OVERVIEW OF NONDESTRUCTIVE TESTING

ACUREN

DEFINITION OF NDT

- NDT – NONDESTRUCTIVE TESTING
- NDI – NONDESTRUCTIVE INSPECTION
- NDE – NONDESTRUCTIVE EXAMINATION OR EVALUATION
- compared to DESTRUCTIVE TESTING

DETECTION

How do we detect for DEFECTS ?

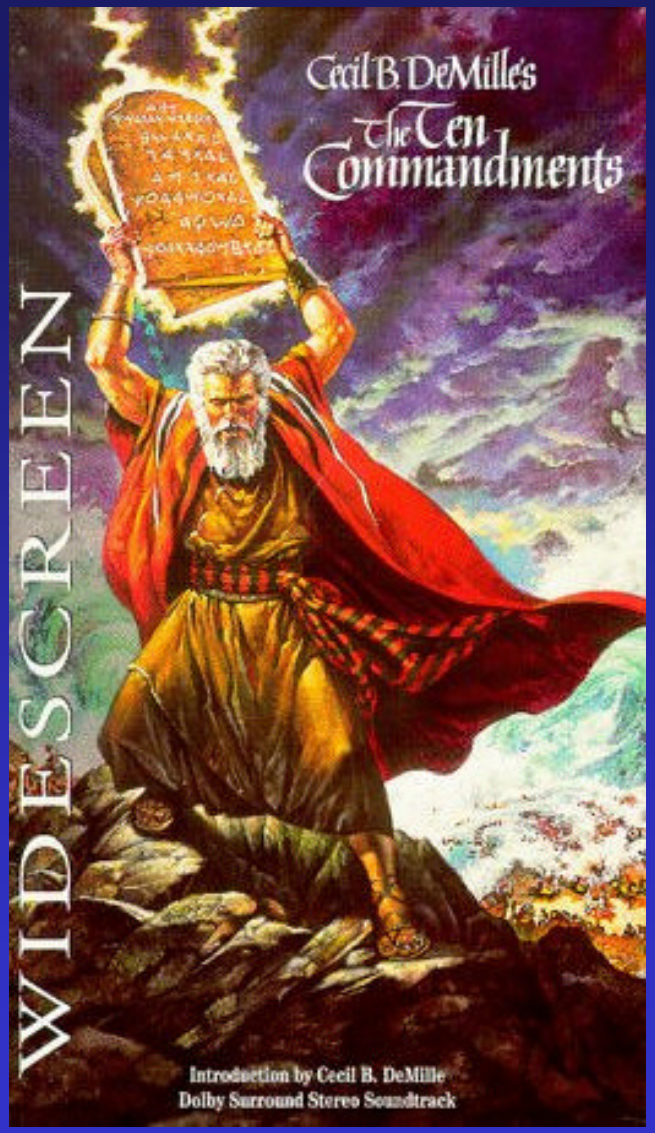
- Visual Inspection
- Penetrant Testing
- Magnetic Particle Testing
- Ultrasonic Testing
- Radiography Testing
- Eddy Current Inspection
- Advanced NDT

METHODOLGY

To Locate DEFECTS:

- Selection of the correct NDT testing method to detect the presents of a structural problems
- Determine what type of DEFECT that may be present
- Interpretation of the Test response from the selected NDT testing method
- Evaluation of the test data and comparing this to acceptance criteria.

WHY?



Regulations/Laws
To ensure public safety
Statutory requirements
Fitness for service

The Ten Commandments, an early example of regulations.
•The rules governing inspection are cradle to grave.
•Construction standards new equipment
Inspection standards for in-service equipment
•You must service them, like your car.
•That is you Inspect, Maintain & Repair them.

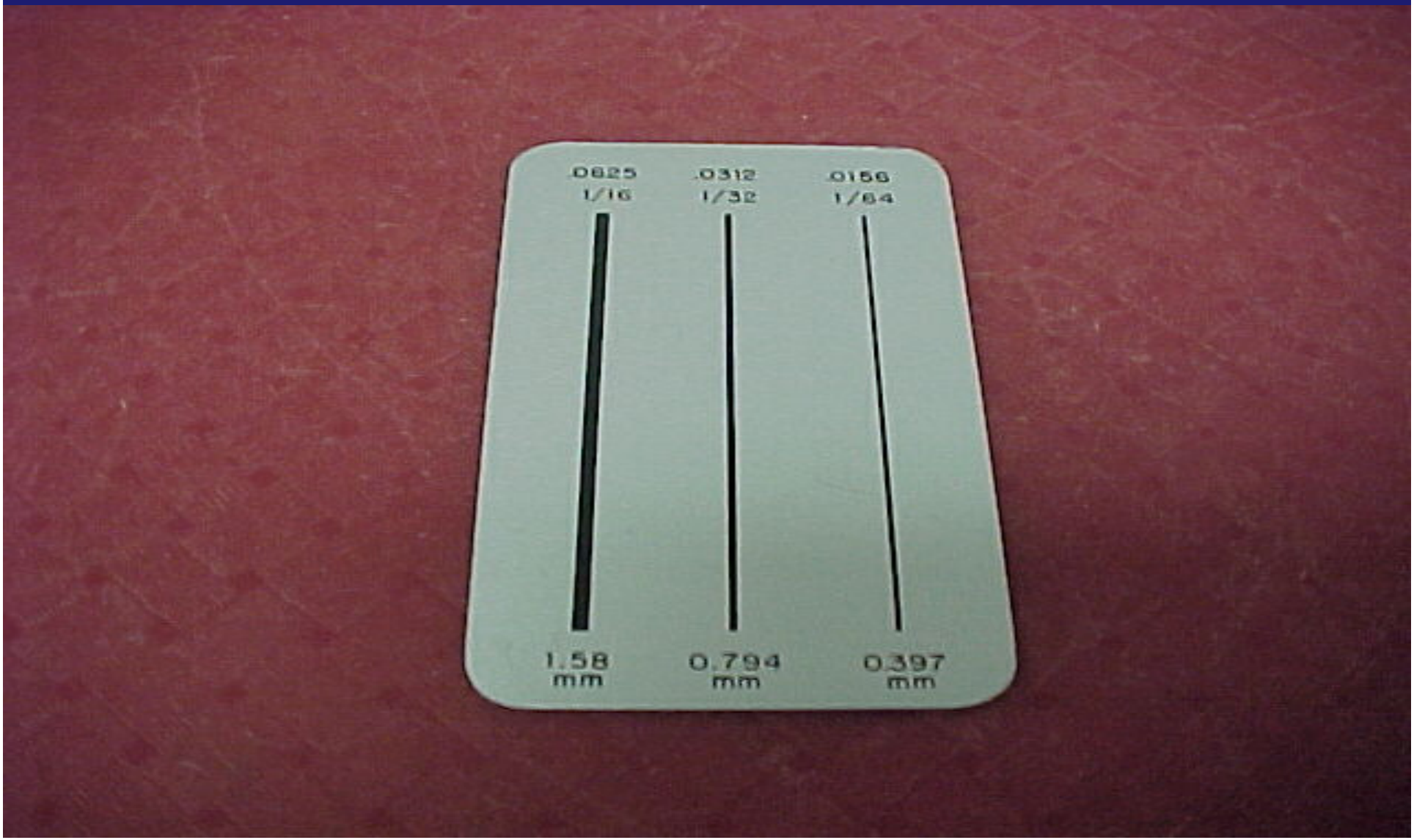
VISUAL TESTING

VT

ILLUMINATION

- **<u>FOOTCANDLE</u>**
- AMOUNT OF LIGHT GIVEN OFF BY A CANDLE AT A DISTANCE OF ONE FOOT FROM THE EYE

RESOLUTION TEST



SIX ELEMENTS OF VT

- Examiner
- Test Object
- Illumination
- Optical Aids
- Mechanical Aids
- Recording Methods

MECHANICAL AIDS

- STEEL RULES
- VERNIER CALIPERS
- DIAL INDICATOR CALIPERS
- MICROMETERS
- DIAL INDICATORS
- COMBINATION SQUARES
- THREAD PITCH, THICKNESS GAGES
- WELD GAGES

OPTICAL AIDS

- MIRRORS
- MAGNIFIERS
- BOROSCOPES
- FIBERSCOPES
- VIDEOSCOPES

VIDEO BORESCOPE

VALVE EXAMINATION

RECORDING METHODS

- Hard Copy
  - photograph(film)
  - videotape
  - digital photograph
- Subjective - depends on examiner's:
  - memory
  - visual acuity
  - competence

VISUAL ELEMENTS

- Testing Procedure
- Techniques
  - Direct Visual
  - Remote visual
  - Translucent visual
- Evaluation
- Documentation

ADVANTAGES OF VT

- Simplicity
- Speed
- Low cost
- Training
- Equipment can be simple

DISADVANTAGES OF VT

- Only surface
- Resolution limitations of the eye
- Fatigue
- Distractions
- Some equipment is expensive

First documented Visual Inspection

…and He saw that it was good

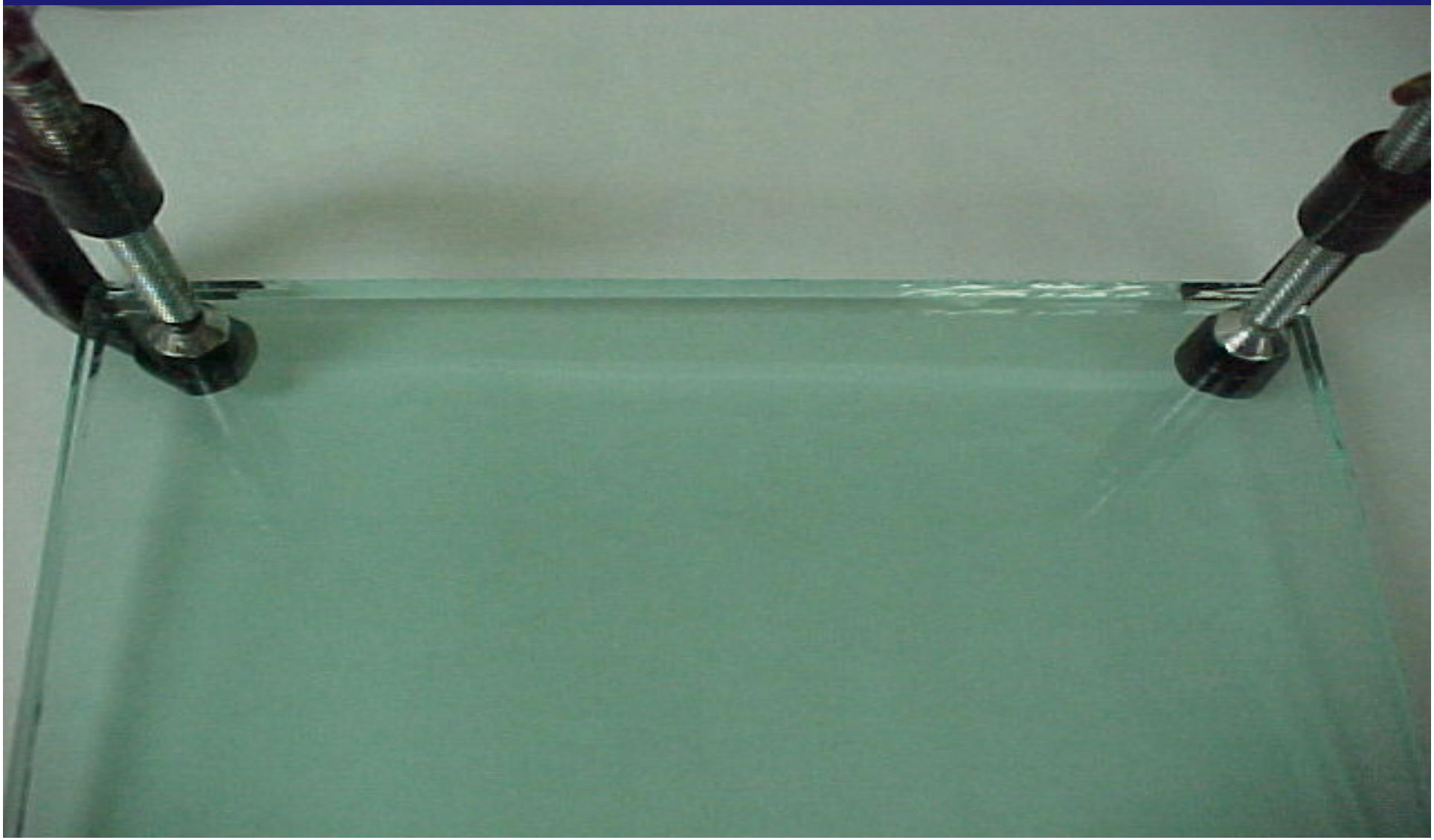
LIQUID PENETRANT TESTING

PT

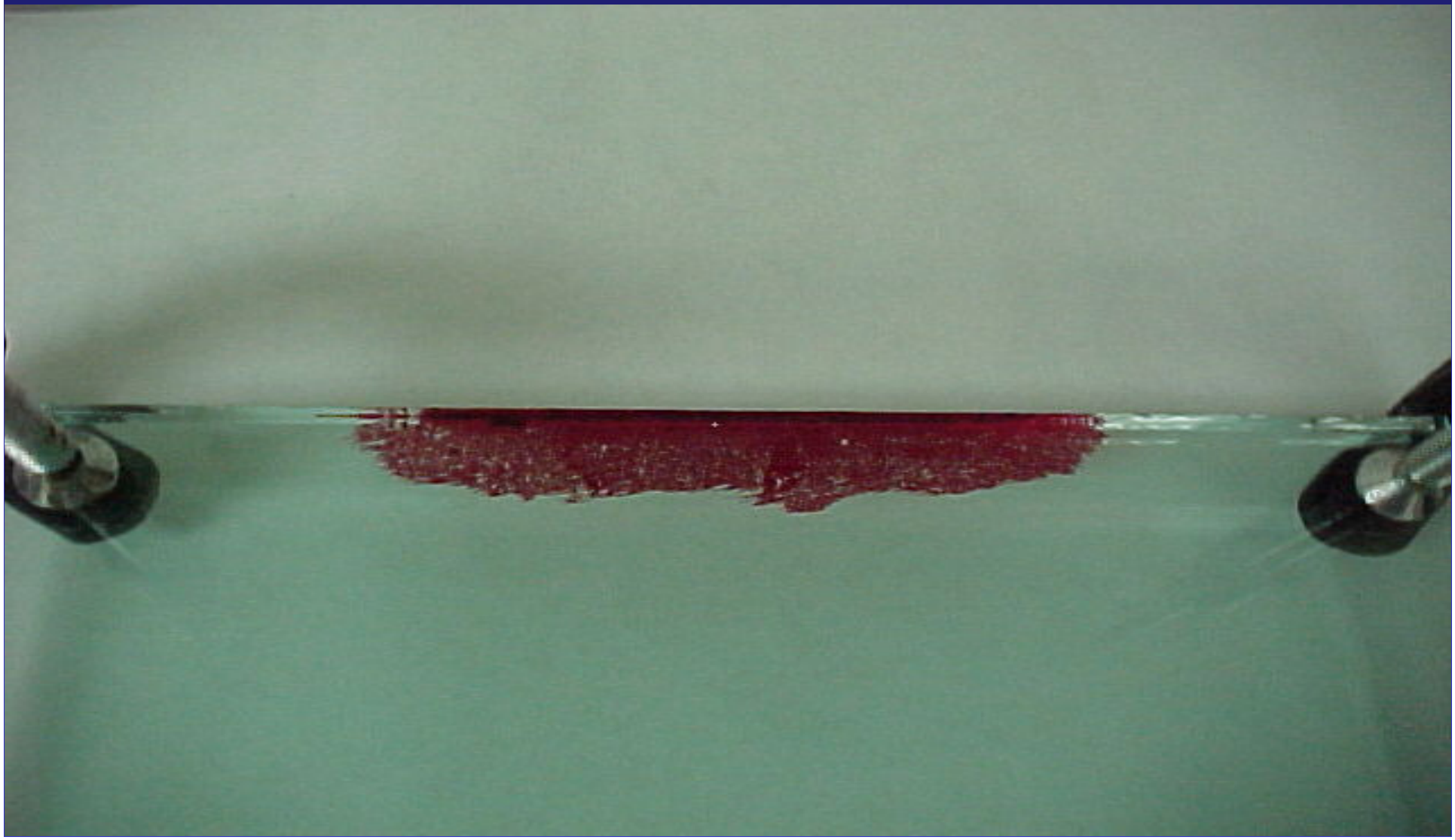
BASIC PRINCIPLES HOW DOES IT WORK

- Capillary Action
  - Wetting Characteristics (contact angle)
  - Dye Concentrate
  - Viscosity
  - Contrast Ratio

TWO PIECES OF GLASS



CAPILLARY ACTION



DISCONTINUITIES

- Must be open to the surface
- Penetrant must have good wetability
- Contact angle must be as low as possible
  in order to increase probability of detetction
- Test material surface tension may prevent detection of surface breaking discontinuities

PT PRINCIPLES (CON'T.)

- **Dye is applied to the surface**
- **Excess penetrant is removed**

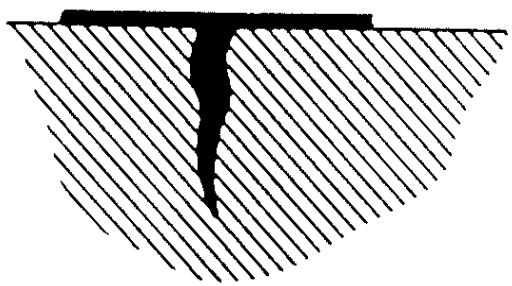


Fig 6

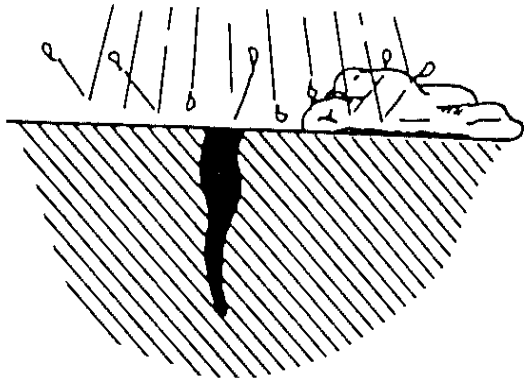
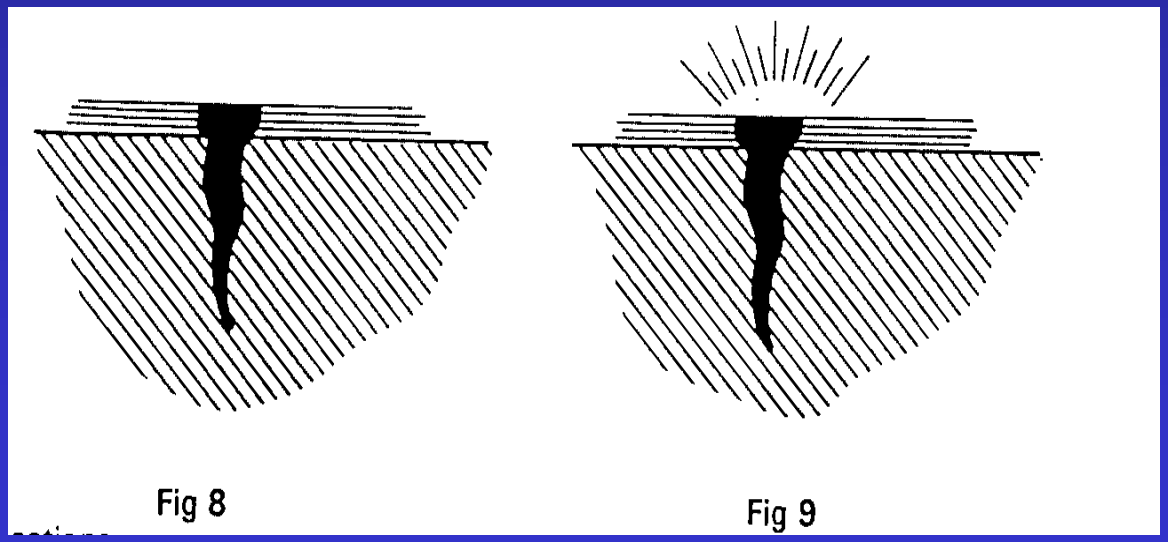


Fig 7

PT PRINCIPLES (CON'T.)

- **Developer is applied**
- **Indication is observed**

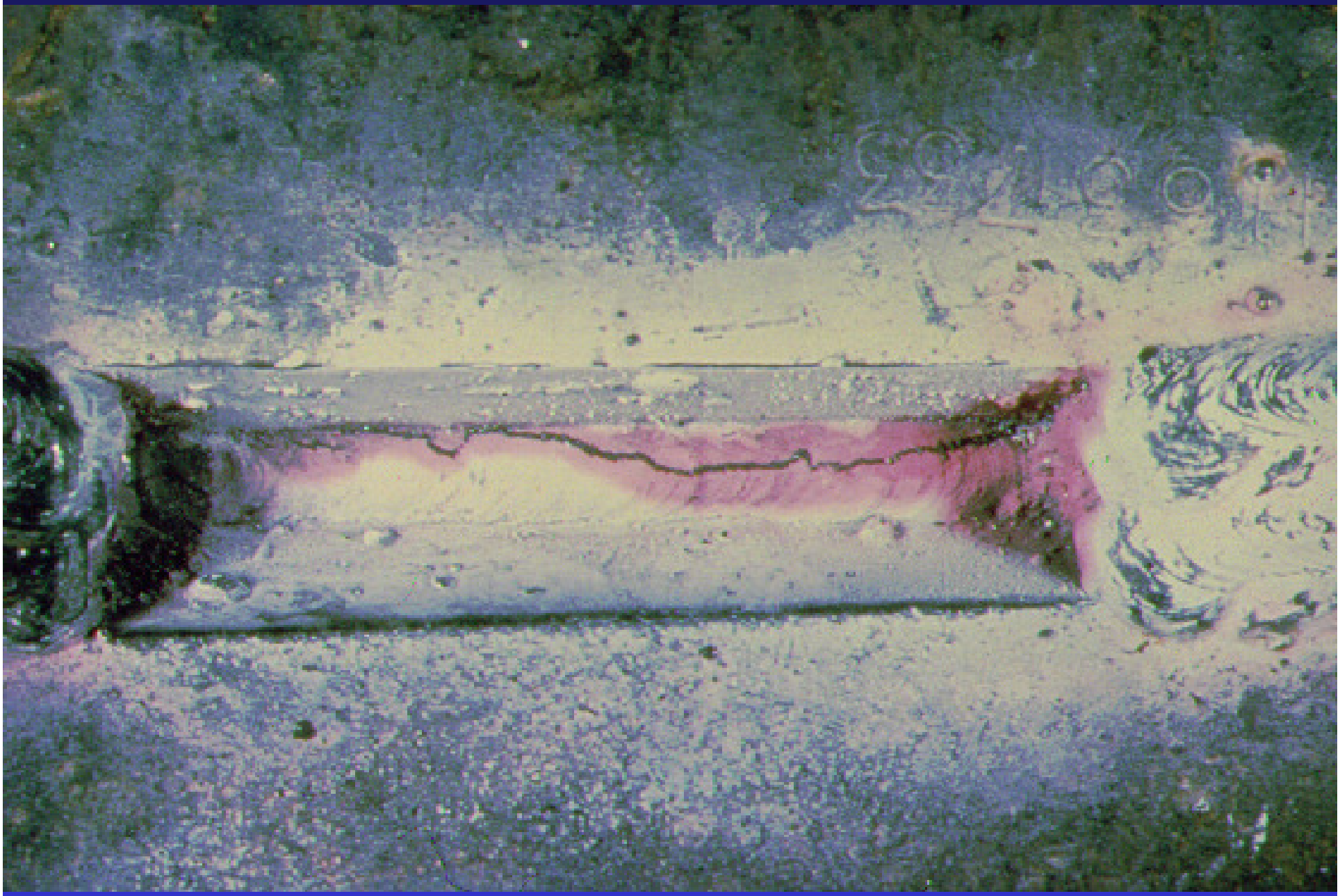


VISIBLE (COLOR CONTRAST)

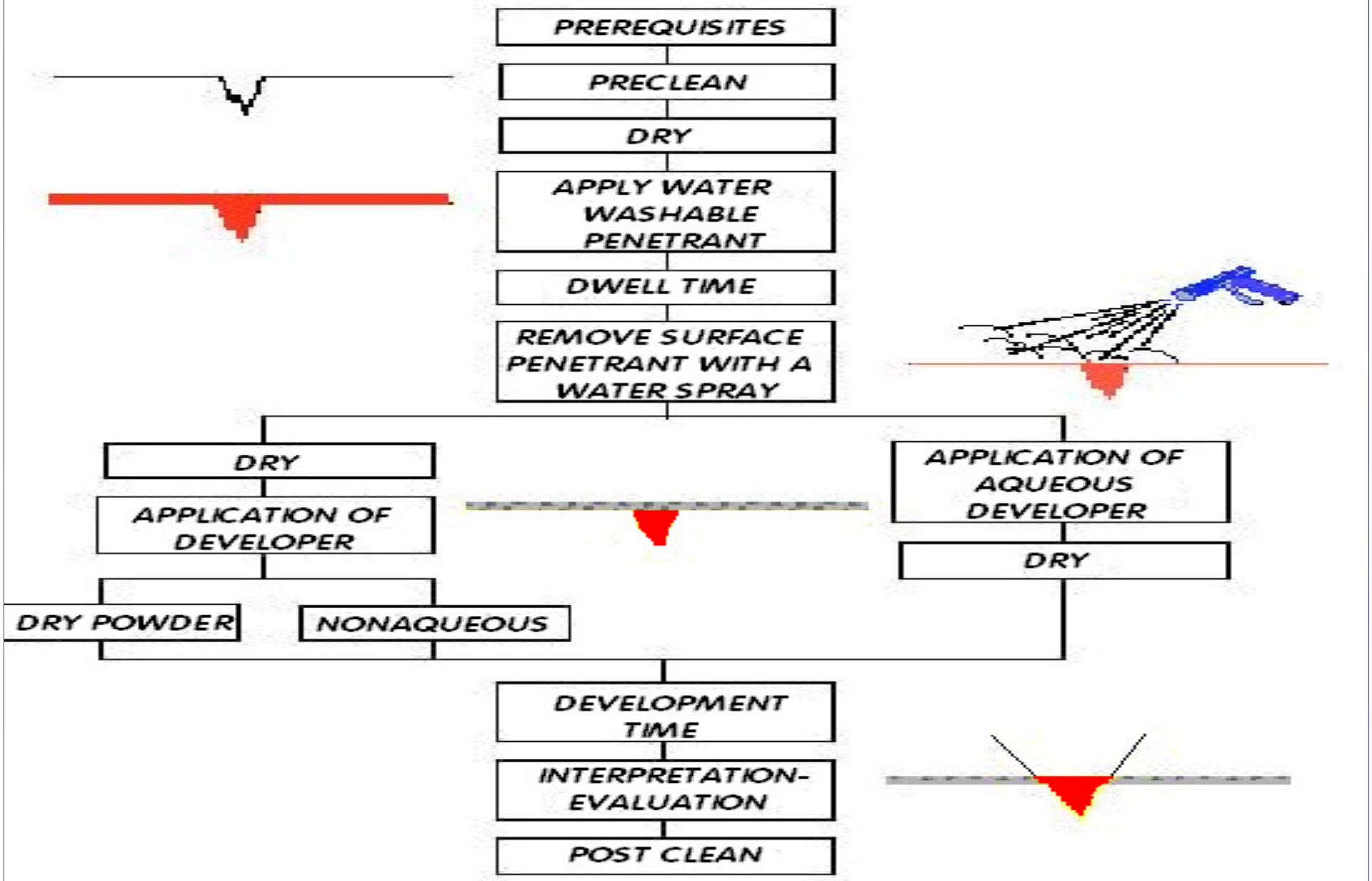
SOLVENT REMOVABLE

PENETRANT KIT

BLEED OUT INDICATION

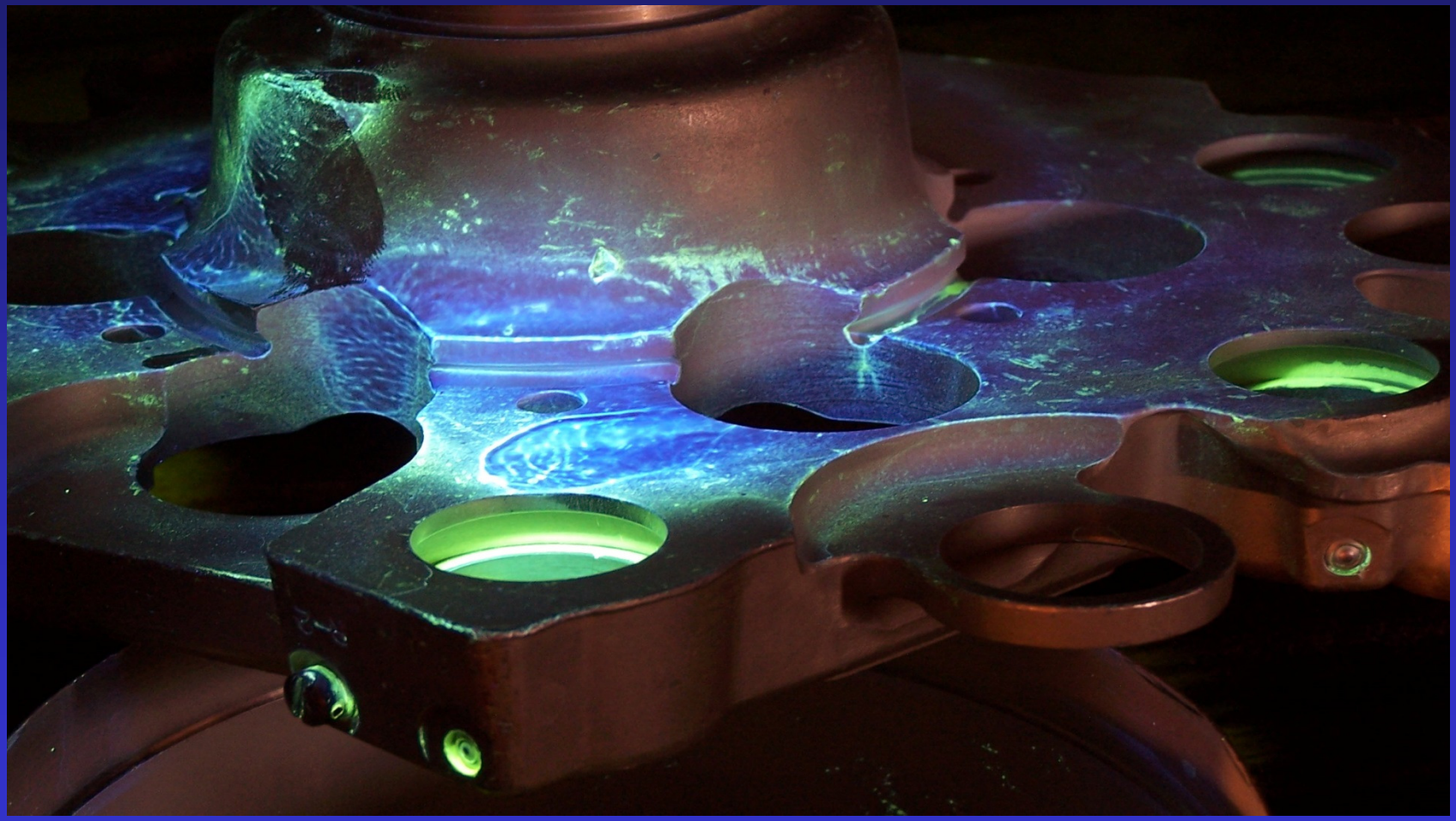


WATER WASHABLE - METHOD A, TYPE I or II



WHEEL BRAKE ASSEMBLY

BLACK LIGHT INSPECTION



ADVANTAGES OF PT

- Materials are inexpensive
- Sensitive
- Versatile
- Almost any size or shape
- Easy to use
- Nondestructive

LIMITATIONS OF PT

- Only discontinuities open to the surface
- Time consuming
- Temperature
- Rough surface considerations
- Ventilation needed
- No permanent record
- Messy

MAGNETIC PARTICLE TESTING

MT

BASIC MAGNETISM PRINCIPLES

HOW DOES IT WORK

MAGNETIC PARTICLE PROPERTIES

- Permeability
- Retentivity
- Reluctance

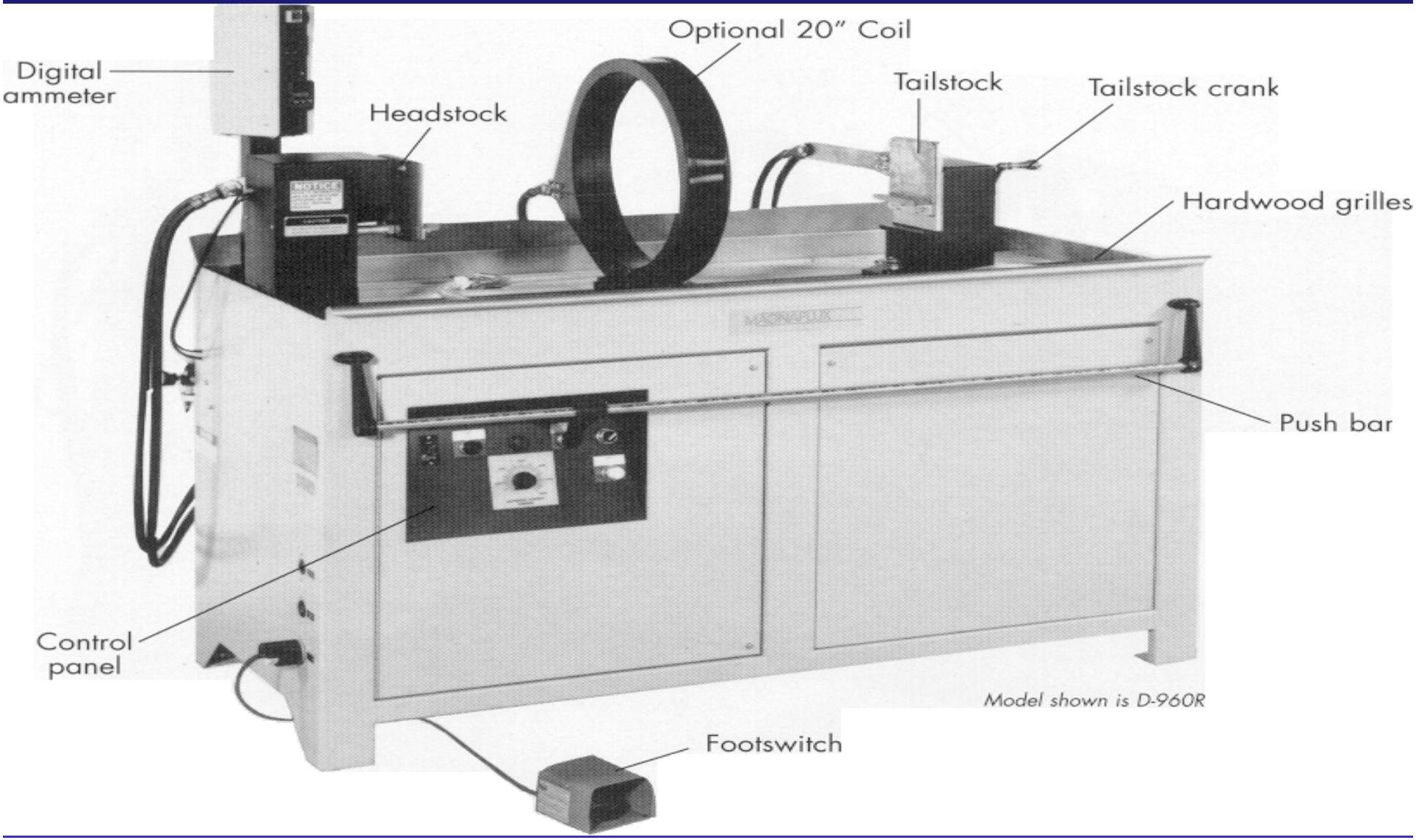
MATERIAL CLASSIFICATION

- **Diamagnetic** - Bismuth, phosphorous, antimony, flint glass, mercury
- **Paramagnetic -** Platinum
- **Ferromagnetic -** Iron, nickel, cobalt, steel, etc.

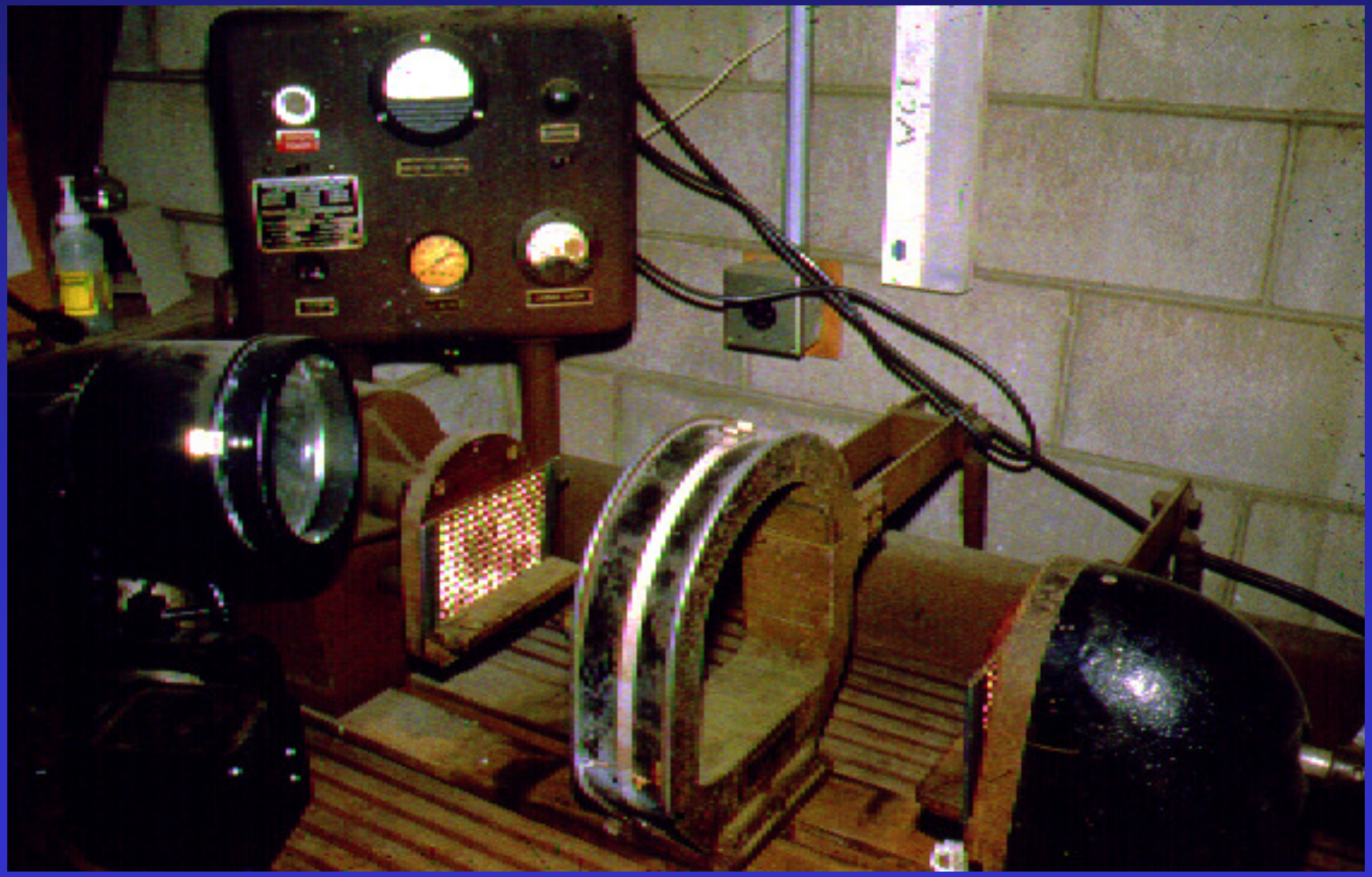
MT EQUIPMENT

- Stationary
  - Wet horizontal
- Portable
  - Permanent magnets
  - Yokes
  - Prods
  - Contact clamps

HORIZONTAL WET BENCH

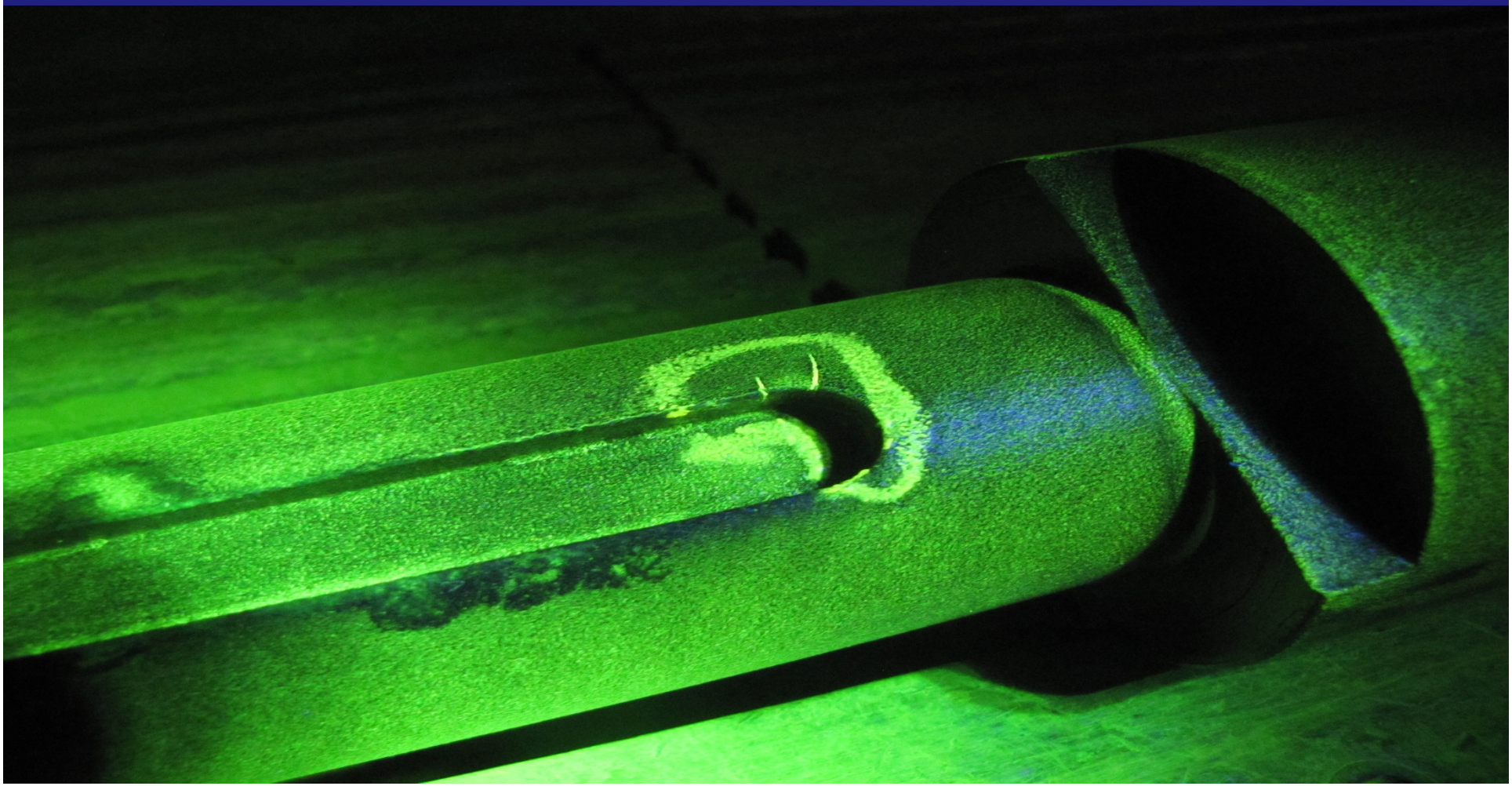


WET BENCH

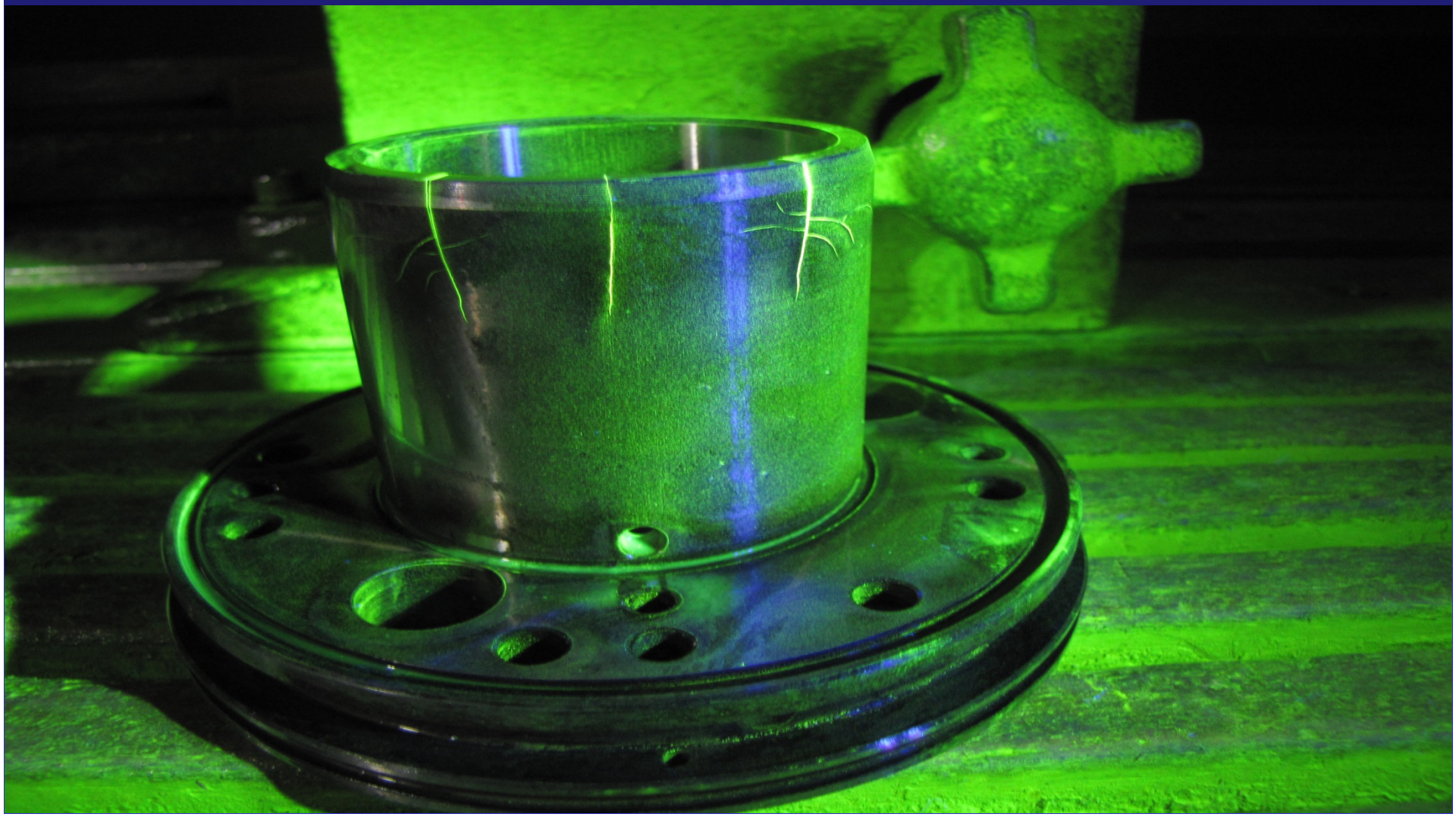


COIL SHOT
Circumferential Defects

Coil Shot
Circumferential Defects

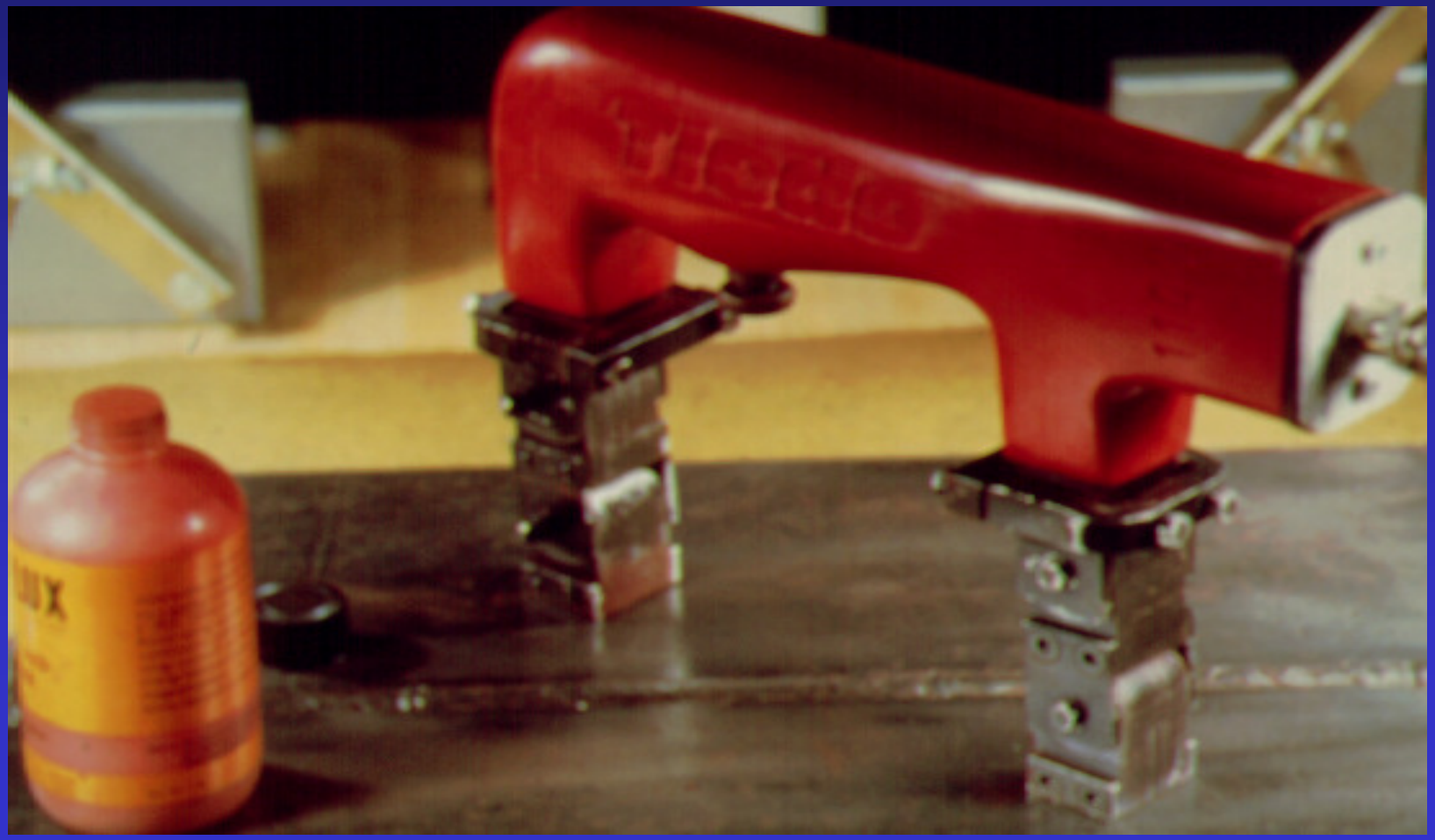


Head Shot
Longitudinal Defects



Head Shot
Longitudinal Defects

YOKE METHOD

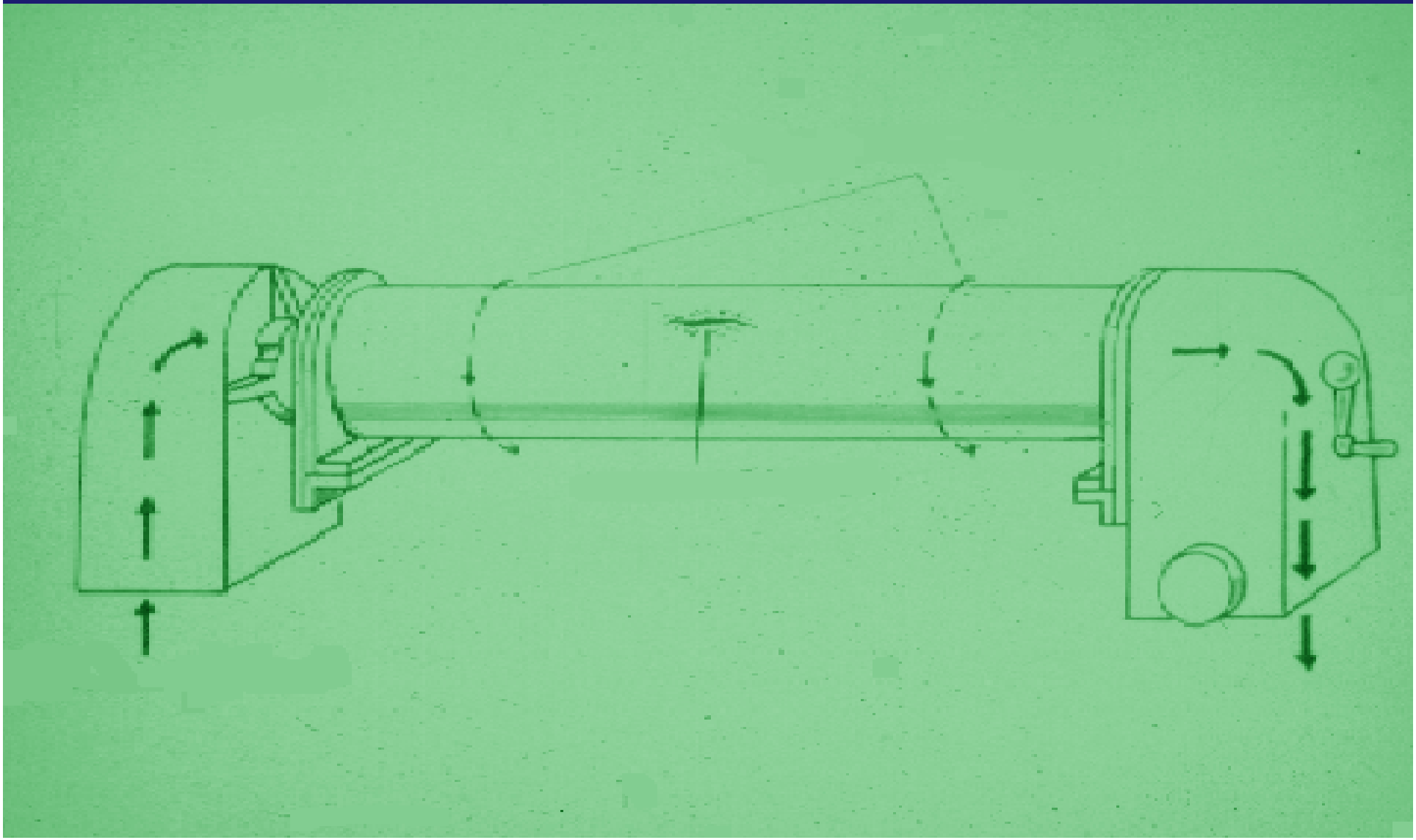


EXAMPLES OF DRY PARTICLES

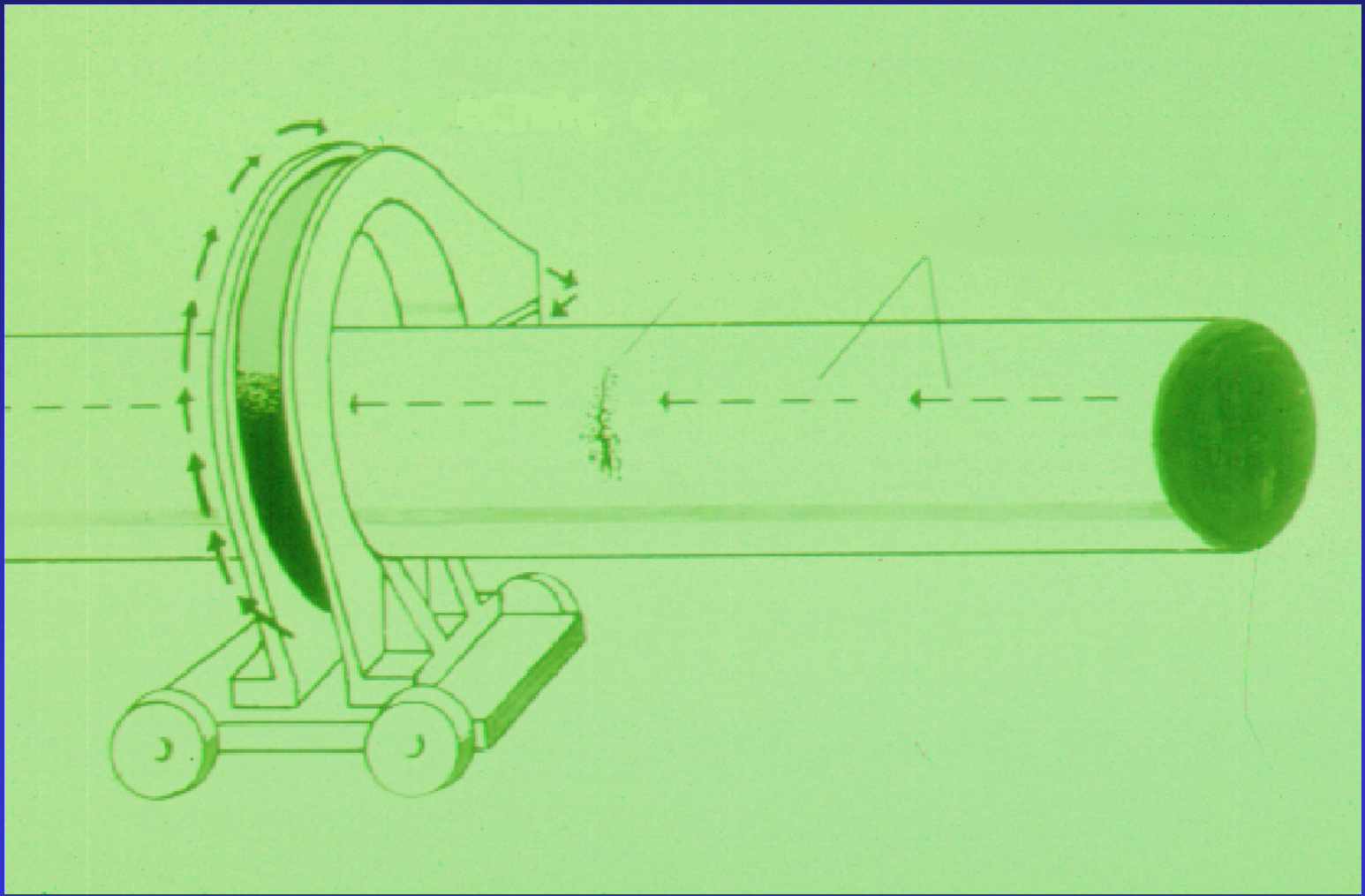
TECHNIQUES

- Circular
  - Direct (head shot)
  - Indirect (central conductor)
- Longitudinal
  - Coil
  - Cable wrap

CIRCULAR MAGNETIZATION



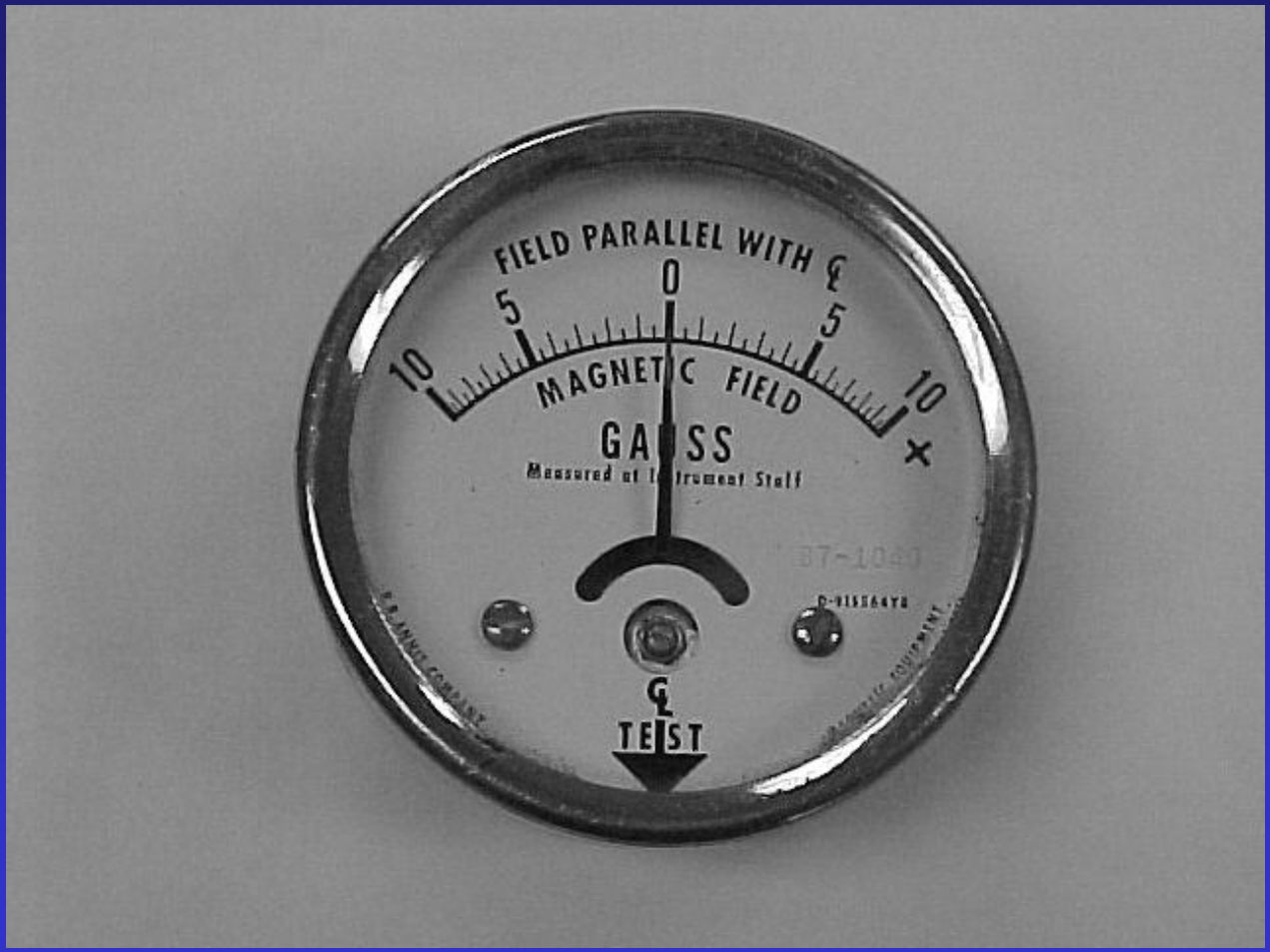
LONGITUDINAL MAGNETIZATION



DEMAGNETIZATION

- Alternating current
- Direct current
- Heating
- Impact

GAUSS STRENGHT METER



ADVANTAGES OF MT

- Surface and near surface discontinuities
- Better surface prep = Better Exam
- Thin coatings possible
- Quick, simple and relatively inexpensive
- Can be automated or portable
- Direct indications
- Post-test cleaning minimal

LIMITATIONS OF MT

- Only ferromagnetic materials
- Decrease in sensitivity under surface
- Electrical contact (some techniques)
- Discontinuity orientation
- High current (possibility of arc strikes)
- Demagnetization usually required

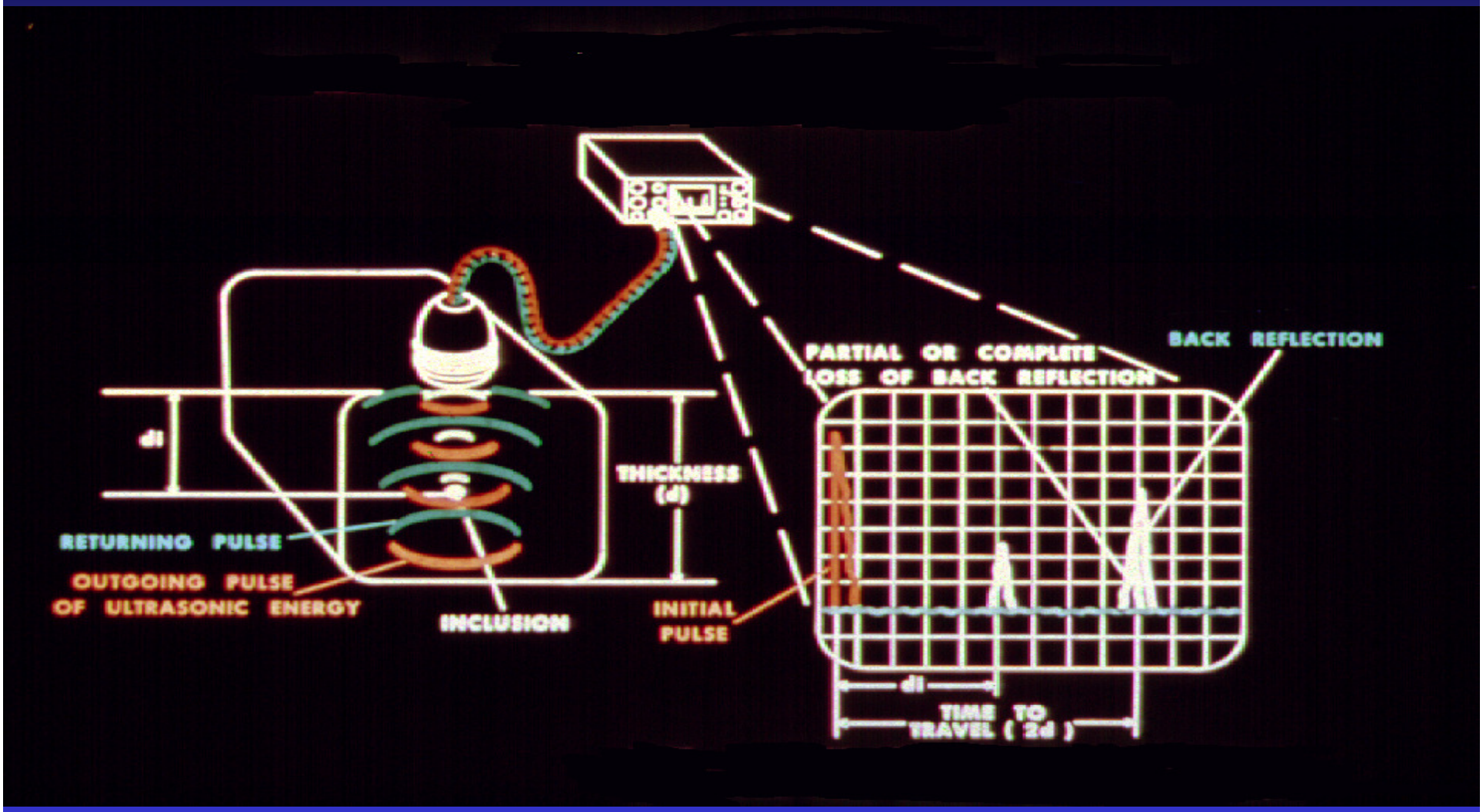
ULTRASONIC TESTING

UT

Introduction

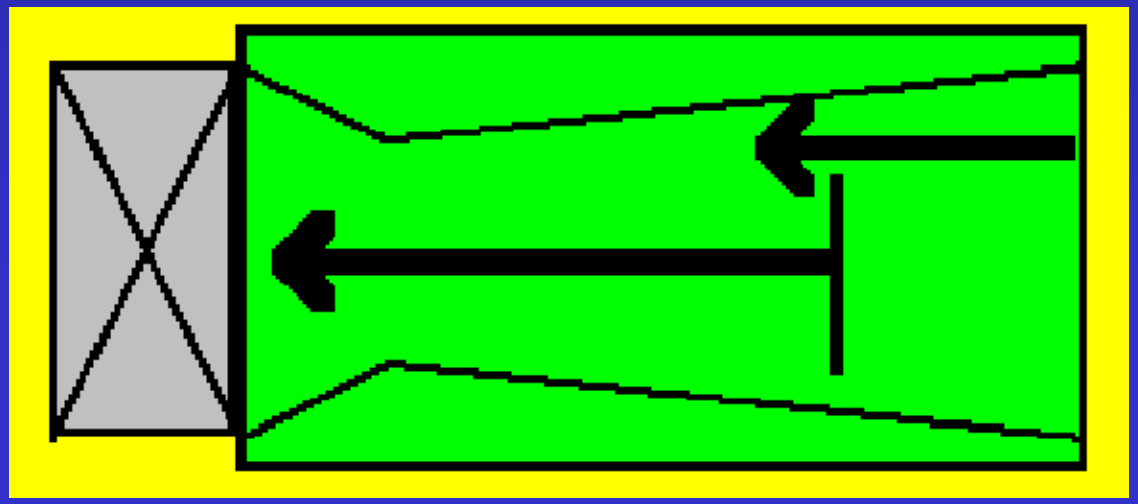
- Ultrasonic Testing
  - introduces high frequency sound waves into a test object
    - to obtain information about that object

HOW DOES IT WORK



Basic Test Technique
Pulse-echo

- Test object information provided by reflected sound energy
- Individual echo signal for each reflector perpendicular to beam axis



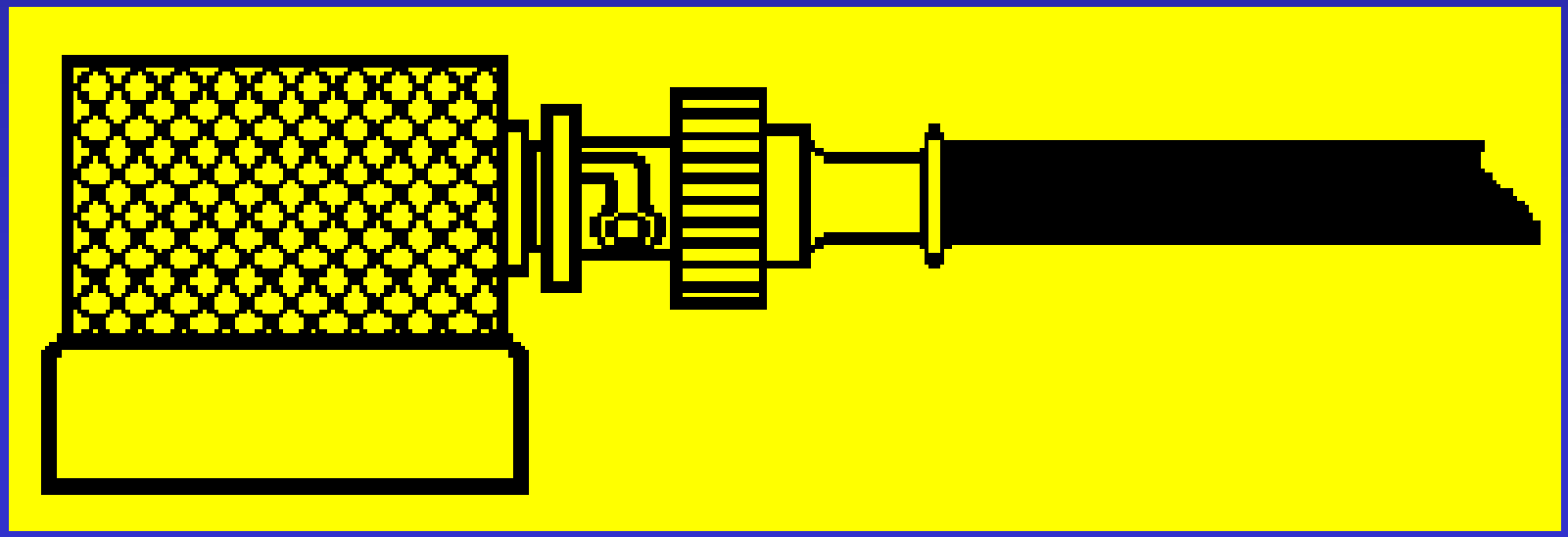
Introduction

- Primary Applications
  - Thickness measurement
  - Flaw detection

Types of Transducers

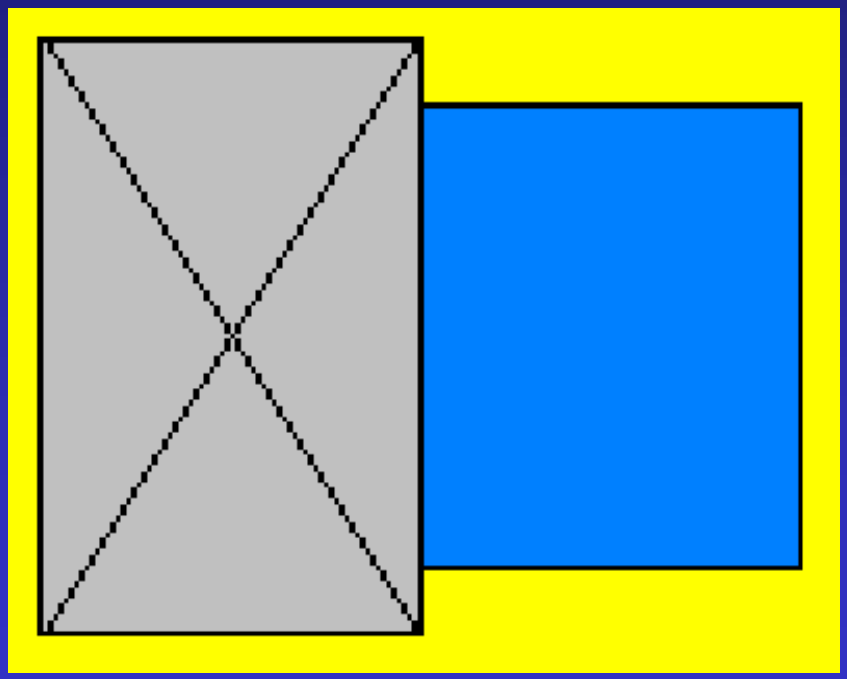
Types of Transducers

- <u>Straight Beam, Contact</u>: introduces sound perpendicular to the test surface to obtain echoes from reflectors parallel to the test surface



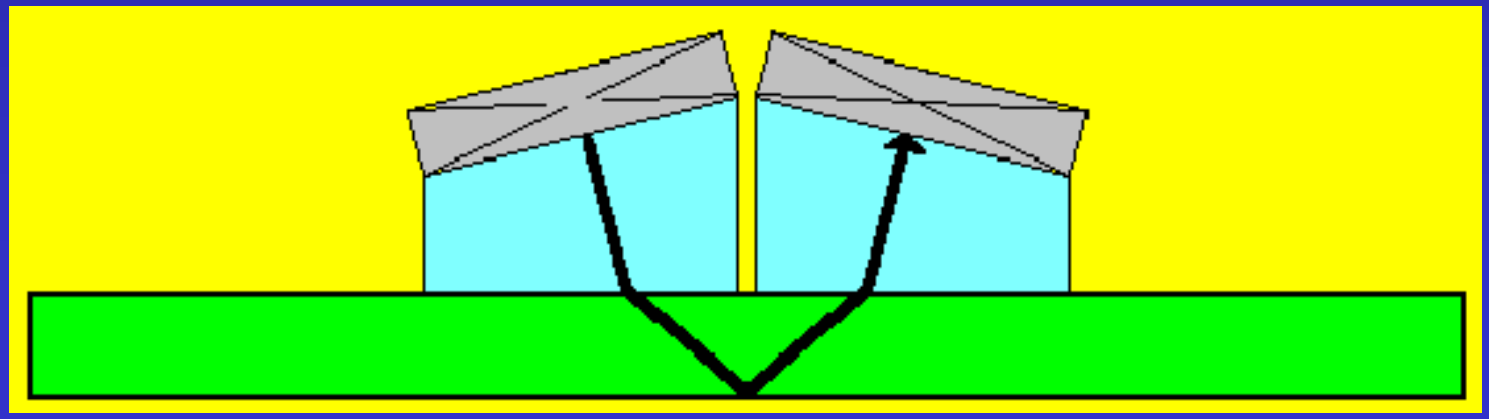
Types of Transducers

- Delay Line: high resolution near surface flaw detection, plus thickness gauging on thin materials with smooth back surface



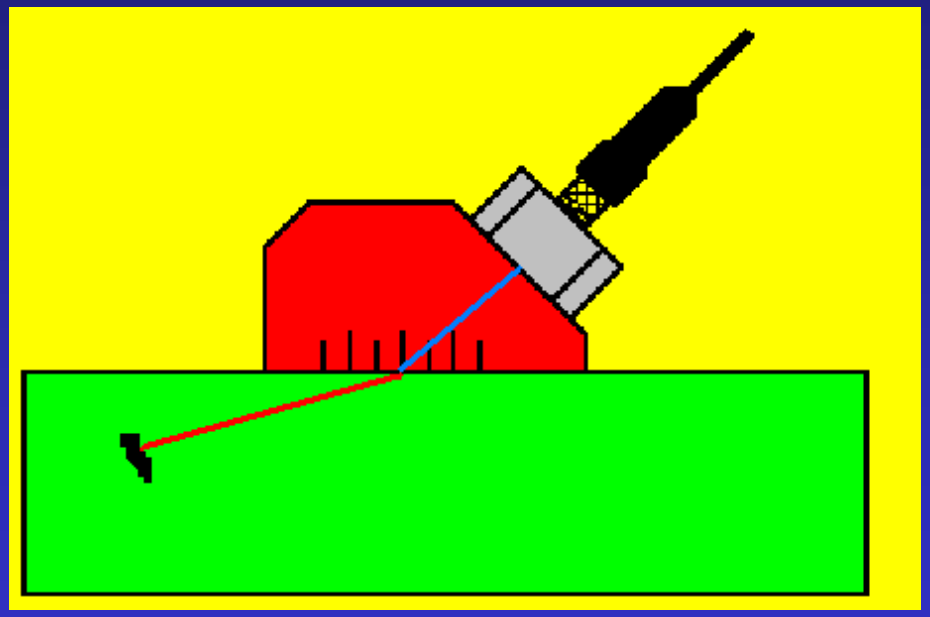
Types of Transducers

- Dual Element: for testing materials thinner than approximately .5" - 1"
  - especially thickness gauging of materials with corroded/eroded back surface

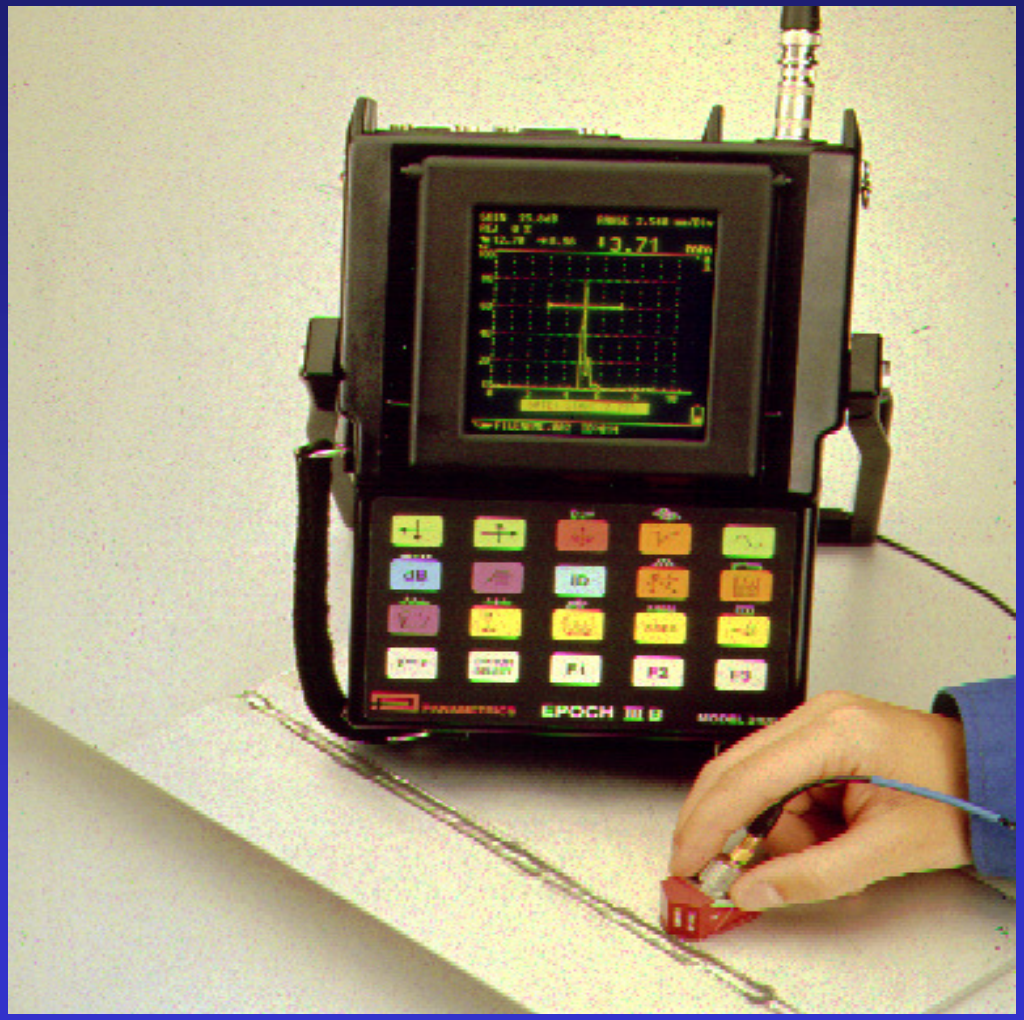


Types of Transducers

- Angle Beam: introduces sound at an angle to the test surface to obtain echoes from reflectors obliquely oriented to the test surface



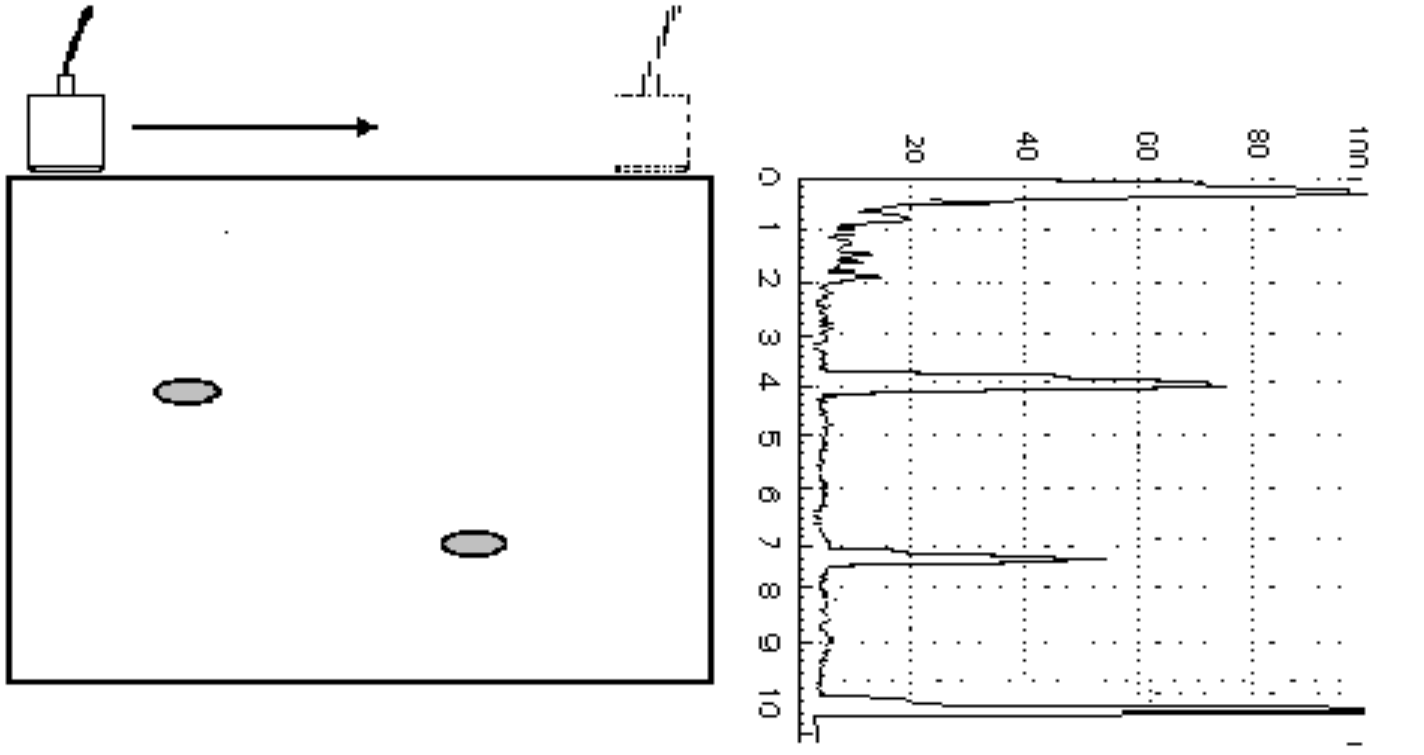
WELD INSPECTION (IP) INDICATION



DATA DISPLAY

- A-scan
- B-scan
- C-scan

SHOWING DEPTH AND AMPLITUDE



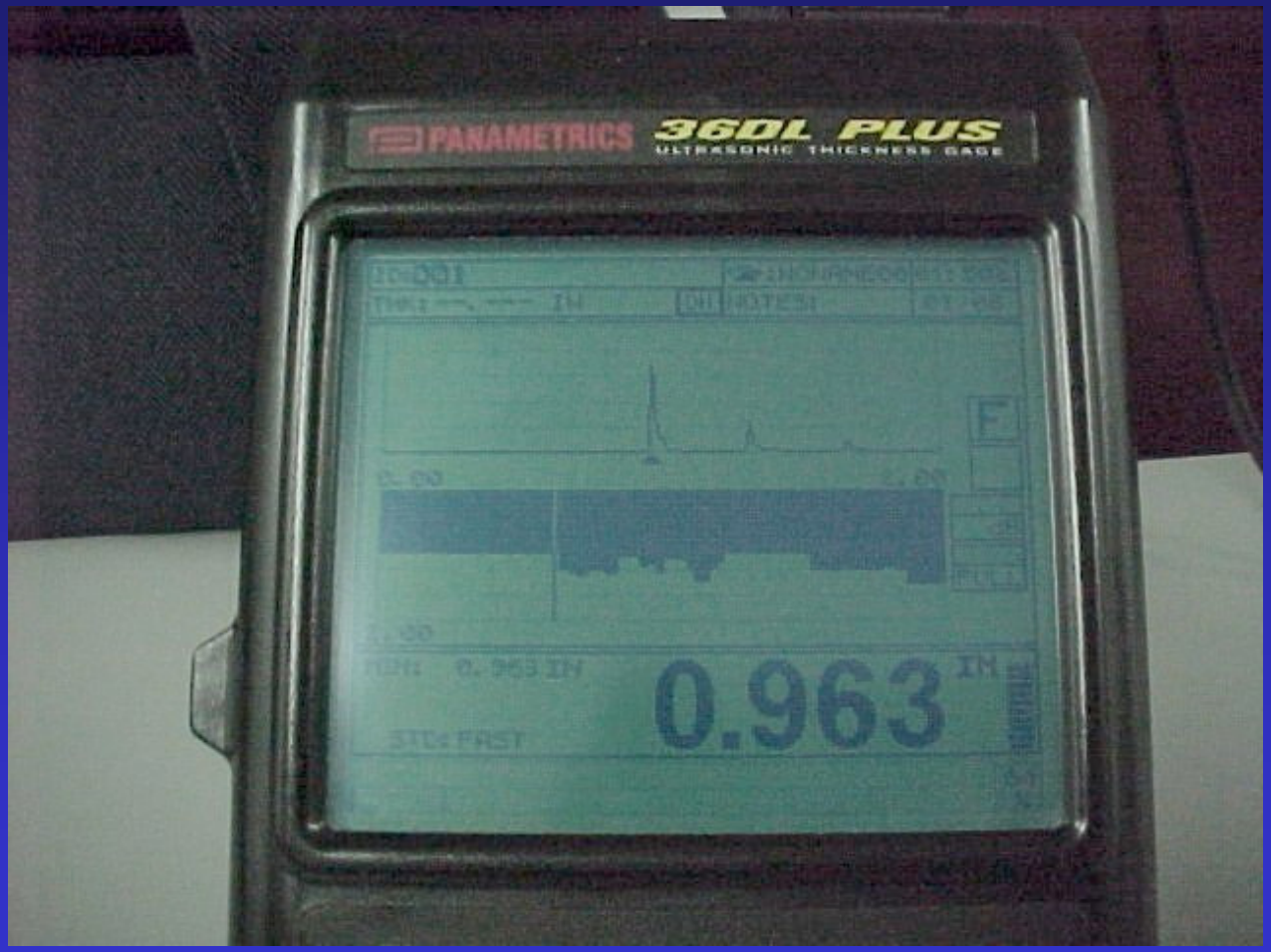
A-SCAN DISPLAY

3 INCH GEOMETRY INDICATION SHOWING GOOD PENETRATION LOW GRAIN NOISE

3/32 INCH SIDE DRILL HOLE REFLECTION CALIBRATION STANDARD

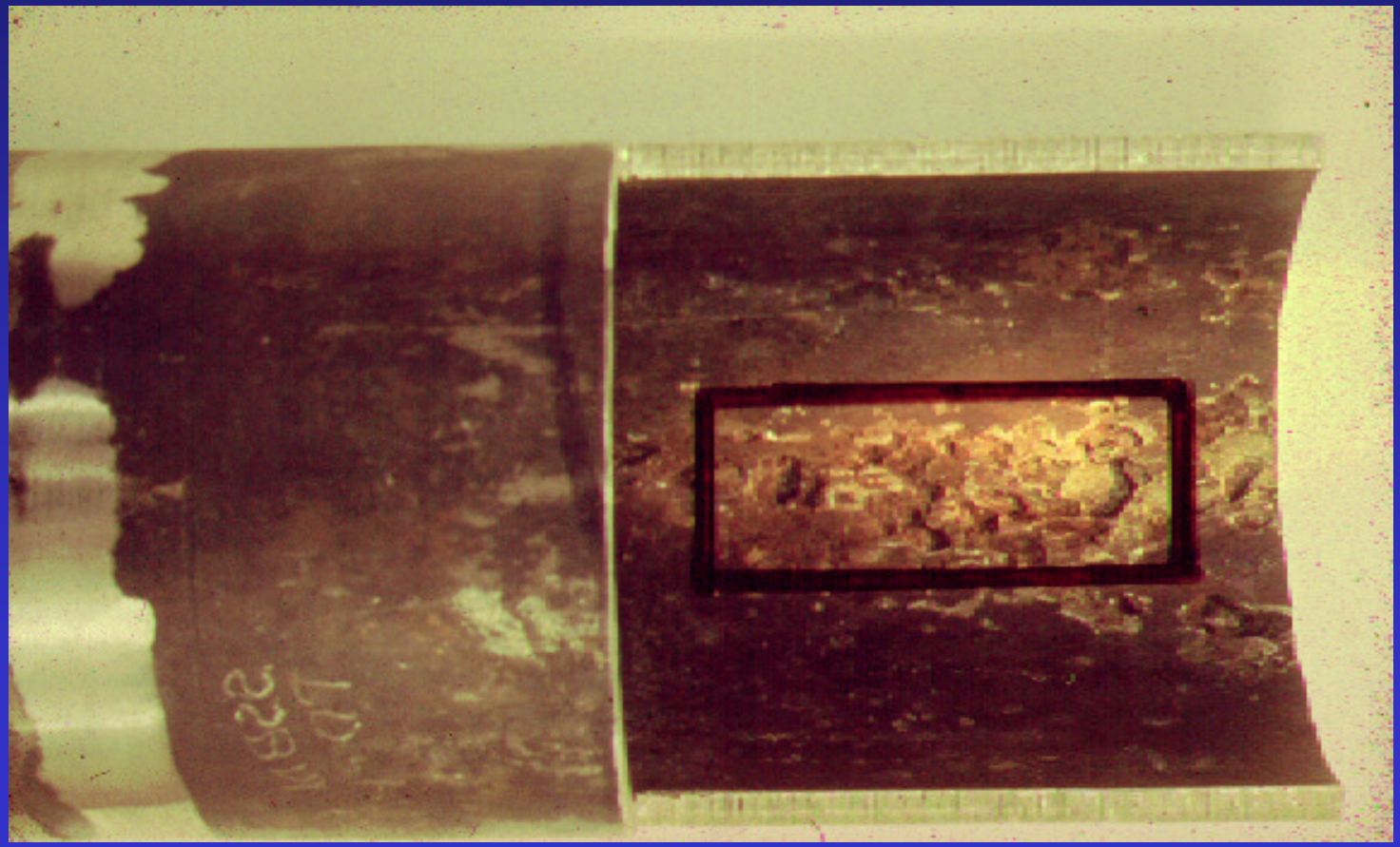
“B” SCAN SHOWING THE CROSS SECTION PART VIEW

CLOSE UP OF THE PREVIOUS SLIDE

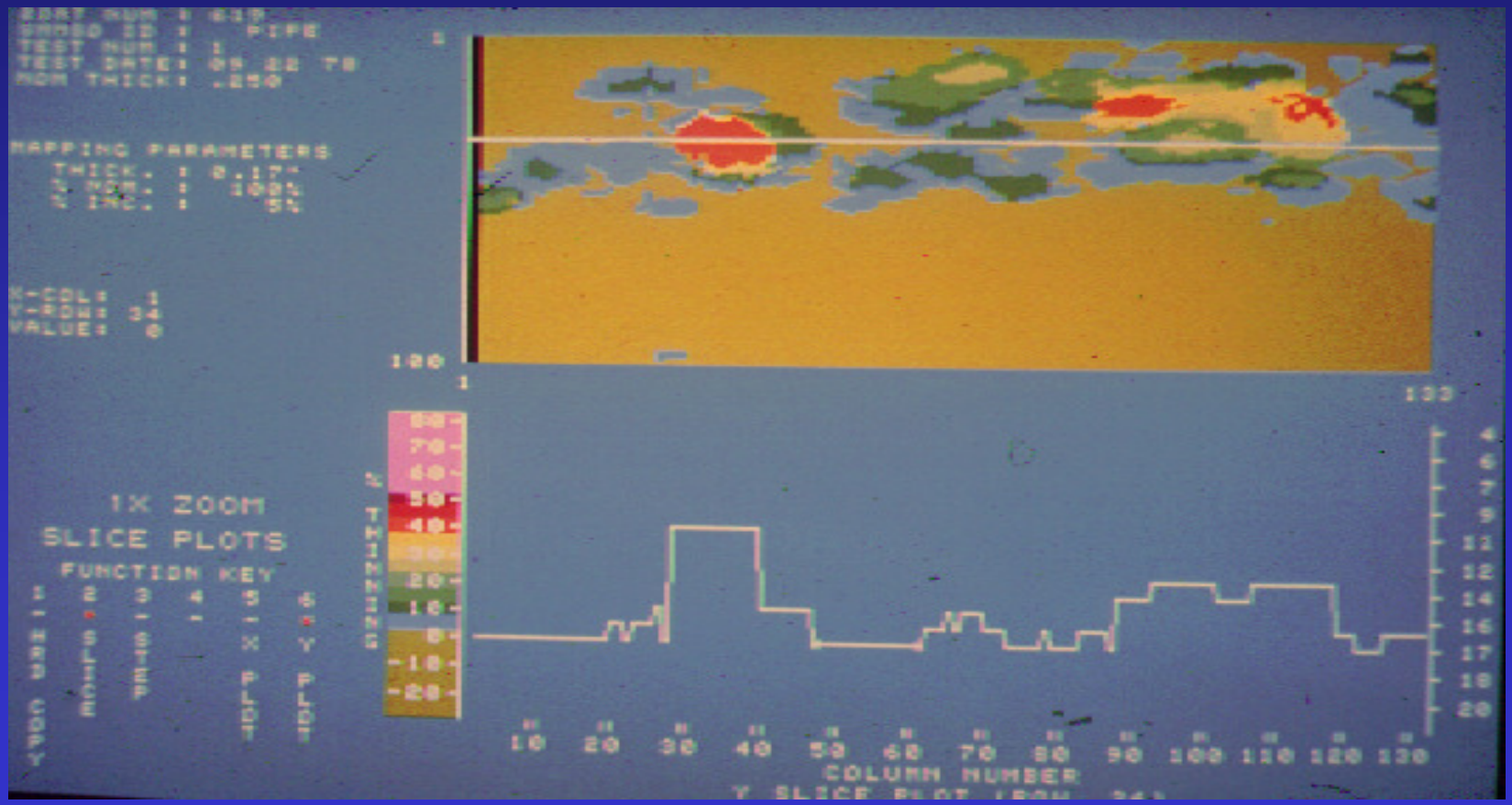


“B” SCAN ON PIPE BACK WALL CORROSION EVALUATION

PIPE “ID” VIEW OF THE BACK CORROSION



"C" SCAN OF THE PIPE "ID" BACK WALL CORROSION



ADVANTAGES OF UT

- GREATER THICKNESSES THAN RT
- PORTABLE
- ONE SIDE ACCESSIBILITY ONLY
- PRECISE THICKNESS AND FLAW DEPTH
- NO RADIATION HAZARD

LIMITATIONS OF UT

- MATERIAL STRUCTURE
- COUPLANT REQUIRED
- HIGHLY QUALIFIED PERSONNEL
- DISCONTINUITY ORIENTATION
- SURFACE CONDITION

RADIOGRAPHIC TESTING

RT

GENERATION OF X-RAYS

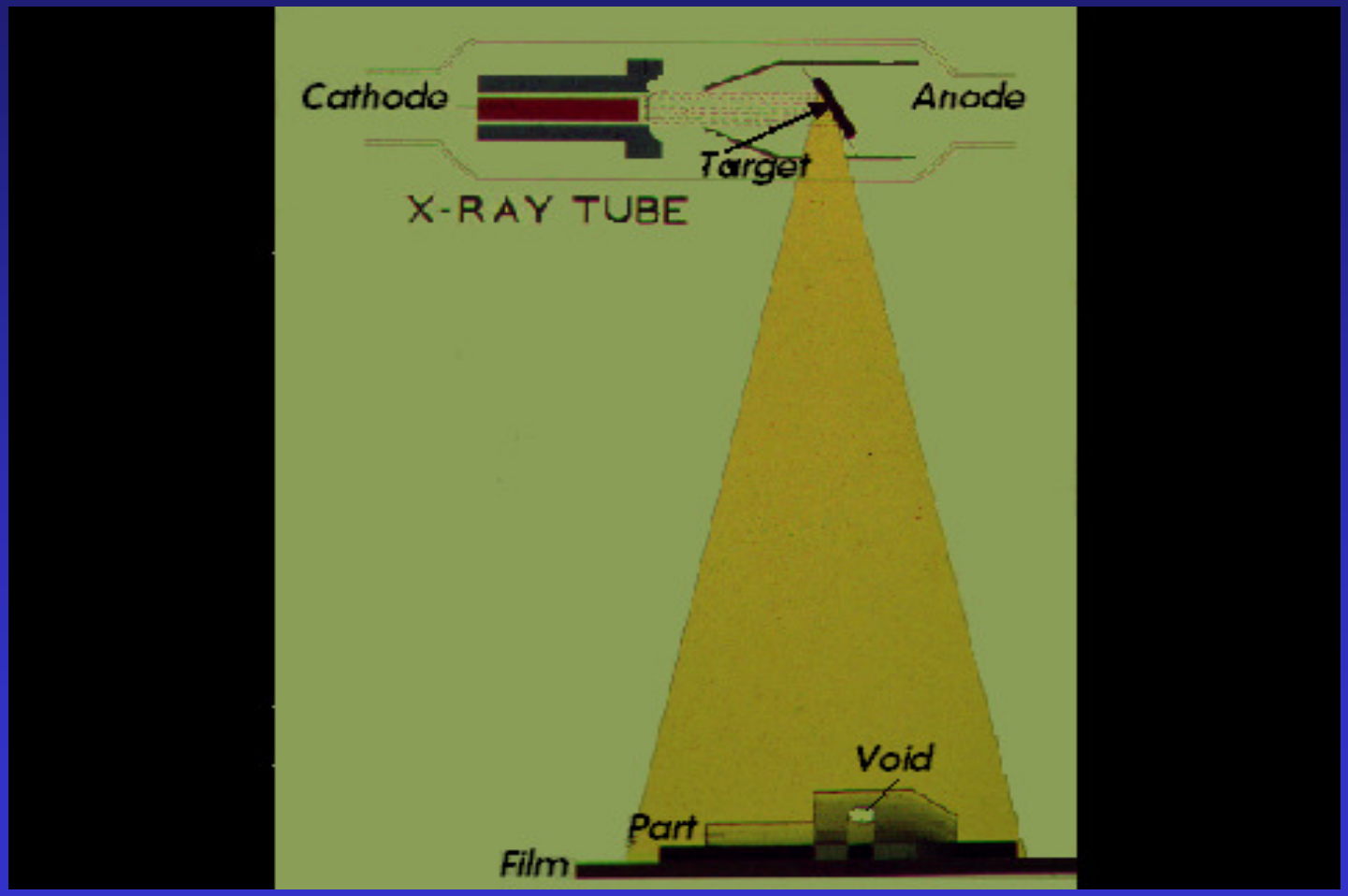
REQUIRED

- A source of electrons
- A means of accelerating the electrons
- A target for the impact of the electrons

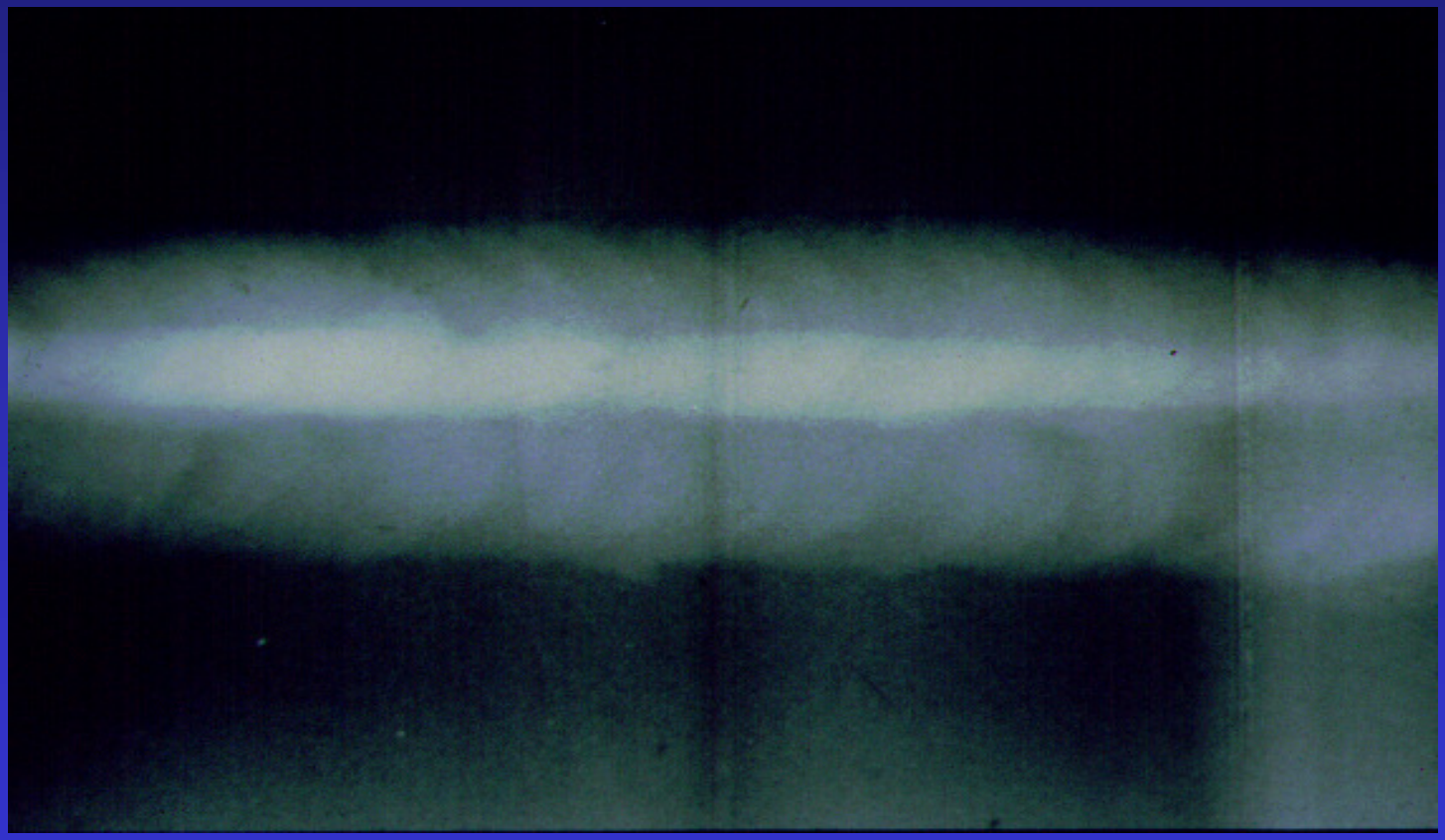
RESULTS IN

- Continuous X-rays “Primary Radiation”
- Characteristic X-rays “SCATTER RADIATION”
- Heat (98%)

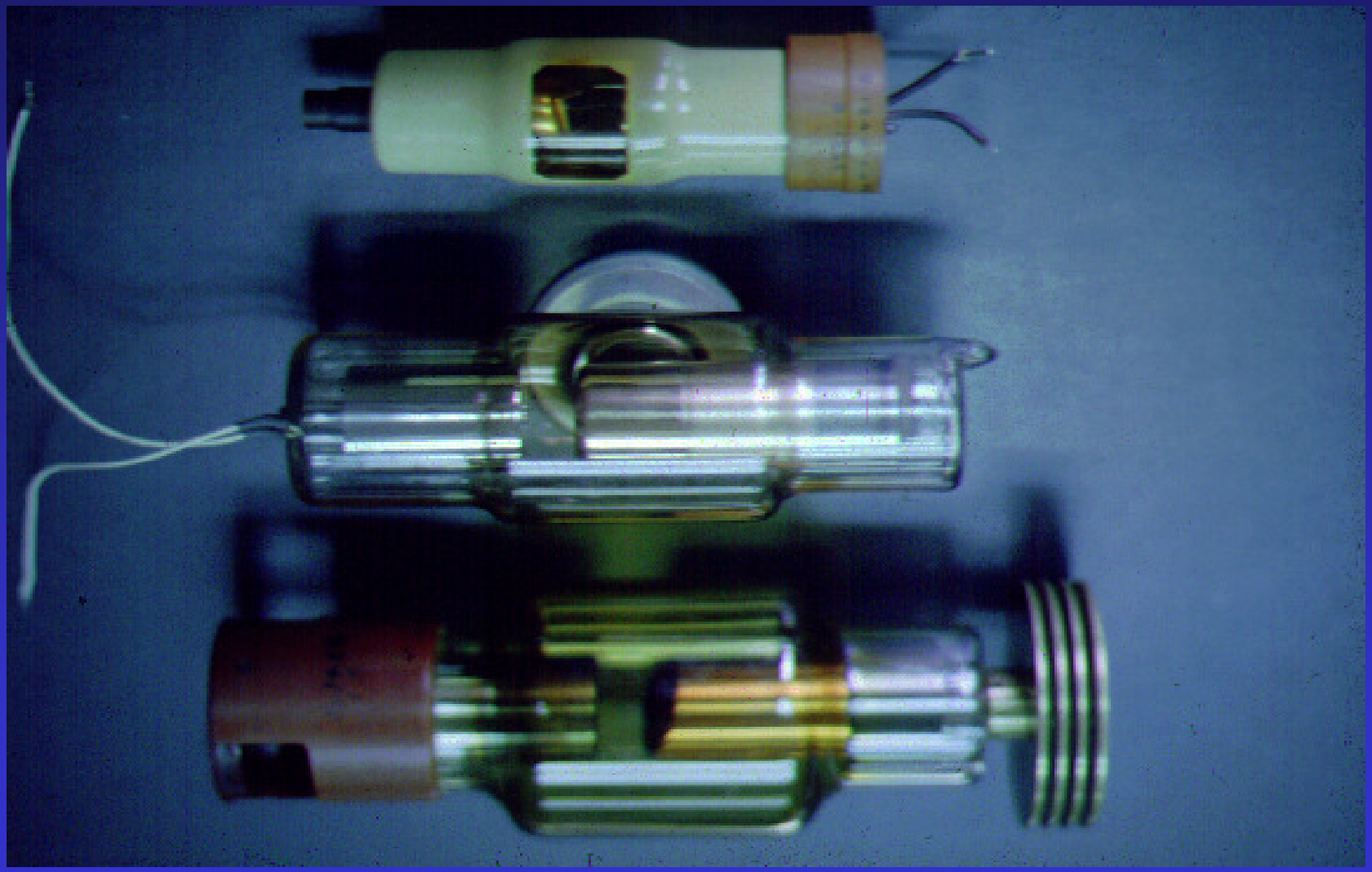
X-RAY SYSTEM



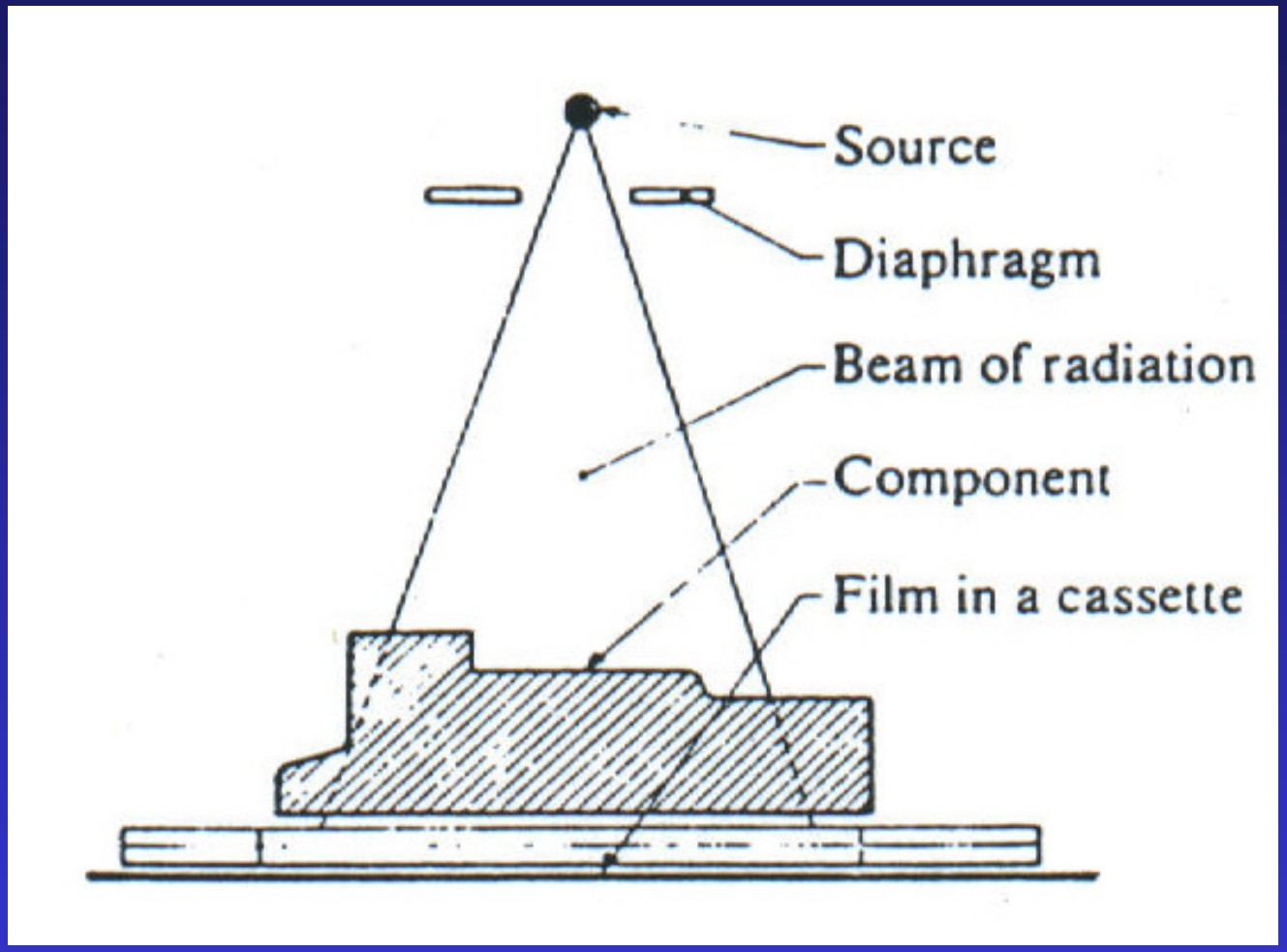
RADIOGRAPH SHOWING NORMAL INDICATION



X-RAY TUBE'S

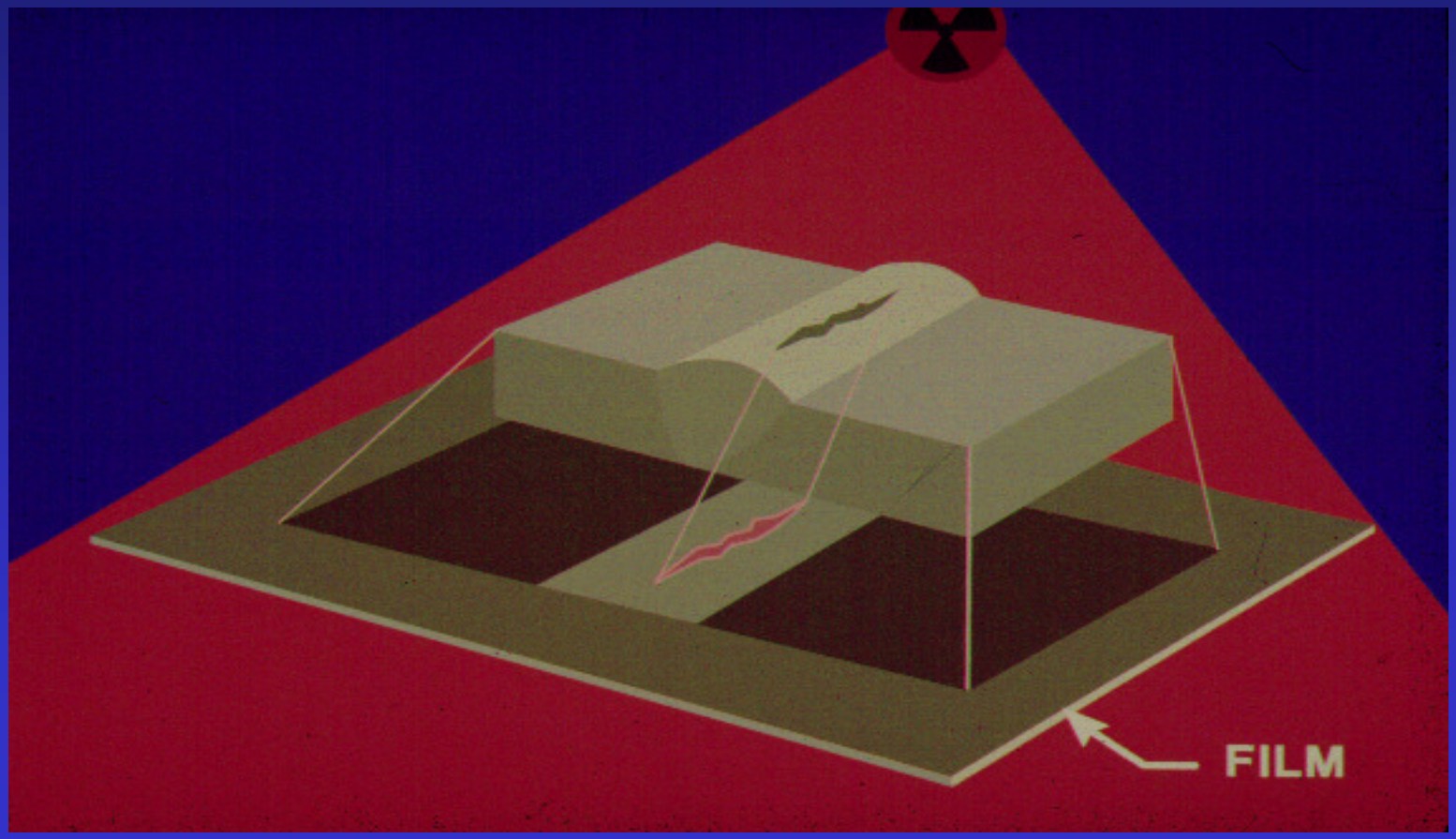


The Radiographic Process

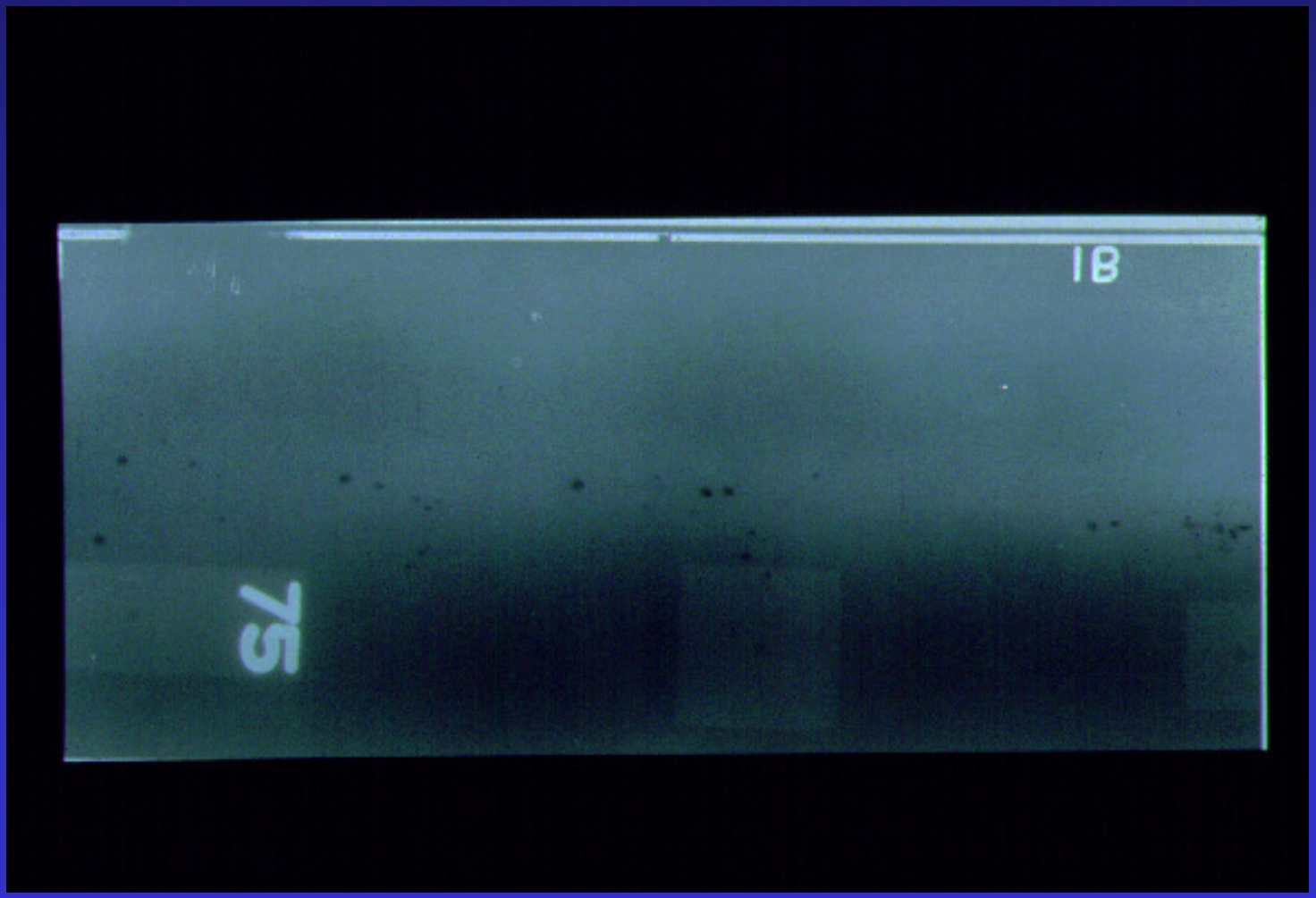


The component is placed between the radiation source and the detection media.

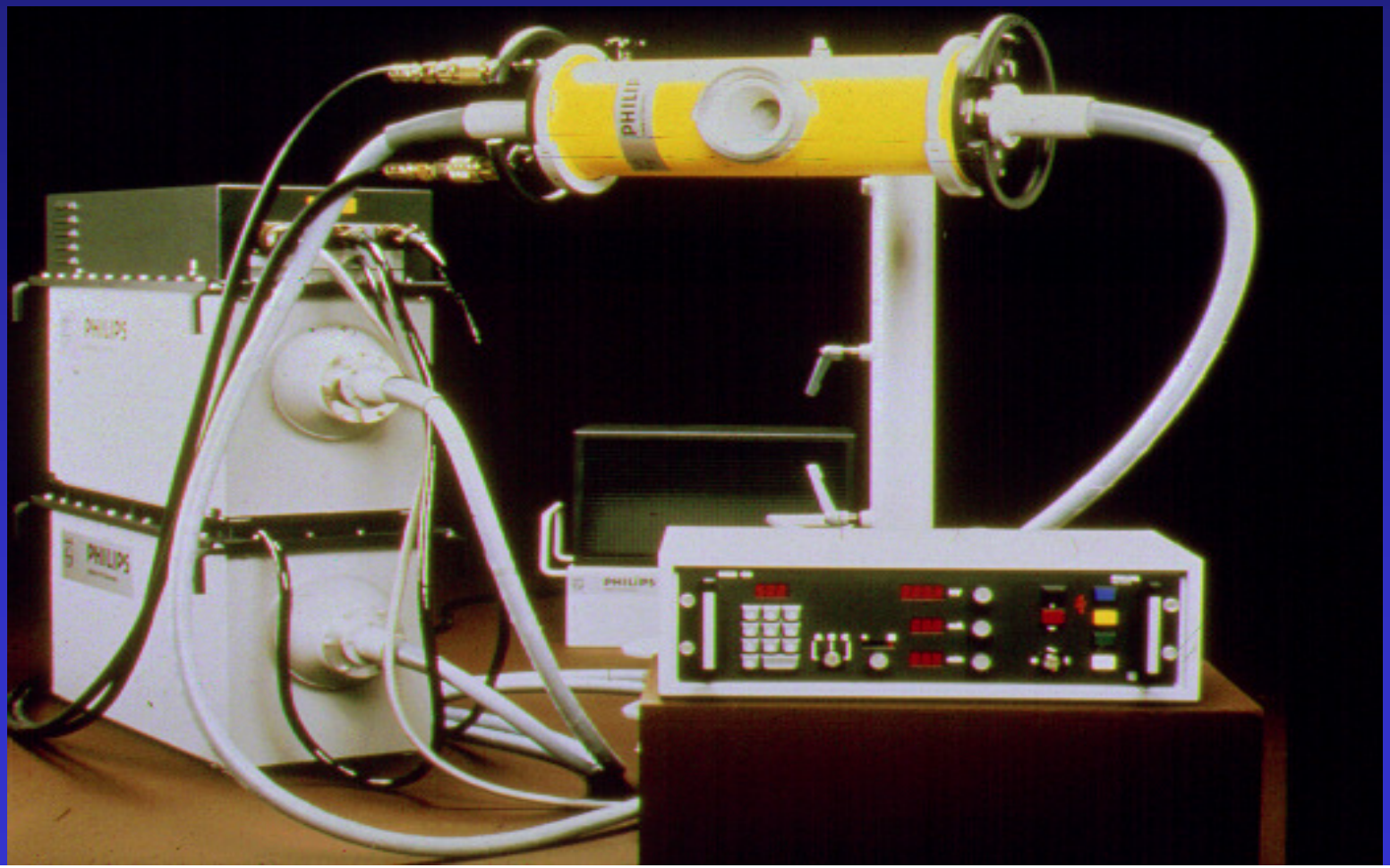
TEST SPECIMEN TO FILM EXPOSURE TECHNIQUE



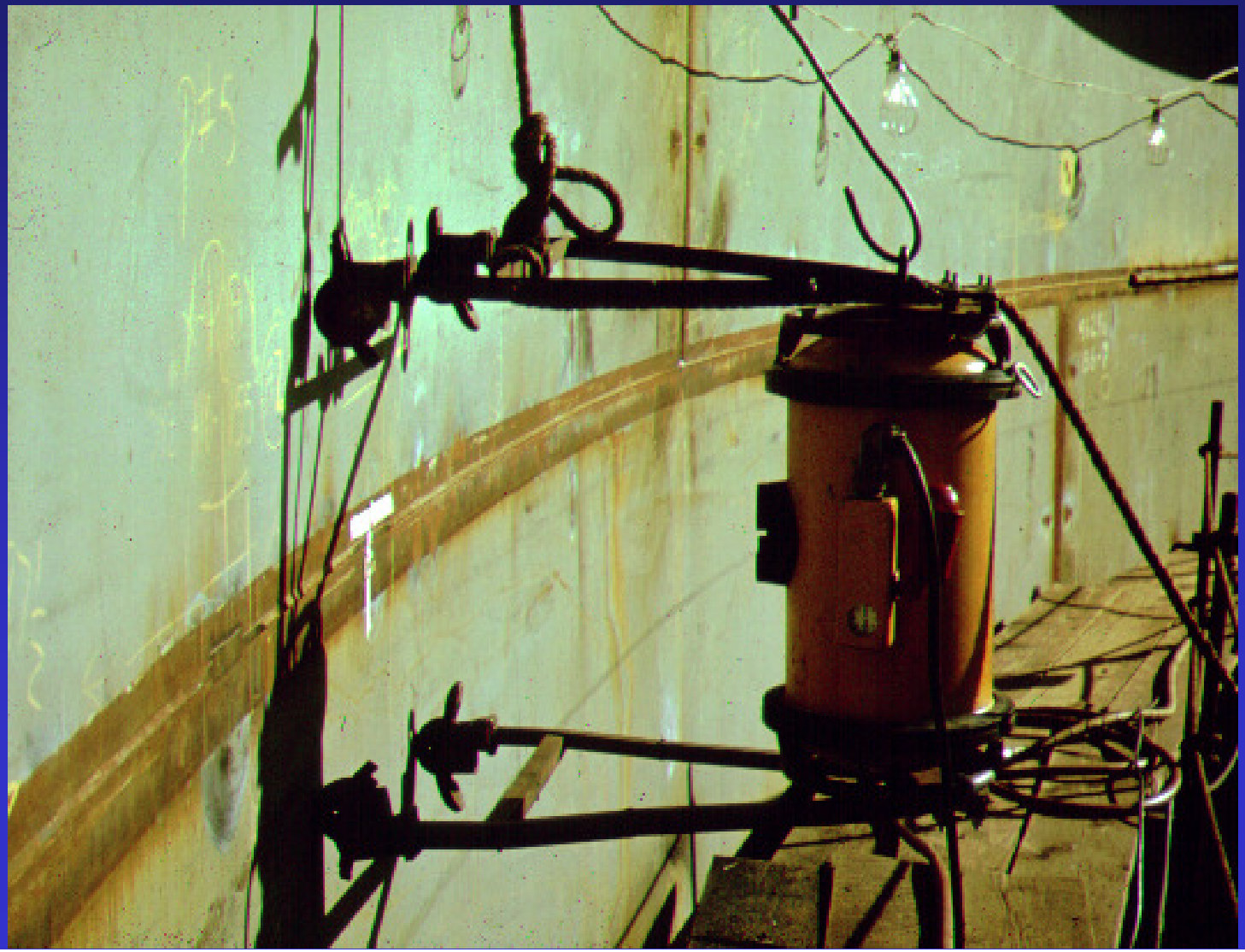
RADIOGRAPH SHOWING POROSITY(GAS HOLE'S)



X-RAY SYSTEM SHOWING EXPOSURE HEAD, CONTROL PANNEL AND HIGH VOLTAGE TRANSFORMER'S



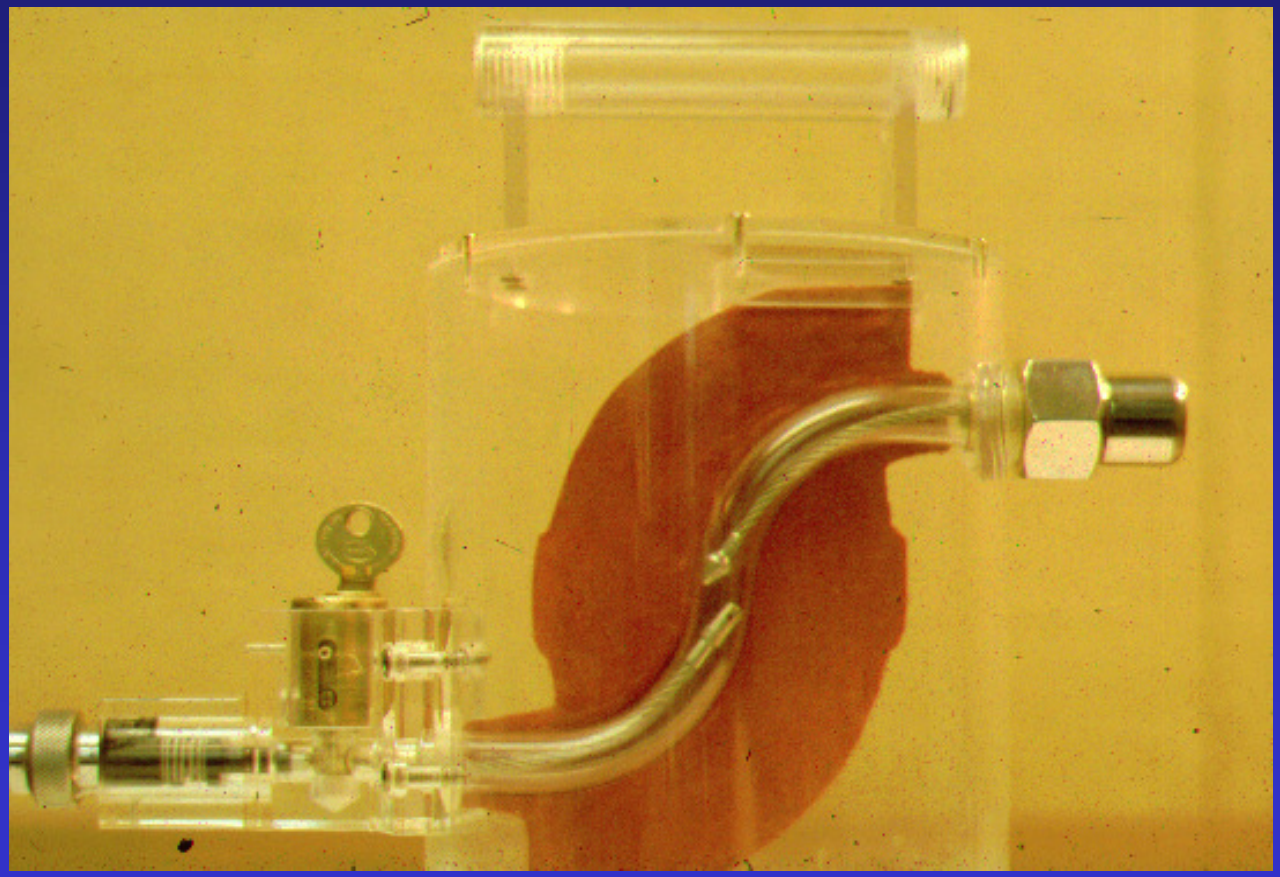
X-RAY EXPOSURE OF A TANK LONG SEAM



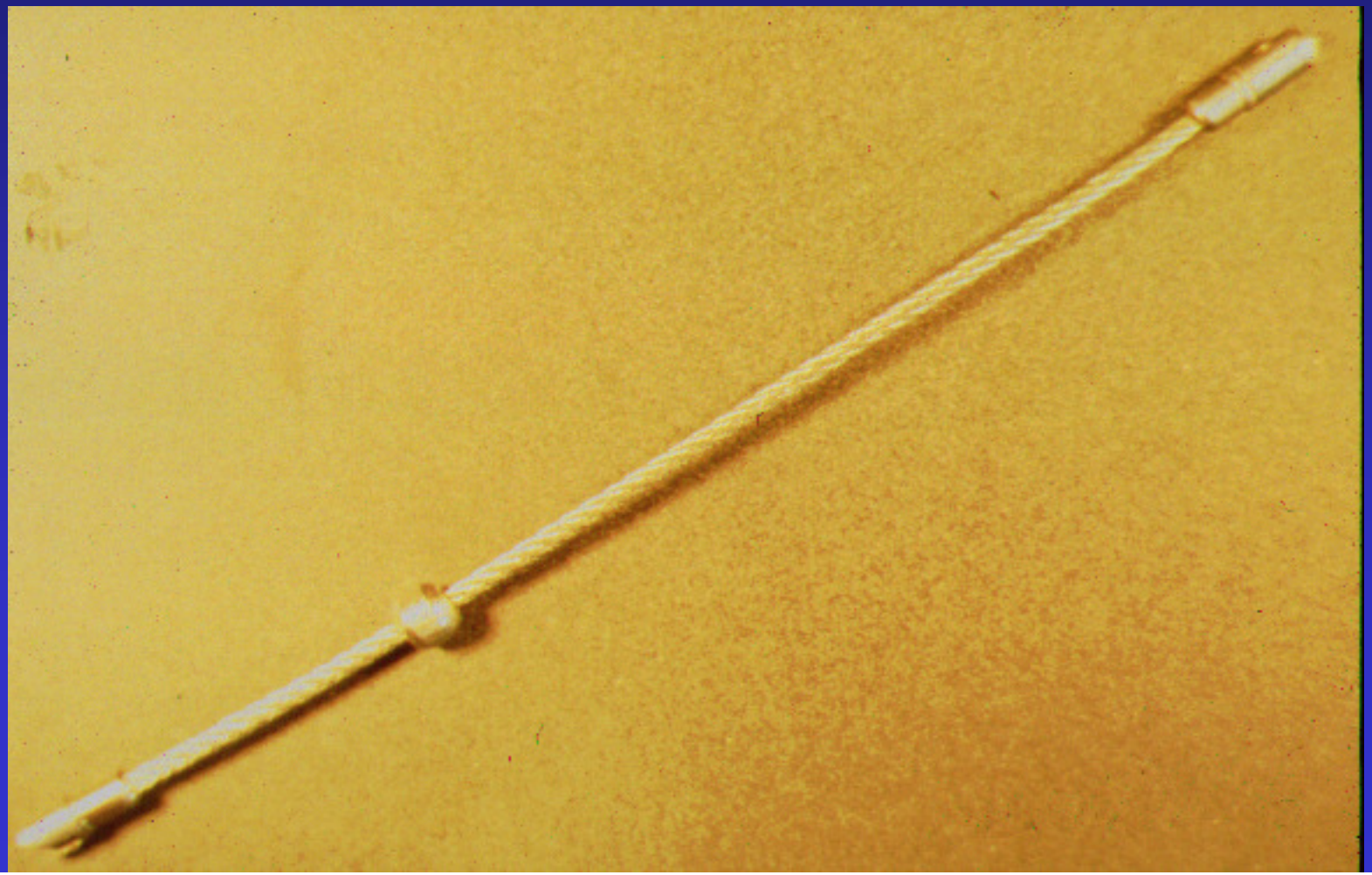
VARION LINEAR ACCELERATOR HIGH ENERGY

GAMMA RADIOGRAPHY ON CROSS COUNTRY PIPE LINE

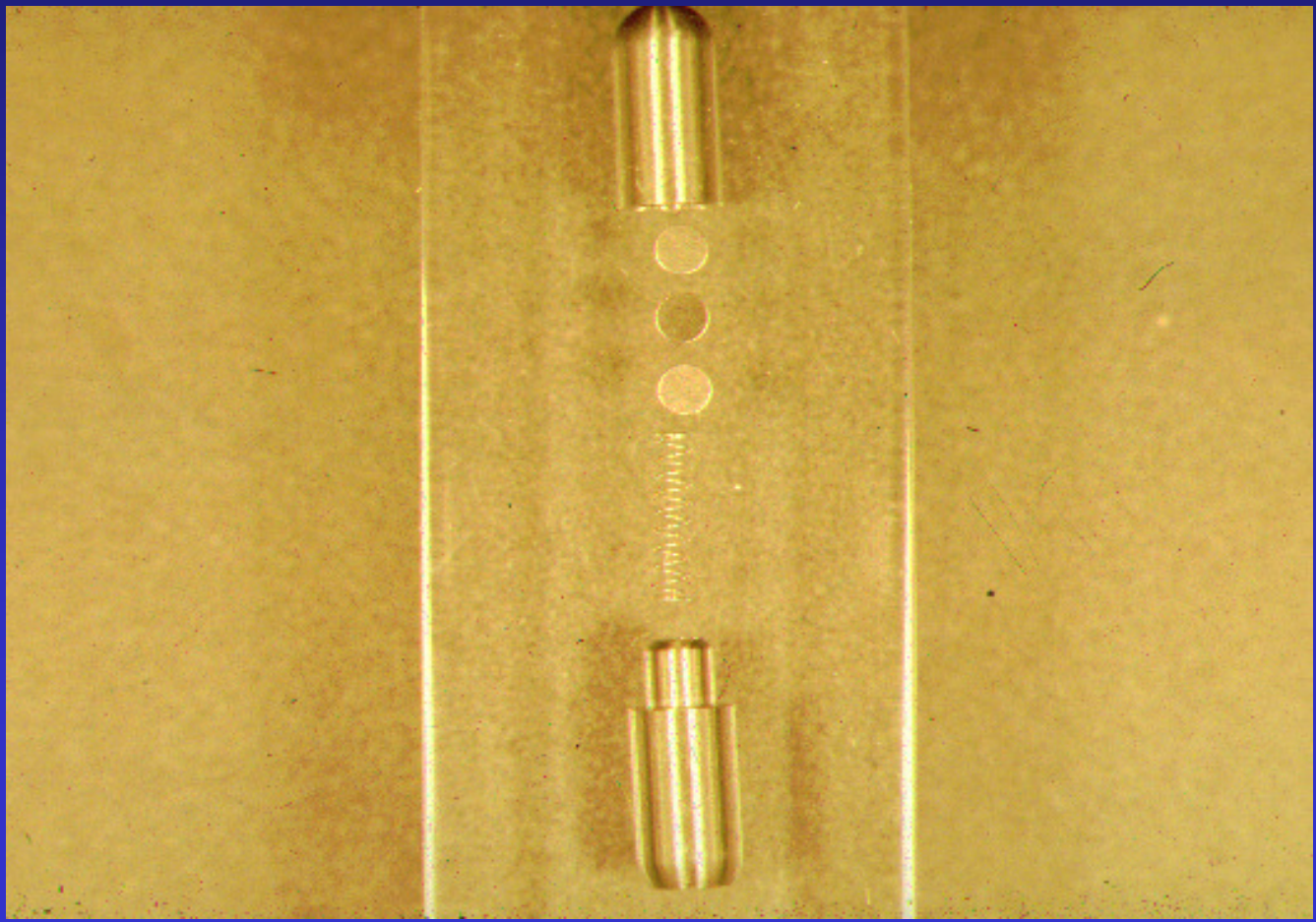
GAMMA EXPOSURE CAMERA



GAMMA SOURCE WAFFES ARE SEALED IN THE PICK TAIL END CAPSULE



IRIDIUM 192 GAMMA WAFFLES



FIELD GAMMA RADIOGRAPHIC RIG WITH DARK ROOM

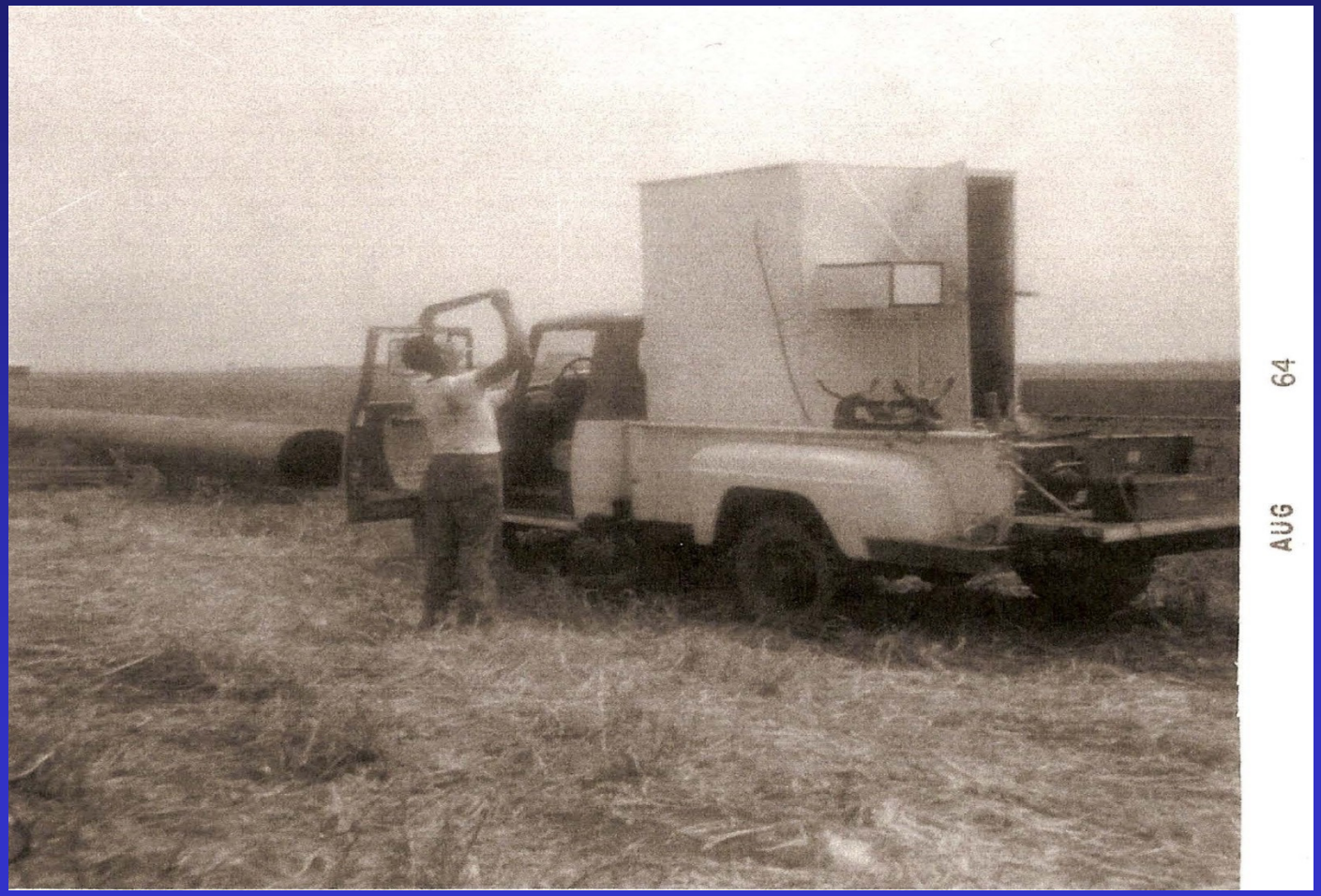
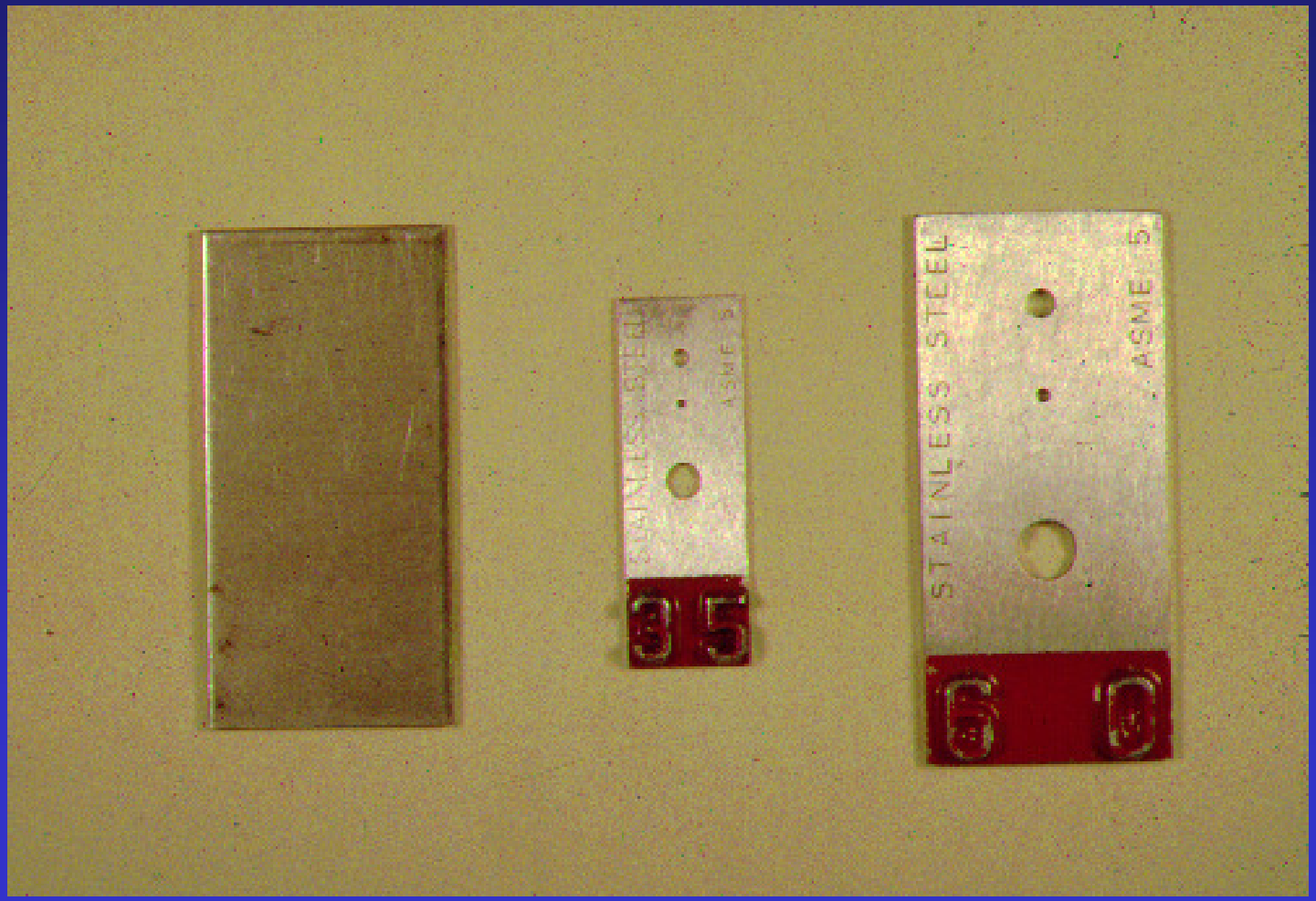


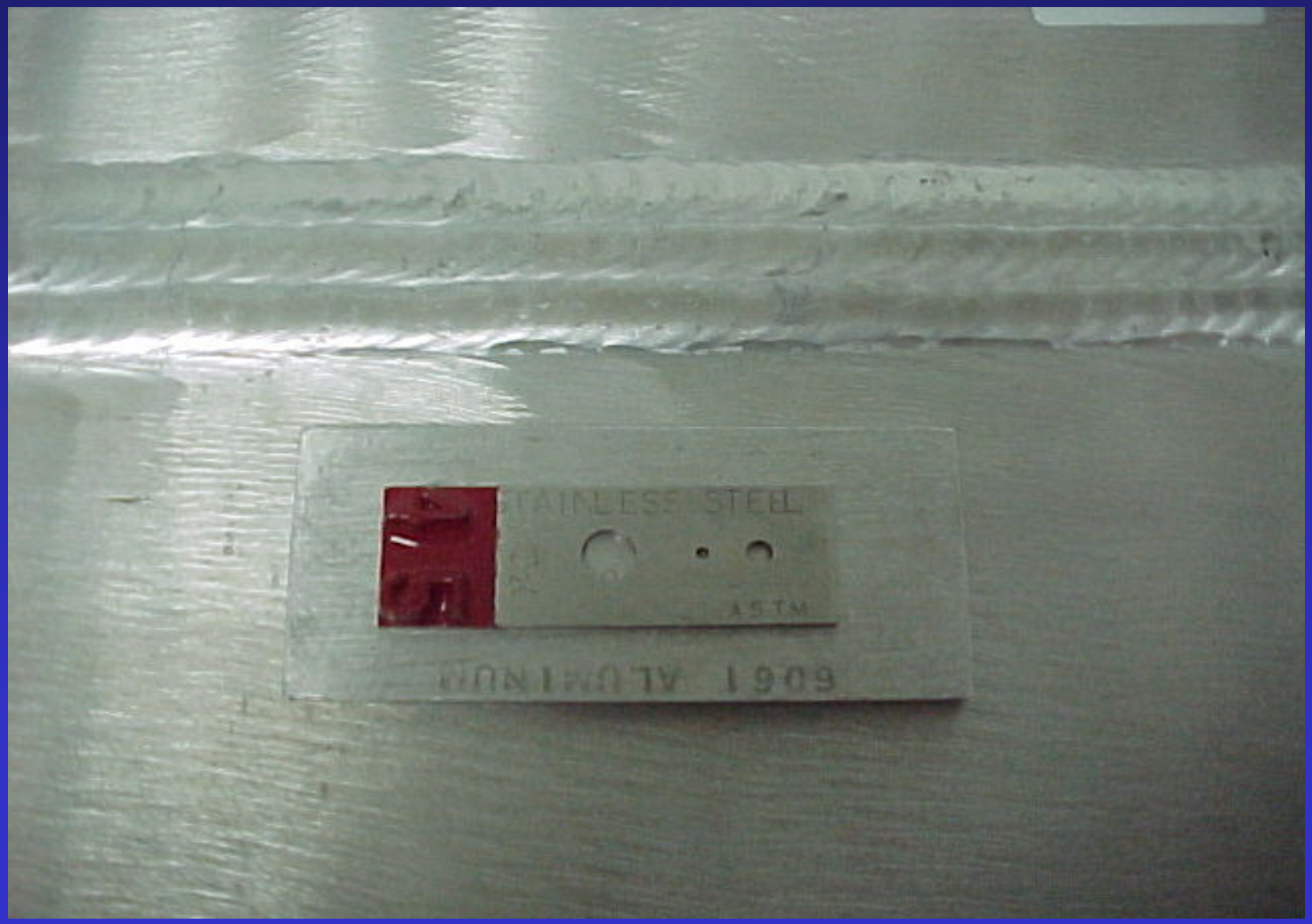
IMAGE QUALITY INDICATORS

- Hole type (shim) and Wire type
  - Placement
  - Penetramenter
  - Shims
  - ASTM wire gauge

IMAGE QUALITY INDICATORS(IQI)



WELD INSPECTION USING IQI AND SHIM



ASTM WIRE PENETRAMETERS

INTERPRETATION OF RADIOGRAPHS

- Qualifications of the interpreter
- Establish quality level
- Evaluate for discontinuities/conditions
- Establish compliance with code/specification
- Report results