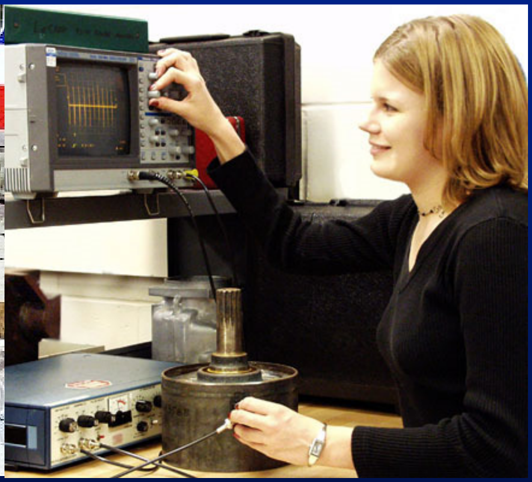
Introduction to Casting and Forging



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Outline

- Introduction to Casting Defects
- Introduction to Forging Defects
- Effects of alloy Elements in Aluminium alloy

MOST

COMMON DEFECTS

IN

CASTING

BLOWHOLE

Blowhole is a kind of cavities defect, which is also divided into pinhole and subsurface blowhole. Pinhole is very tiny hole. Subsurface blowhole only can be seen after machining.

Blowhole Defect

SAND BURNING

Burning-on defect is also called as sand burning, which includes chemical burn-on, and metal penetration.

Sand Burning Defect

SAND INCLUSION

Sand inclusion and slag inclusion are also called as scab or blacking scab. They are inclusion defects. Looks like there are slag inside of metal castings.

Sand Inclusion Defect

SAND HOLE

Sand hole is a kind of

shrinkage cavity defect.

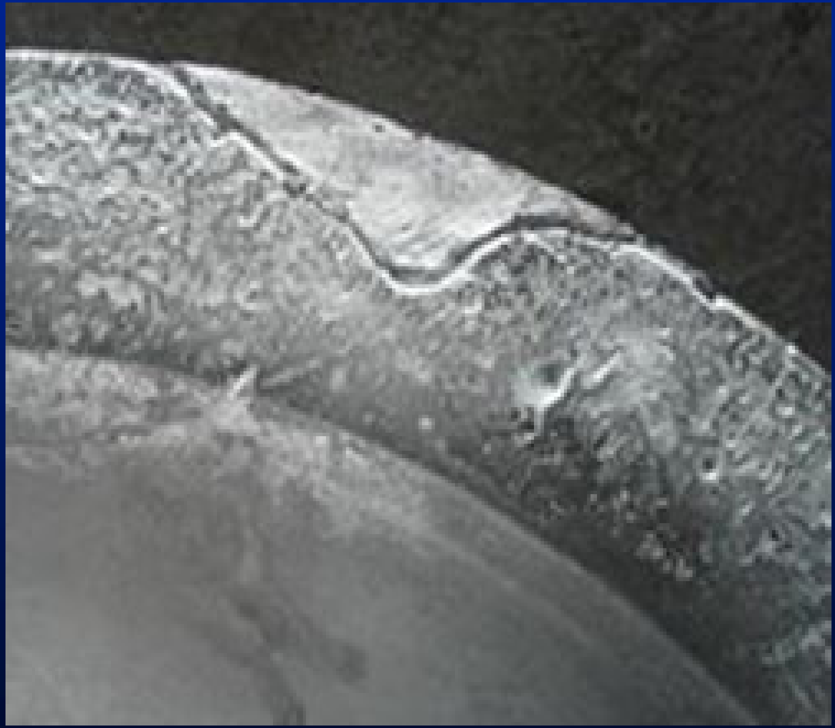
They are empty holes

after sand blasting.

sand hole defect

COLD LAP

Cold lap or also called as cold shut. It is a crack with round edges. Cold lap is because of low melting temperature or poor gating system.



Cold Lap Defect

MISRUN

Misrun defect is a kind

of incomplete casting

defect, which causes

the casting uncompleted.

The edge of defect is

round and smooth.

Misrun Defect

SHRINKAGE

- Shrinkage defects include dispersed shrinkage, micro-shrinkage and porosity.

Porosity Shrinkage Defect

- Shrinkage cavities are also called as shrinkage holes, which is a type of serious shrinkage defect.

Shrinkage Cavity Defect

ROUGH SURFACE

Rough surface, coarse surface is also a kind of surface defect. Normal rough surfaces can not be judged as defects, but too rough and uneven in surface will be a defect.

Rough Surface Defect

SLAG INCLUSION

Slag inclusion is also called as exogenous inclusion, entrapped slag.

Slag Inclusion Defect

CRACK

Crack defects normally happen inside of metal castings. This defect will reduce the physical properties of metal castings.

Crack Defect

SAND DROP

Sand drop is also called as sand crush. The sand mold drops part of sand blocks, so they will cause the similar shaped sand holes or incomplete.

Sand Drop Defect

COMMON DEFECTS

IN

FORGING

FORGING DEFECTS

Though forging process give generally prior quality product compared other manufacturing processes. There are some defects that are lightly to come a proper care is not taken in forging process design.

UNFILLED SECTION

In this some section of the die cavity are not completely filled by the flowing metal. The causes of this defects are improper design of the forging die or using forging techniques.

COLD SHUT

This appears as a small cracks at the corners of the forging. This is caused manely by the improper design of die. Where in the corner and the fillet radii are small as a result of which metal does not flow properly into the corner and the ends up as a cold shut.

SCALE PITS

This is seen as irregular depurations on the surface of the forging. This is primarily caused because of improper cleaning of the stock used for forging. The oxide and scale gets embedded into the finish forging surface. When the forging is cleaned by pickling, these are seen as depurations on the forging surface.

DIE SHIFT

These are basically internal ruptures caused by the improper cooling of the large forging. Rapid cooling causes the exterior to cool quickly causing internal fractures. This can be remedied by following proper cooling practices.

IMPROPER GRAIN FLOW

This is caused by the improper design of the die, which makes the flow of the metal not flowing the final interred direction.

INFLUENCES OF MOST COMMON ALLOYING ELEMENTS ON THE ALUMINUM ALLOYS

INTRODUCTION

Aluminium and aluminium alloy are gaining huge industrial significance because of their outstanding combination of mechanical, and physical properties over the base alloys. These properties include high specific strength, high wear and seizure resistance, high stiffness, better high temperature strength, controlled thermal expansion coefficient and improved damping capacity.

The most common alloying elements are:-

1. copper
2. magnesium
3. manganese
4. silicon
5. tin and
6. zinc

EFFECTS OF MOST

COMMON ALLOYING

ELEMENTS IN ALUMINIUM

SILICON (Si)

* Silicon is the most important single alloying element used in majority of aluminum casting alloys. It effects are

1. Good castibility (high fluidity, low shrinkage)

2. Low density

3. Machinability is poor

4. Slightly increase ultimate tensile strength

5. It also increase solidification time.

COPPER (Cu)

1.copper effect the strength and hardness of aluminum casting alloys, both heat treated and not heat treated.

2. It also improve the machinability

3. It reduces the corrosion resistance of aluminum

MAGNESIUM (Mg)

1. Improvement of the work-hardening characteristics of aluminium

2. It produce good corrosion resistance

3. It produce good weldability

4. It increase the strength

Manganese (Mn)

Soo Woo Nam and Duck Hee Lee Investigate the

effect of Mn on the Mechanical Behavior of Al

Alloys.

1. It increase the both yield and ultimate tensile strength without decreasing the ductility over 0.5% in aluminum alloy.

2. It increase the fatigue resistance.

3. It also improved the corrosion resistance.

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Zinc (Zn)

ZHU Mei-jun, DING Dong-yan et al Investigate the effect of Zn content on tensile and electrochemical properties of Al alloy.

1. It produce high density precipitates.

2. It produce highest ultimate tensile strength with 1.5% Zn.

3. It effect the corrosion resistance of Al.

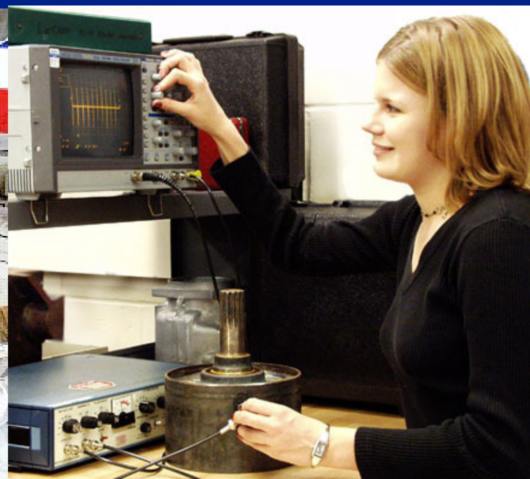
Tin (Sn)

1. Tin (Sn) used in aluminum casting alloys for reducing friction in bearing and bushing applications.
2. Alloying element Tin in emegency condition can provide short-term liquid lubrication to rubbing surfaces if such bearings/bushing severely overheat in service.

THANK YOU

Introduction to Non-destructive Testing





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Outline

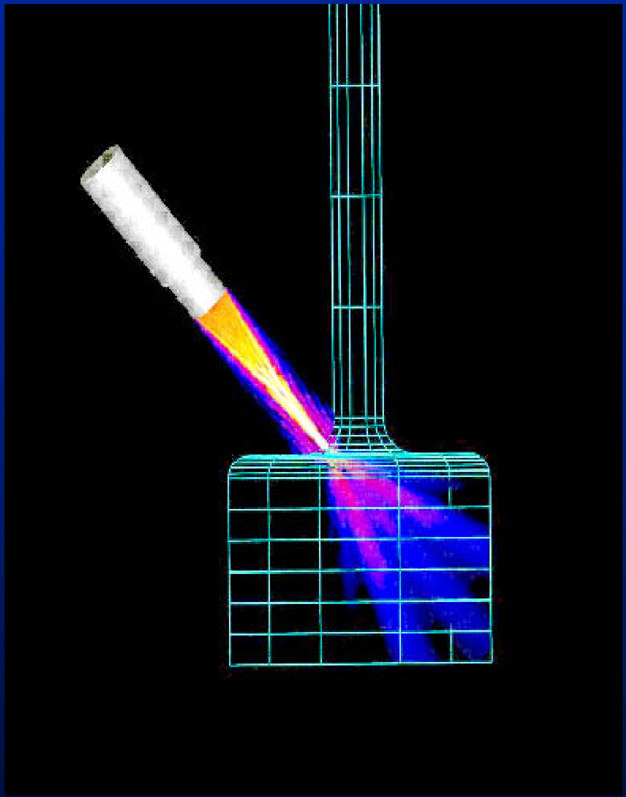
- Introduction to NDT
- Overview of Five Most Common NDT Methods
- Selected Applications
- Advantage & Disadvantage
- Introduction to DT

Definition of NDT

The use of non-invasive techniques to determine the integrity of a material, component or structure

or

quantitatively measure some characteristic of an object.



i.e. Inspect or measure without doing harm.

Methods of NDT

Visual

Microwave

Thermography

Magnetic Particle

Acoustic Microscopy

X-ray

Acoustic Emission

Magnetic Measurements

Eddy Current

Liquid Penetrant

Ultrasonic

Flux Leakage

Laser Interferometry

Replication

What are Some Uses of NDE Methods?

- Flaw Detection and Evaluation
- Leak Detection
- Location Determination
- Dimensional Measurements

Fluorescent penetrant indication

- Structure and Micro structure Characterization
- Chemical Composition Determination

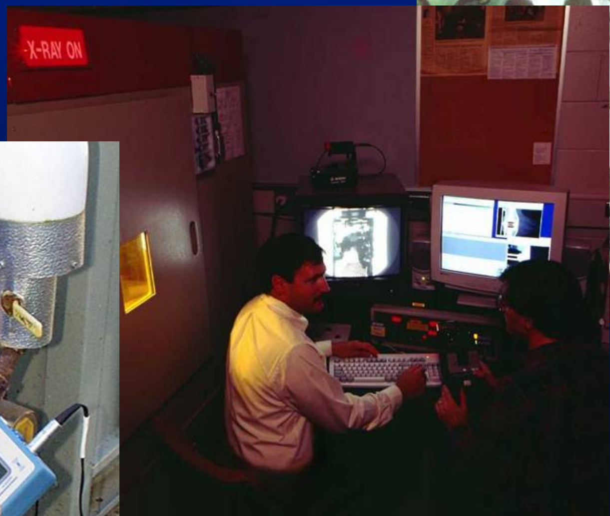
When are NDE Methods Used?

There are NDE application at almost any stage in the production or life cycle of a component.

- To assist in product development
- To screen or sort incoming materials
- To monitor, improve or control manufacturing processes
- To verify proper processing such as heat treating
- To verify proper assembly
- To inspect for in-service damage

Five Most Common NDT Methods

- Visual
- Liquid Penetrant
- Magnetic
- Ultrasonic
- Radiography



Some common defects in NDT?

- Porosity
- Undercut
- Slag inclusion
- Poor penetration
- Voids
- Lack of Fusion
- Cracks
- Mismatch

Visual Testing

Introduction to Visual Inspection (VT)

- VT is probably the oldest and most common method of NDT, having numerous industrial and commercial applications. Examiners follow procedures ranging from simple to very complex, some of which involve comparison of workmanship samples with production parts. Visual techniques are used with all other NDT methods.
- VT reveals spatter, excessive build-up, incomplete slag removal, cracks, heat distortion, undercutting, & poor penetration
- Typical tools for VT consist of Fillet gauges Magnifying glasses, Flash lights, & Tape or Vernier callipers

Some Visual Inspection Method

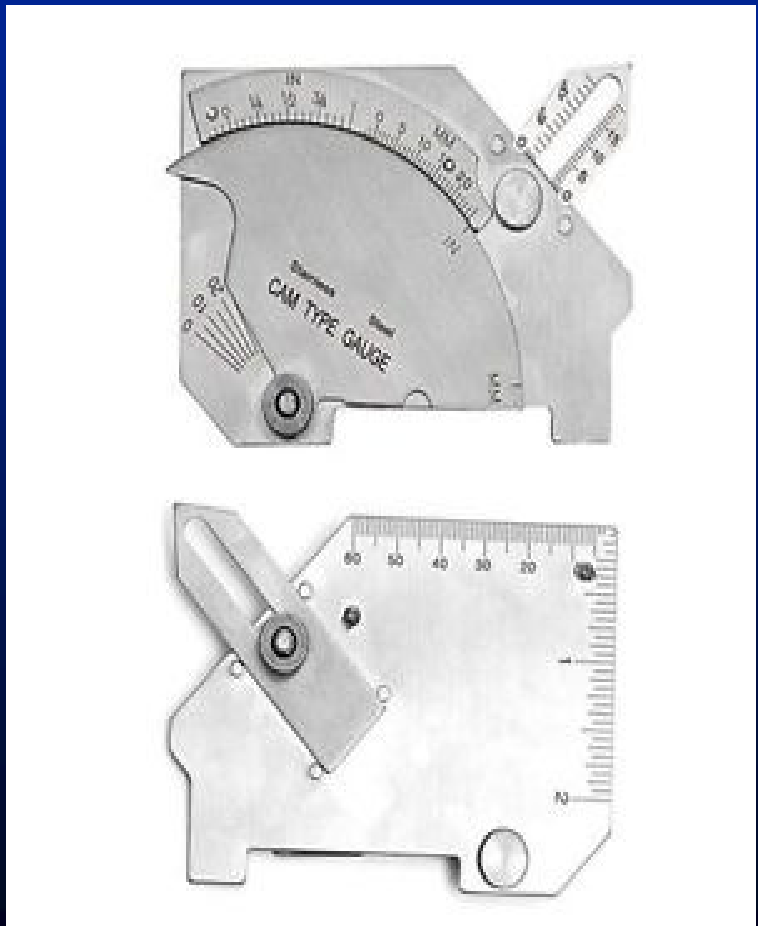
Most basic and common inspection method.

Tools include fiberscopes, borescopes, magnifying glasses and mirrors.

Portable video inspection unit with zoom allows inspection of large tanks and vessels, railroad tank cars, sewer lines.

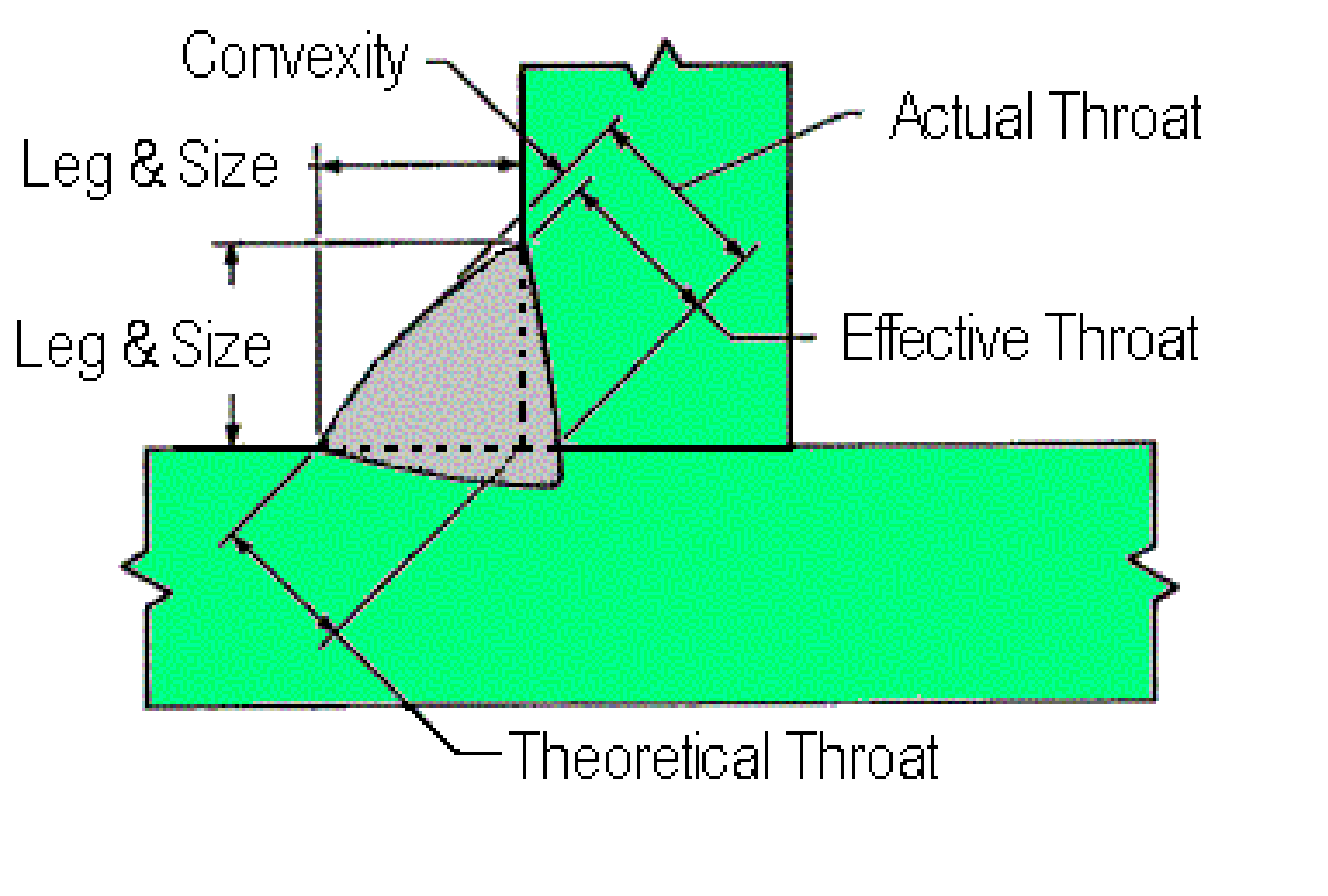
Robotic crawlers permit observation in hazardous or tight areas, such as air ducts, reactors, pipelines.

Visual Inspection (VT) Kits



- Fillet gauges measure
  - The “Legs”of the weld
  - Convexity
    - » (weld rounded outward)
  - Concavity
    - » (weld rounded inward)
  - Flatness

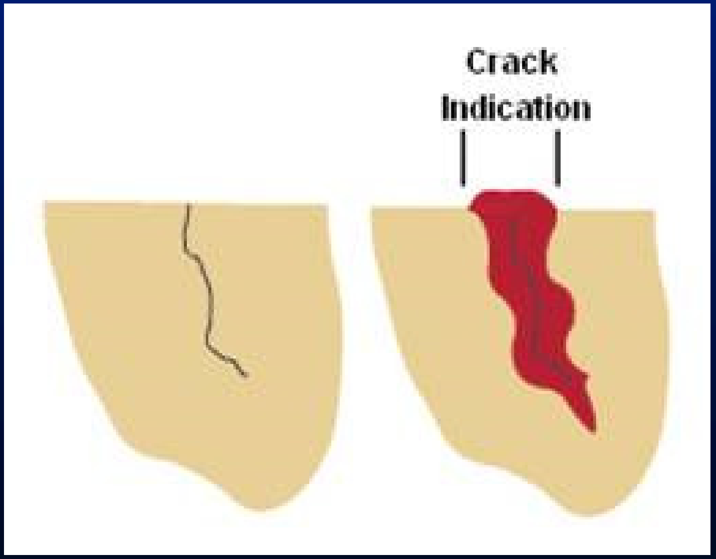
Visual Inspection of Fillet Welding



Penetrant Testing

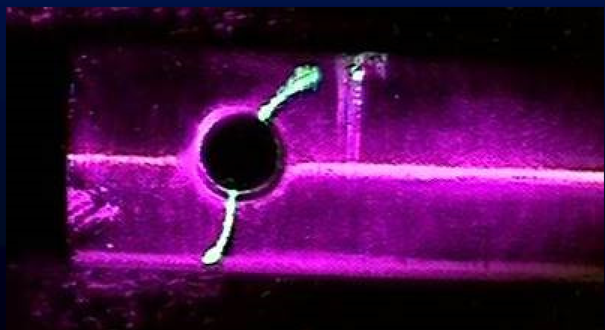
Introduction to Penetrant Testing

- This module is intended to provide an introduction to the NDT method of penetrant testing.
- Penetrant Testing, or PT, is a nondestructive testing method that builds on the principle of Visual Inspection.
- PT increases the "see ability" of small discontinuities that the human eye might not be able to detect alone.



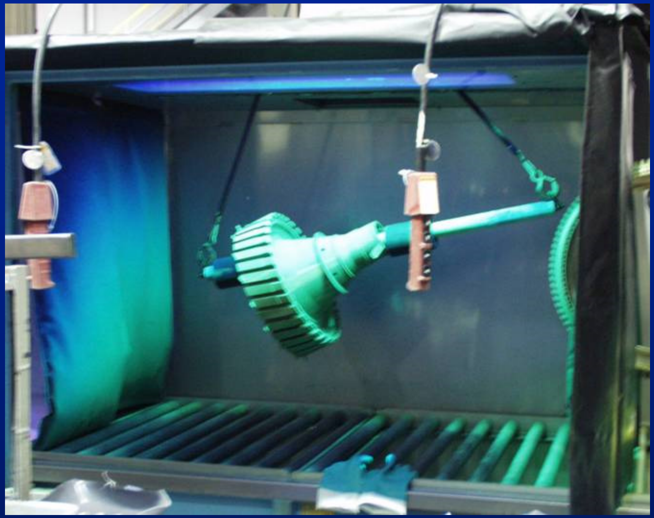
How Penetrant Testing Perform

- A liquid with high surface wetting characteristics is applied to the surface of the part and allowed time to seep into surface breaking defects.
- The excess liquid is removed from the surface of the part.
- A developer (powder) is applied to pull the trapped penetrant out the defect and spread it on the surface where it can be seen.
- Visual inspection is the final step in the process. The penetrant used is often loaded with a fluorescent dye and the inspection is done under UV light to increase test sensitivity.



6 Steps of Penetrant Testing

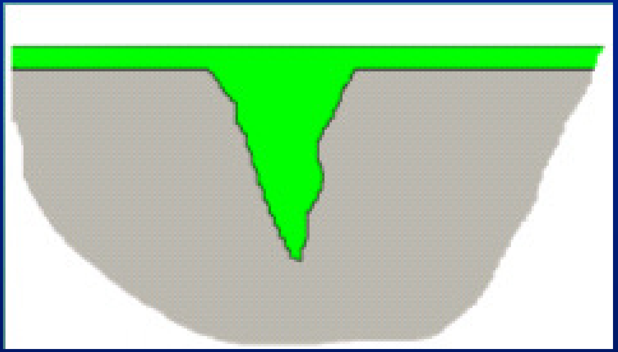
1. Pre-Clean
2. Penetrant Application
3. Excess Penetrant Removal
4. Developer Application
5. Inspect/Evaluate
6. Post-clean



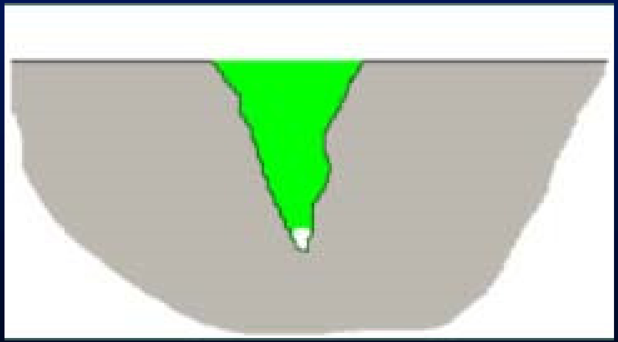
Basic Process of PT

1) Clean & Dry Component

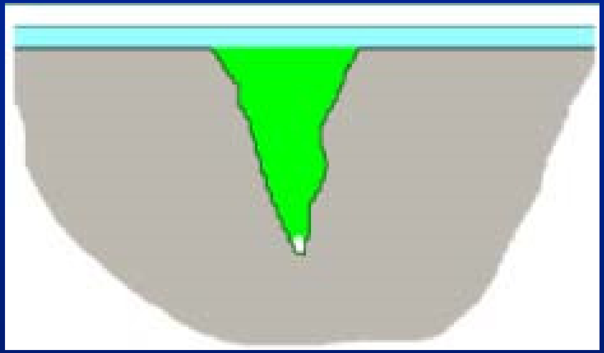
2) Apply Penetrant



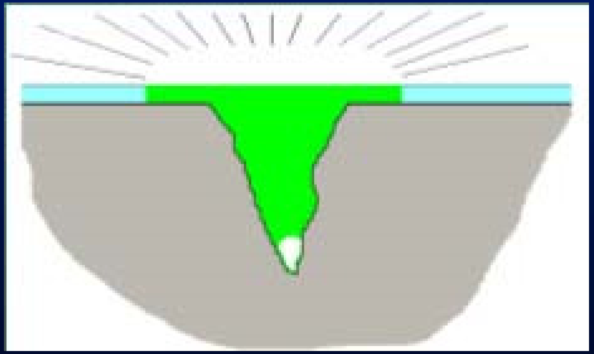
3) Remove Excess



4) Apply Developer



5) Visual Inspection

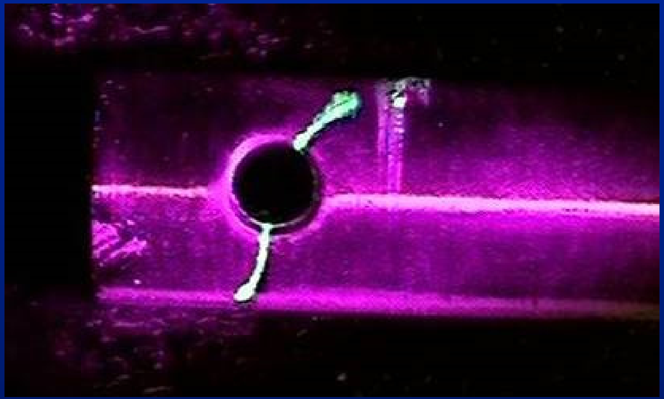


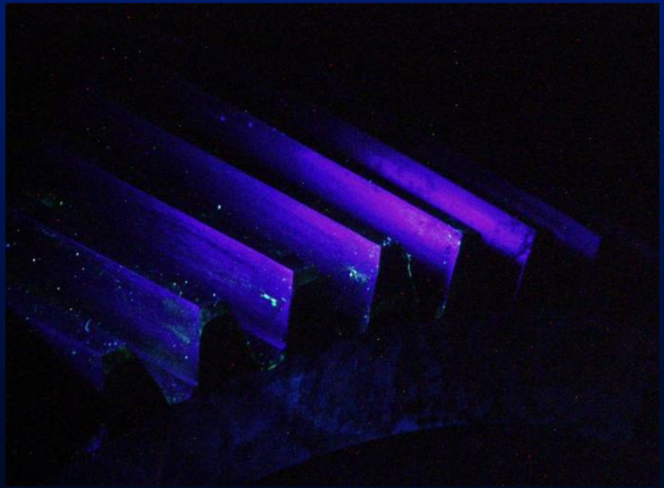
6) Post Clean Component

What Types of Discontinuities Can Be Detected Via PT?

All defects that are open to the surface.

- Rolled products-- cracks, seams, laminations.
- Castings:cold shuts, hot tears, porosity, blow holes, shrinkage.
- Forgings– cracks, external bursts.
- Welds– cracks, porosity, undercut, overlap, lack of fusion, lack of penetration.





Advantages of Penetrant Testing

- Relative ease of use.
- Can be used on a wide range of material types.
- Large areas or large volumes of parts/materials can be inspected rapidly and at low cost.
- Parts with complex geometries are routinely inspected.
- Indications are produced directly on surface of the part providing a visual image of the discontinuity.
- Initial equipment investment is low.

Limitations of Penetrant Testing

- Only detects surface breaking defects.
- Requires relatively smooth nonporous material.
- Precleaning is critical. Contaminants can mask defects.
- Chemical handling precautions necessary (toxicity, fire, waste).
- Metal smearing from machining, grinding and other operations inhibits detection. Materials may need to be etched prior to inspection.
- Post cleaning is necessary to remove chemicals.

Magnetic Particle Testing

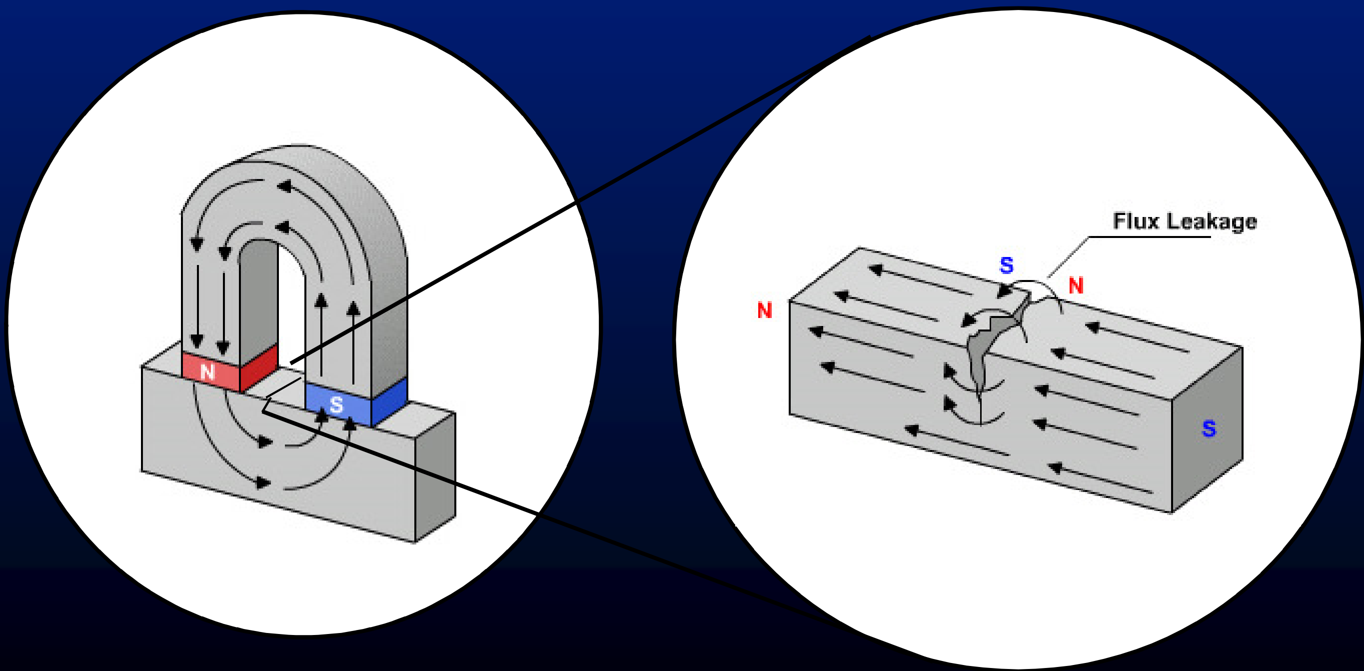
Introduction Magnetic Particle Inspection

- This module is intended to present information on the widely used method of magnetic particle inspection.

- Magnetic particle inspection can detect both production discontinuities (seams, grinding cracks and quenching cracks) and in-service damage (fatigue and overload cracks).

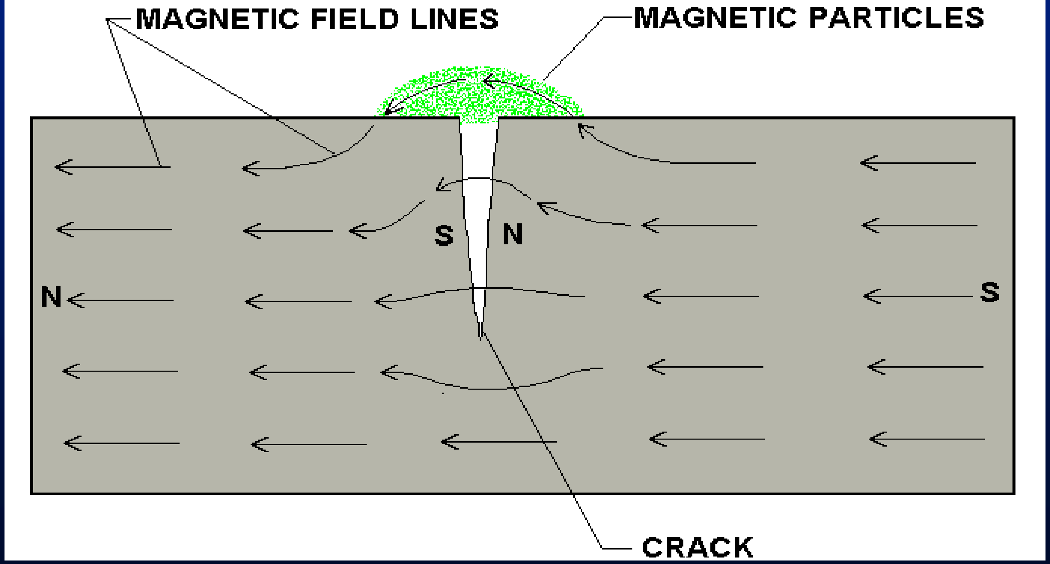
How Does Magnetic Particle Inspection Work?

A ferromagnetic test specimen is magnetized with a strong magnetic field created by a magnet or special equipment. If the specimen has a discontinuity, the discontinuity will interrupt the magnetic field flowing through the specimen and a leakage field will occur.



Magnetic Particle Inspection

The part is magnetized. Finely milled iron particles coated with a dye pigment are then applied to the specimen. These particles are attracted to magnetic flux leakage fields and will cluster to form an indication directly over the discontinuity. This indication can be visually detected under proper lighting conditions.



Basic Procedure

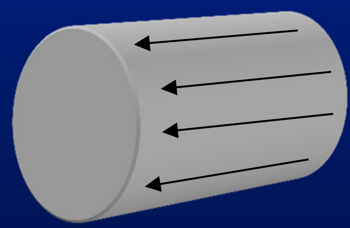
Basic steps involved:

- Component pre-cleaning
- Introduction of magnetic field
- Application of magnetic media
- Interpretation of magnetic particle indications
- Visual Inspection

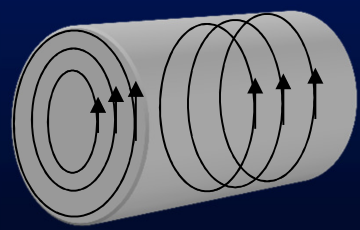
Direction of the Magnetic Field

Two general types of magnetic fields (longitudinal and circular) may be established within the specimen. The type of magnetic field established is determined by the method used to magnetize the specimen.

- A longitudinal magnetic field has magnetic lines of force that run parallel to the long axis of the part.



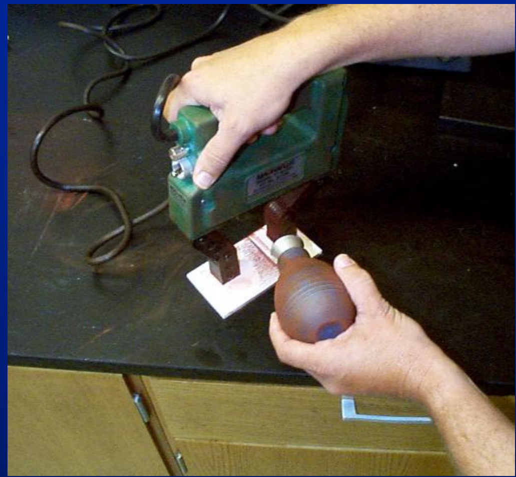
- A circular magnetic field has magnetic lines of force that run circumferentially around the perimeter of a part.



Application of Magnetic Media
(Wet Versus Dry)

MPI can be performed using either dry particles, or particles suspended in a liquid. With the dry method, the particles are lightly dusted on to the surface. With the wet method, the part is flooded with a solution carrying the particles.

The dry method is more portable. The wet method is generally more sensitive since the liquid carrier gives the magnetic particles additional mobility.



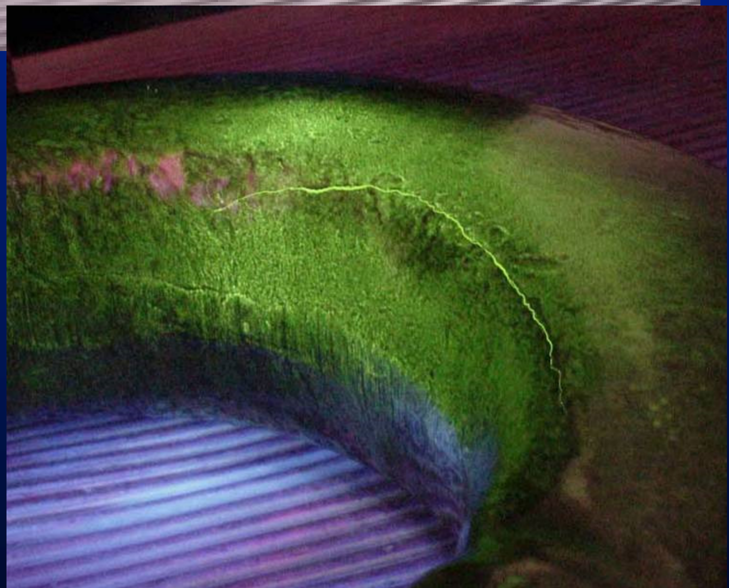
Advantages of Magnetic Particle Inspection

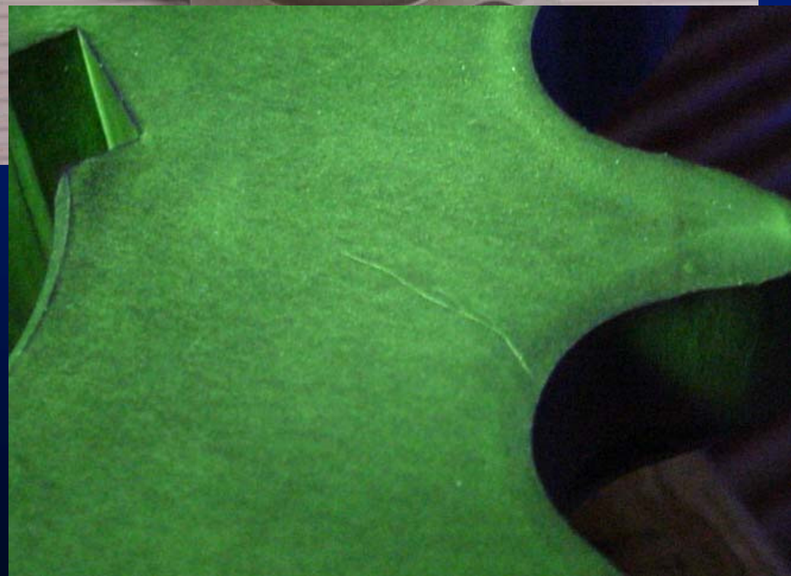
- Can detect both surface and near sub-surface defects.
- Can inspect parts with irregular shapes easily.
- Pre cleaning of components is not as critical as it is for some other inspection methods. Most contaminants within a flaw will not hinder flaw detectability.
- Fast method of inspection and indications are visible directly on the specimen surface.
- Considered low cost compared to many other NDT methods.
- Is a very portable inspection method especially when used with battery powered equipment.

Limitations of Magnetic Particle Inspection

- Cannot inspect non-ferrous materials such as aluminum, magnesium or most stainless steels.
- Inspection of large parts may require use of equipment with special power requirements.
- Some parts may require removal of coating or plating to achieve desired inspection sensitivity.
- Limited subsurface discontinuity detection capabilities. Maximum depth sensitivity is approximately 4-5 mm (under ideal conditions).
- Post cleaning, and post demagnetization is often necessary.
- Alignment between magnetic flux and defect is important

Magnetic Particle Crack Indications





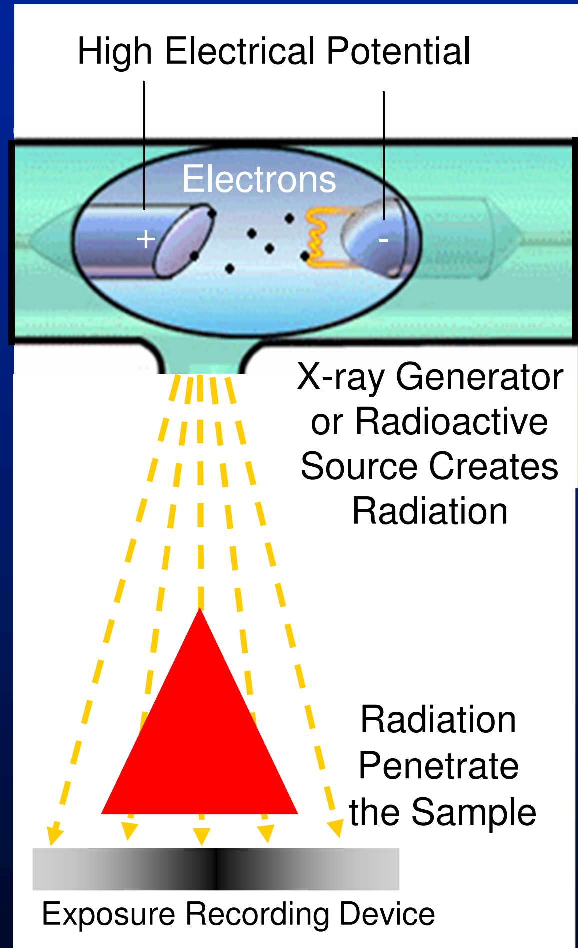
Radiography(X-Ray Inspection)

INTRODUCTION TO RADIOGRAPHY

- RT involves the use of penetrating X-Ray or gamma radiation to examine parts and products for imperfections. An X-ray machine or radioactive isotope is used as a source of radiation. Radiation is directed through a part and onto film. When the film is developed, a shadow graph is obtained that shows the internal soundness of a part. Possible imperfections show up as density changes in the film, in much the same manner as a medical radiograph can show broken bones.

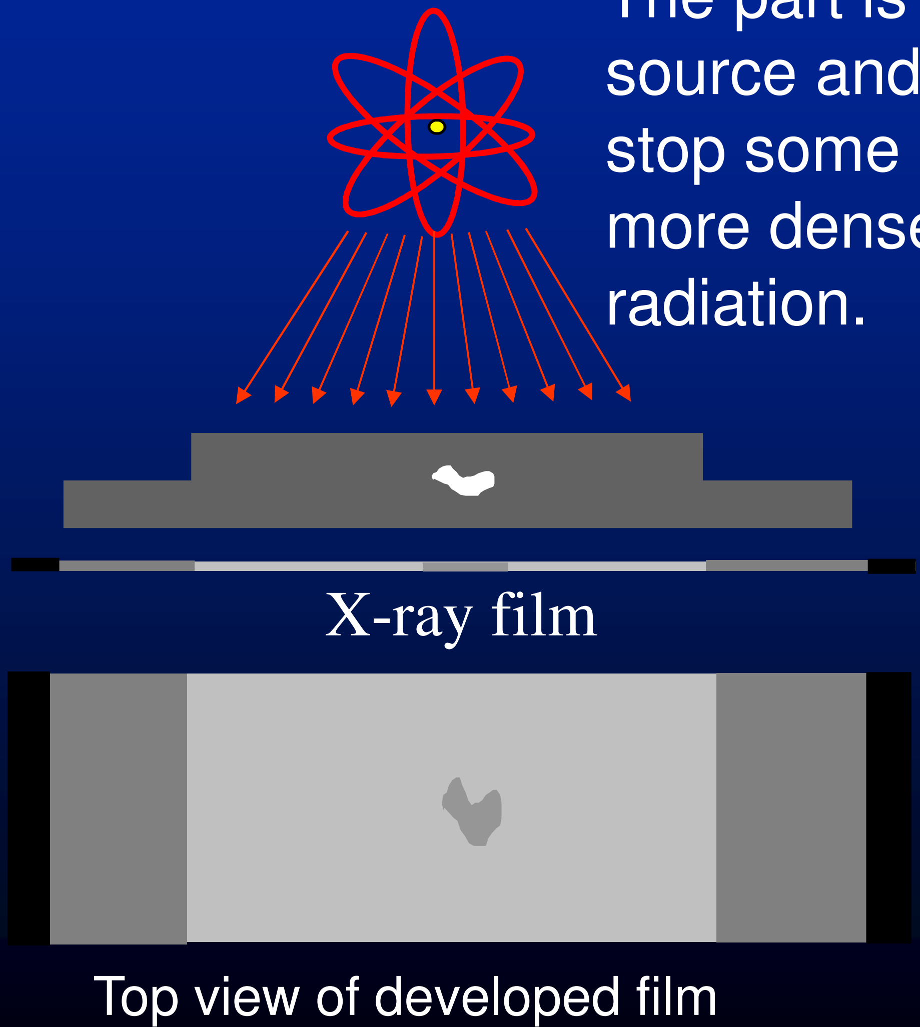
Radiation Emission in X-Ray

The radiation used in radiography testing is a higher energy (shorter wavelength) version of the electromagnetic waves that we see as visible light. The radiation can come from an X-ray generator or a radioactive source.



Radiography Film

The part is placed between the radiation source and a piece of film. The part will stop some of the radiation. Thicker and more dense area will stop more of the radiation.



The film darkness (density) will vary with the amount of radiation reaching the film through the test object.

Radiography(X-Ray Inspection)

X-rays are produced by high voltage x ray machines whereas gamma rays are produced from radioactive isotopes such as Iridium 192,Selenium 75,Cobalt -60 .The x-ray or gamma rays are placed close to the material to be inspected and they pass through the material and are then captured on film. This film is then processed and the image is obtained as a series of gray shades between black and white.

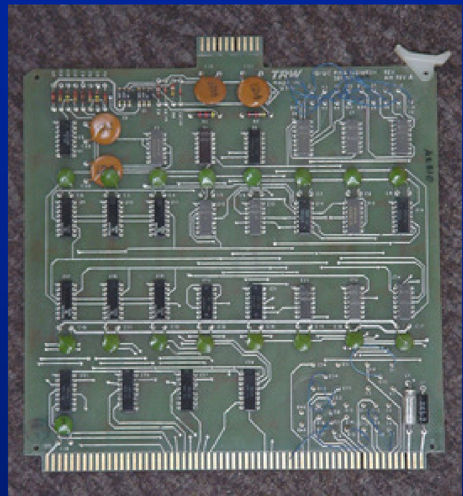
Radiography(X-Ray Inspection)

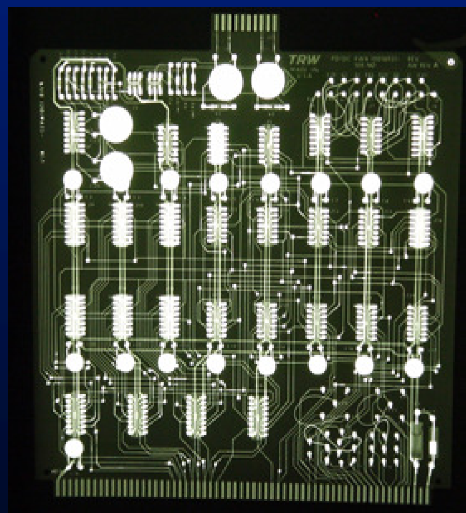
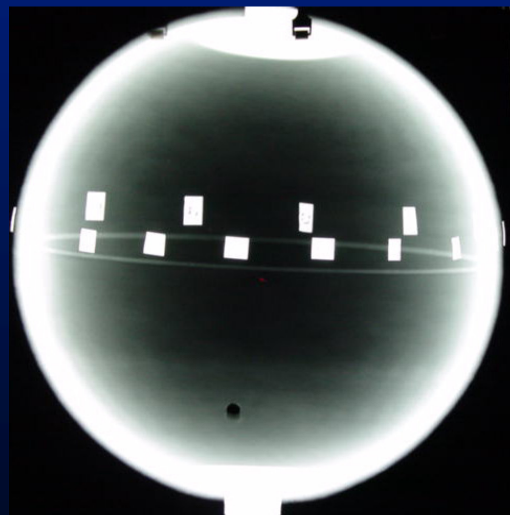
The choice of which type of radiation is used (x ray or gamma) depends on the thickness of the material to be tested. Gamma sources have the advantage of portability which makes them ideal for use in construction site working.

Radiography(X-Ray Inspection)

X-rays and gamma rays are very hazardous. Special precautions must be taken when performing radiography. Therefore the operator will use these inside a protective enclosure or with appropriate barriers and warning signals to ensure there are no hazards to personnel.

Radiographic Images

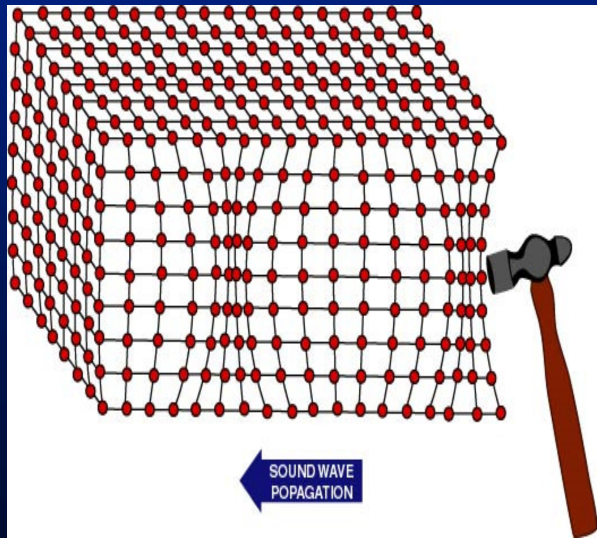




Ultrasonic Testing

Ultrasonic Testing

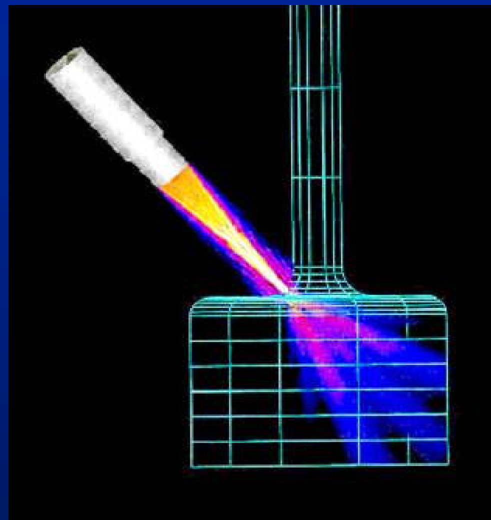
Basic Principles of Sound

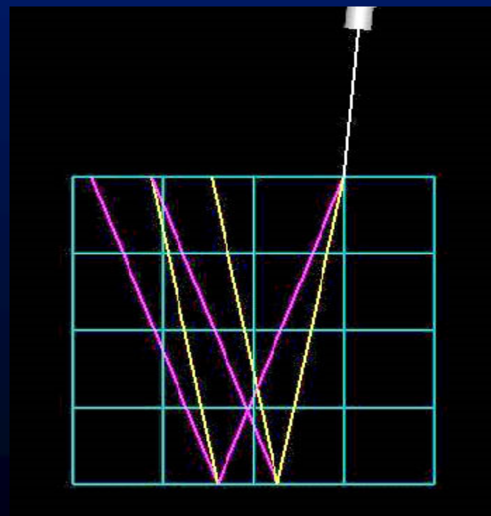
- Sound is produced by a vibrating body and travels in the form of a wave.
- Sound waves <u>travel</u> through materials by <u>vibrating the particles</u> that make up the material.
- The <u>pitch</u> of the sound is determined by the <u>frequency of the wave</u> (vibrations or cycles completed in a certain period of time).
- Ultrasound is sound with a pitch too high frequency which cannot be detected by the human ear.



Basic Principles of Sound (cont.)

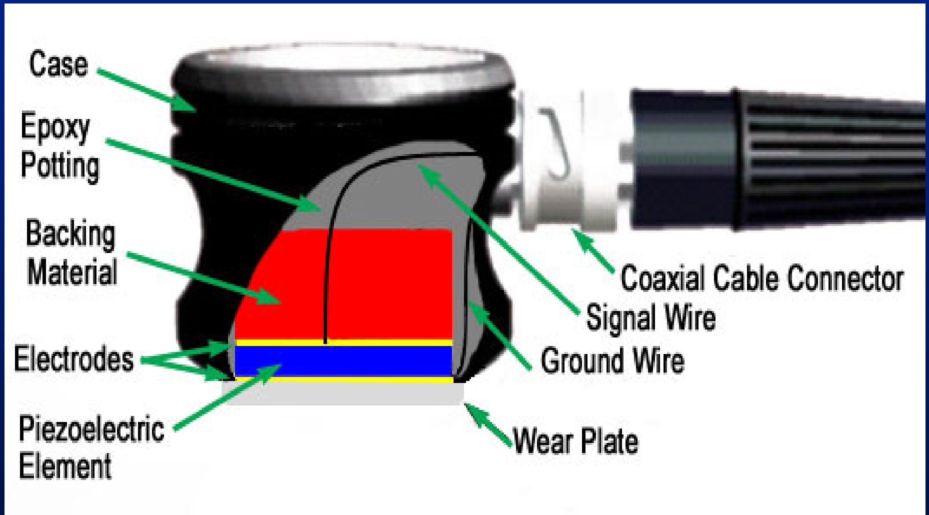
- Ultrasonic waves are very similar to light waves in that they can be reflected, refracted, and focused.
- Reflection and refraction occurs when sound waves interact with interfaces of differing acoustic properties.
- In solid materials, the vibrational energy can be split into different wave modes when the wave encounters an interface at an angle other than 90 degrees.
- Ultrasonic reflections from the presence of discontinuities or geometric features enables detection and location.
- The velocity of sound in a given material is constant and can only be altered by a change in the mode of energy.





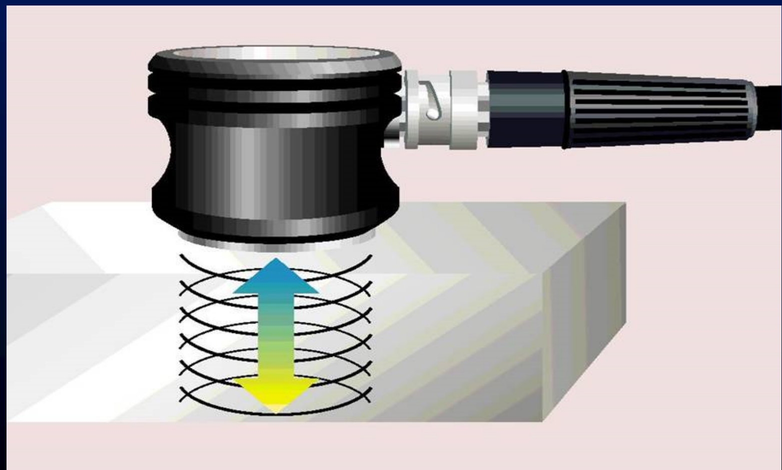
Ultrasound (UT) Generation

UT inspection system : Pulser/ Receiver, Transducer, Display Device
Pulser / Receiver : Electronic device to produce electrical pulse
High frequency ultrasound is generated with a transducer.



A piezoelectric element in the transducer converts electrical energy into mechanical vibrations (sound), and vice versa.

The transducer is capable of both transmitting and receiving sound energy.



Test Techniques

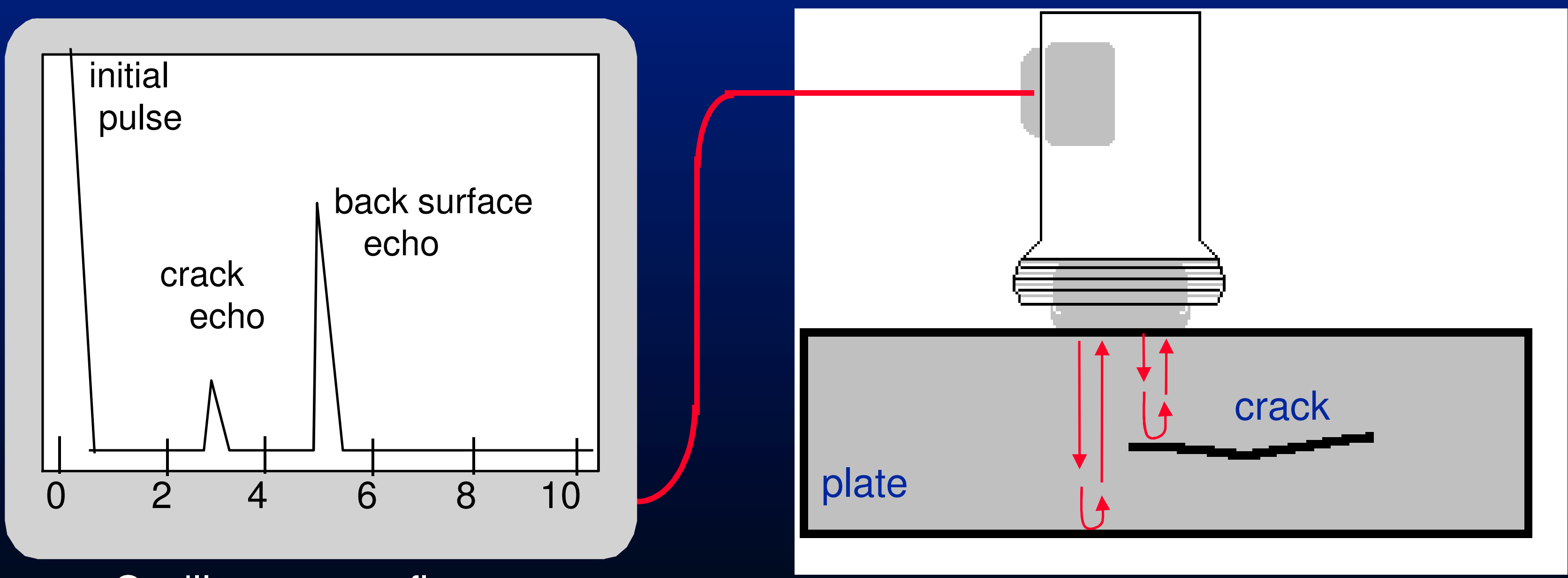
- Ultrasonic testing is a very versatile inspection method, and inspections can be accomplished in a number of different ways.
- Ultrasonic inspection techniques are commonly divided into three primary classifications.
  - Pulse-echo and Through Transmission
    (Relates to whether reflected or transmitted energy is used)
  - Normal Beam and Angle Beam
    (Relates to the angle that the sound energy enters the test article)
  - Contact and Immersion
    (Relates to the method of coupling the transducer to the test article)

Each of these techniques will be discussed briefly in the following slides.

Ultrasonic Inspection (Pulse-Echo)

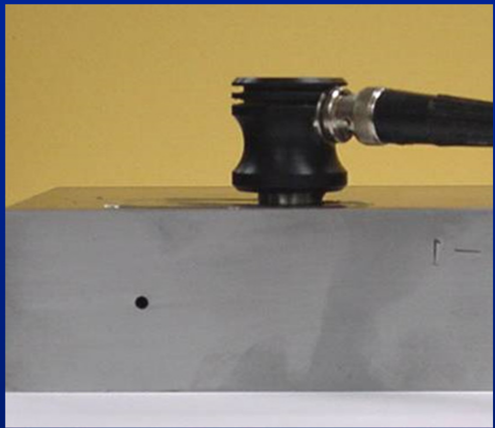
High frequency sound waves are introduced into a material and they are reflected back from surfaces or flaws.

Reflected sound energy is displayed versus time, and inspector can visualize a cross section of the specimen showing the depth of features that reflect sound.



Oscilloscope, or flaw detector screen

Test Techniques – Pulse-Echo (cont.)

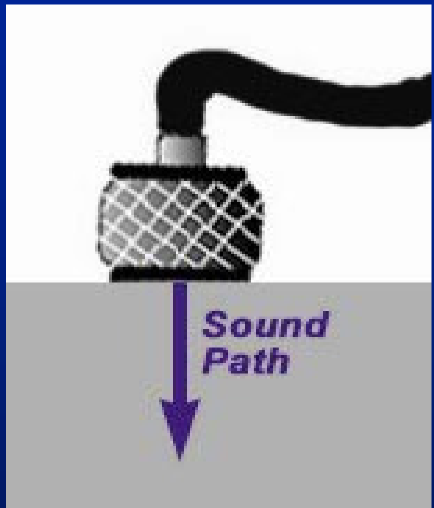


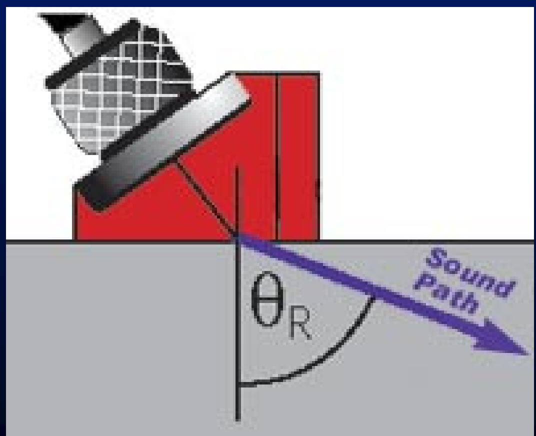
Digital display showing signal generated from sound reflecting off back surface.

Digital display showing the presence of a reflector midway through material, with lower amplitude back surface reflector.

The pulse-echo technique allows testing when access to only one side of the material is possible, and it allows the location of reflectors to be precisely determined.

Test Techniques – Normal and Angle Beam





- In normal beam testing, the sound beam is introduced into the test article at 90 degree to the surface.
- In angle beam testing, the sound beam is introduced into the test article at some angle other than 90.
- The choice between normal and angle beam inspection usually depends on two considerations:
  - The orientation of the feature of interest – the sound should be directed to produce the largest reflection from the feature.

Inspection Applications

Some of the applications for which ultrasonic testing may be employed include:

- Flaw detection (cracks, inclusions, porosity, etc.)
- Erosion & corrosion thickness gauging
- Assessment of bond integrity in adhesively joined and brazed components
- Estimation of void content in composites and plastics

On the following slides are examples of some common applications of ultrasonic inspection.

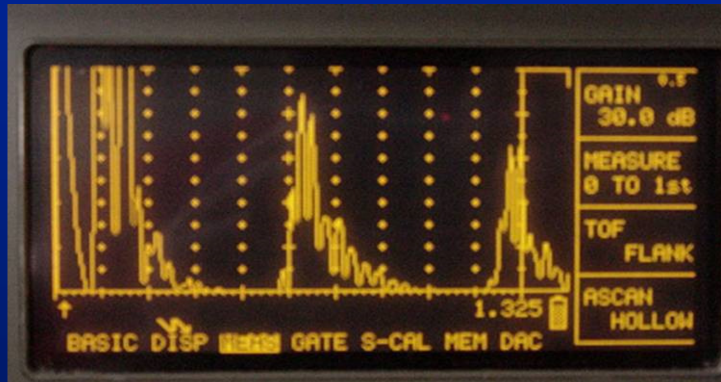
Thickness Gauging

- Ultrasonic thickness gauging is routinely utilized in the petrochemical and utility industries to
- determine various degrees of corrosion/erosion.

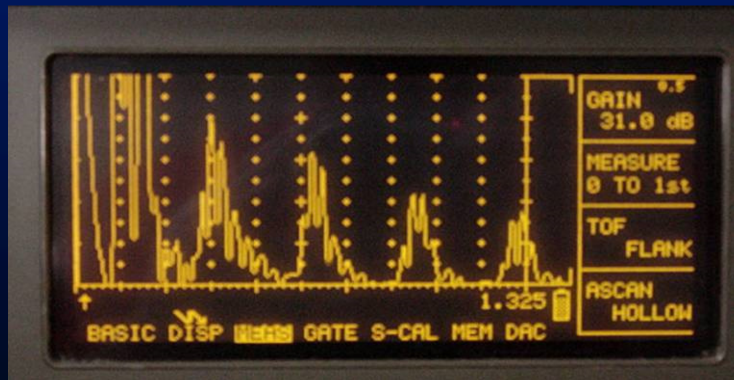
- Applications include piping systems, storage and containment facilities, and pressure vessels.

Flaw Detection - Delaminations

Contact, pulse-echo inspection for delaminations on 36” rolled beam.



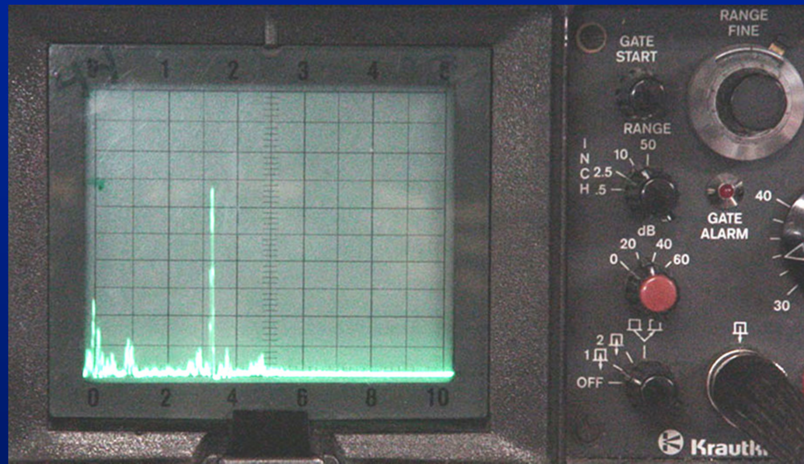
Signal showing multiple back surface echoes in an unflawed area.

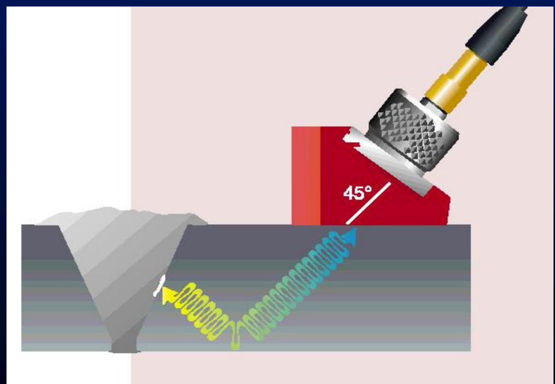


Additional echoes indicate delaminations in the member.

Flaw Detection in Welds

- One of the most widely used methods of inspecting weldments is ultrasonic inspection.
- Full penetration groove welds lend themselves readily to angle beam shear wave examination.





Advantage of Ultrasonic Testing

- Sensitive to both surface and subsurface discontinuities.
- Depth of penetration for flaw detection or measurement is superior to other methods.
- Only single-sided access is needed when pulse-echo technique is used.
- High accuracy in determining reflector position and estimating size and shape.
- Minimal part preparation required.
- Electronic equipment provides instantaneous results.
- Detailed images can be produced with automated systems.
- Has other uses such as thickness measurements, in addition to flaw detection.

Limitations of Ultrasonic Testing

- Surface must be accessible to transmit ultrasound.
- Skill and training is more extensive than with some other methods.
- Normally requires a coupling medium to promote transfer of sound energy into test specimen.
- Materials that are rough, irregular in shape, very small, exceptionally thin or not homogeneous are difficult to inspect.
- Cast iron and other coarse grained materials are difficult to inspect due to low sound transmission and high signal noise.
- Linear defects oriented parallel to the sound beam may go undetected.
- Reference standards are required for both equipment calibration, and characterization of flaws.

Common Application of NDT

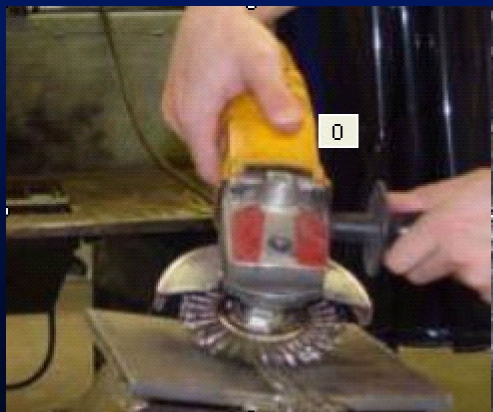
- Inspection of Raw Products
- Inspection Following Secondary Processing
- In-Services Damage Inspection

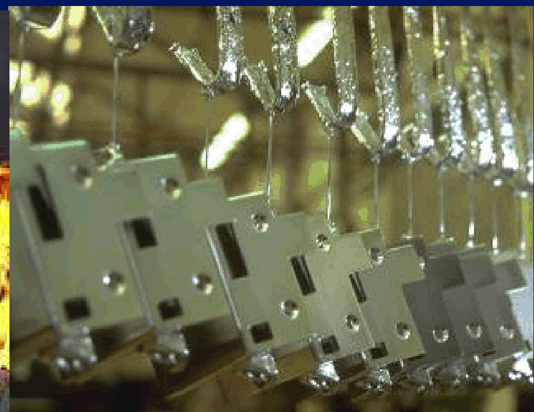
Inspection of Raw Products

- Forgings,
- Castings,
- Extrusions,
- etc.

Inspection Following Secondary Processing

- Machining
- Welding
- Grinding
- Heat treating
- Plating
- etc.

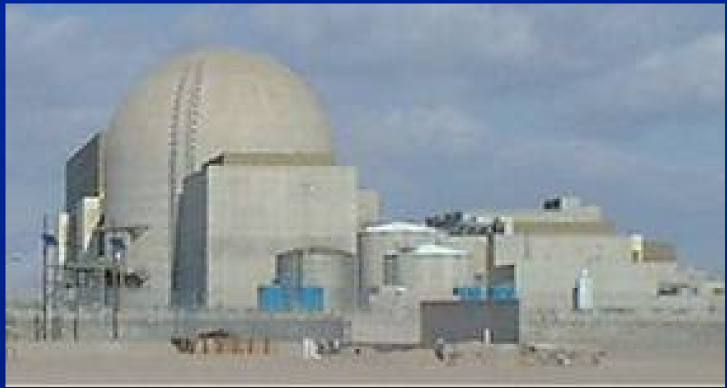




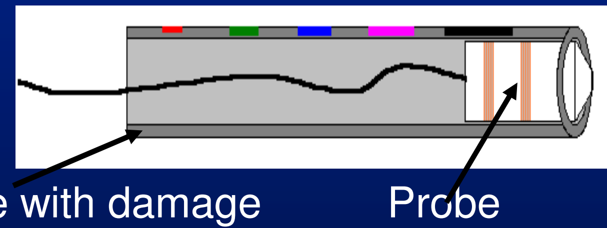
Inspection For In-Service Damage

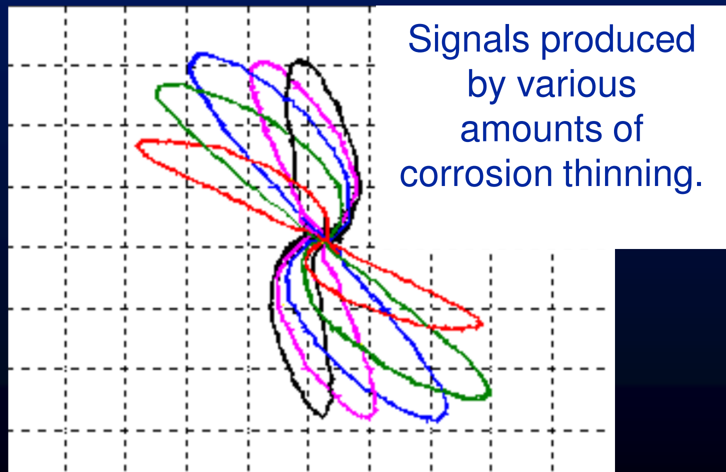
- Cracking
- Corrosion
- Erosion/Wear
- Heat Damage
- etc.

Power Plant Inspection



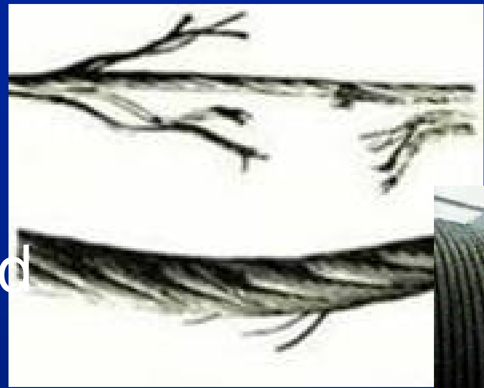
Periodically, power plants are shutdown for inspection. Inspectors feed eddy current probes into heat exchanger tubes to check for corrosion damage.

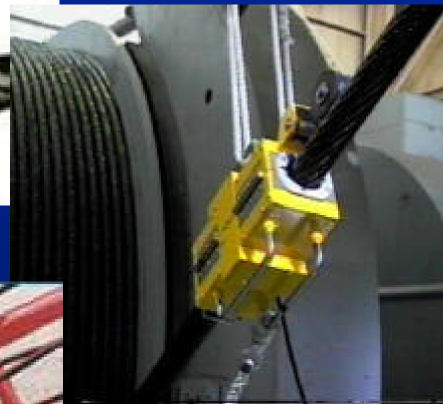


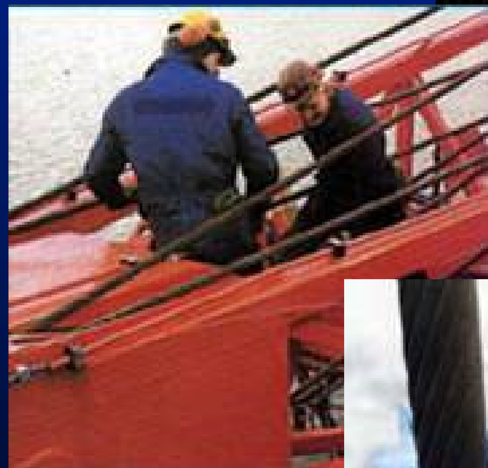


Wire Rope Inspection

Electromagnetic devices and visual inspections are used to find broken wires and other damage to the wire rope that is used in chairlifts, cranes and other lifting devices.



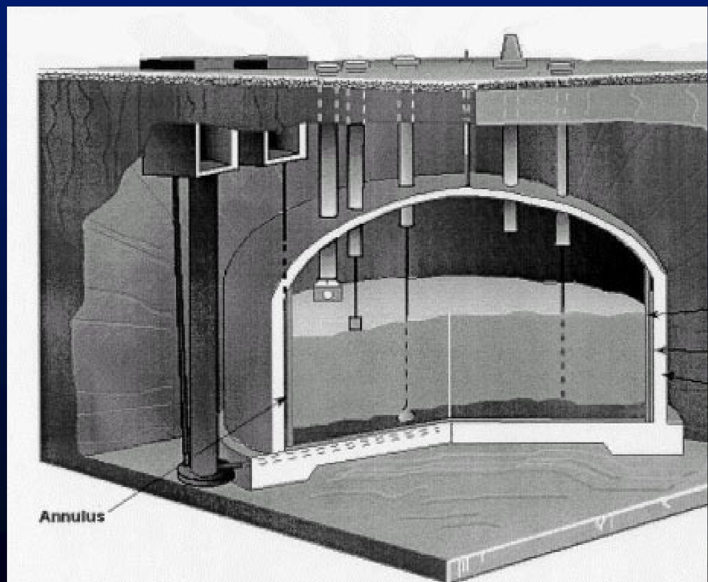




Storage Tank Inspection

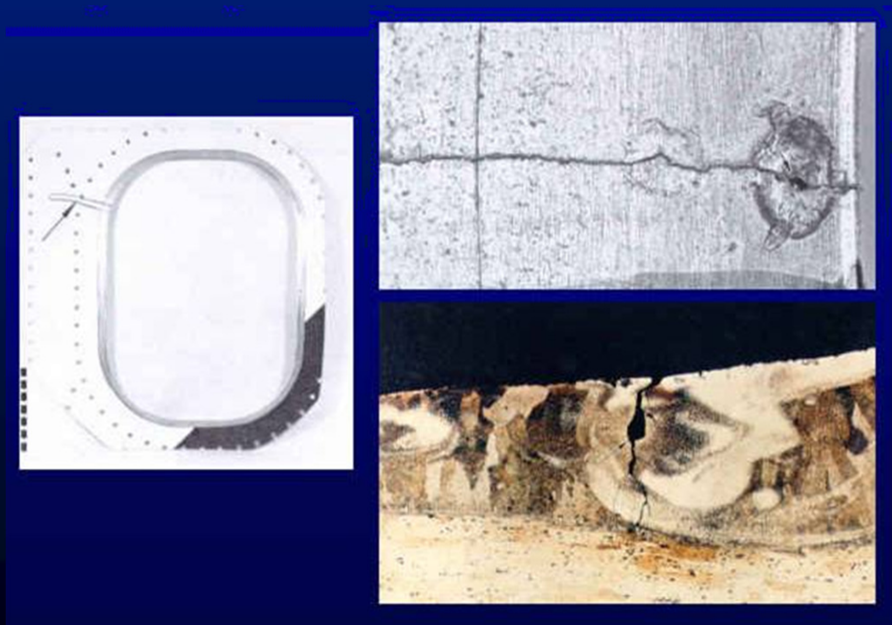
Robotic crawlers use ultrasound to inspect the walls of large above ground tanks for signs of thinning due to corrosion.

Cameras on long articulating arms are used to inspect underground storage tanks for damage.



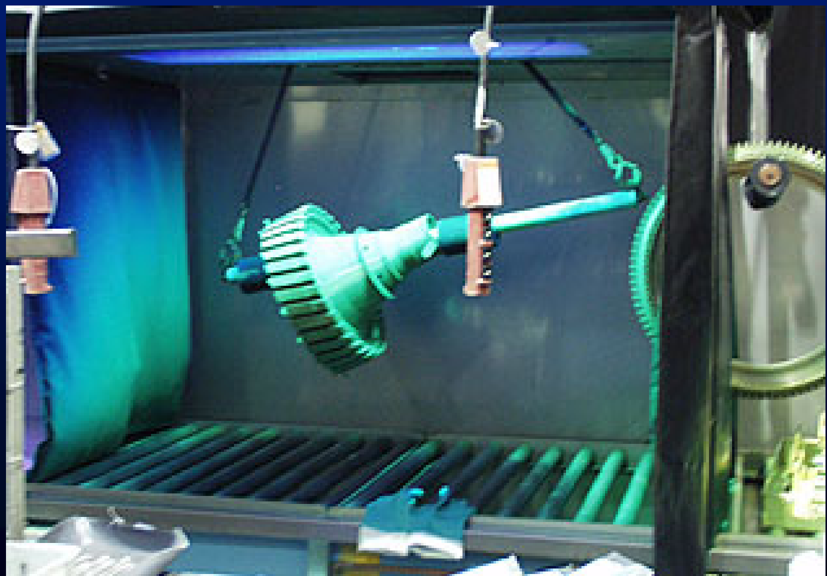
Aircraft Inspection

- Nondestructive testing is used extensively during the manufacturing of aircraft.
- NDT is also used to find cracks and corrosion damage during operation of the aircraft.
- A fatigue crack that started at the site of a lightning strike is shown below.



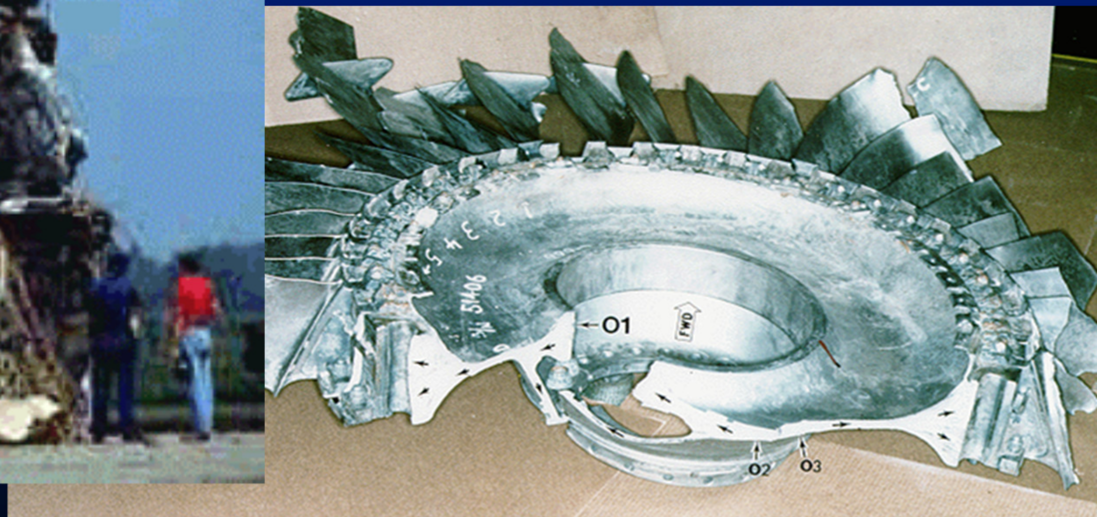
Jet Engine Inspection

- Aircraft engines are overhauled after being in service for a period of time.
- They are completely disassembled, cleaned, inspected and then reassembled.
- Fluorescent penetrant inspection is used to check many of the parts for cracking.



Crash of United Flight 232
Sioux City, Iowa, July 19, 1989

A defect that went undetected in an engine disk was responsible for the crash of United Flight 232.



Pressure Vessel Inspection

The failure of a pressure vessel can result in the rapid release of a large amount of energy. To protect against this dangerous event, the tanks are inspected using radiography and ultrasonic testing.

Rail Inspection

Special cars are used to inspect thousands of miles of rail to find cracks that could lead to a derailment.

Bridge Inspection

- The US has 578,000 highway bridges.
- Corrosion, cracking and other damage can all affect a bridge's performance.
- The collapse of the Silver Bridge in 1967 resulted in loss of 47 lives.
- Bridges get a visual inspection about every 2 years.
- Some bridges are fitted with acoustic emission sensors that "listen" for sounds of cracks growing.

Photo Courtesy of Physical Acoustics Corporations

Pipeline Inspection

NDT is used to inspect pipelines to prevent leaks that could damage the environment. Visual inspection, radiography and electromagnetic testing are some of the NDT methods used.

Magnetic flux leakage inspection. This device, known as a pig, is placed in the pipeline and collects data on the condition of the pipe as it is pushed along by whatever is being transported.

Remote visual inspection using a robotic crawler.

Photo Courtesy of Yxlon International

Radiography of weld joints.

INTRODUCTION TO DESTRUCTIVE TESTING

DESTRUCTIVE TESTING

- These can be divided into two parts,
- Tests capable of being performed in the workshop.
- Laboratory tests.
  - microscopic-macroscopic , chemical and corrosive.

WORKSHOP TESTS

TENSILE

BENDING

IMPACT

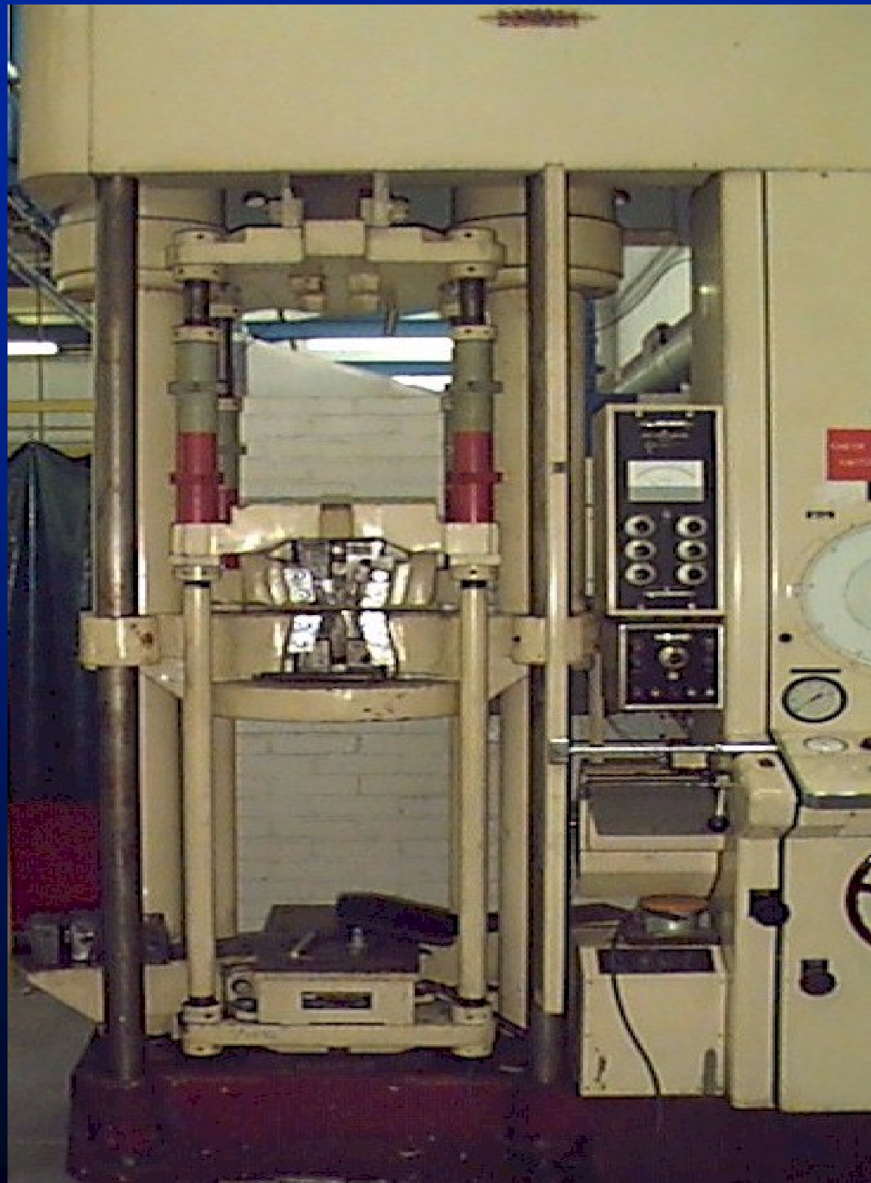
HARDNES

FATIGUE

CRACKING

TENSILE

- Material is sectioned and edges rounded of to prevent cracking.
- Punch marks are made to see elongation.



BEND TESTING

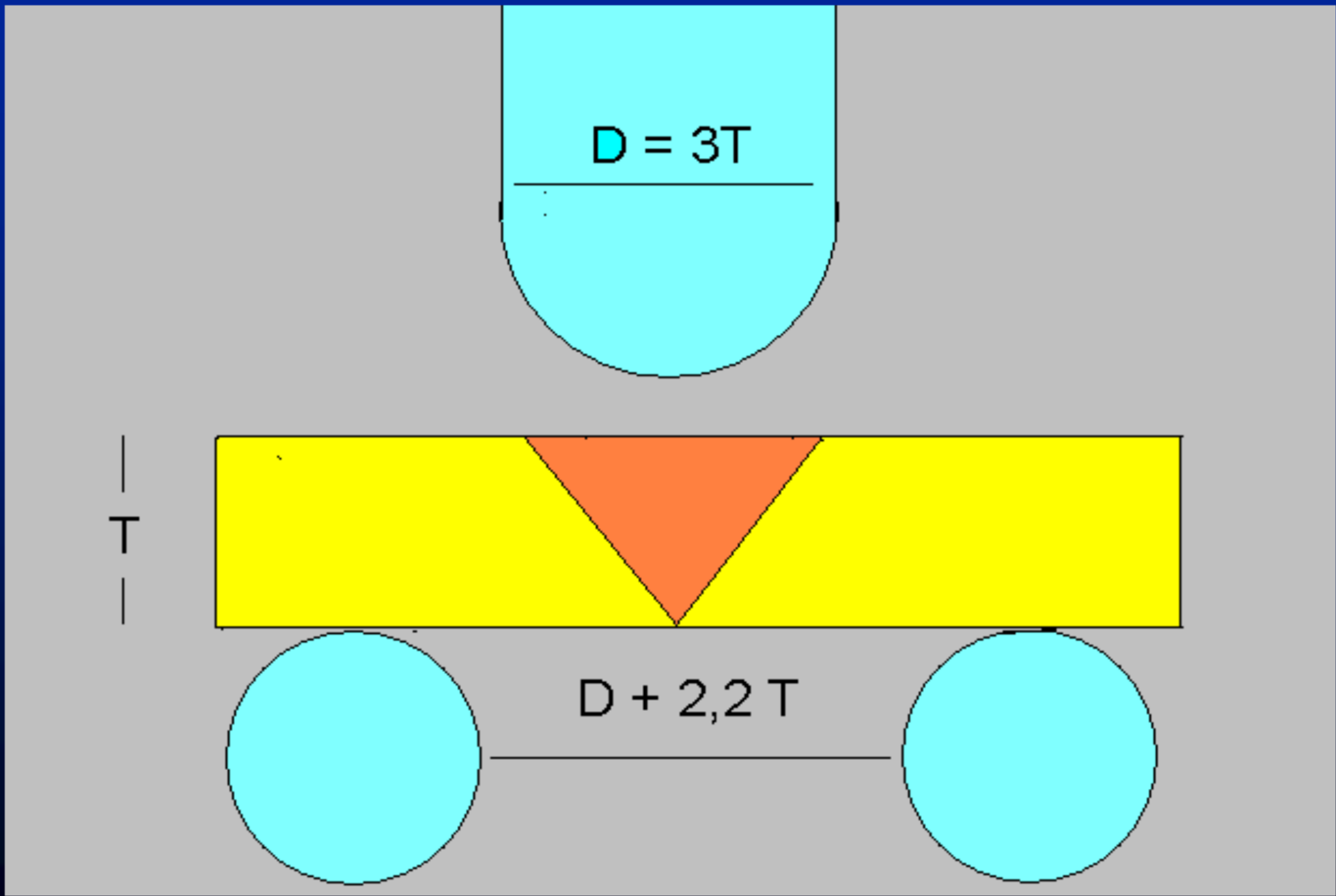
- Shows

Physical condition of the weld

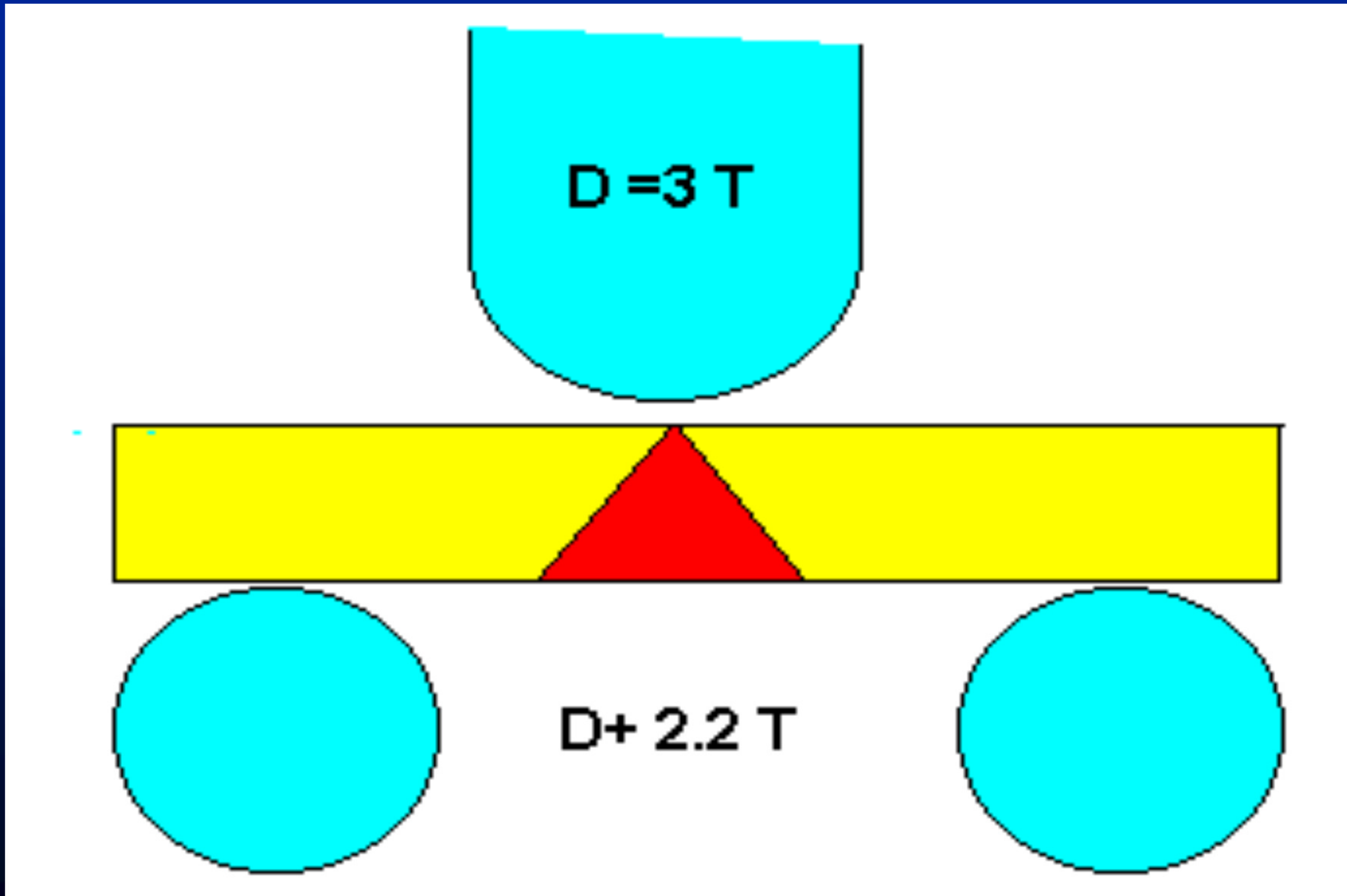
Determine welds efficiency

  - Tensile strength
  - Ductility
  - Fusion and penetration

Root bend



FACE BEND

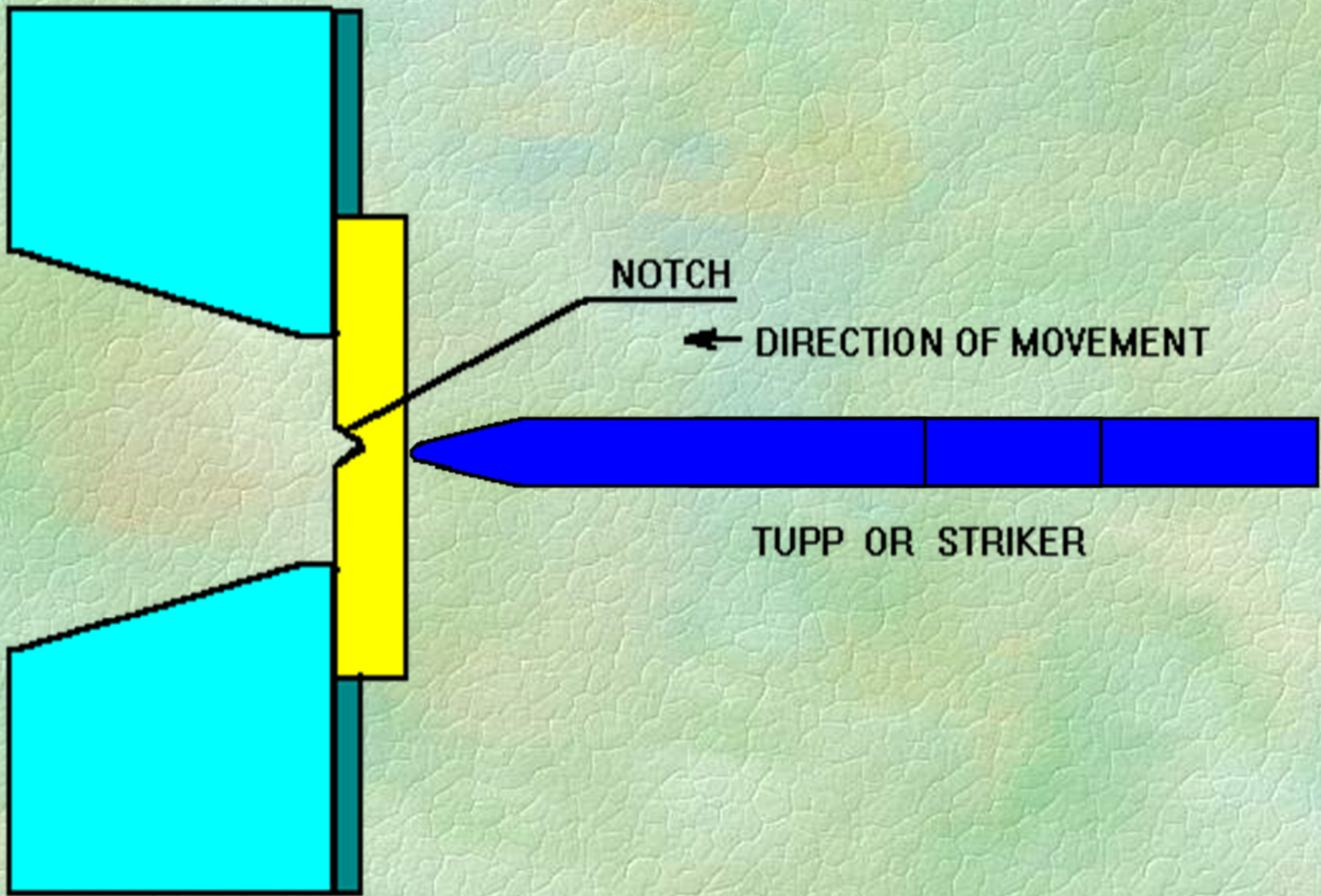


IMPACT

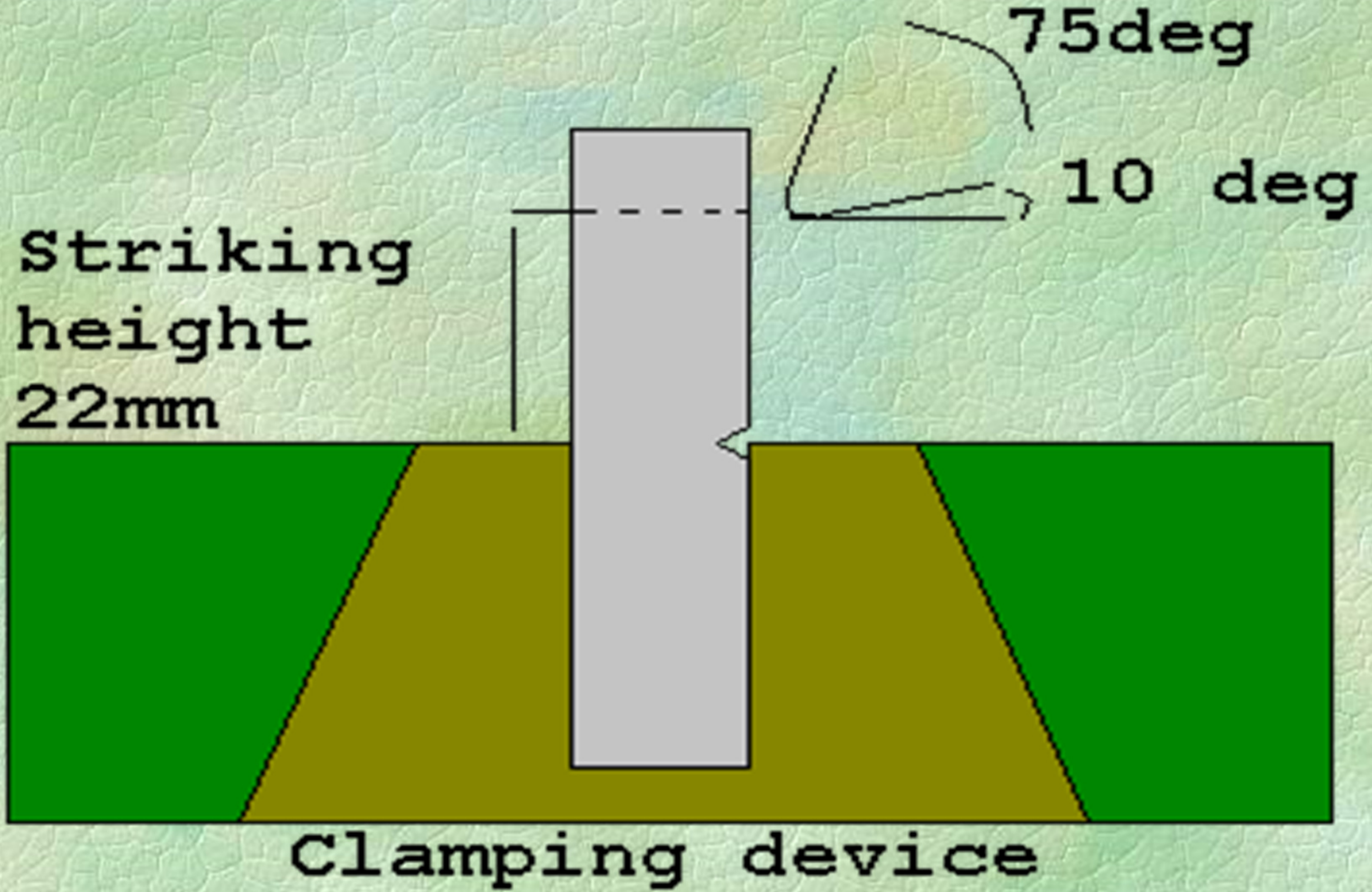
- CHARPY AND IZOD
- Gives the toughness and shock loading of the material and weld at varying temperatures with a notch such as under cut
- The measurement is the energy required to to break a specimen with a given notch
- 2mm depth at a 45^{o} bevel or a “U” notch.

TEST MACHINE

CHARPY



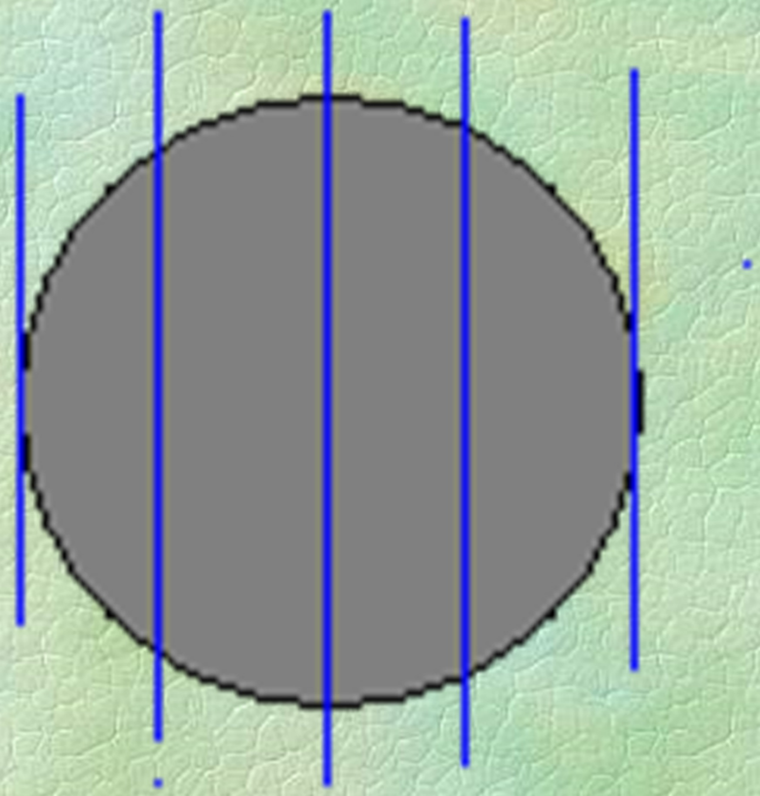
IZOD



HARDNESS TESTS.

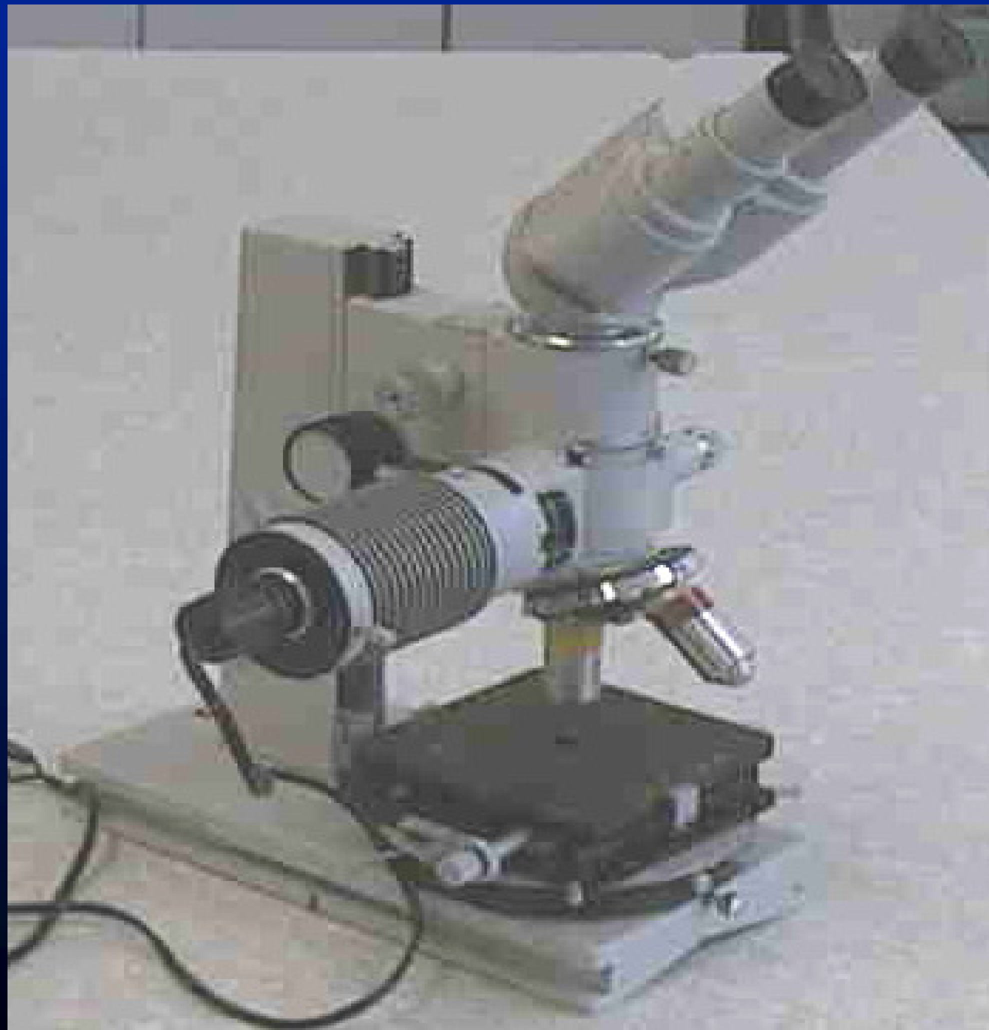
- This gives the metals ability to show resistance to indentation which show it's resistance to wear and abrasion.
- The tests are
  - Brinell
  - Rockwell
  - Vickers diamond pyramid
  - Scleroscope

VICKERS HARDNES



MICROSCOPIC

- Used to determine the actual structure of the weld and parent metal
- Up to 50,000 times magnification with an electron beam microscope
- Polishing must be of a very high standard



MACROSCOPIC

- Examined using a magnifying glass .
- magnification from 2 to 20 time.
- it will show up slag entrapment or cracks .
- polishing not as high as micro.

ETCHING REAGENTS

- These are acids used to show up different structures in metals
- For steels the most common is “1-2 % nitric acid in distilled water or alcohol.
- Aluminum uses a solution of 10-20%caustic soda in water

THANK YOU