



Welding Inspection

Non-Destructive Testing

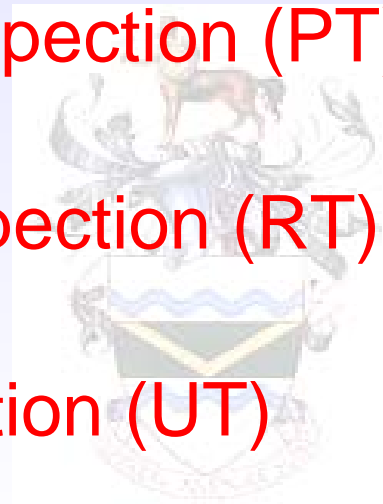
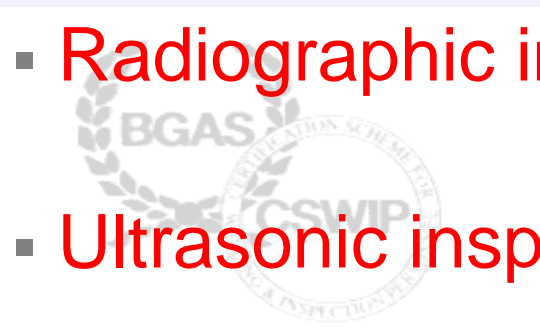
Course Reference WIS 5

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



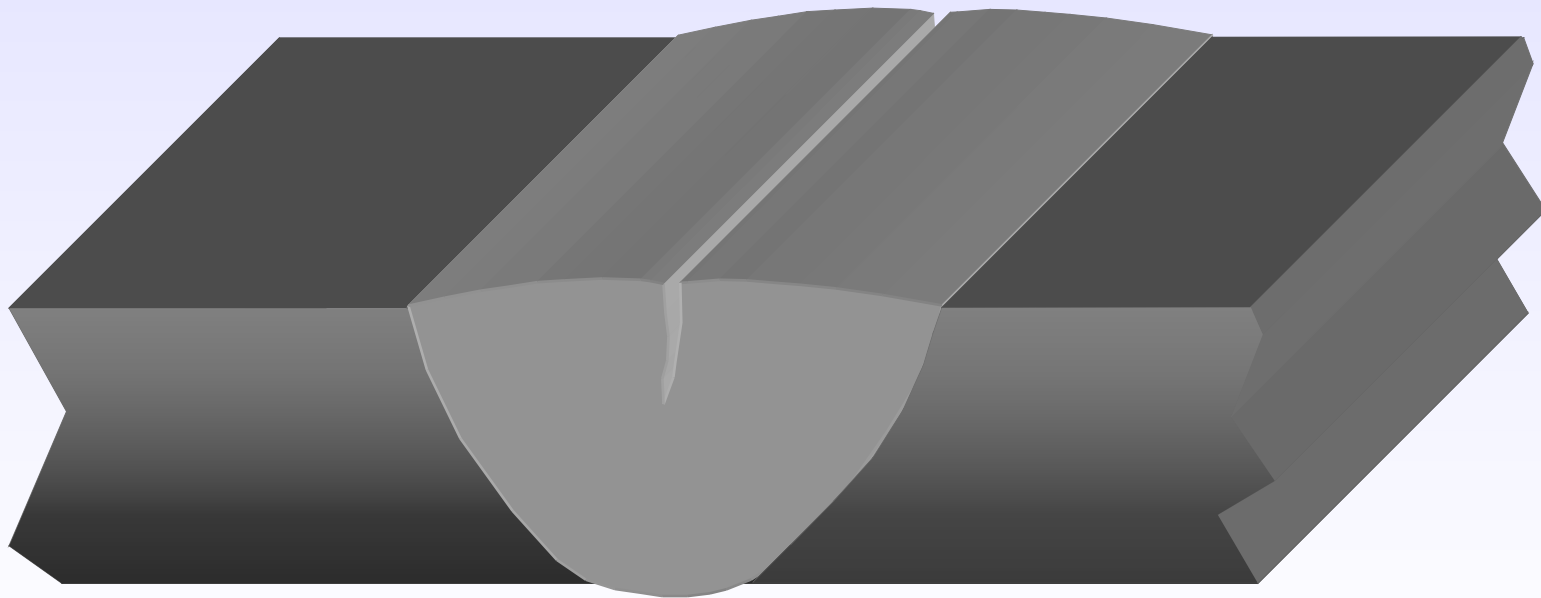
Dye Penetrant Inspection

- 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

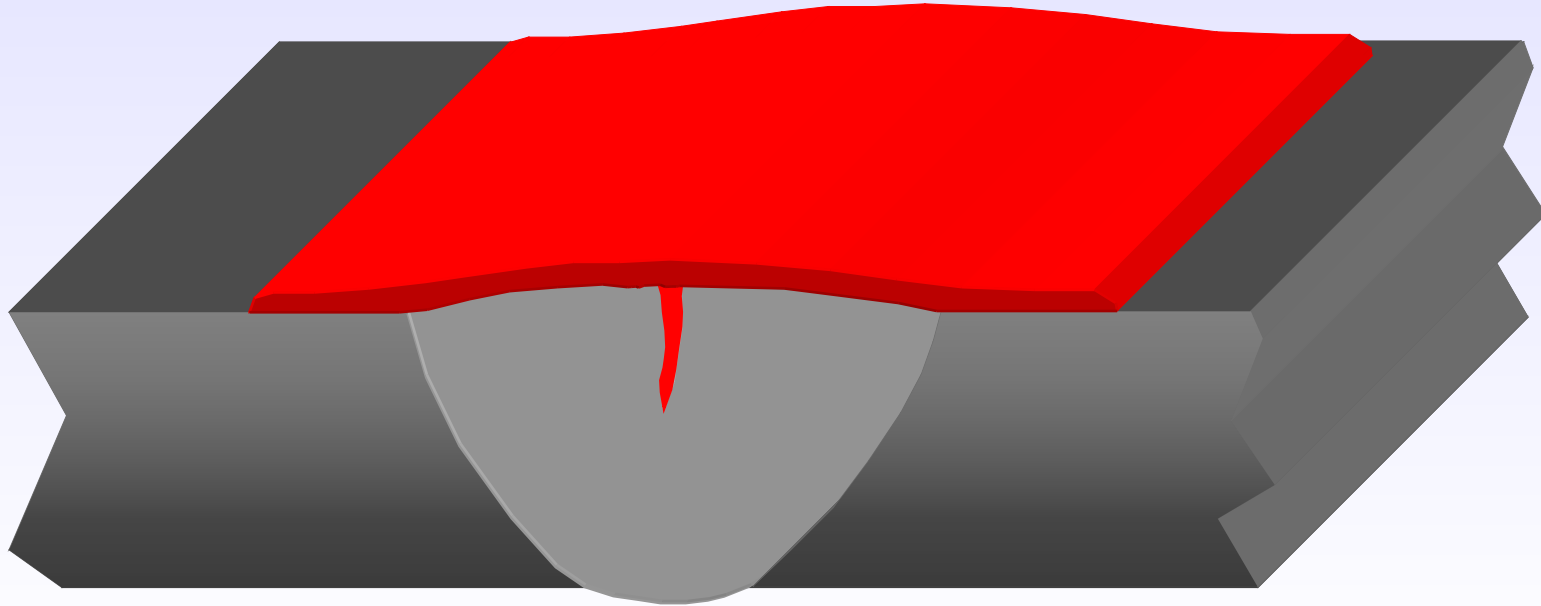
Ensure surface is very Clean normally with the use of a solvent



Dye Penetrant Inspection

Step 2. Apply penetrant

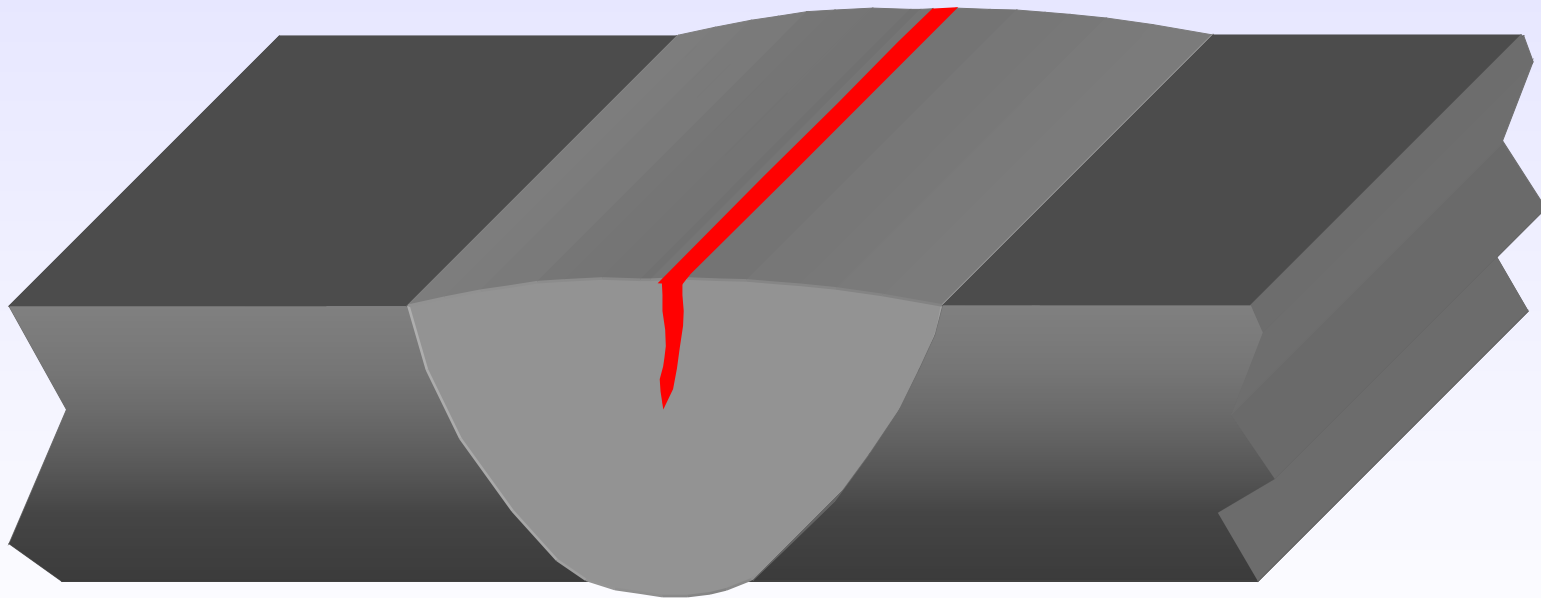
After the application of the penetrant the penetrant is normally left on the components surface for approximately 15 minutes (dwell time). The penetrant enters any defects that may be present by capillary action



Dye Penetrant Inspection

Step 3. Clean off penetrant

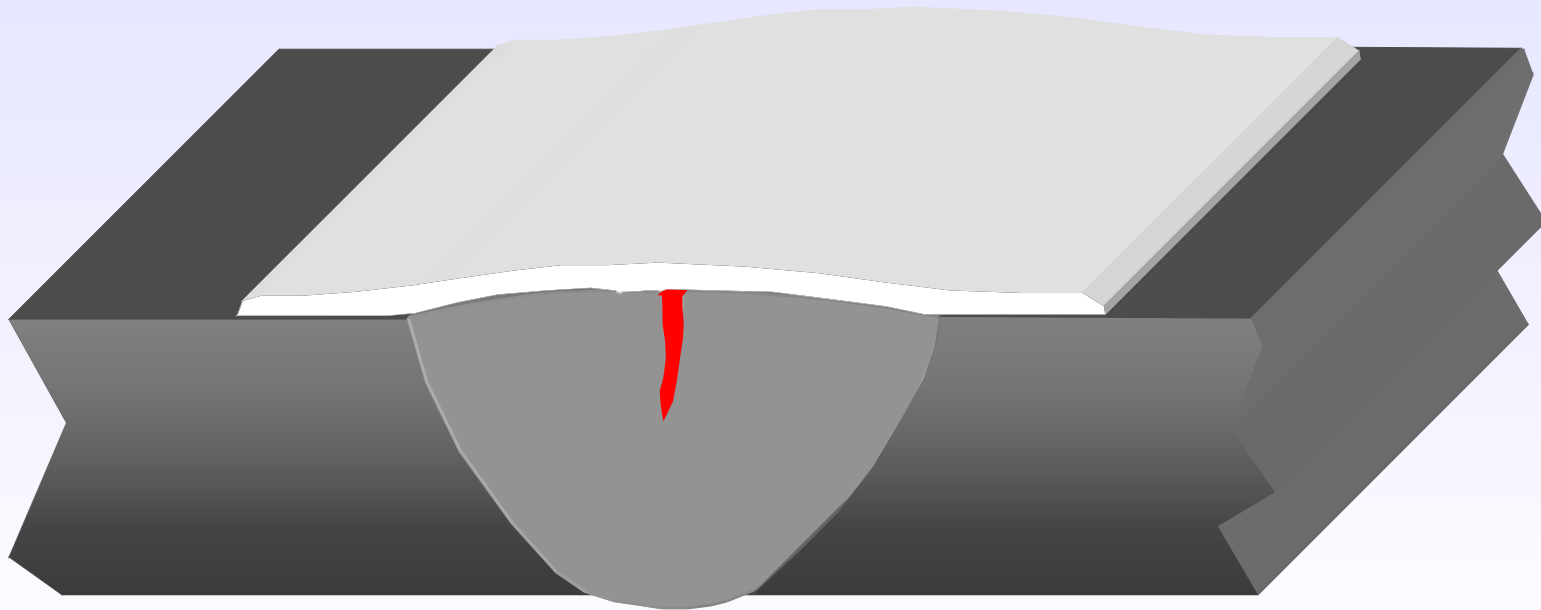
After sufficient penetration time (dwell time) has been given the penetrant is removed, care must be taken not to wash any penetrant out of any defects present



Dye Penetrant Inspection

Step 3. Apply developer

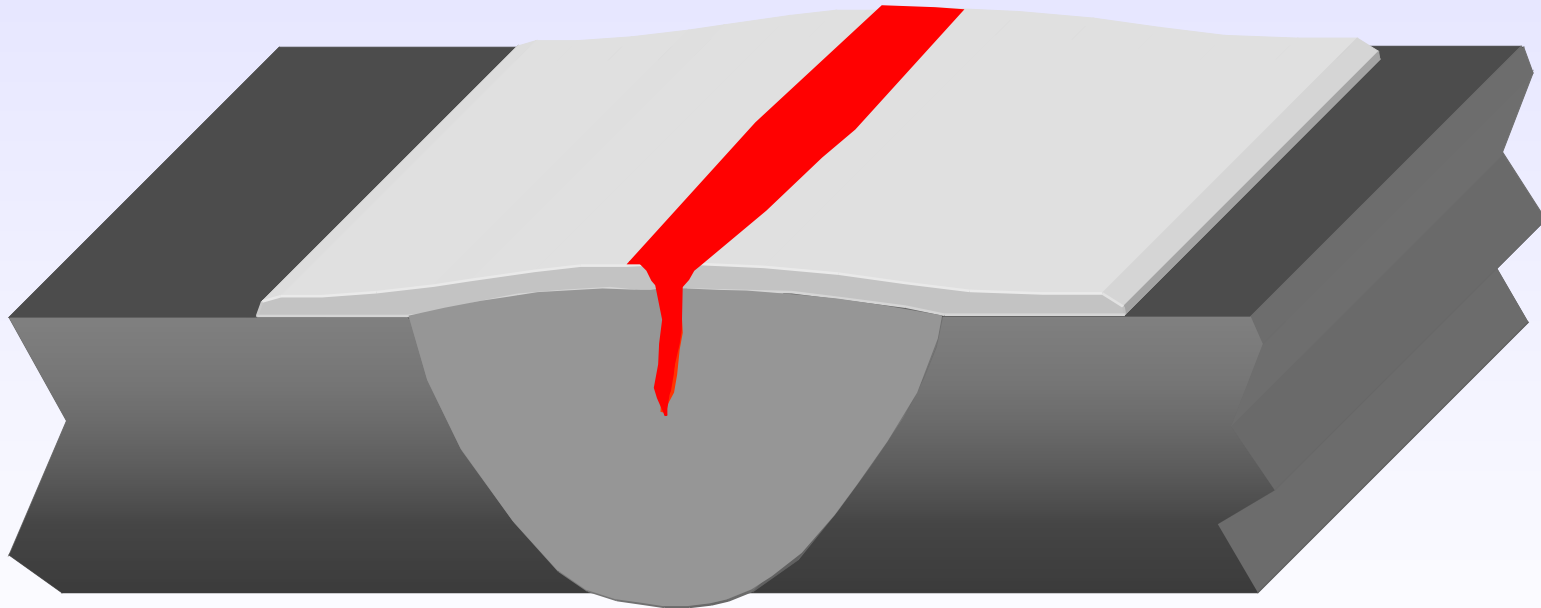
After the penetrant has been cleaned sufficiently a thin even layer of developer is applied. The developer acts as a contrast against the penetrant and allows for reverse capillary action to take place



Dye Penetrant Inspection

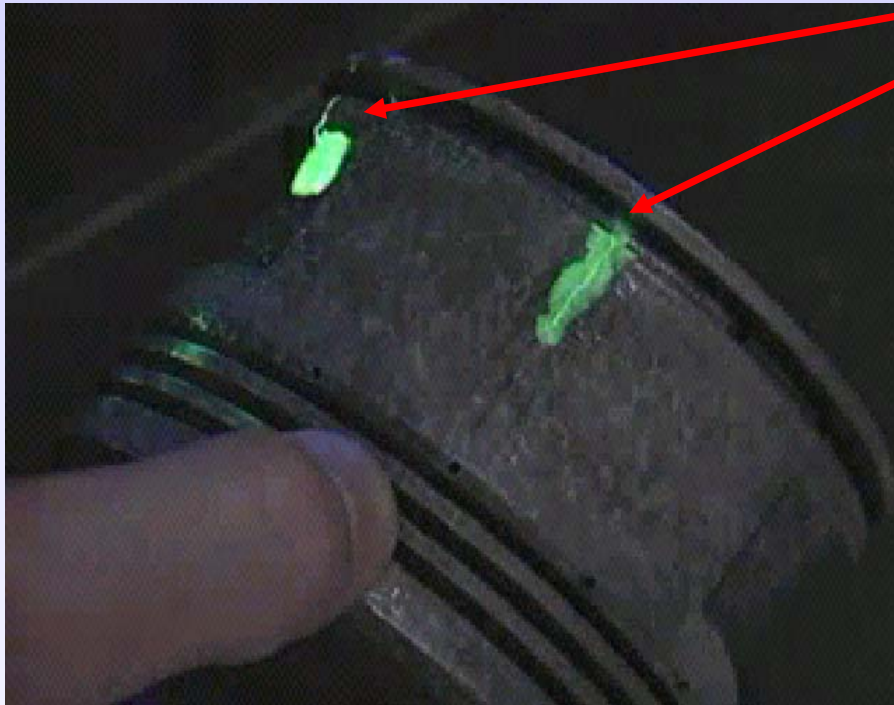
Step 4. Inspection / development time

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

Any Questions



Magnetic Particle Inspection

WI 3.1

TECHNOLOGY



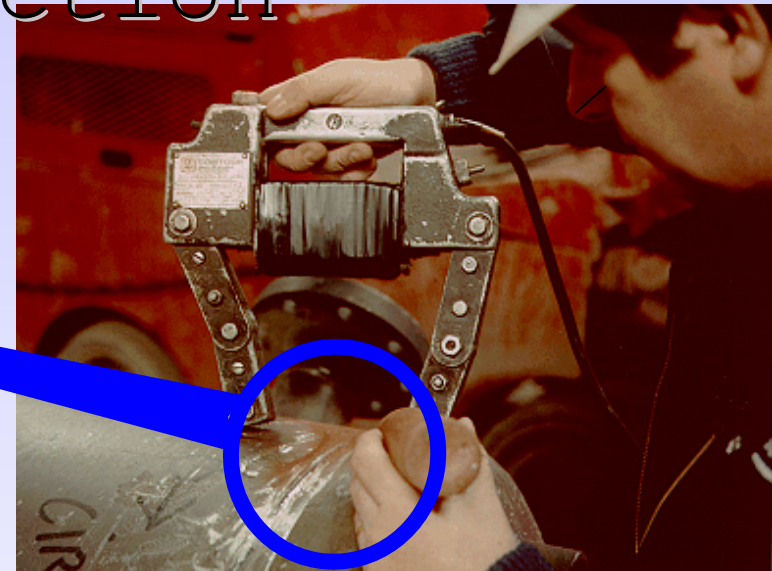
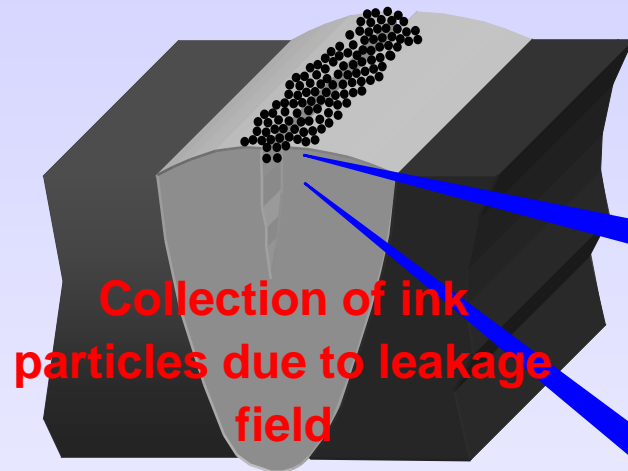
Magnetic Particle.

WI 3.1

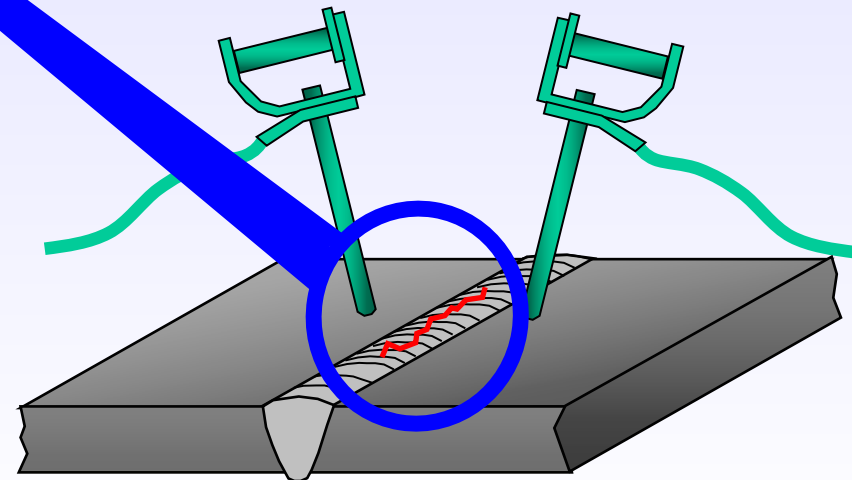
Inspection

- 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



Magnetic Particle. Inspection

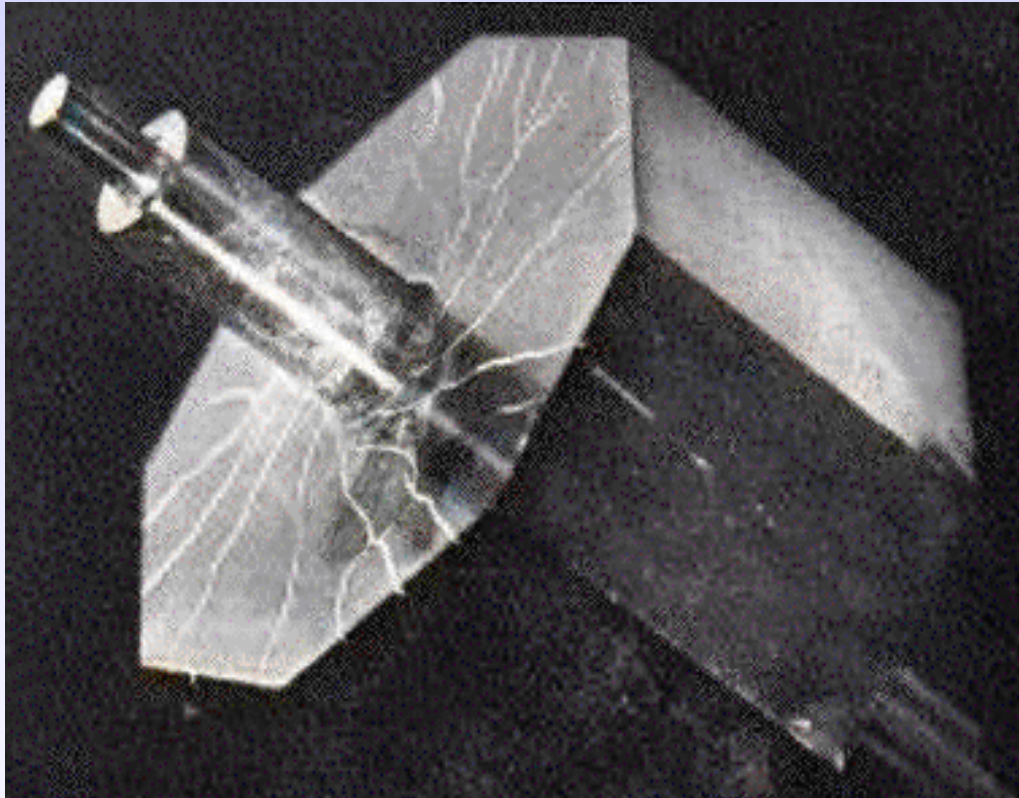
WI 3.1

**A crack like
indication**



Magnetic Particle Inspection

WI 3.1



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

Inspection

Typical sequence of operations to inspect a weld

- Clean area to be tested
- Apply contrast paint
- Apply magnetism to the component
- Apply ferro-magnetic ink to the component during magnetising
- Interpret the test area
- Post clean and de-magnetise 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

Any Questions



Ultrasonic Inspection

WI 3.1



Ultrasonic Inspection

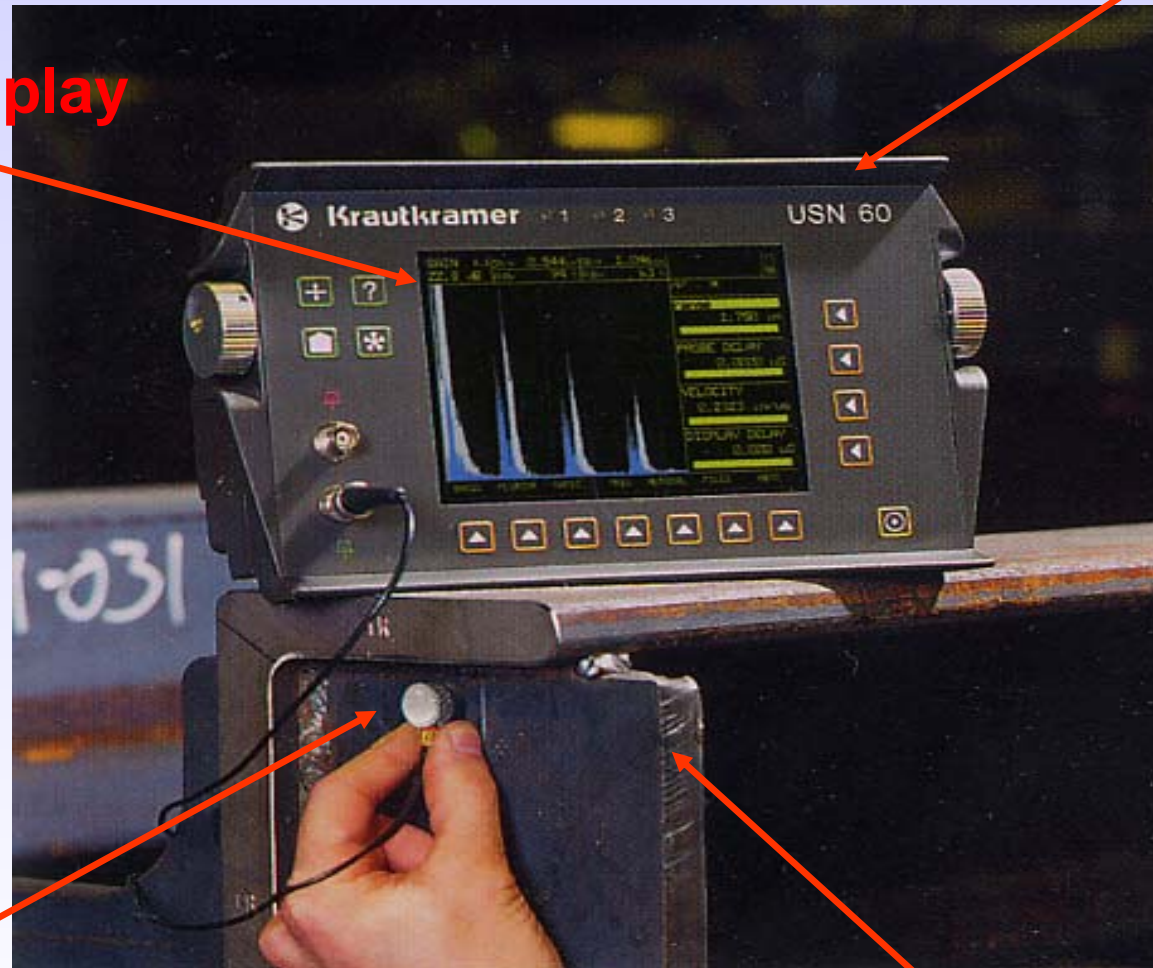
- Surface and sub-surface detection
- This detection method uses high frequency sound waves, typically above 2MHz to pass through a material
- A probe is used which contains a piezo electric crystal to transmit and receive ultrasonic pulses and display the signals on a cathode ray tube or digital display
- 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

TECHNOLOGY

Pulse echo
signals
A scan Display

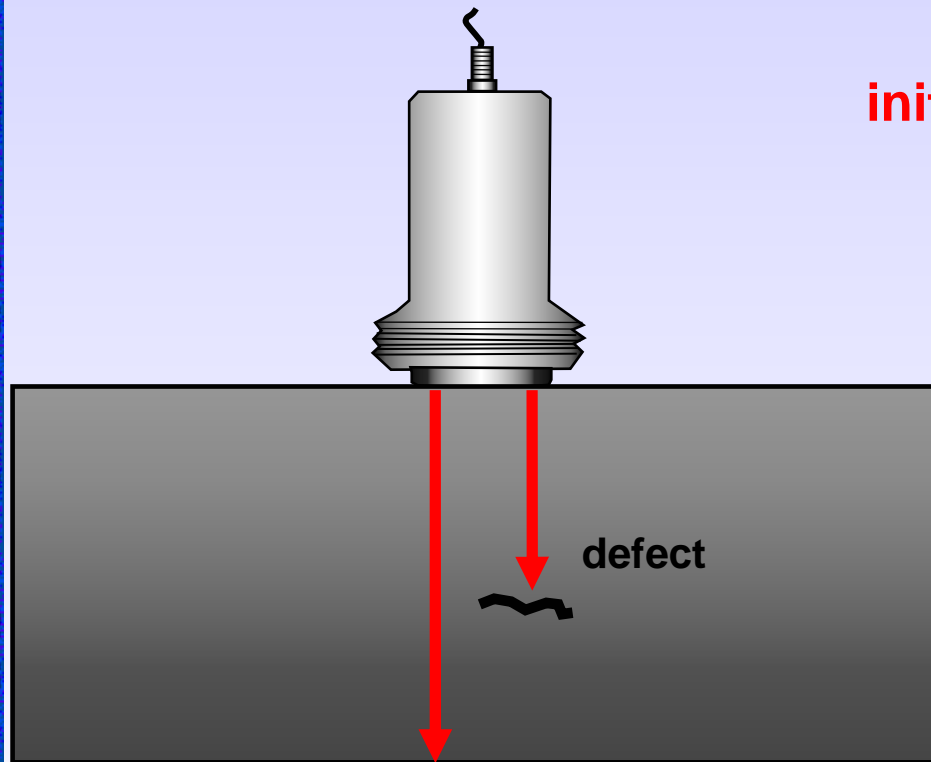
UT Set, Digital



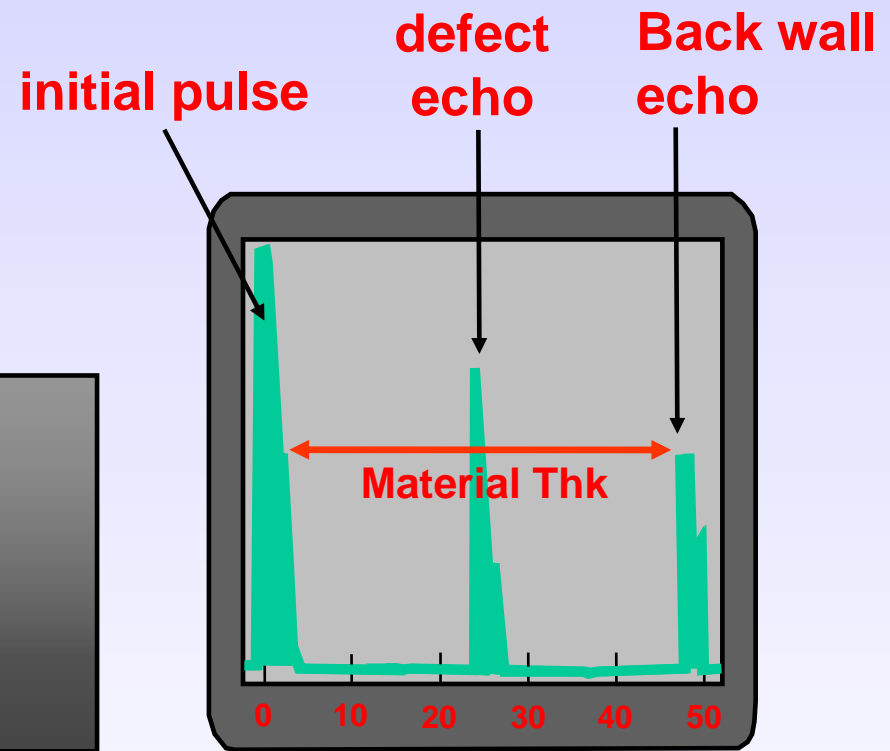
Compression probe

Thickness checking the material

Ultrasonic Inspection



Compression Probe



CRT Display

Ultrasonic Inspection

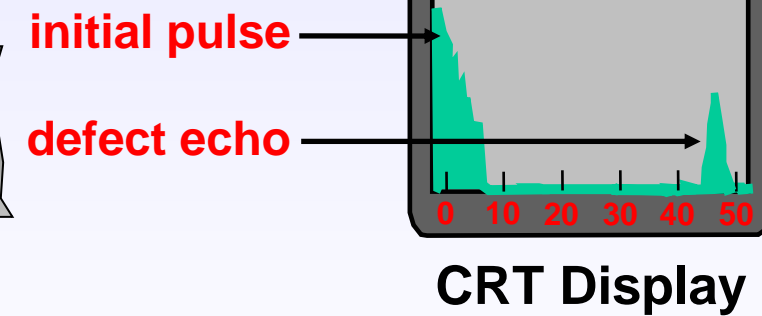
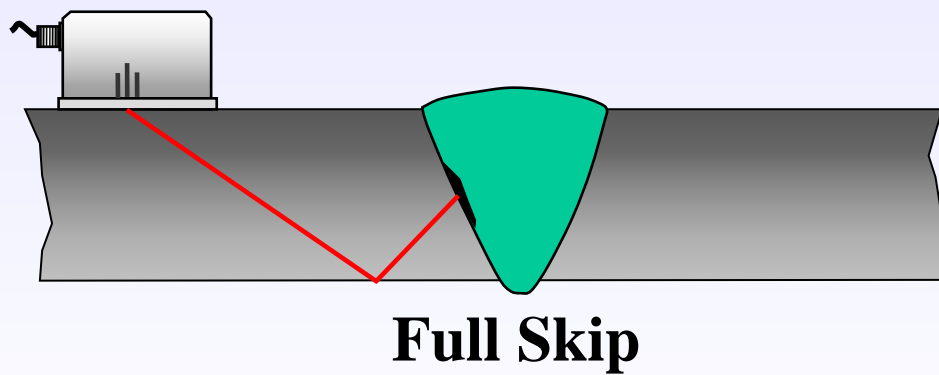
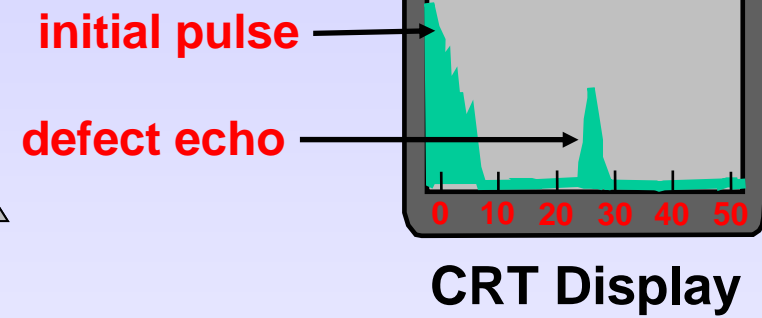
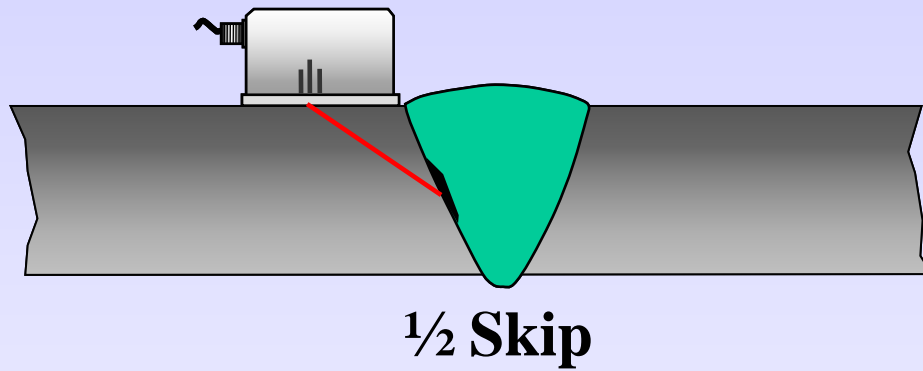
A Scan Display

UT Set

Angle Probe



Ultrasonic Inspection



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

WI 3.1



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

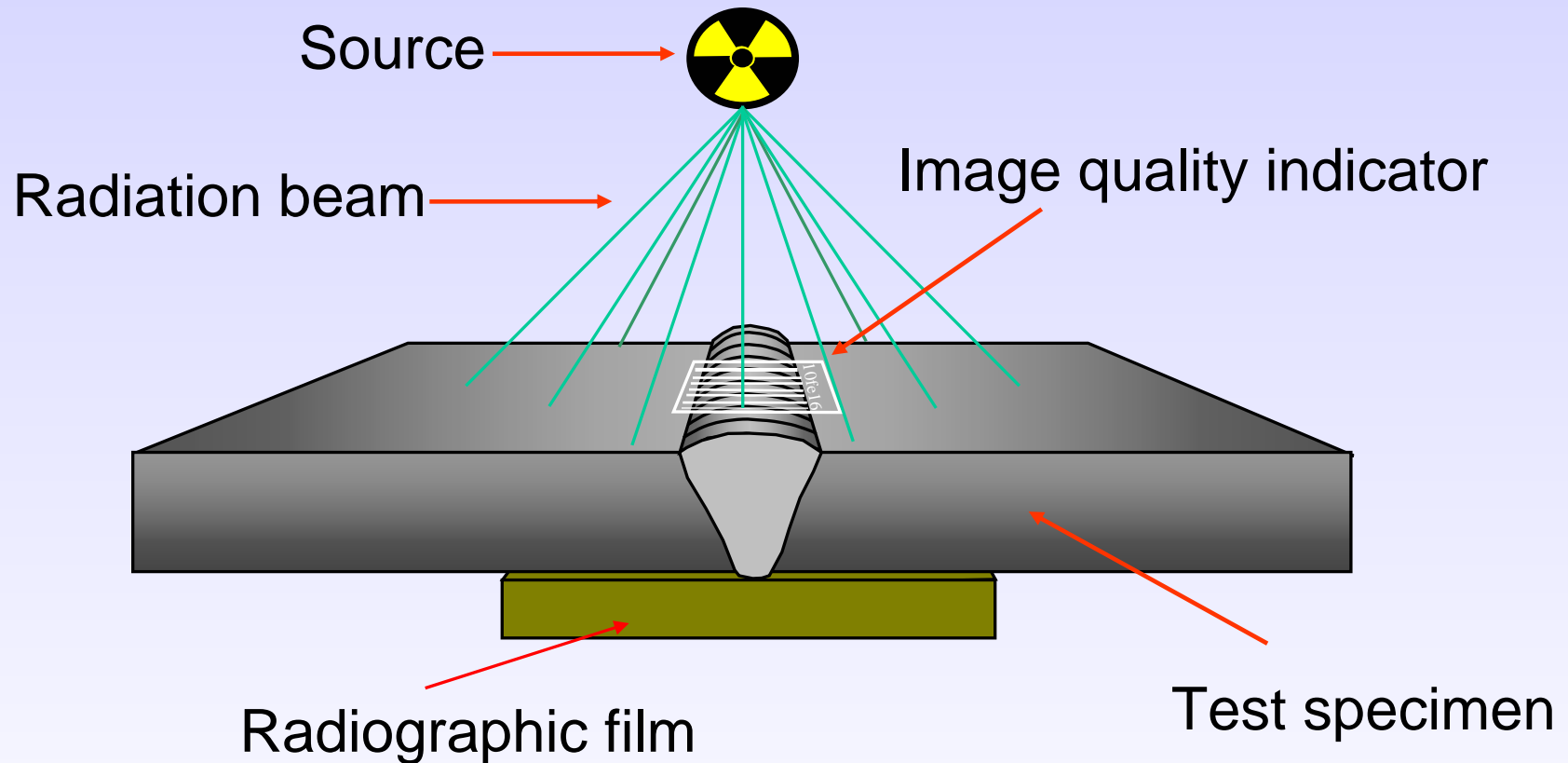
Electrically generated



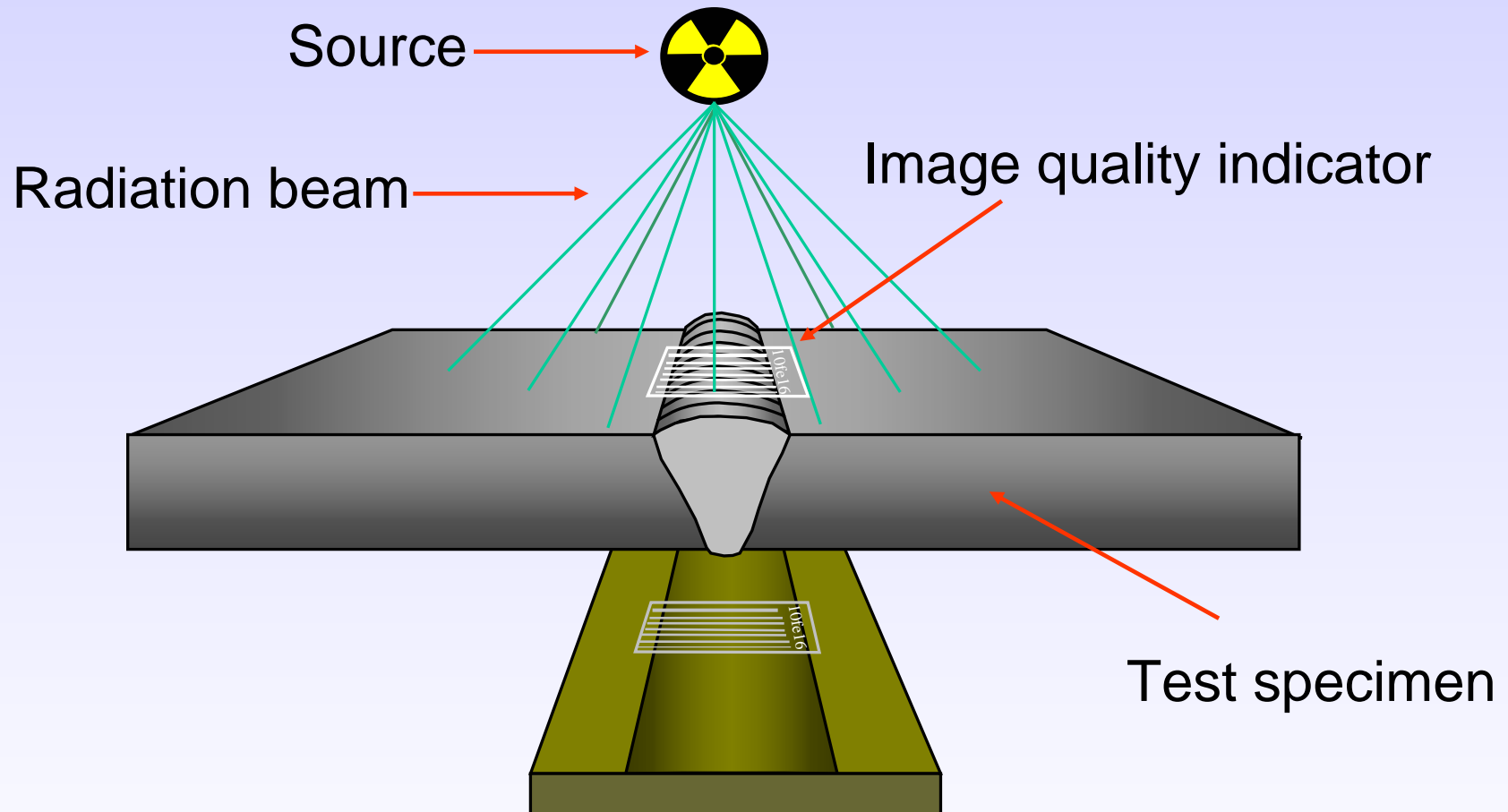
Gamma Rays

Generated by the
decay of unstable
atoms

Radiographic Inspection.



Radiographic Inspection.



Radiographic film with latent image after exposure

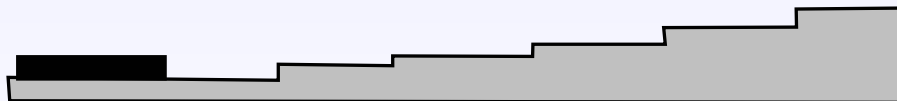
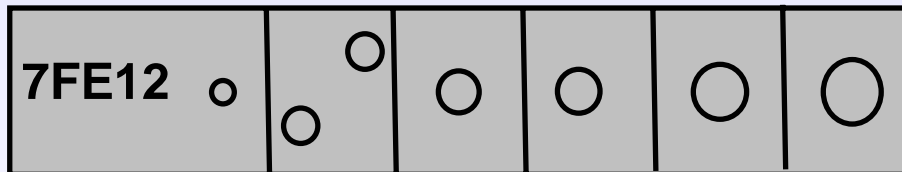
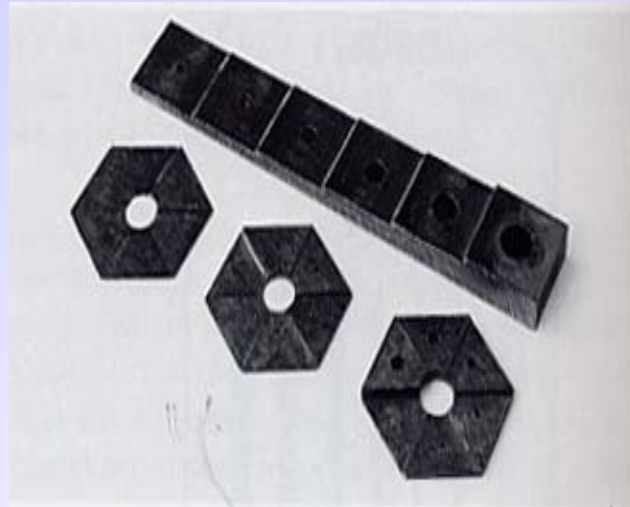
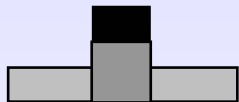
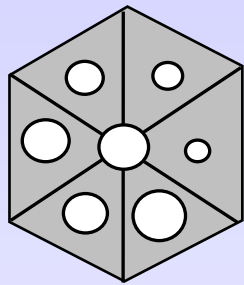
Radiographic Quality

- **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.

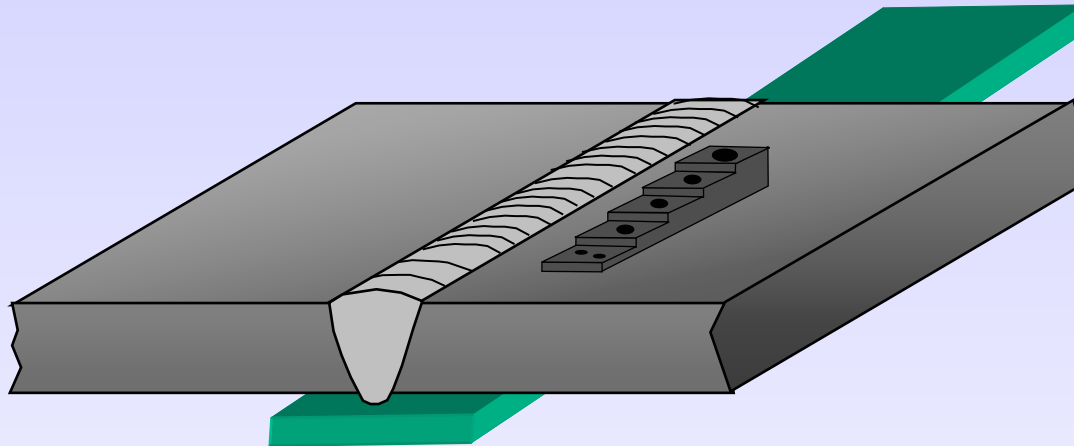


Step / Hole type IQI

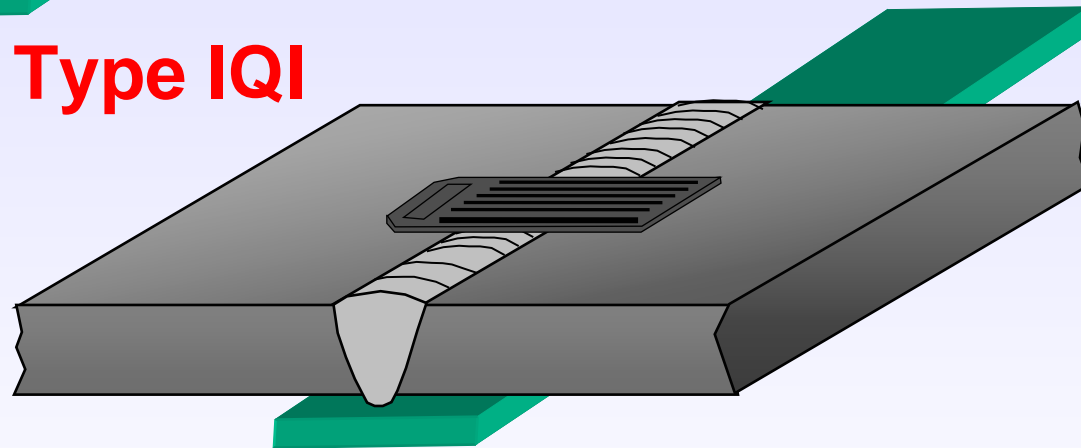


Wire type IQI

Image.Quality.Indicators.



Step/Hole Type IQI



Wire Type IQI

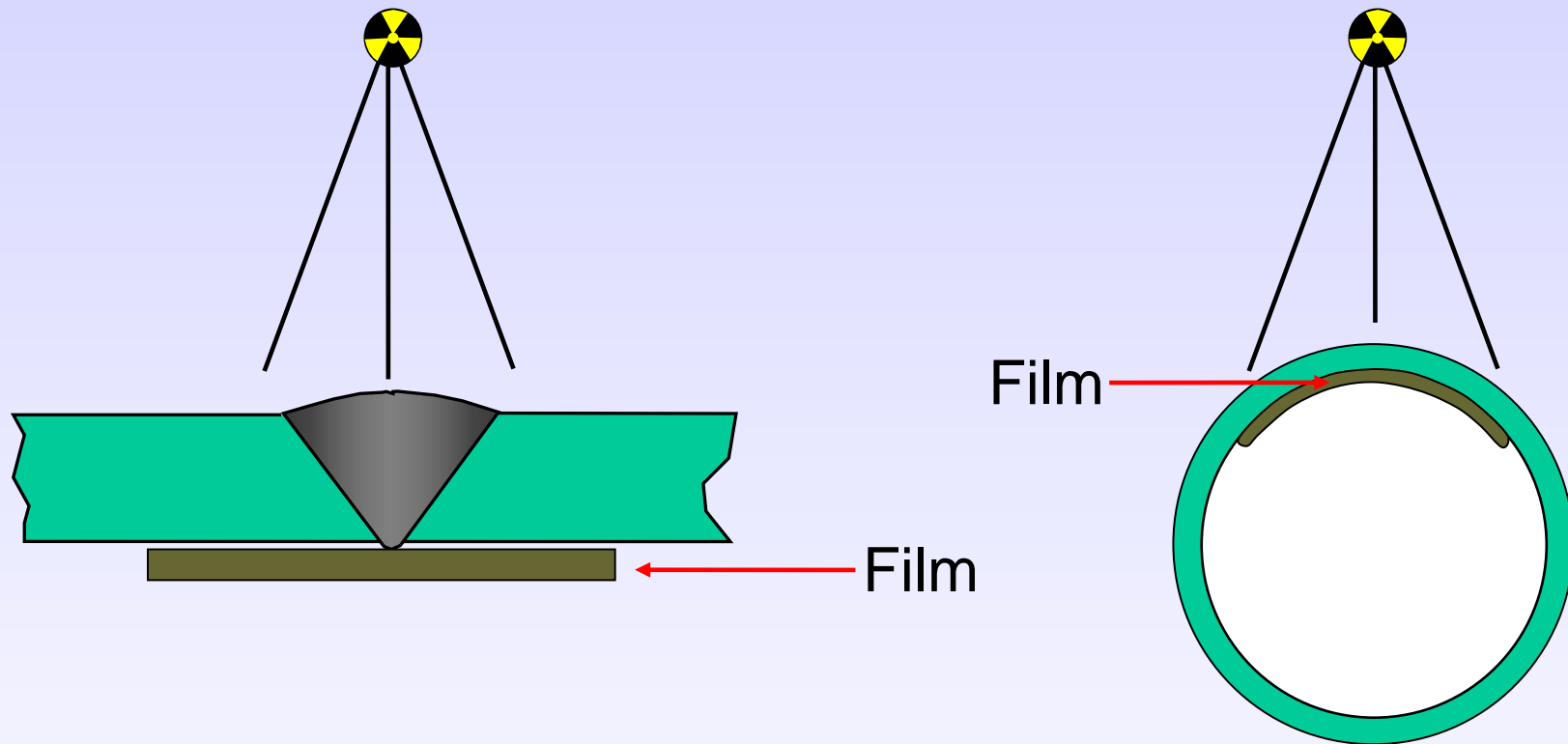
Radiographic Techniques

- 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.

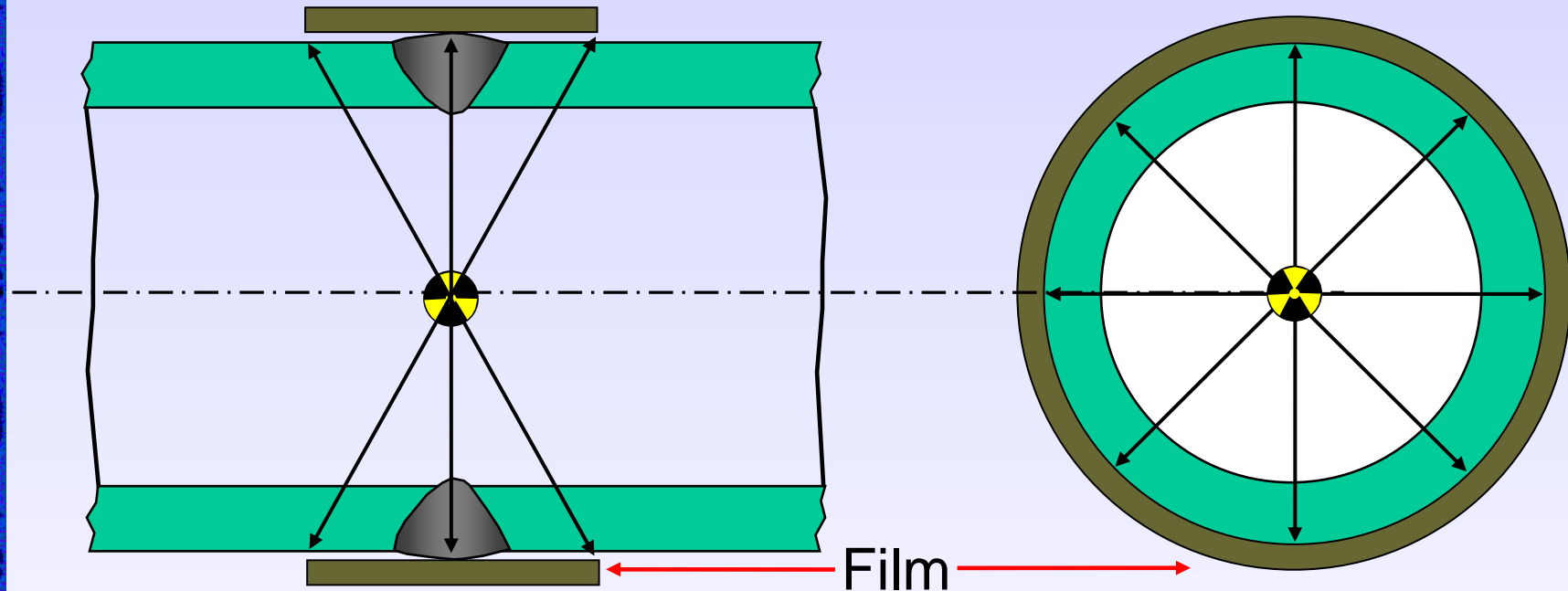
WI 3.1

SWSI.



- IQI's should be placed source side

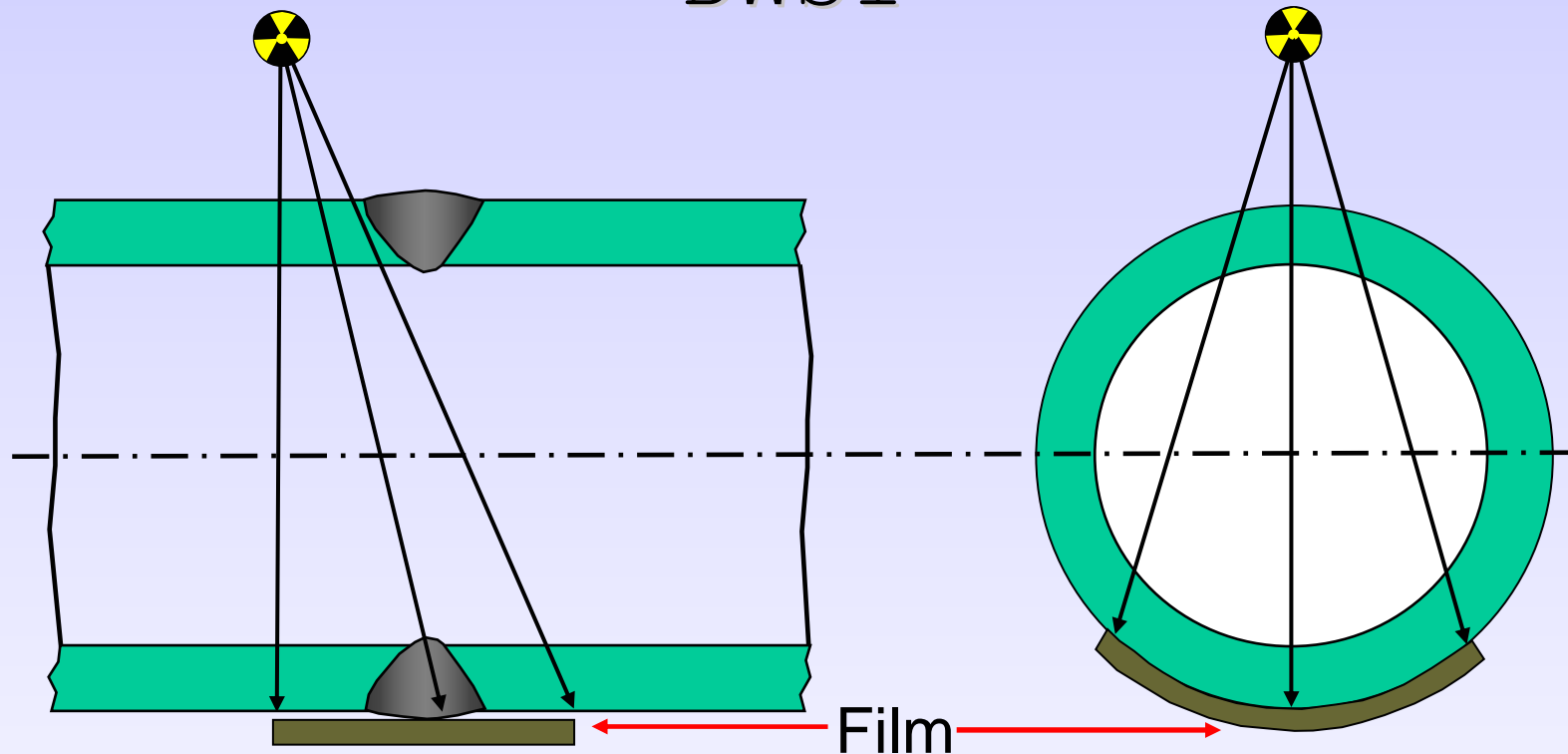
Single.wall.single.image.SWSI.^{WI 3.1} panoramic



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

Double wall single image. WI 3.1

DWSI

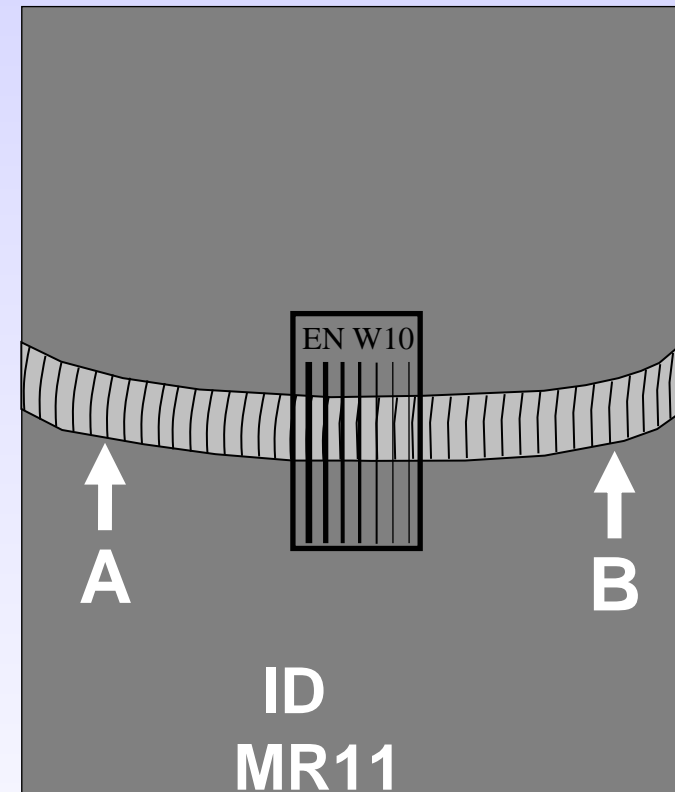


- IQI's are placed on the film side
- Source outside film outside (multiple exposure)
- This technique is intended for pipe diameters over 100mm

DWSI

Identification

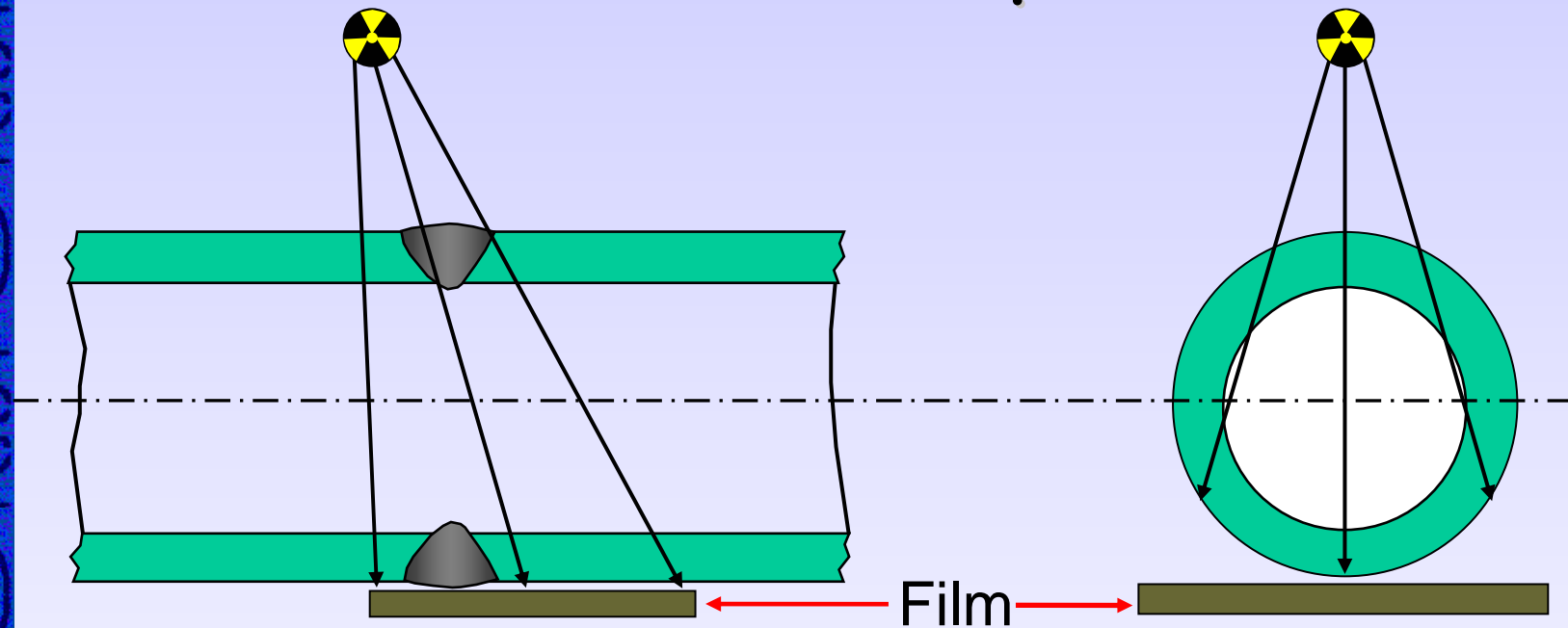
- Unique identification
- IQI placing
- Pitch marks indicating readable film length



Radiograph

Double wall double image. DWDI.

WI 3.1

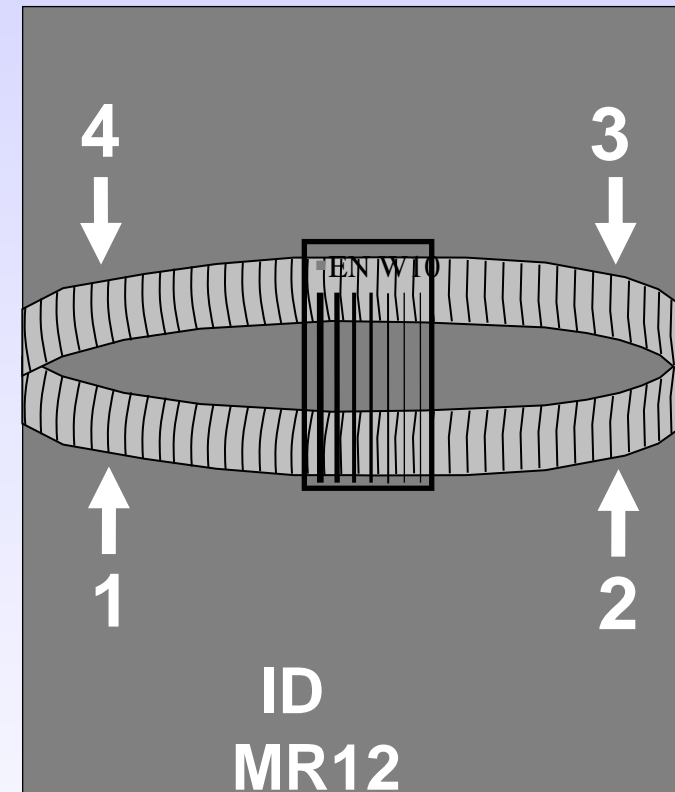


- IQI's are placed on the source or film side
- Source outside film outside (multiple exposure)
- A minimum of two exposures
- This technique is intended for pipe diameters less than 100mm

DWDI

Identification

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

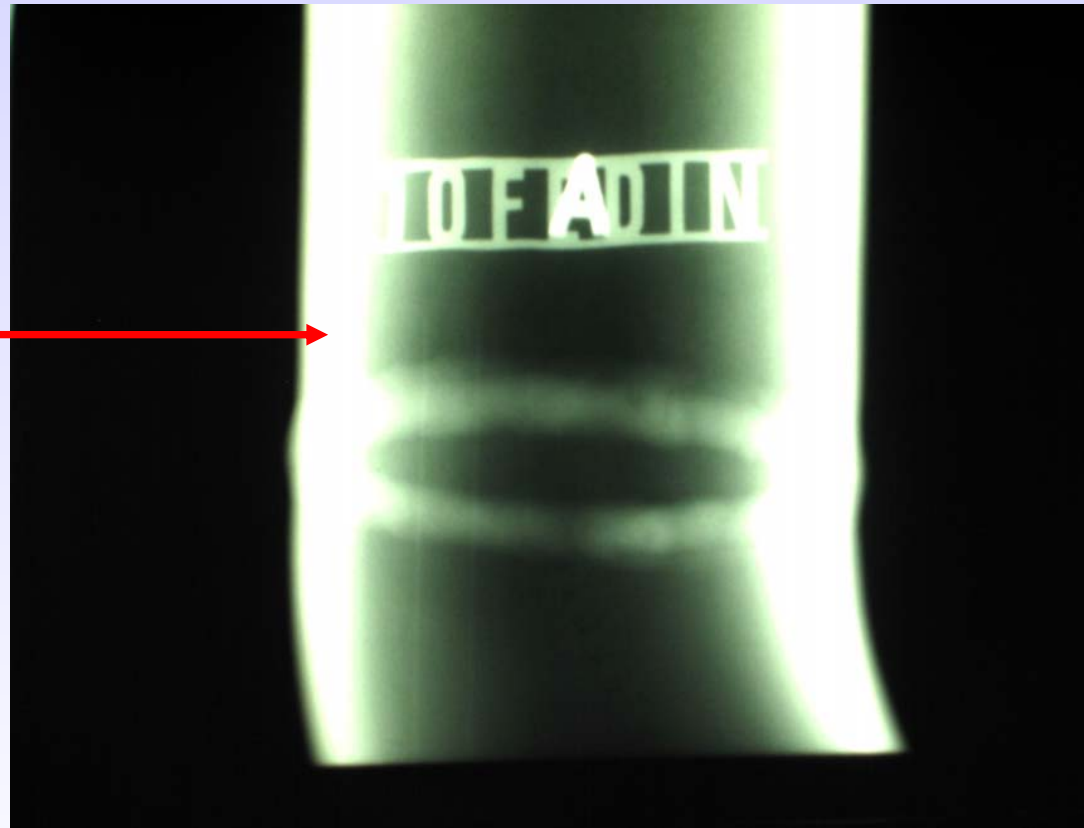


Shot A Radiograph

Double.wall.double.image. WI 3.1

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.