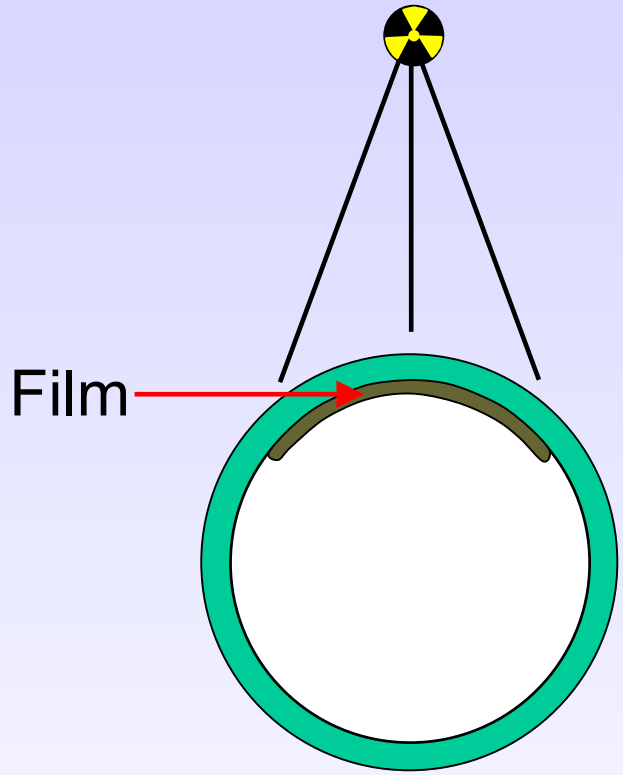
  - film outside, source outside (external exposure)

- Double Wall Double Image (DWDI)

  - film outside, source outside (elliptical exposure)

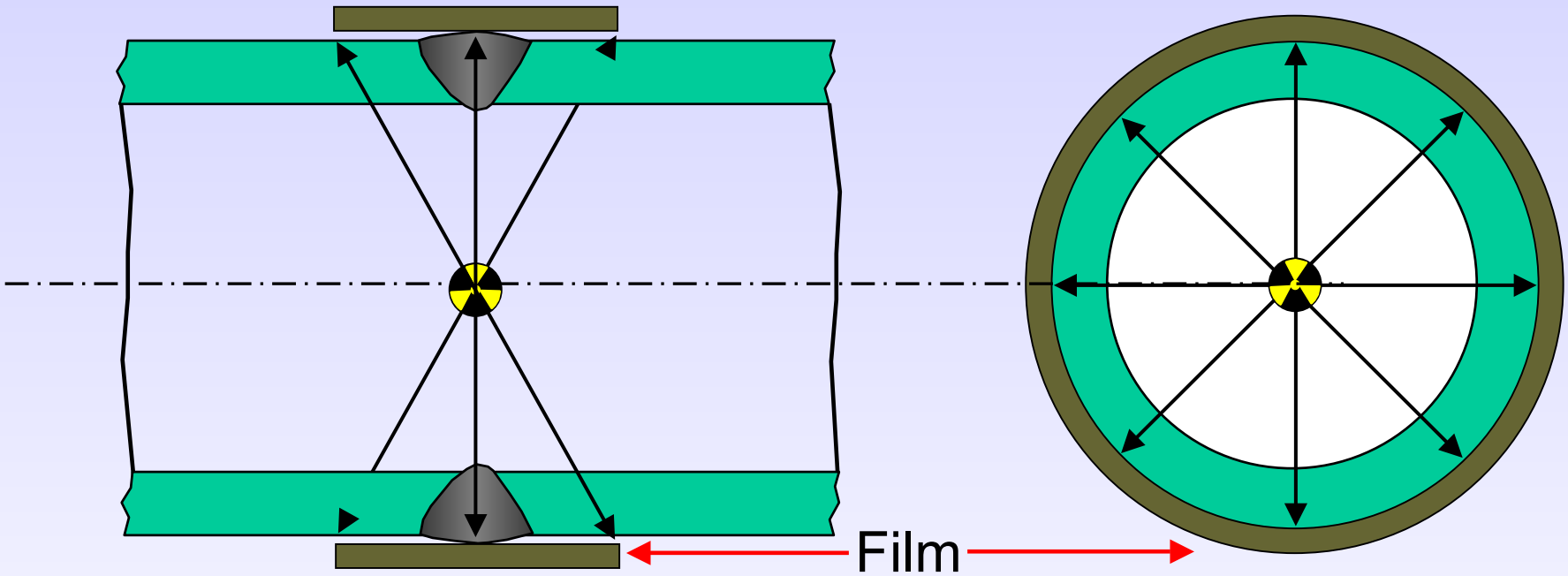
Single wall single image SWSI





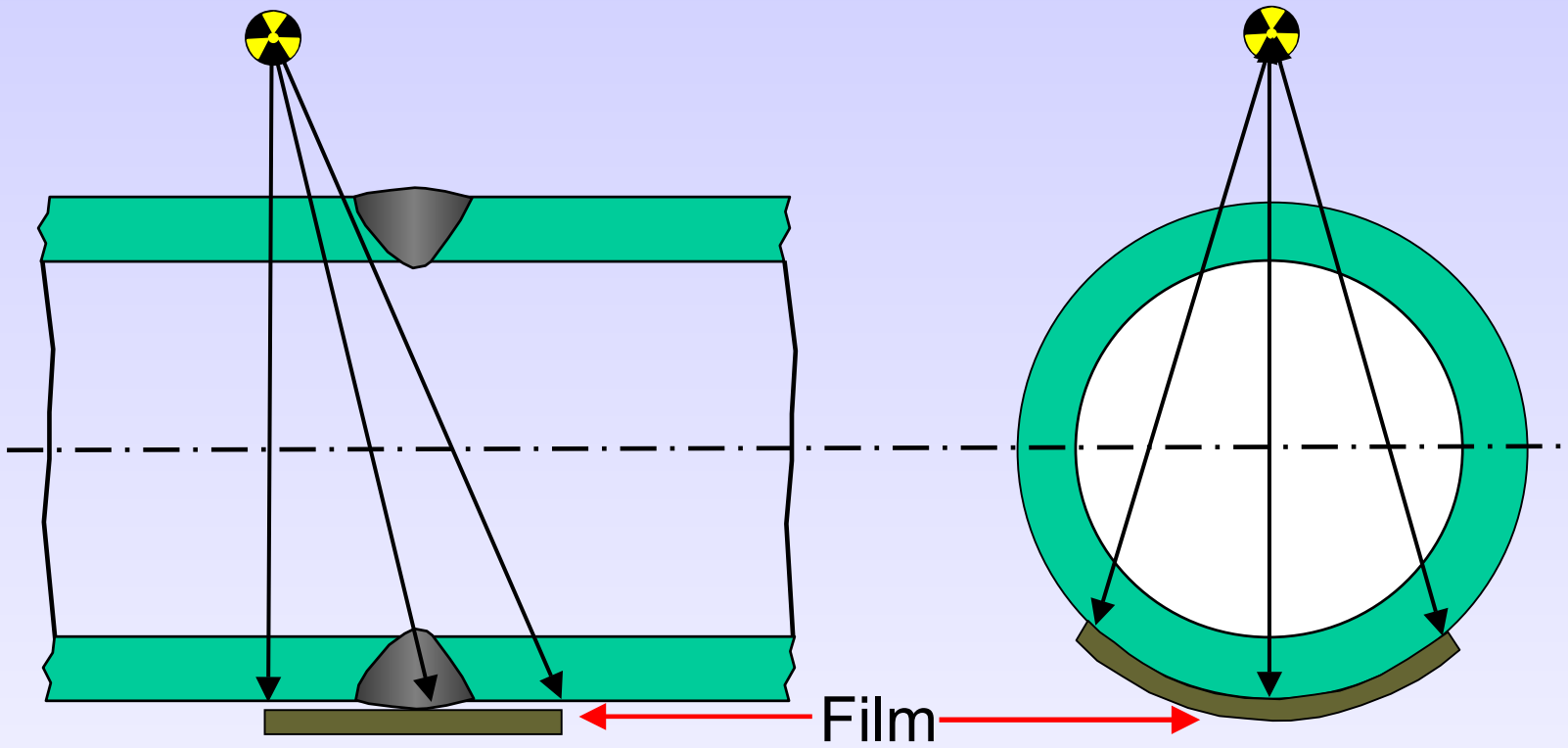
- IQI's should be placed source side

Single wall single image SWSI panoramic



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

Double wall single image DWSI

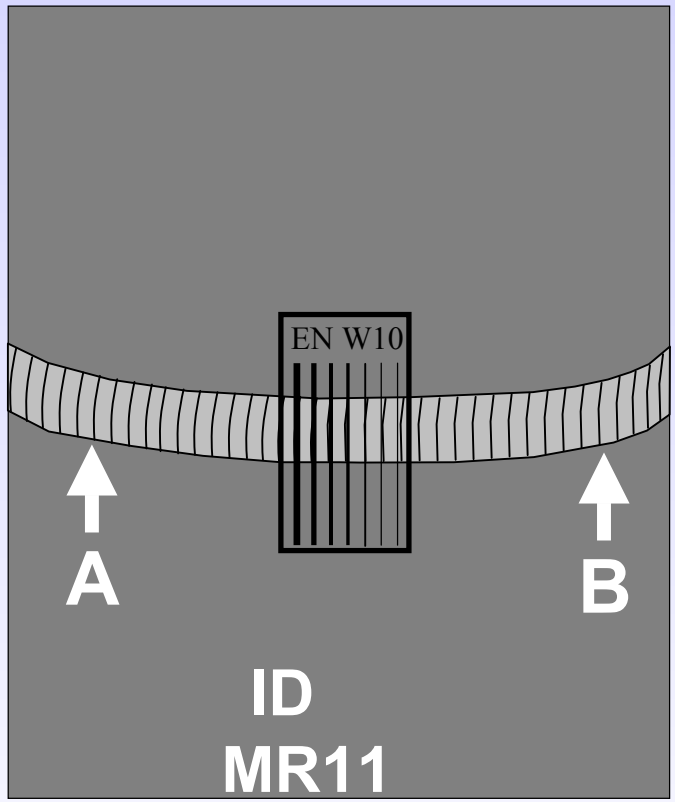


- IQI's are placed on the film side
- Source outside film outside (multiple exposure)
- This technique is intended for pipe diameters over 100mm

Double wall single image DWSI

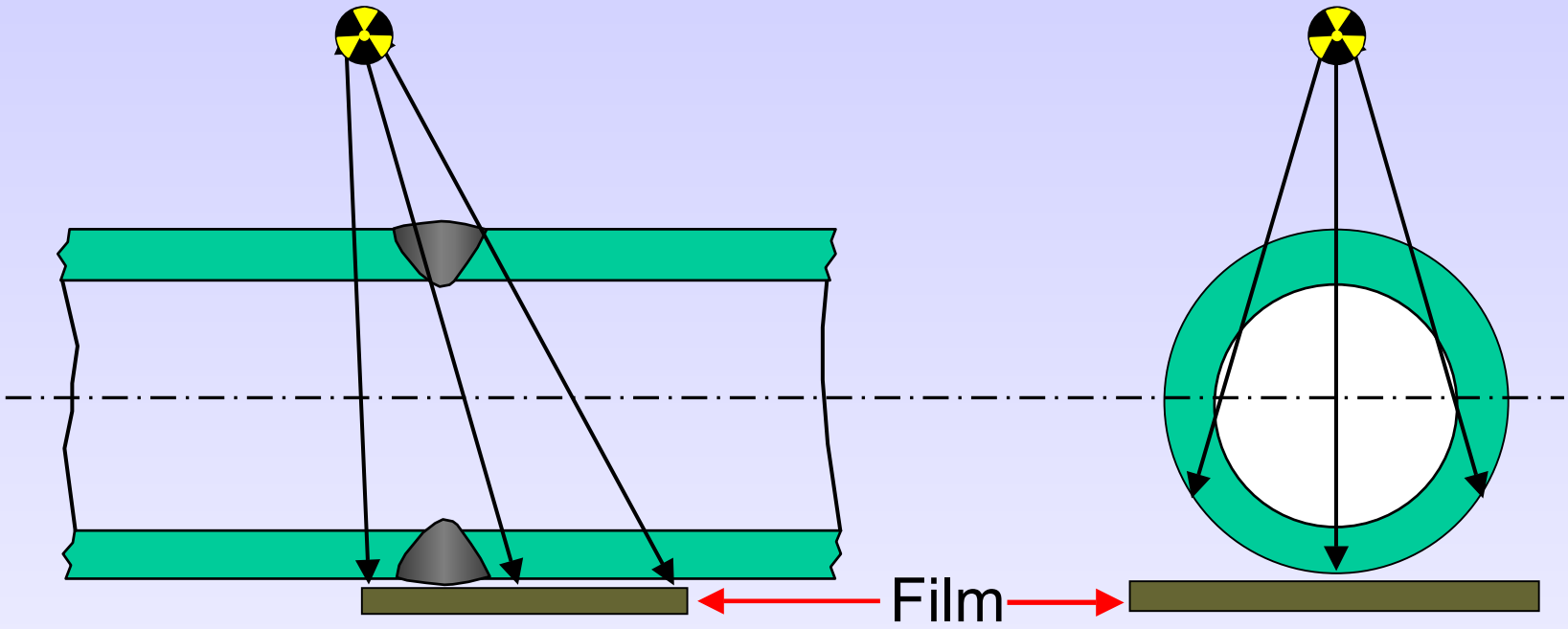
Identification

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



Radiograph

Double wall double image DWDI

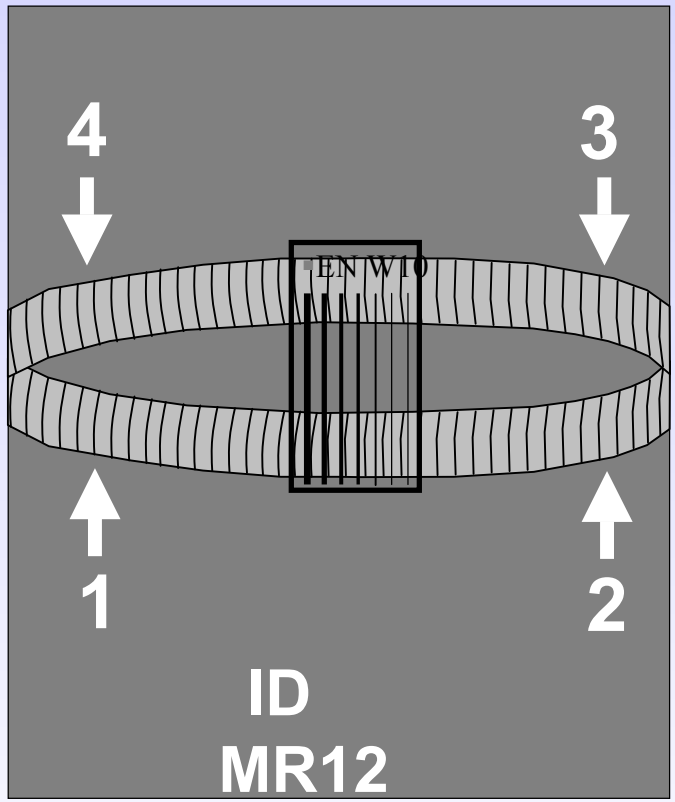


- IQI's are placed on the source or film side
- Source outside film outside (multiple exposure)
- A minimum of two exposures
- This technique is intended for pipe diameters less than 100mm

Double wall double image DWDI

Identification

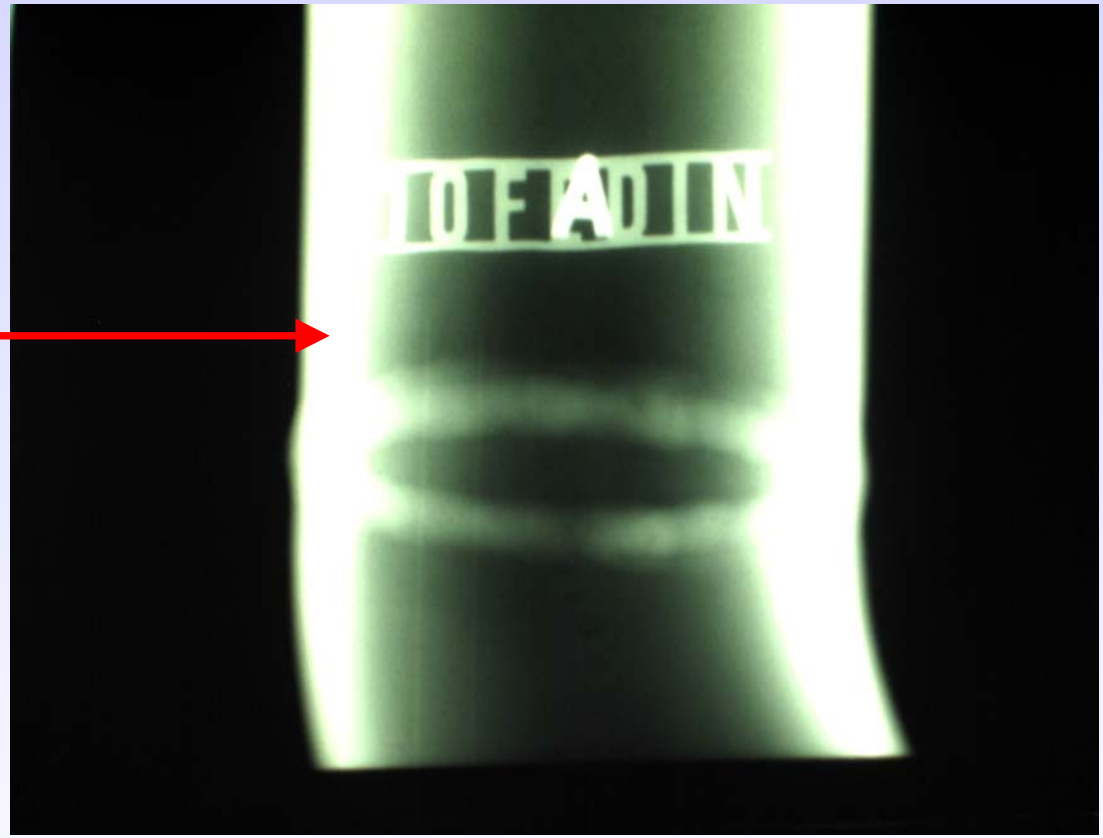
- Unique identification
- IQI placing
- Pitch marks indicating readable film length



Shot A Radiograph

Double wall double image DWDI

Elliptical exposure



Radiographic Inspection

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
- Access to both sides required

Any Questions

Questions

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 to magnetise a component.

QU 5 State the main limitations of dye penetrant inspection.