



elcometer®
inspection equipment

PROTECTIVE COATINGS

60 years of excellence
www.elcometer.com



Material Thickness



Surface Profile



Surface Cleanliness



Climatic Testing



Wet Film Thickness



Dry Film Thickness



Adhesion



Pinhole & Porosity



Inspection Kits

Ultrasonic Thickness Measurement

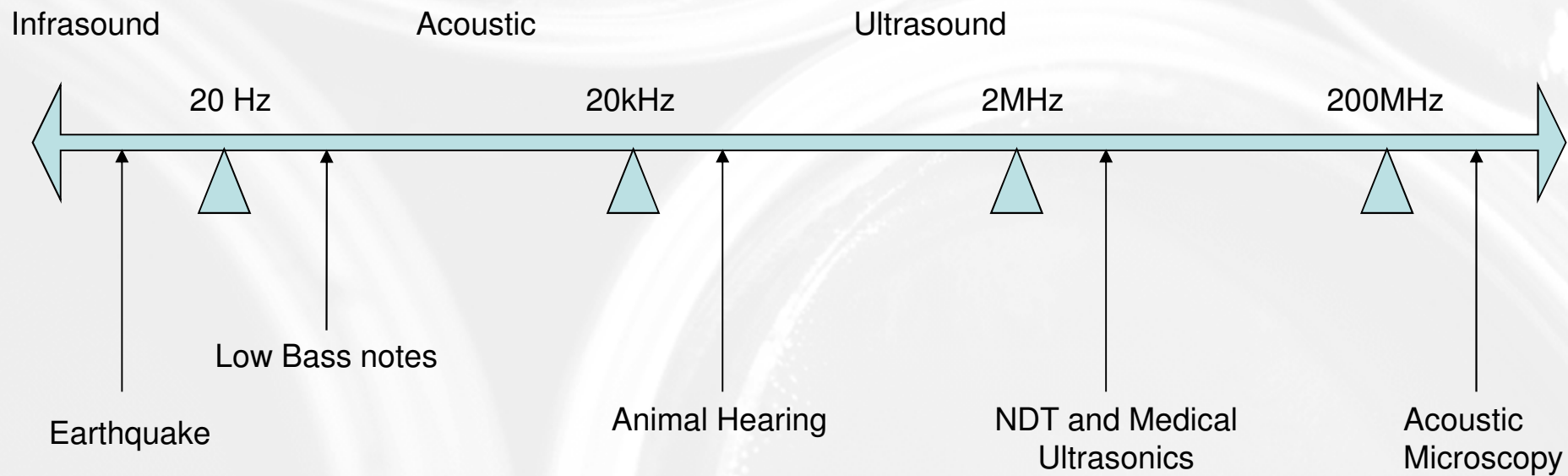
What are we going to learn

- What ultrasound is
- Why it is used
- Where it is used
- What the benefit is
- What instruments and probes are available
- Which instrument and probe to choose

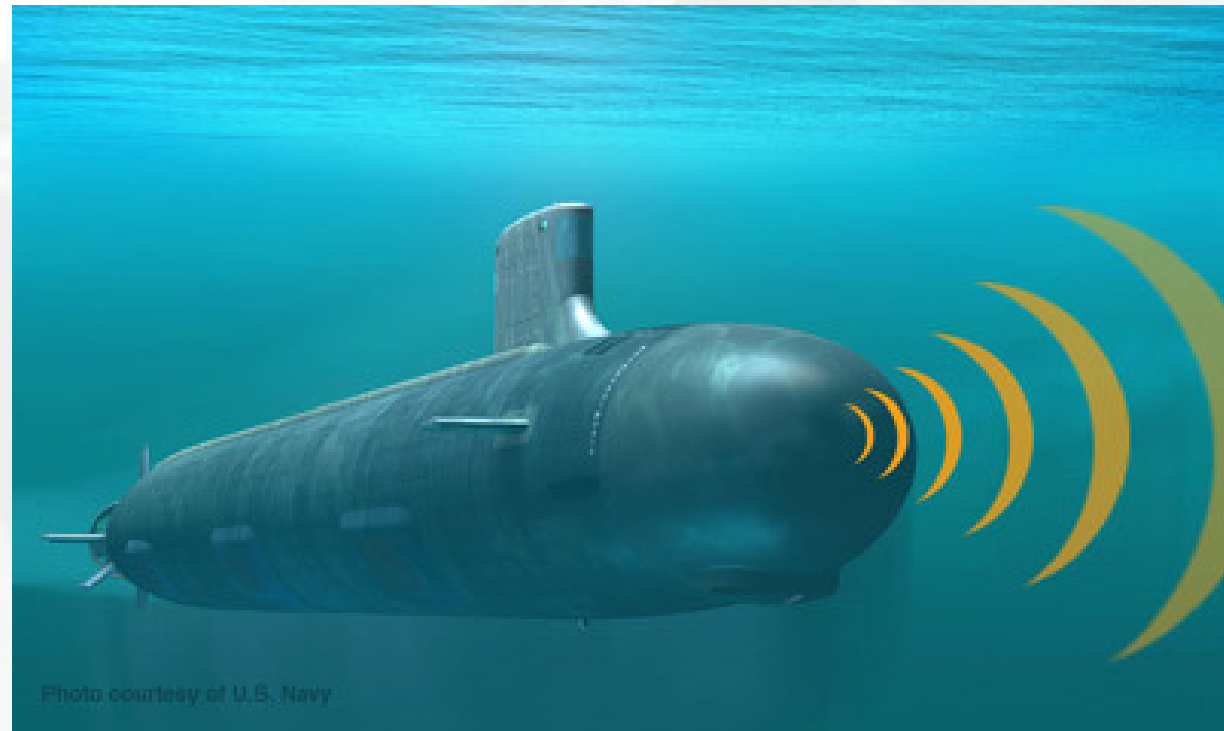


What is Ultrasound?

Ultrasound is sound with a frequency too high for humans to hear.



Sonar

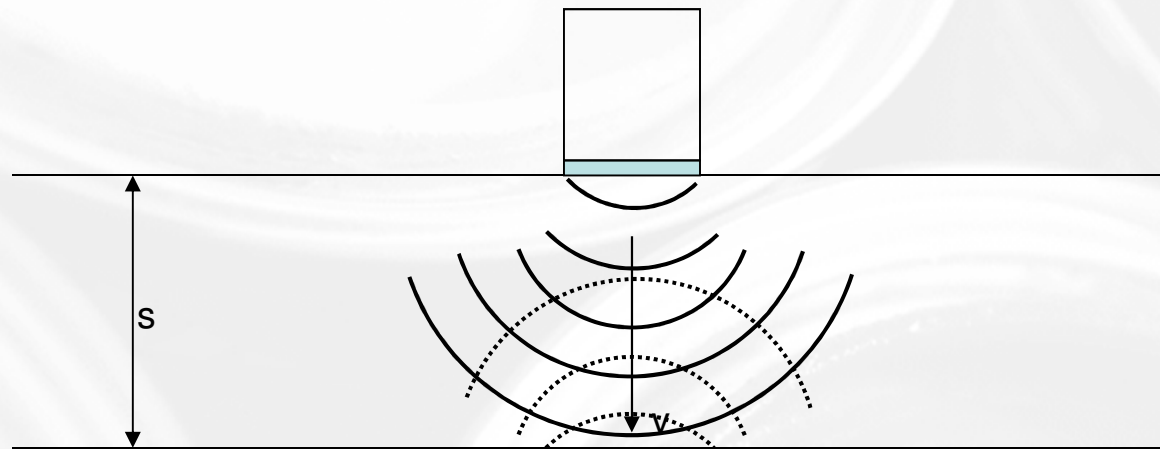


SOund **N**avigation **A**nd **R**anging

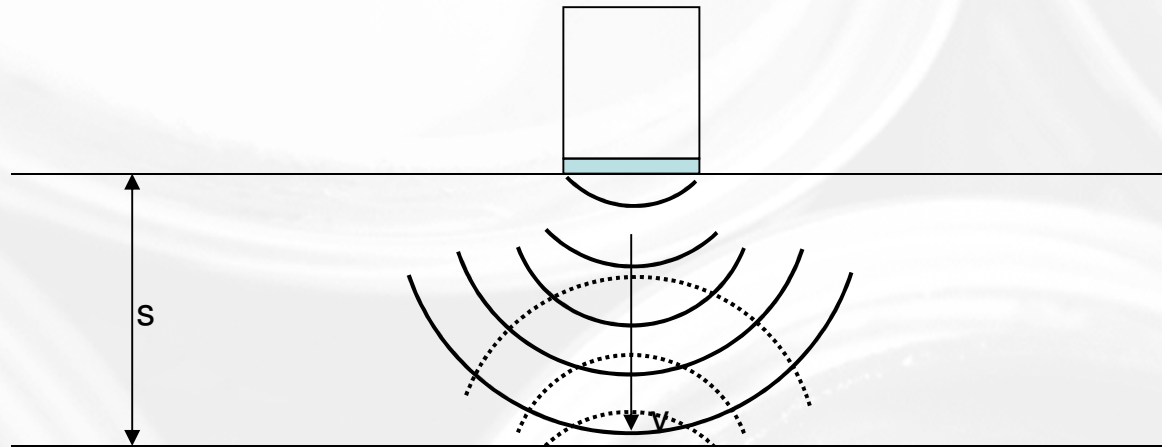
- UTGs generate a sound pulse in a probe called a transducer
- The transducer transmits the sound pulse into the material, through a layer of couplant



- Sound waves are reflected from the boundaries between dissimilar materials
- Metals and air
- Metals and liquids
- The transducer listens for the echo coming back
- An accurate electronic timer is used to determine the interval between pulse and echo



Time interval is usually measured in nanoseconds. The gauge is programmed with the speed of sound in the test material, from which it can then calculate thickness.



$$s = v \times \frac{t}{2}$$

Where s = substrate thickness

v = the velocity of sound in the substrate material

t = the measured round trip time (pulse to echo)

- **v is an essential part of this calculation**
- **Different materials transmit sound at different velocities**

Material	Speed of Sound
Rubber	60 m/s
Air at 40°C	355 m/s
Air at 20°C	343 m/s
Lead	1210 m/s
Gold	3240 m/s
Glass	4540 m/s
Copper	4600 m/s
Aluminum	6320 m/s

- Calibration of gauges sets the speed of sound
- Accuracy of instruments dependant on calibration
- Speed of sound can vary with different grades of a material
- Better to calibrate with a sample of known thickness than put in a speed of sound

Why use an Ultrasonic Thickness gauge?

- Access to only one side of a component
- Pipes
- Tubes
- Sealed vessels
- Where mechanical measurement is impossible due to limited access.

- Pits and flaws are also detectable from one side

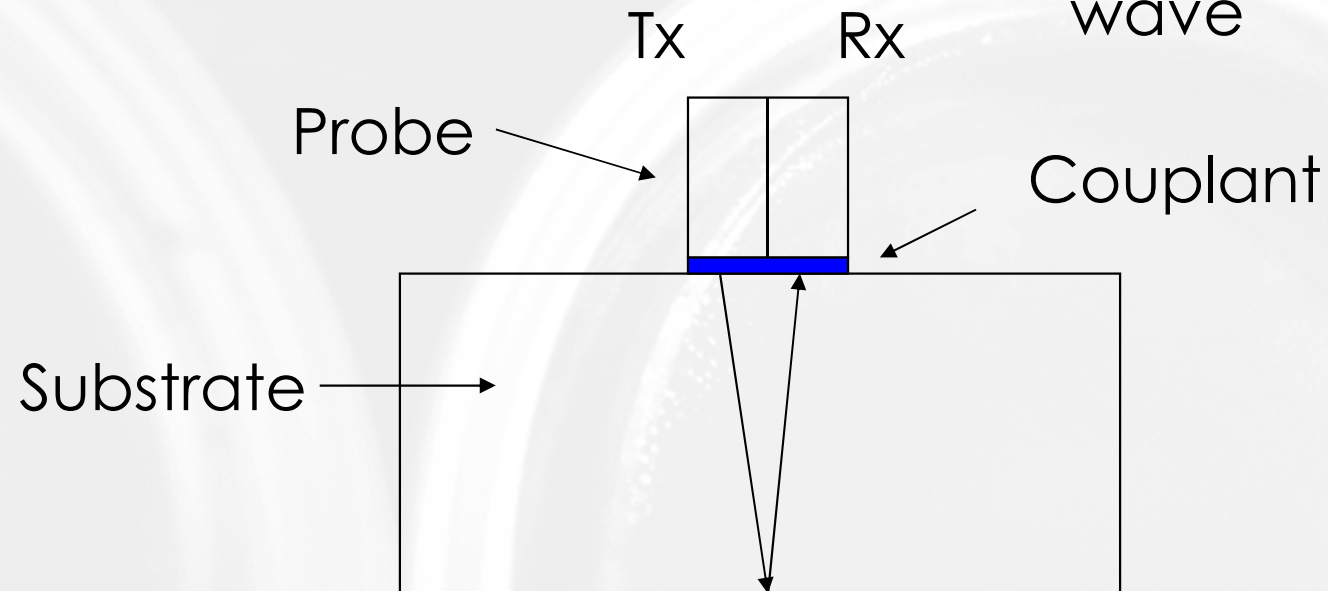
- No need to destroy the component to get access, hence NDT (Non-destructive testing)

Theory

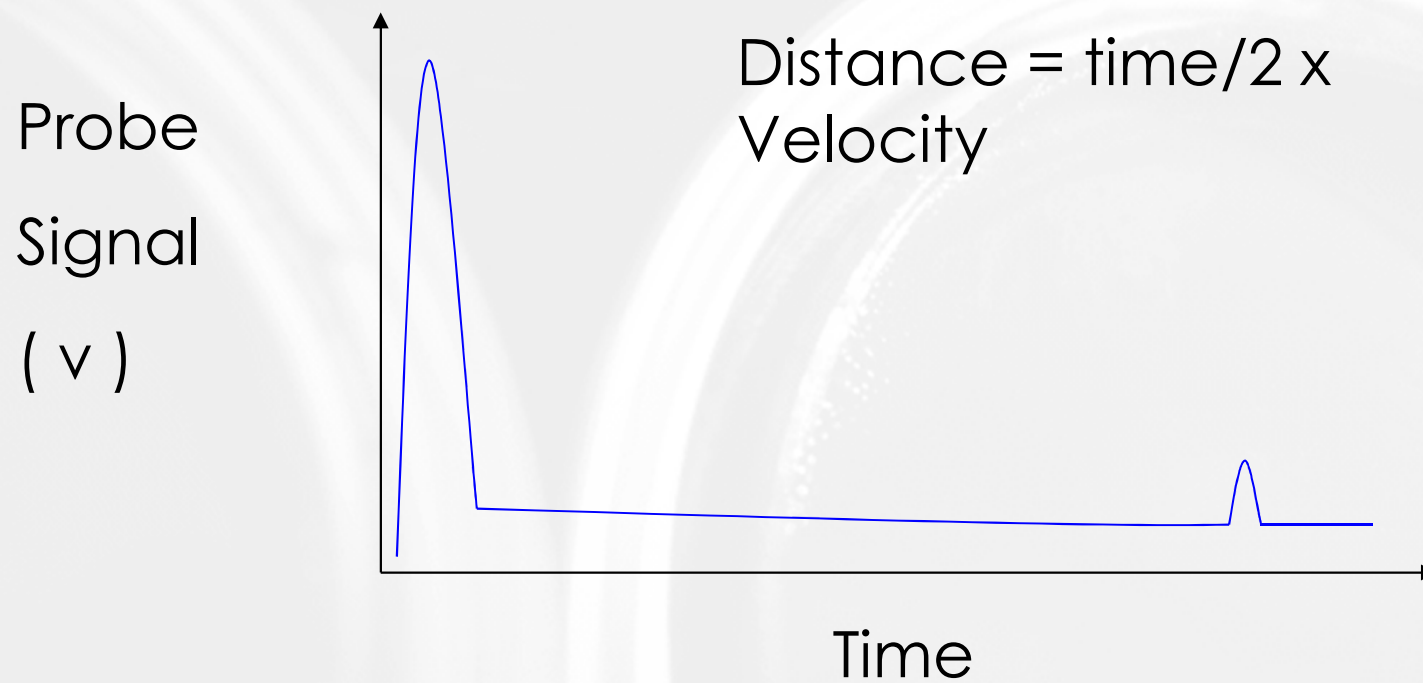
- Measurement from one side
- Time of Flight Measurement
- Transmit/Receive Probes
- Velocity of Sound in Materials
- Couplant – ensures good acoustic contact

Theory

Pulse of
electricity
initiates sound
wave



Theory





Elcometer 204

- Precalibrated for steel
- Supplied with 5Mhz transducer



Elcometer 304

- 2-Point, 1-Point, Material, Velocity, Thickness Set and Factory calibrations
- Measurement rate control (4, 8 and 16Hz)
- PE and EE modes
- Gauge memory up to 100,000 readings / 1000 batches



Elcometer 307

- Precision gauge for thin materials
- Extra resolution
- IE, EE and PLAS mode
- Gauge memory up to 100,000 readings / 1000 batches



MTG Gauge

- Material Thickness Gauge by Elcometer
- Modern Interface
- Elcomaster connectivity



MTG2

- ▶ Calibrated for steel only
- ▶ Modern
- ▶ Elcomaster connectivity



MTG4

- Pulse-Echo (P-E) and Echo-Echo ThruPaint™ (E-E) measurement modes
- 1-Point, Material and Factory calibration options
- Wide range of transducers for any suitable application



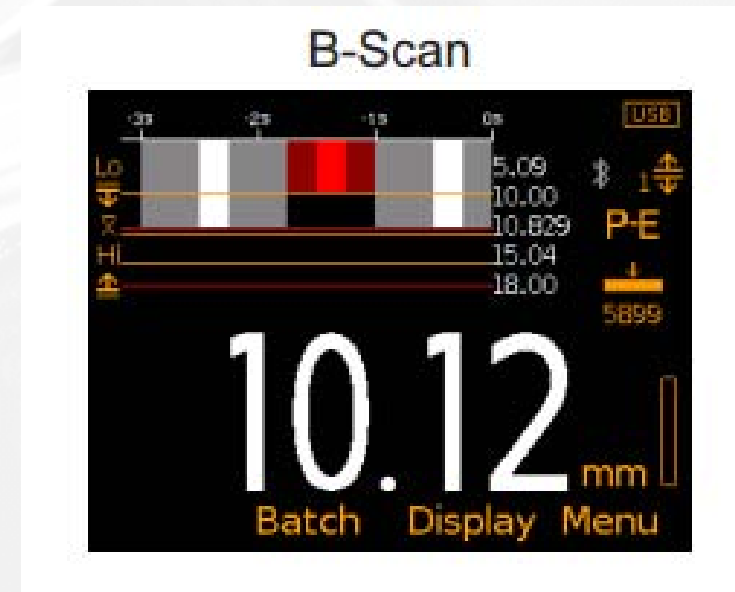
MTG6 and MTG6DL

- 2-Point, 1-Point, Material, Velocity, Thickness Set and Factory calibrations
- Measurement rate control (4, 8 and 16Hz)
- Scan Mode
- Gauge memory up to 1500 readings in one batch

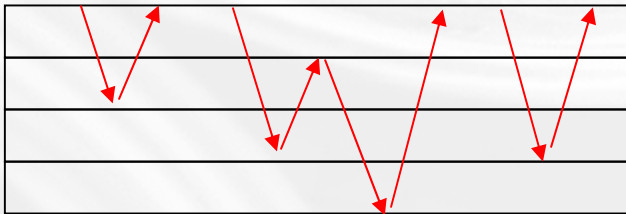


MTG8 and MTG8DL

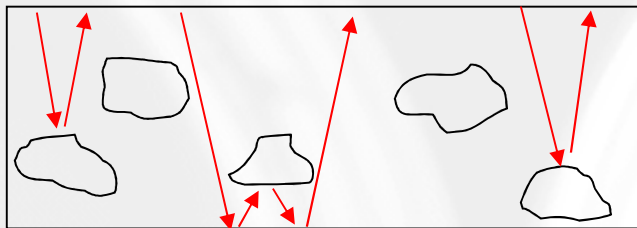
- Three user programmable calibration memories
- B-scan display
- Memory: 100,000 readings in up to 1,000 sequential or grid batches



Problems



Laminations



Non-homogenous



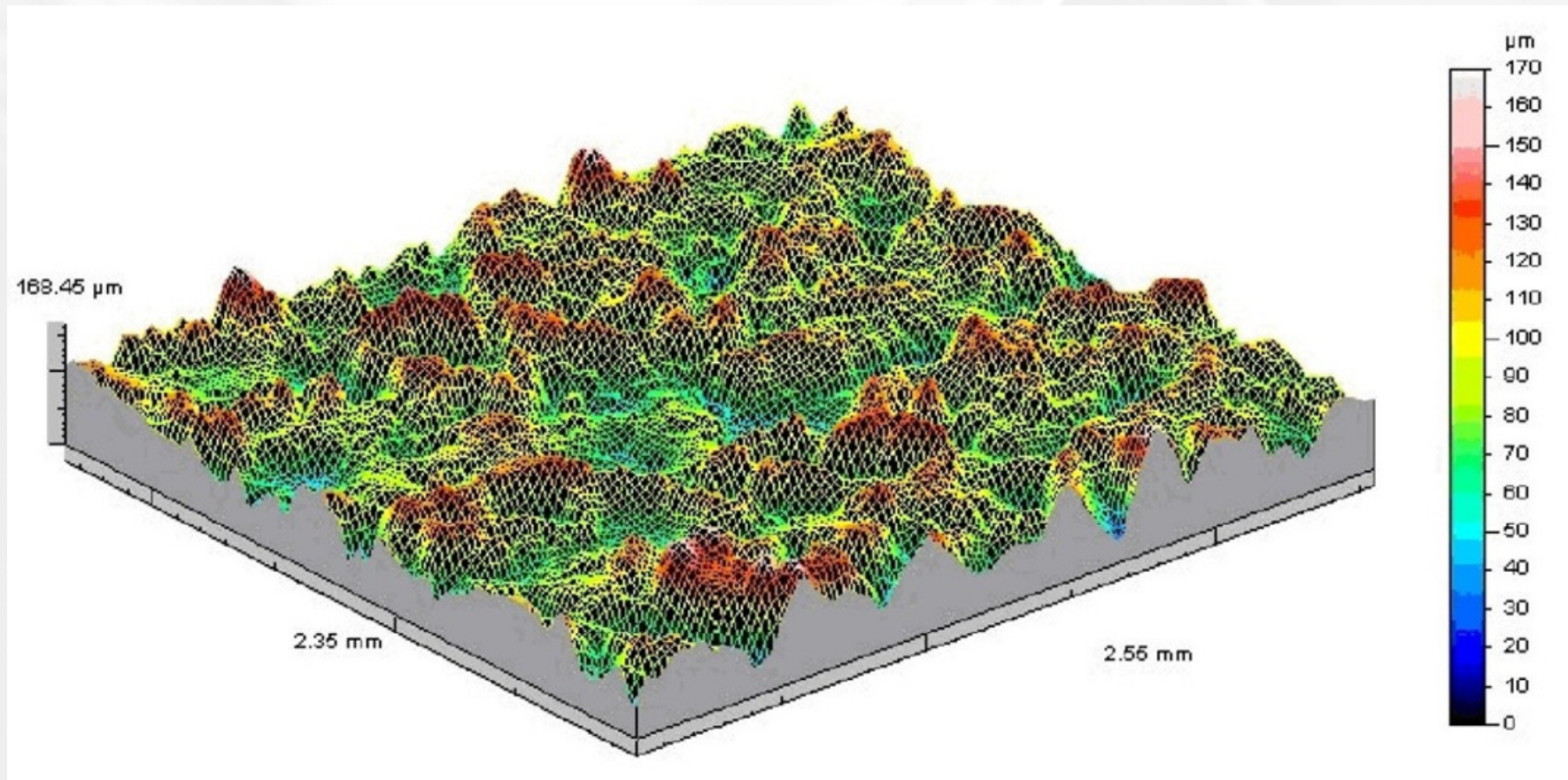
Acoustic Absorption

What have we learnt ? ...

- What is ultrasound ?
- Why is it used ?
- Where is it used ?
- What is the benefit ?
- What instruments and probes are available ?
- How do you choose the correct instrument and probe ?



Surface Preparation



What are we going to learn ? ...

- Why we need a profiled substrate
- Why we measure profile
- How profile differs from roughness
- What instruments are available
- Why they give different results
- Choosing a measurement method



- Now we are going to measure in microns
 - What does this mean?
 - A micron is a millionth of a metre

- What size are the following items ?



1200µm

- What size are the following items ?



100μm

- What size are the following items ?



3µm

- Blast cleaning is used to:
 - Remove contamination from substrates prior to applying protective coatings
 - To provide an anchor pattern to increase adhesion of paint coating

- The surface conditions after blasting can be:
 - Measured for Profile
 - Measured for Roughness
 - Visually assessed for Appearance

- Visual Appearance :
 - Often misconstrued as a 'measurable' attribute
 - Assessed using hi res digital photographs
 - Comparison of surface finish against photos

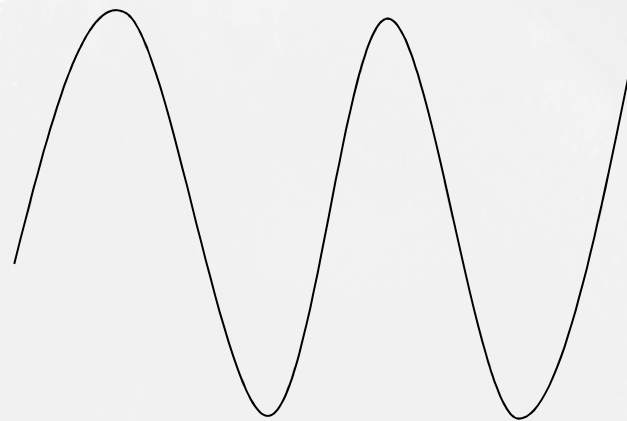
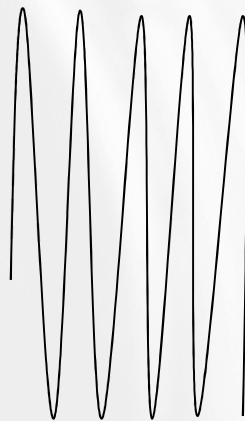


➤ Blasting Examples



Profile vs Roughness

- Profile is not the same as roughness and vice versa
- Profile is measured by average peak to valley height in a small area
- Roughness measures amplitude fluctuations but over a wavelength
- Consider the following surfaces :-



Profile vs Roughness

- Profile can be measured easily with simple instrumentation
- Roughness requires sensitive instrumentation and complex formulae
- e.g.

$$Ra = \frac{1}{N} \sum_{i=1}^N |Y_i|$$

$$Ry \text{ (JIS'82, JIS'94)} = Y_p + Y_v$$

$$Rz \text{ (JIS)} = \frac{1}{5} \sum_{i=1}^5 Y_{pi} + \frac{1}{5} \sum_{i=1}^5 Y_{vi}$$



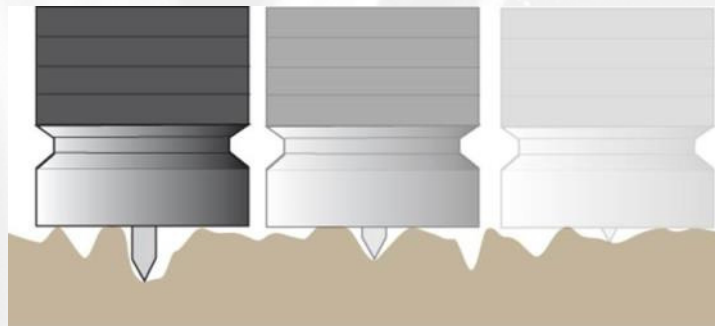
ASTM D4417 Method A - Surface Comparator Elcometer 125

- Method of Use
 - Visual or Tactile Comparison with blast cleaned surface
 - Finer than Fine, Fine, Medium, Coarse & Coarser than Coarse ratings
- Quick to use, durable, low cost per test
- Verify by visual inspection



ASTM D4417 Method B – Dial Depth Gauge

- Method of Use
 - Set zero on flat surface (Glass slide)
 - Take average of 10 readings in same area
- Quick to use, durable, low cost per test
- Calibration check against glass slide
- Verify by visual inspection of tip, field check using shims



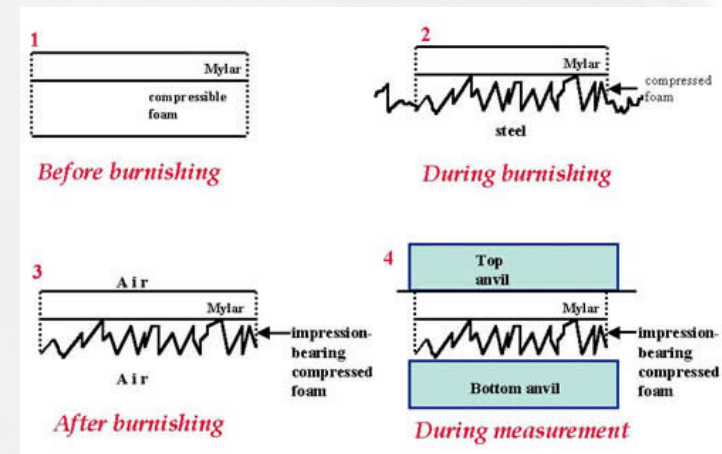
Calibrating the gauge is a simple process of zeroing on a smooth glass “zero” tile

The new Elcometer 224 has on screen instructions to guide the user through the calibration process



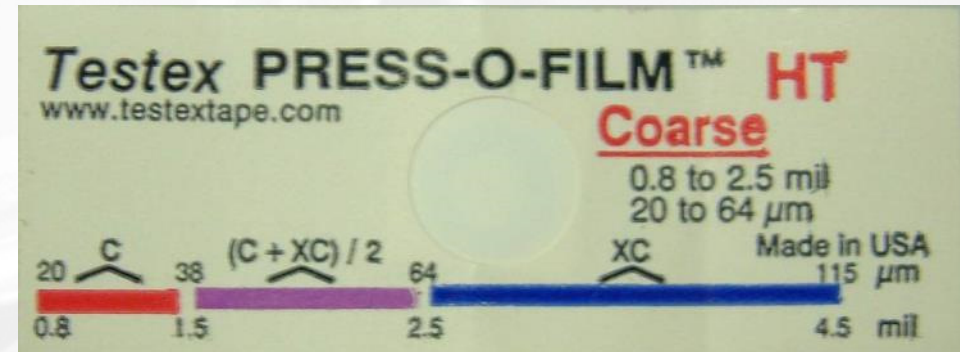
ASTM D4417 Method C – Replica Tape

- Method of Use
 - Create surface impression with 4 grades of Mylar tape
 - Take average of either 3 or 6 readings in same area
- Slow to use, high cost per test
- Calibration of snap gauge only
- Verify snap gauge using shims



Elcometer 122/124

➤ Testex Tape :



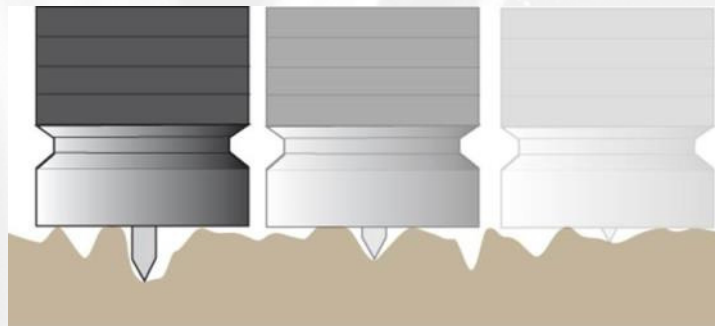
➤ There are four ranges of tape

- Coarse minus (C-) (not used in blast profiles)
- Coarse (C) for 20-38µm profiles
- X-Coarse (XC) 64-115µm
- X-Coarse plus (XC+) for profiles between 115-127µm

➤ Special test required for profiles between 38 and 64 microns

ASTM D4417 Method B – Dial Depth Gauge

- Method of Use
 - Set zero on flat surface (Glass slide)
 - Take average of 10 readings in same area
- Quick to use, durable, low cost per test
- Calibration check against glass slide
- Verify by visual inspection of tip, field check using shims



224 Options

Basic – Statistics only

Top – 150,000 readings in
2500 batches

Integral – Probe built into base of
unit. One handed operation

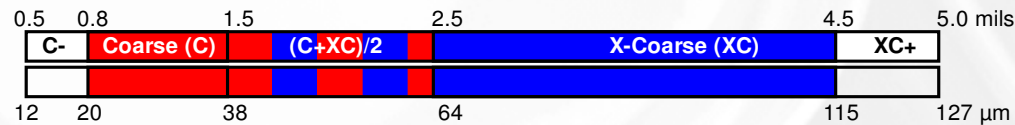
Separate – Probe on wire

Additional maneuverability

May be used with convex surface
probe for outside of pipes

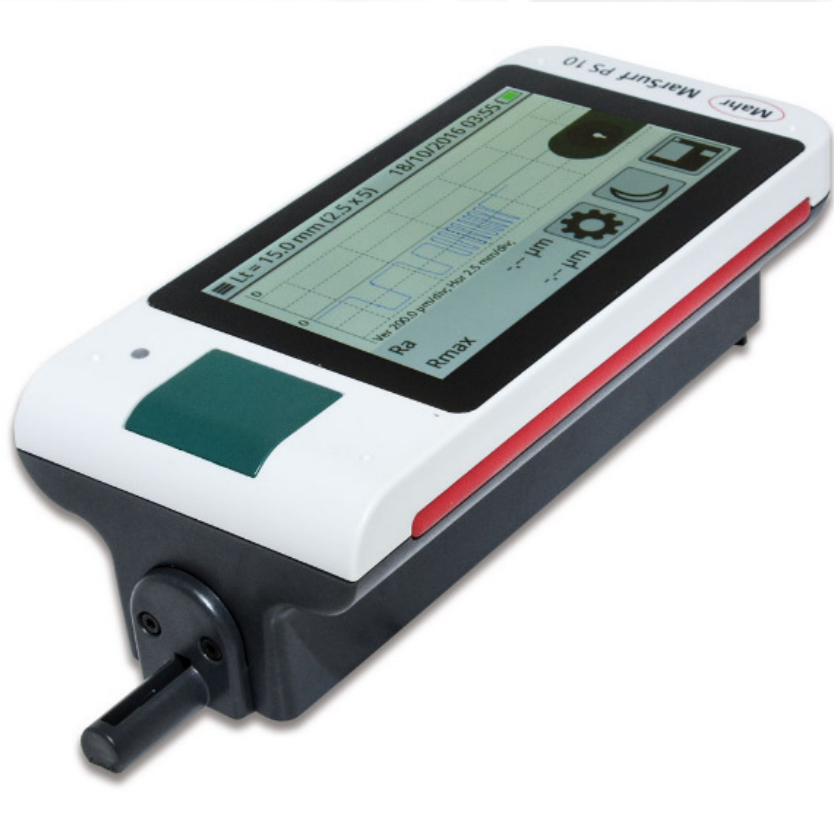


Replica Tape Update



- If a measurement is made with Coarse grade tape which is greater than 38µm a second measurement must be taken at the same spot with the X-Coarse grade
- If BOTH readings are between 38-64µm the average of the two measurements should be taken as the surface profile
- If the reading taken with the X-Coarse grade tape is between 38-64µm then a second measurement must be taken with the Coarse grade at the same spot, and the average recorded as the surface profile
- Finally, if the measurement taken with the X-Coarse grade is above 64µm then this single measurement should be recorded as the surface profile at this spot. In this case the measurement taken with the Coarse grade should be discarded

ASTM D7127 - Stylus Roughness Trace Method
Elcometer 7062



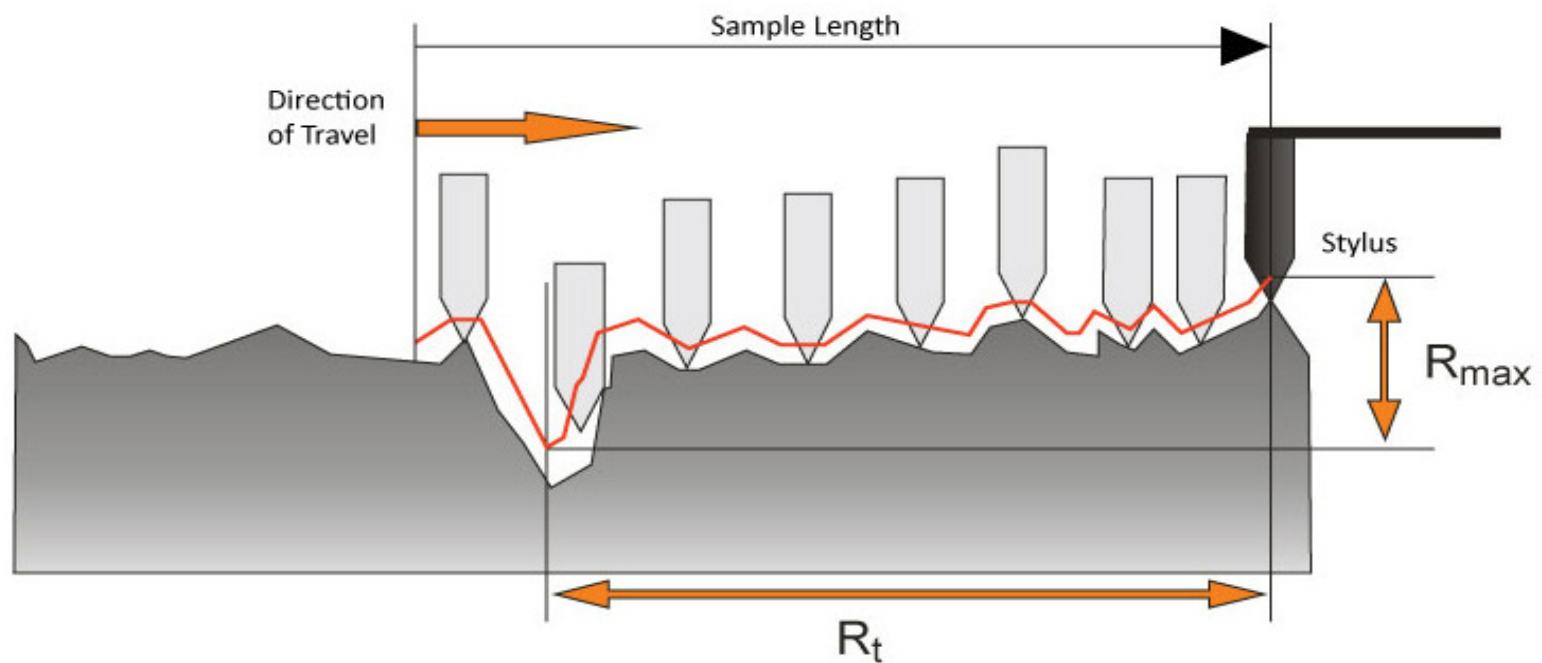
Elcometer 7061

R_{max}: The greatest distance between the highest peak and lowest valley over the sampling length.

R_a: The average surface roughness over the sampling length.

R_t: The distance between the highest peak and the lowest valley within any given sampling length.

R_z: The average distance between the highest peak and the lowest valley over a number of sampling lengths.



➤ Blasting Examples



What have we learnt ?

- Why do we need a profile ?
- Why do we measure profile ?
- How does profile differ from roughness ?
- What instruments are available ?
- Why do different methods give different results ?
- How do we choose a measuring method ?

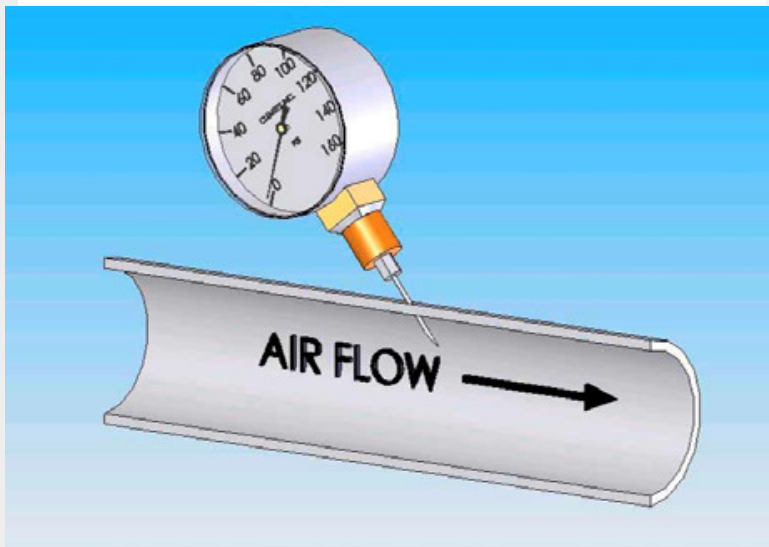
Blasting Accessories



Elcometer 102

➤ Needle Pressure Gauge

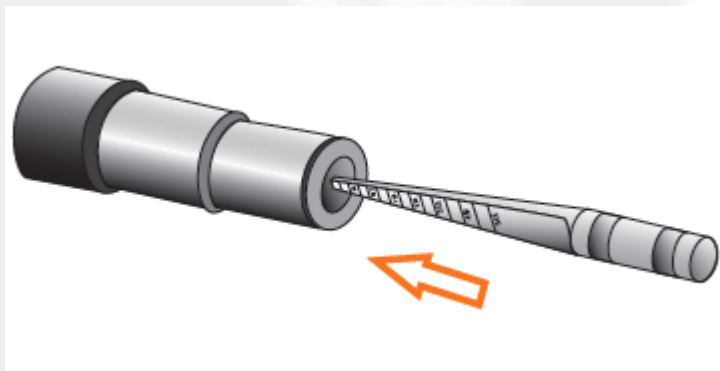
- Measures air pressure in blast & air hoses
- Needle guard
- Insert needle at 45 degree angle
- Read pressure in psi



Elcometer 103

➤ Blast Nozzle

- Measures the orifice size of an abrasive blasting nozzle
- Grease pencil included
- Insert greased gauge into nozzle
- Read nozzle size.
- Replace nozzle if size has increased by 1/16" or more



Surface Cleanliness

What are we going to learn ? ...

- Why we need a clean surface
- What contaminates the surface
- What instruments and methods are available
- Why they give different results
- What method should be used
- How to assess visual appearance

Chloride Salt Detection

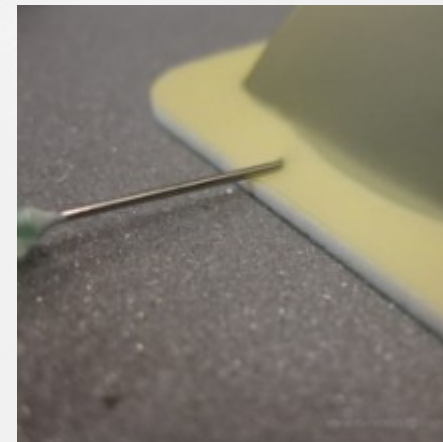


Surface Salt Measurement Methods

elcometer®
inspection equipment

Elcometer 138 - Bresle Patch ISO 8502-6/9

- ▶ Method of Use
 - ▶ Adhesive Patch applied to surface
 - ▶ Water injected and agitated to extract salts
 - ▶ Water removed and tested for conductivity
- ▶ Verify by conductivity
 - ▶ Temperature compensation to 25°C
- ▶ Many 'alternative' patches available



60 years of excellence
www.elcometer.com

Surface Salt Measurement Methods

elcometer®
inspection equipment

Elcometer 135C - Bresle Patch ISO 8502-6/9

- Water tight seal
- Thicker foam – easier to insert syringe
- No foam residue on removal
- Certificate of cleanliness

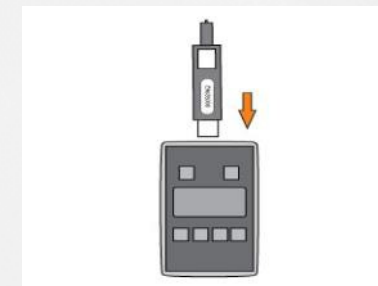
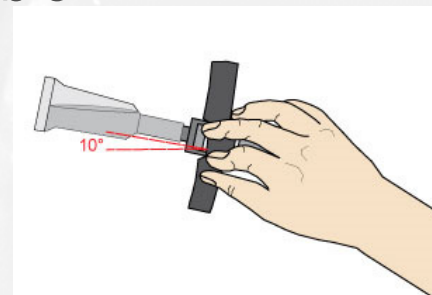
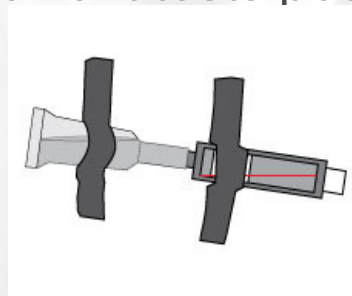
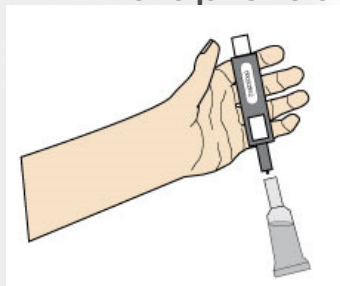


60 years of excellence
www.elcometer.com

Surface Salt Measurement Methods

Elcometer 146 Salt Smart Test

- Method of Use
 - Attach water bottle to test strip
 - Attach strip assembly to sample
 - Allow water to flow through strip
 - Leave 8 minutes
 - Remove strip and test conductivity
- Proven equivalence to ISO 8502-9
- Multiple concurrent tests possible



Surface Salt Measurement Methods

elcometer®
inspection equipment

Elcometer 134 Chlor*Test

- Method of Use
 - Pour test solution into sleeve
 - Place sleeve on surface & work solution
 - Remove sleeve with solution
 - Test solution with titration tube
- Multiple concurrent tests possible



60 years of excellence
www.elcometer.com

Elcometer 134
Titration Tube Test

Surface Salt Measurement Methods

Hedon Gauge

- Method of Use
 - Automated Bresle Type Test
- Simple to use, high initial gauge cost

TOA DKK Gauge

- Method of Use
 - Automated Bresle Type Test
- Simple to use, high initial gauge cost
- Equivalent to ISO 8502-6

Elcometer 130

- Model S: Surface Cleanliness Measurement Mode
- Range: 0 - 25 μ g/cm²
- Accuracy: \pm 1% of the reading plus \pm 0.1 μ g/cm²
- USB data output to ElcoMaster 2.0 (live readings only)



Elcometer 130

- Model T: Surface Cleanliness & Conductivity Measurement Modes
- Extended measuring range, multiple measuring units, user selectable statistics, memory, upper limit, batching and review graphs to the user
- USB & Bluetooth data output to ElcoMaster 2.0



elcometer[®]
inspection equipment

**Gold plated contacts
ensures lifetime accuracy**

**Pressure plate ensures a
constant and uniform
pressure to paper**

**Dust and water resistant
rugged design to IP64**

**Automatic paper size
detection and adjustment of
the reading value**

**Automatic temperature
compensation ensures
accurate results**

**USB and *Bluetooth*[®] data output
to ElcoMaster™ 2.0 software**

**Stores up to 150,000 readings in
2,500 alpha numerical batches**



60 years of excellence
www.elcometer.com

- The gauges are calibrated using Calibration Verification Tile Sets in accordance with Certification Procedures
- Optional Calibration Verification Tile Sets
Supplied as a set of 3, these tiles can be used to verify the accuracy of the gauge calibration at 0.4, 5 and 20 $\mu\text{g}/\text{cm}^2$.



Surface Cleanliness

elcometer®
inspection equipment

➤ Elcometer 130 Soluble Salt Profiler

- Latest technology allows mapping of salt density over paper area
- Reveals peak salt concentration as well as average
- Peak salt concentration areas cause localised corrosion cells – rust spotting

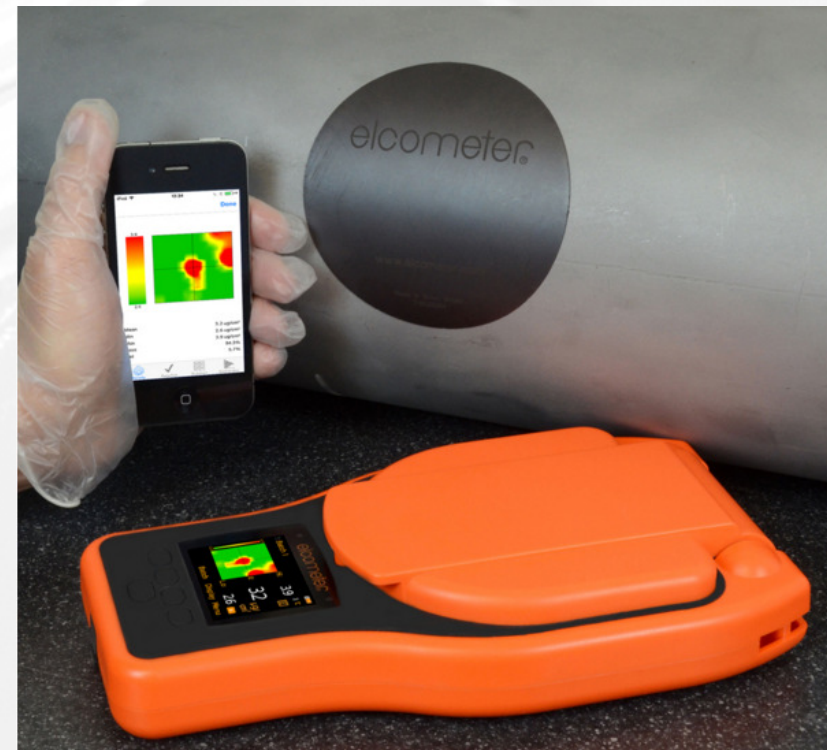


60 years of excellence
www.elcometer.com

Surface Cleanliness

elcometer®
inspection equipment

- **Elcometer 130 SSP**
- Compatible with Android / Iphone
- Density expressed as hotspots
- 3D images
- Pass / Fail salt map



60 years of excellence
www.elcometer.com

134A - Salt Detection in Abrasives

- CHLOR*TEST - A™
- It is important to detect salt in abrasives to prevent salt being blasted back onto surface during cleaning
- Four tests per kit
- Simple to use



134W Salt Detection in Water



- CHLOR*TEST - W™
- 5 Tests per kit
- Place sample in clean test bottle using dropper
- Test with titration tube



134 CSN Kit

- Detects Sulphates, Nitrates & Chlorides ions.
- Chloride test by titration tube
- Nitrate test by colour change on paper strip
- Sulphate test by colourimeter

Other Surface Cleanliness Tests

Elcometer 142 Dust Kit

- Assessment of quantity and size of dust particles on a surface
- Used as a pass / fail device
- Permanent record of test
- Dust comparator display board



Elcometer 142 Roller

- ▶ The Dust Tape Roller presses the Elcometer 142 Dust Tape to the surface using a controlled constant force as required by ISO 8502-3



Elcometer 139 Amine Swab Kit

- Identifies the presence of amine blush
- Indicated by colour change of swabbed sample
- Compare to a control sample
- Lower intensity yellow in test sample indicates amines present



Elcometer 139 Amine Chip Kit

- Identifies the presence of amine blush in paint chips
- Indicated by colour change of sample containing paint chips
- Compare to a control sample
- Lower intensity yellow in test sample indicates amines present





Rust Standards

- Elcometer 128
 - Swedish Standard
 - British Standard
 - SSPC VIS 1
 - SSPC VIS 3

➤ Blasting Examples



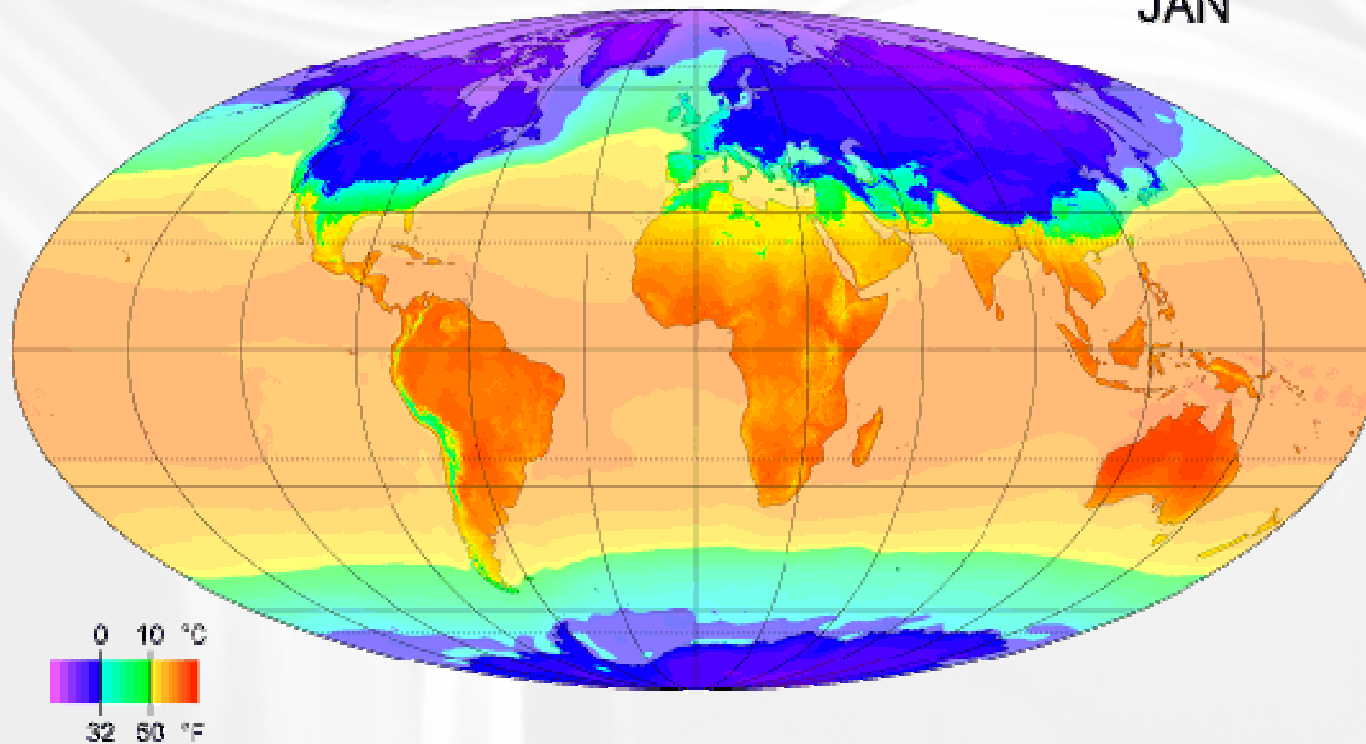
What have we learnt ?

- Why do we need a clean surface to paint on ?
- What contaminates the surface ?
- What instruments are available ?
- Why do they give different results ?
- Which method should be used ?
- How do we assess visual appearance ?



Climatic Monitoring

JAN



What are we going to learn ?

- What climatic conditions are acceptable for painting
- What the consequences are of ignoring climatic conditions
- What the 'dewpoint' is and why it is important
- What instruments are available

- Coatings can only be applied in the right conditions
- Poor conditions can result in poor curing and adhesion, leading to failure
- The key parameters are
 - Relative Humidity
 - Air Temperature
 - Surface Temperature
 - Dewpoint Temperature



Relative Humidity

- A ratio of the amount of moisture in the air at a given temperature to the maximum amount of water that the air at that temperature can hold expressed as a percentage
- Saturation - 100% RH

Dew Point Temperature

- ▶ The temperature at which the moisture in the air condenses as water
 - ▶ The surface temperature must be a minimum of 3 degrees above the dew point temperature. (Delta T)



Elcometer 116 Whirling/Sling Hygrometers

- Wet bulb temp decreases as it dries
- Dry bulb temp stabilises
 - Sling – 116A
 - Bacharach – 116C



116C

116A



Elcometer 114

➤ Dewpoint Calculator



Elcometer 114

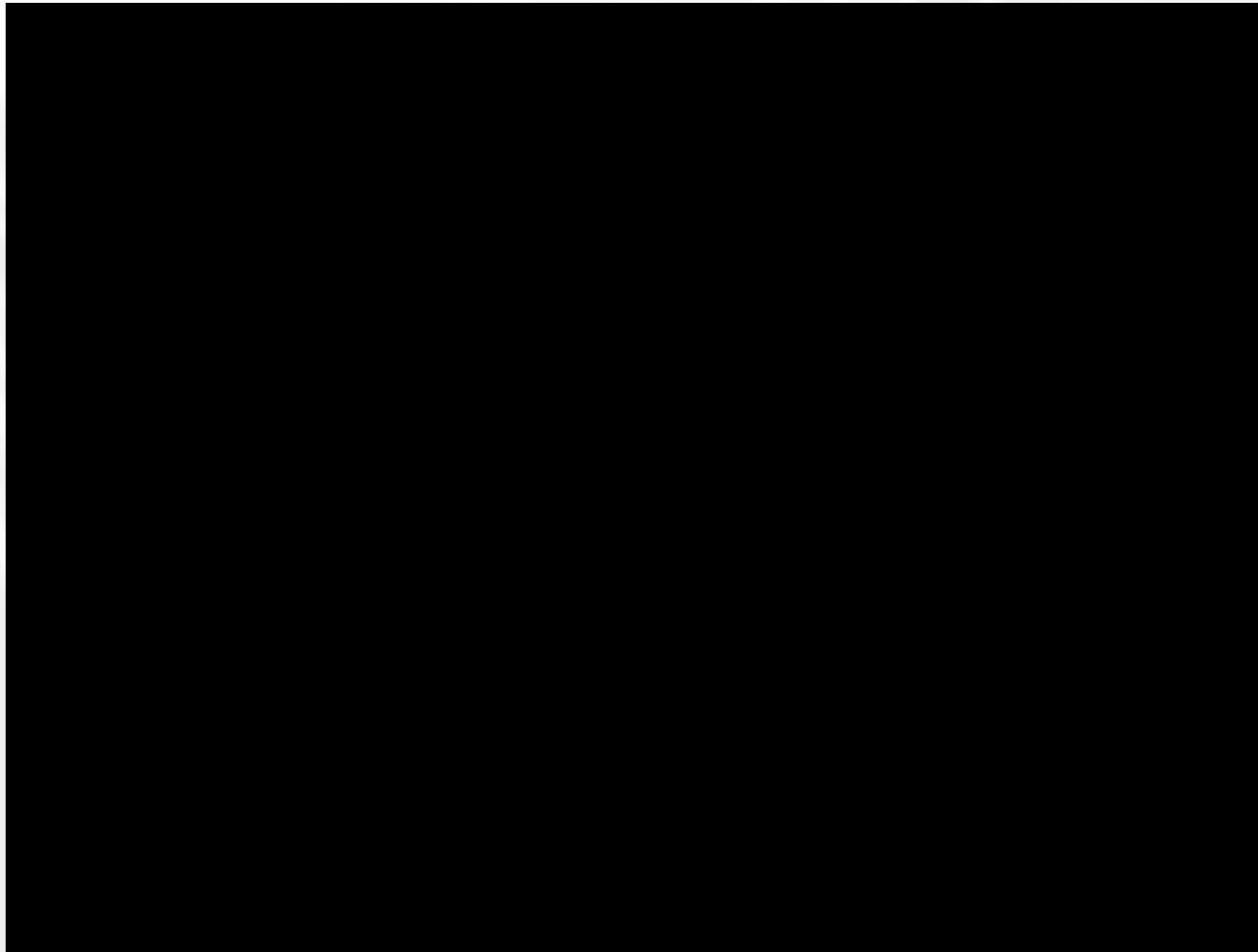
➤ Dewpoint Calculator

➤ Example

- Dry bulb = 18°C
- Wet bulb = 14°C



elcometer®
inspection equipment



60 years of excellence
www.elcometer.com

Elcometer 319 Dewpoint Meter

- Available as standard or top models
- Measures all relevant climatic properties
- Fully compatible with ElcoMaster™



Key features

- Easy menu-driven user interface in multiple languages
- Clear illuminated display showing up to five parameters from
 - RH: % Relative Humidity
 - Ts: Surface Temperature
 - Ta: Ambient Air Temperature
 - Td: Dewpoint Temperature
 - ΔT : Difference between the dewpoint and surface temperatures
 - Tdb: Dry bulb temperature
 - Twb¹: Wet bulb temperature



¹ Calculated Value

Elcometer 319 Dewmeter

Integrated magnets allow remote data monitoring on steel substrates

Dustproof and waterproof gauge with fully sealed sensors (equivalent to IP66)

A hand-held Dewpoint Meter with manual and interval data logging† in one gauge

On-screen statistics with alarms

USB and Bluetooth®† data output to a PC or PDA

High & low limits can be set against any or all parameters

Store 25,000 records in up to 999 batches†



† Elcometer 319 Top Only. Standard stores last 10 records.



Elcometer 308 Hygrometer

- Entry Level Gauge
- Designed for use in hot climates
- Displays Surface Temperature (T_s) and %RH
- Rapid measurement response
- Dust and waterproof



Elcometer 309 Delta T Hygrometer

- Entry Level Gauge
- Displays Delta T and %RH
- Rapid measurement response
- Dust and waterproof
- Limits on RH can be set to trigger an alarm



Elcometer 213/2 Digital Waterproof Thermometer

- Surface Probes
- Liquid Probes
- Needle Probes
- Magnetic probes
- °C & °F Switchable
- Calibration certificate available



Elcometer 212

- Low cost digital thermometer based on fixed K-type thermocouple
- Switchable °C & °F display



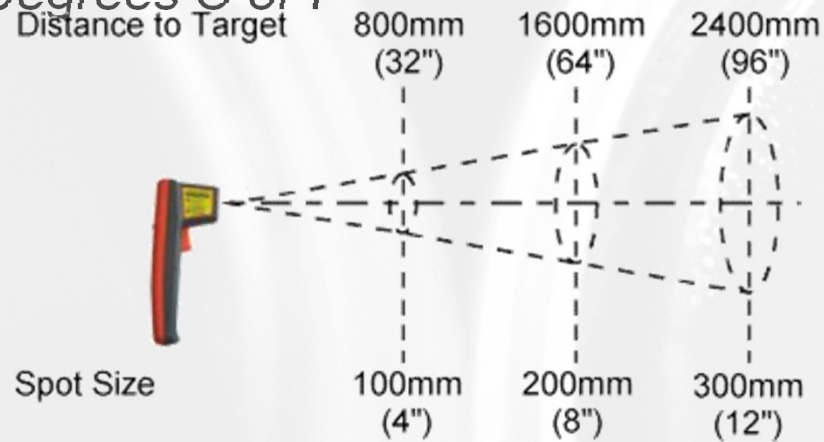
Non-contact Thermal Measurement ...



Elcometer 214L Laser IR Thermometer

- Laser target illumination
- 8:1 optics giving smaller spot size

- Degrees C or F



What Have we Learnt ?

- What climatic conditions are acceptable for painting ?
- What are the consequences of ignoring climatic conditions ?
- What is dewpoint and why is it important ?
- What instruments are available ?

Moisture Measurement

What are we going to learn ?

- How moisture content affect paint
- How moisture can be evaluated
- Which instruments are available to measure moisture

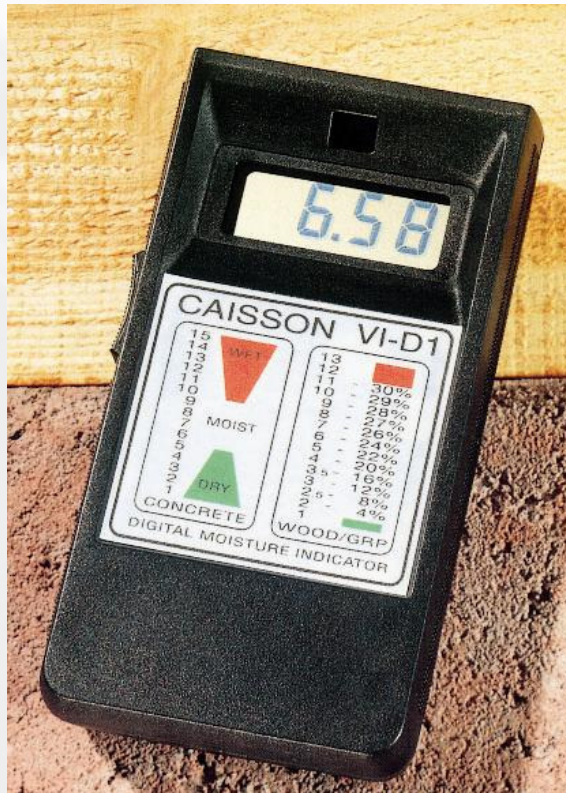
Moisture

- One of the most common causes of coating failure
- Porous substrates – wood, concrete, plaster, brick, etc.
- Conductivity, dielectric & electrical resistance measurement methods

118/2 Moisture Meter

- A direct replacement for the 118
- Built in electrodes
- Also measures moisture in plaster, brick, insulation, roofing and wood by-products
- Measures up to 42% moisture





Elcometer 7420 Moisture Meter

- ▶ Non invasive
- ▶ Concrete & wood to depth of 30 mm
- ▶ High frequency signal
- ▶ Visual comparison scale

7000 Moisture Meter

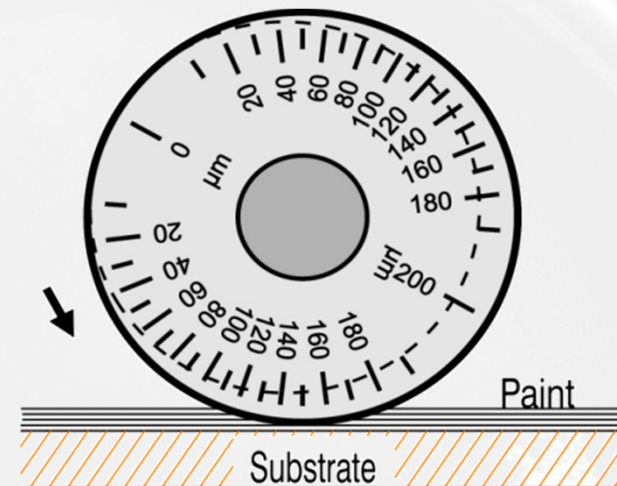
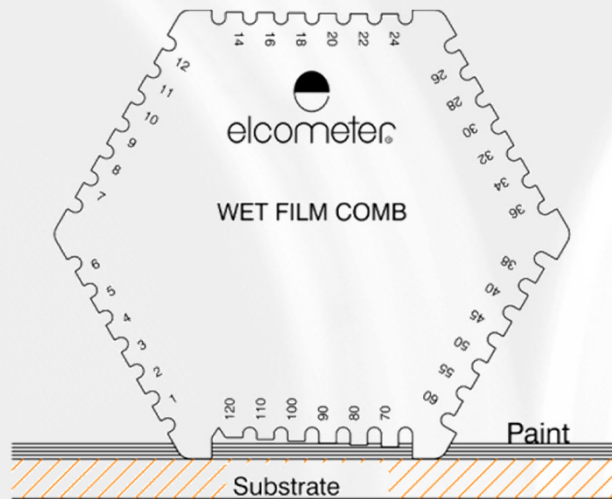
- ▶ Built in electrodes
- ▶ Two models
 - ▶ Non invasive
 - ▶ Invasive and non invasive
- ▶ Gives average moisture content
- ▶ Concrete, plaster, brick, wood etc..
- ▶ Visual red, yellow & green indications



What have we learnt ?

- How can moisture affect paint ?
- How can moisture be evaluated ?
- What instruments are available ?

Wet Film Thickness

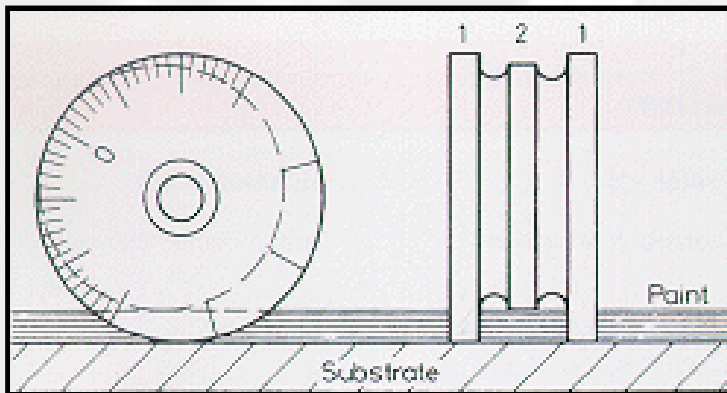


What are we going to learn ?

- Why measuring wet film thickness is of interest
- How we measure it
- What it tells us

Elcometer 3230 Wet Film Wheel

- Different scales available

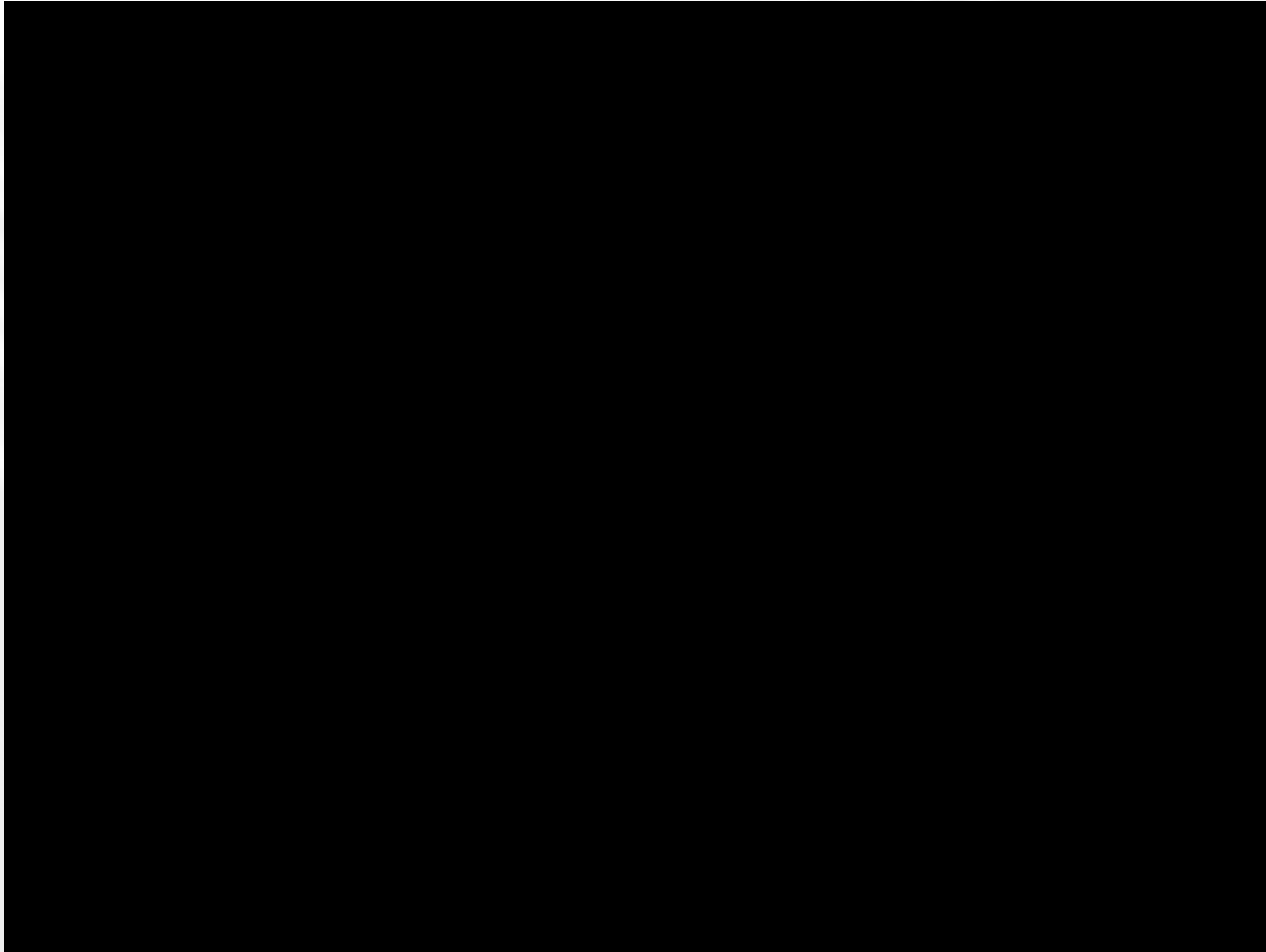


Elcometer 3230 Coil Coating Wet Film Wheel

- ▶ Eccentric centre wheel
- ▶ Start at top of scale and roll to zero
- ▶ Toothed outer wheel for slippery coatings or fast moving substrates



elcometer®
inspection equipment



60 years of excellence
www.elcometer.com

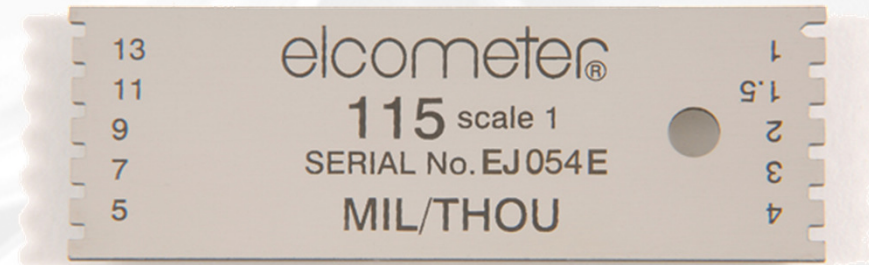
Elcometer 112 & 3230 Hexagonal Wet Film Combs

- ▶ 4 different scales available
- ▶ Stainless Steel or Punched Aluminium



Elcometer 115

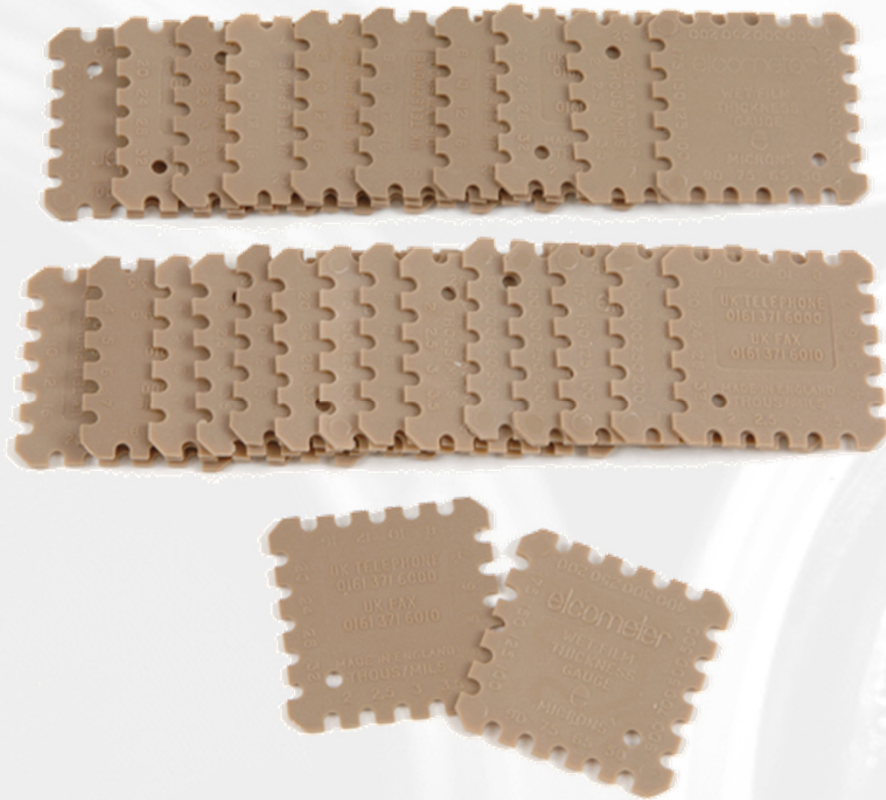
- Precision formed Stainless Steel
- Certificate available
- 4 scale ranges



Elcometer 3238

- Long Edge Wet Film Comb
 - 3 scale ranges





- ▶ Elcometer 154
 - ▶ ABS Plastic
 - ▶ Use Once Only
 - ▶ Cartons of 500
 - ▶ Can be customized
 - ▶ Logo
 - ▶ Colour

What have we learnt ?

- Why is measuring wet film of interest ?
- How can we measure wet film ?
- What does it tell us ?

Dry Film Thickness

What are we going to learn ?

- Why we want to measure a dry film
- What methods are available
- How the instruments work
- How the substrate affects the measurement
- The importance of calibration
- How to speed up collection
- How to improve Data management

Dry Film Thickness Destructive

Elcometer 141 P.I.G.

- ▶ Paint Inspection Gauge
 - ▶ Different cutters for different thicknesses of coating
- ▶ Illuminated Microscope
 - ▶ x50 Magnification



121/4 Paint Inspection Gauge - PIG

- Successor to 121/3
- Available as a standard or top
- Destructive test
- Quick, versatile method of coating thickness examination
- Top version holds 3 cutting tools
- Built in 50x microscope



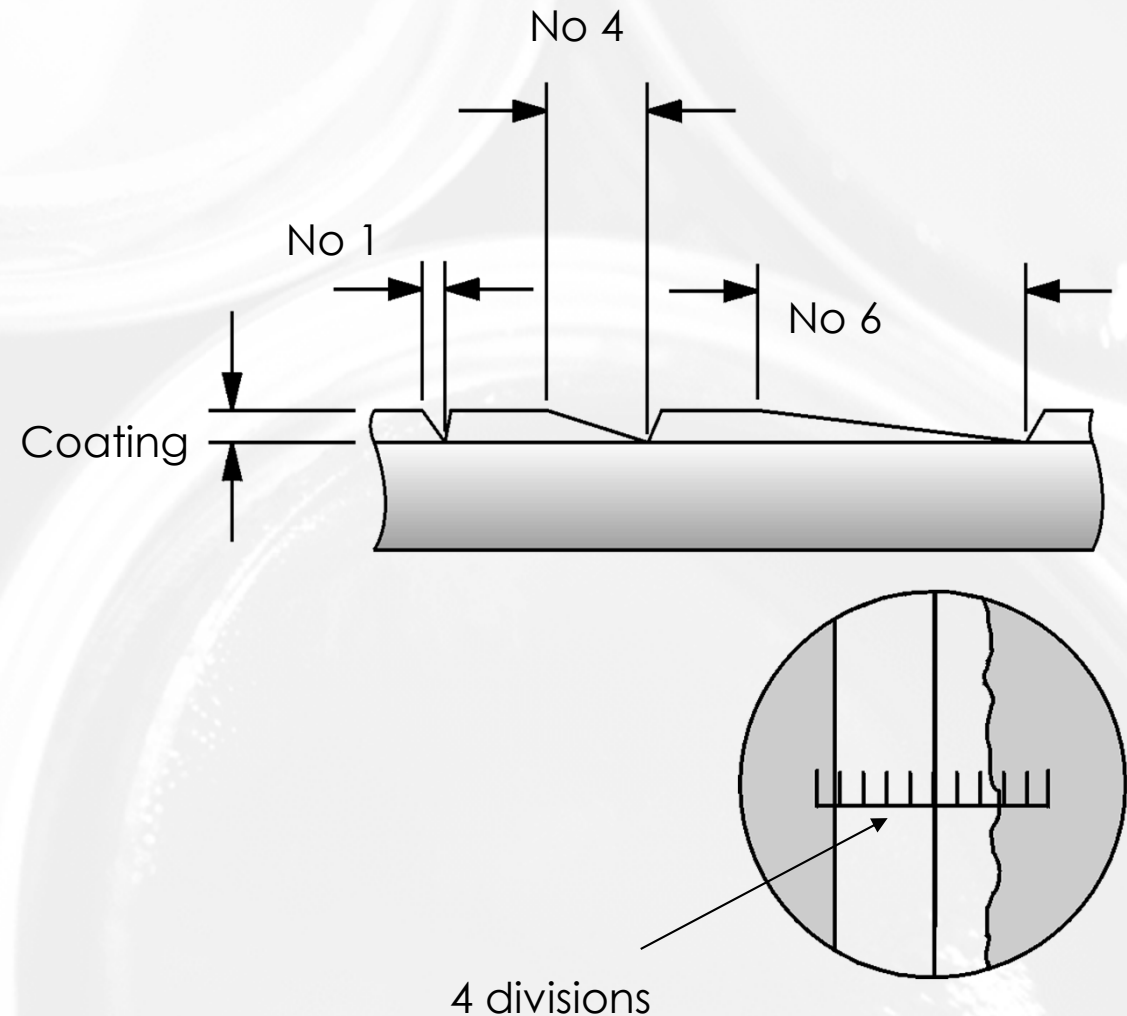
121/4 Paint Inspection Gauge - PIG

- Built in bright LED light
- Small and compact
- Rotating carousel (top)
- Rugged and durable
- Top can be used for cross hatch test (Top)

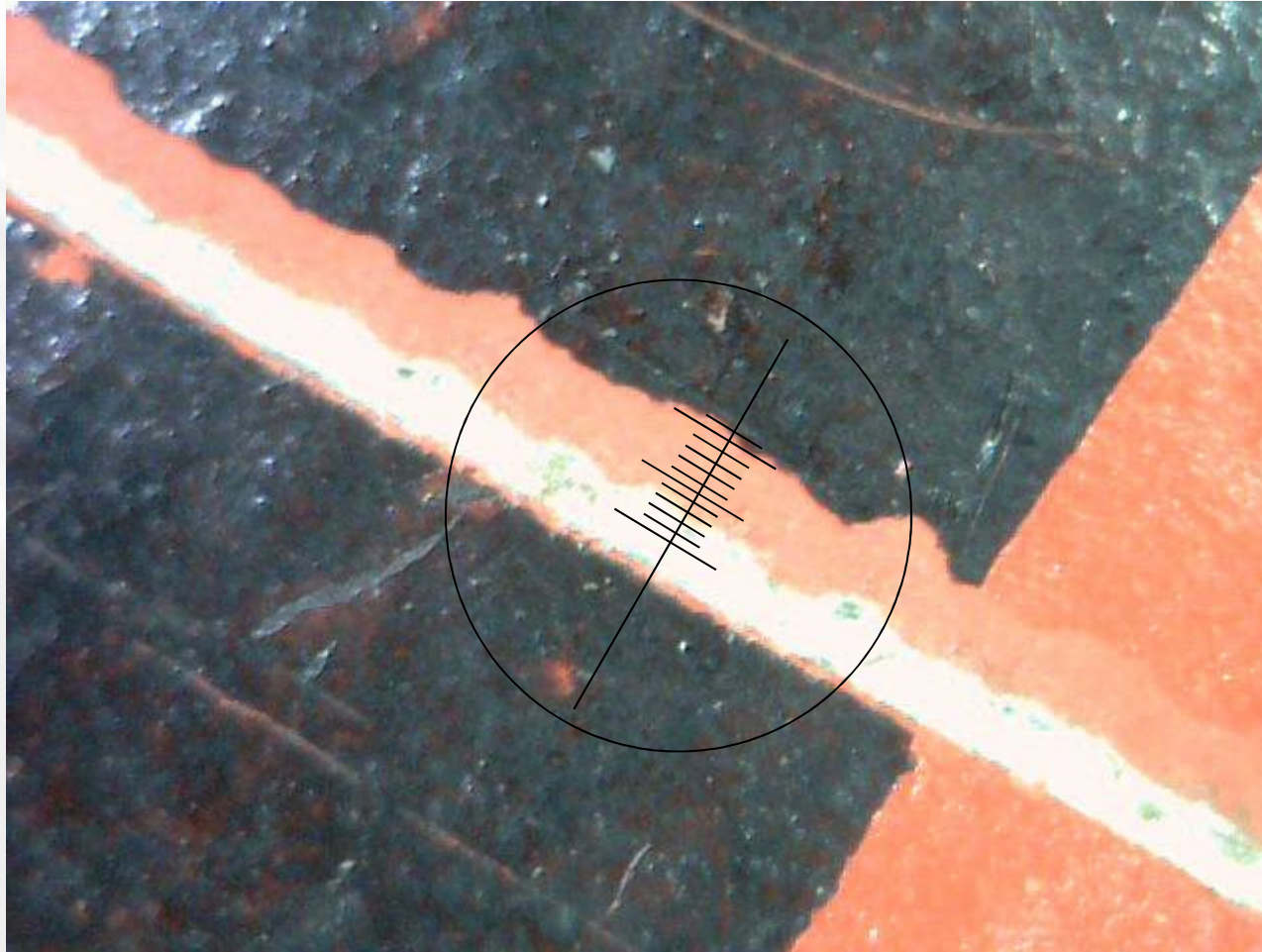


P.I.G. Operation

- Sectional View of Cuts
- View Through Microscope
- Count number of divisions and multiply by cutter factor



elcometer®
inspection equipment



60 years of excellence
www.elcometer.com

Mechanical Coating Thickness Gauges

Elcometer 211

- Known as the Banana Gauge
- $\pm 5\%$ accuracy
- “Fixed” calibration
- Metric & Imperial Scale options
- Used in hazardous environments
- Can be used underwater



Elcometer 157

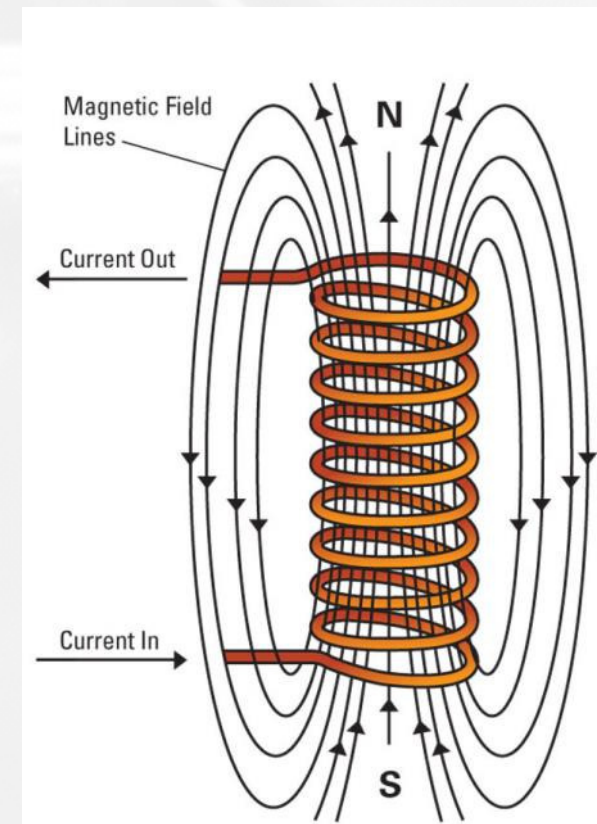
- Simple pull-off gauge
- $\pm 15\%$ accuracy
- 3 scales on body
- Used as an indicator of number of coats



Electronic Coating Thickness Gauges

First Principles

- Electronic gauges can only measure on metallic substrates
- If the substrate is magnetic (ferrous) then the gauge uses Electromagnetic Induction
- If the substrate is non-ferrous (non magnetic) then the gauge uses Eddy Current technique



Electromagnetic Induction

- Coils inside the gauge generate a low frequency magnetic field.
- The variation of the field is proportional to the distance between the probe tip and the substrate
- A measurement coil measures the magnetic field

Eddy Current

- Coils inside the gauge generate a high frequency magnetic field.
- These induce Eddy currents into the substrate
- The strength of the Eddy currents are proportional to the distance between the probe and base material
- The Eddy current magnetic field strength is then measured

Discuss whether the following can be measured ...

- Paint on lead
- Paint on plastic
- Paint on iron
- Paint on wood
- Gold on copper



456C Coating Thickness Gauge



- Robust ergonomic design
- USB and Bluetooth data output to ElcoMaster™ 2.0
- Accurate to 1-3% of range
- 70+ readings per minute

Key Features

elcometer[®]
inspection equipment

Fast reading rate of more than
70 readings per minute

Dust and water resistant
rugged design to IP65

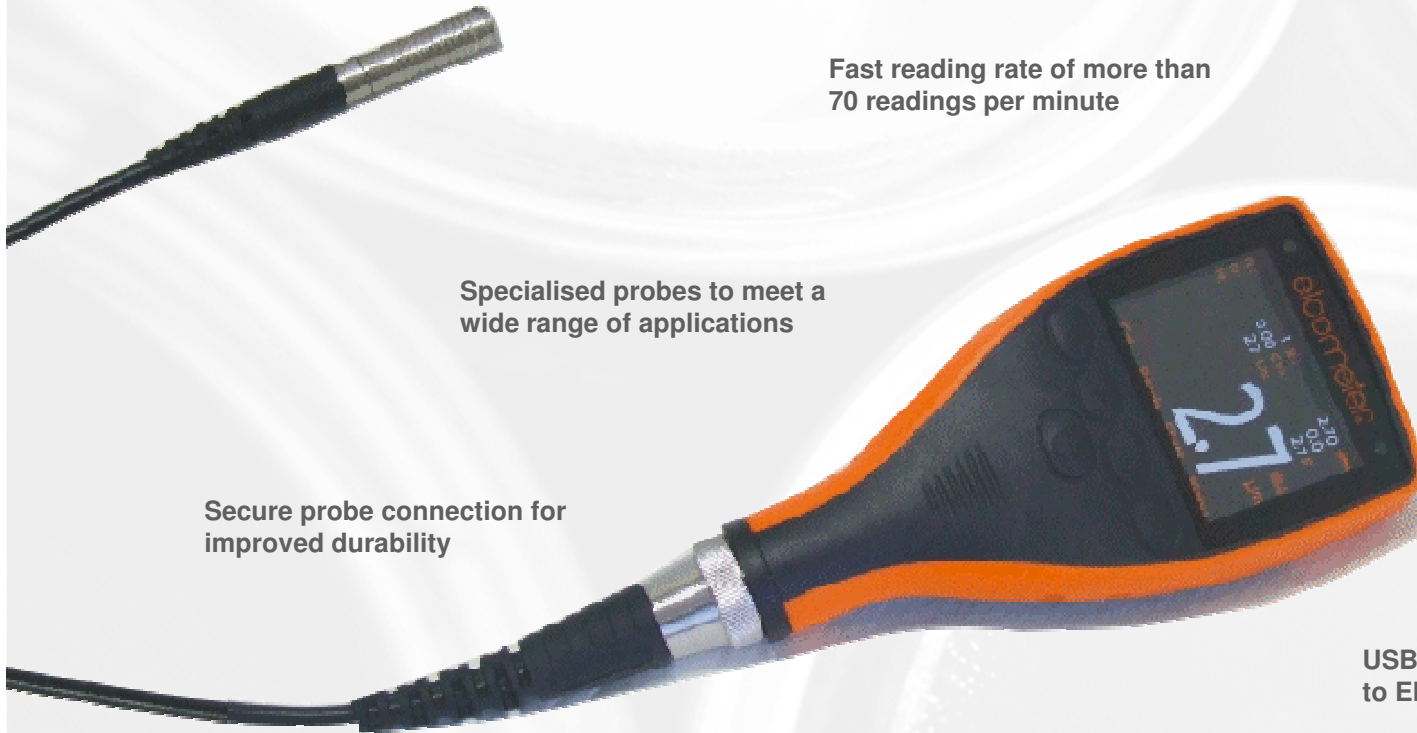
Specialised probes to meet a
wide range of applications

Secure probe connection for
improved durability

USB and *Bluetooth*[®] data output
to ElcoMaster 2.0 software

Integral and separate gauges to measure
coatings up to 30mm thick

60 years of excellence
www.elcometer.com



To select the correct instrument for the job you need to know...

- What the substrate is made of
- What the coating is
- What thickness the coating is
- Integral or separate probe desired
- Data storage required ?



Elcometer 456C

- Ferrous, Non-Ferrous and Dual FNF
 - Other Options
 - Entry Level (Integral gauges only)
 - Basic
 - Standard
 - Top
 - Basic now features Bluetooth for single reading transfer
 - Standard & Top have USB and Bluetooth output
 - Standard 1500 readings in 1 batch
 - Top 250,000 readings in 1500 batches



Scanning Probe

- A new 456C probe for scanning a coated surface
- Scan an area then lift the probe to display :
 - Average coating thickness
 - Maximum coating thickness
 - Minimum coating thickness



Scanning Probe

- Readings can be displayed on a run graph
- Auto repeat mode takes & stores data every 0.5 secs
- Snap on replaceable cap
- 40% faster when used with SSPC PA2
 - Fixed batch size (5)
 - Counted average (3)



Elcometer 355

- Probe Module fitted in rear of gauge
- 1% Accuracy – good accuracy due to dual microprocessors
- μ P's in probe module and in gauge
- F and N modules
- Range of probes



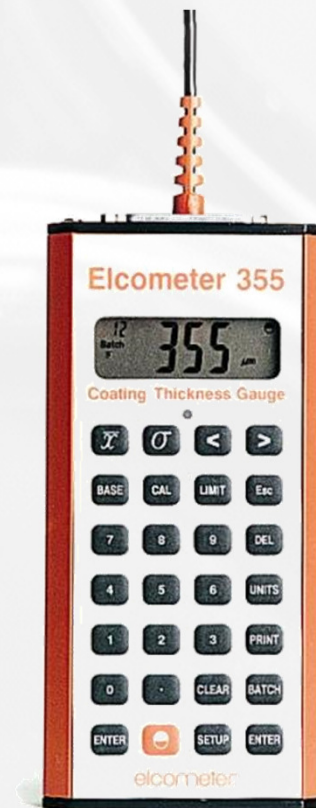
Elcometer 355 Standard

- Memory for 5000 Readings
- 25 pre-set batches
- Statistics
- Serial & Parallel O/P



Elcometer 355 Top

- Memory for 10,000 readings
- 200 batches
- Serial & Parallel O/P
- Date/Time Stamp
- Statistics



Elcometer 500 – Coatings on Concrete

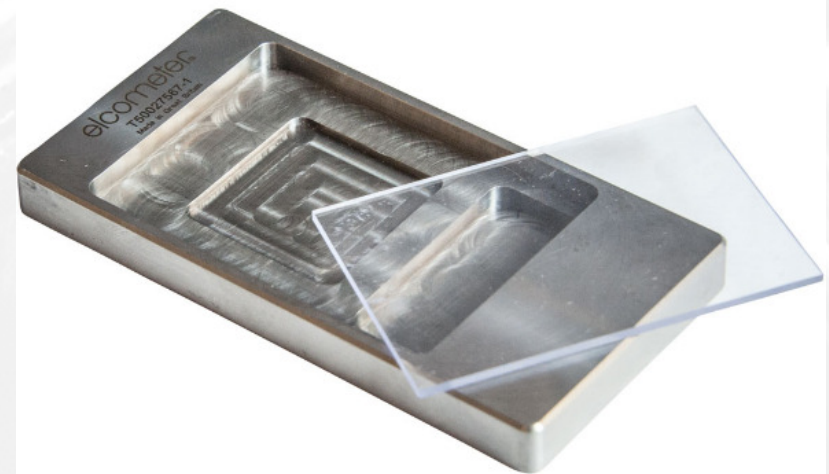
- C1 and C2 probes
- Measure up to 10mm on cement
- 100,000 readings memory, 1000 batches *
- $\pm 2\%$ or $\pm 10\mu\text{m}$ accuracy
- Bluetooth to iOS or Android *



* Top gauge

Elcometer 500 – Coatings on Concrete

- C1 - 150 – 2,500 μm
- C2 – 750 -10,000 μm
- CCM – Coatings calibration mould
- Calibrate to bespoke coatings
- Kit includes 456 & CCM



Elcometer 500 – Coatings on concrete

How to create a coating sample using the Elcometer 500 Coating Calibration Mould (CCM)



1. Place the Coating Calibration Mould (CCM) on a flat surface and completely fill the sample chamber with the test coating.



2. Using the plastic scraper, scrape over the coating allowing the excess to fall into the overflow chamber. Allow the coating to cure.



3. When fully cured, calibrate a ferrous coating thickness gauge on the side of the CCM then measure and record the dry film thickness at the centre of the coating.



4. Measure the same point using the Elcometer 500.

Enter the dry film thickness measurement and save it in the Elcometer 500's Coating Materials list.

What have we learnt ?

- Why do we measure a dry film ?
- What methods are available ?
- How do the instruments work ?
- How does the substrate affect the measurements ?
- Why is calibration so important ?
- How can we speed up data collection ?
- What can we do to manage the data more efficiently ?

Coating Adhesion

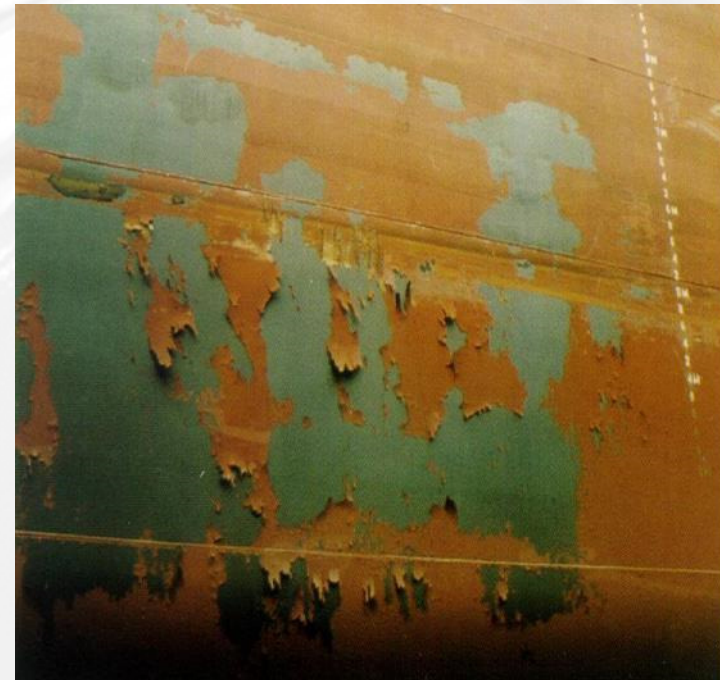


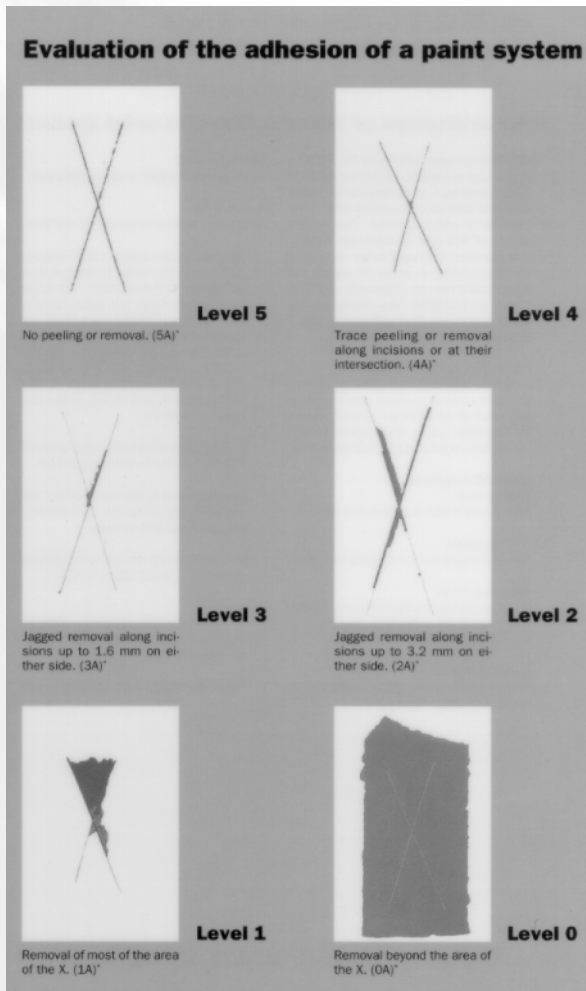
- What are we going to learn ? ...
 - What methods are available to test coating adhesion
 - What instruments are available
 - How you interpret results
 - Why they can give different results
 - Which method do we use

Method selection

- Cross Cut
 - Fast low cost
 - Flat surfaces only
 - Up to 250 μm (10 mil)

- Pull Off
 - Use dollies
 - Slower due to time for adhesive cure
 - Flat & Curved surfaces



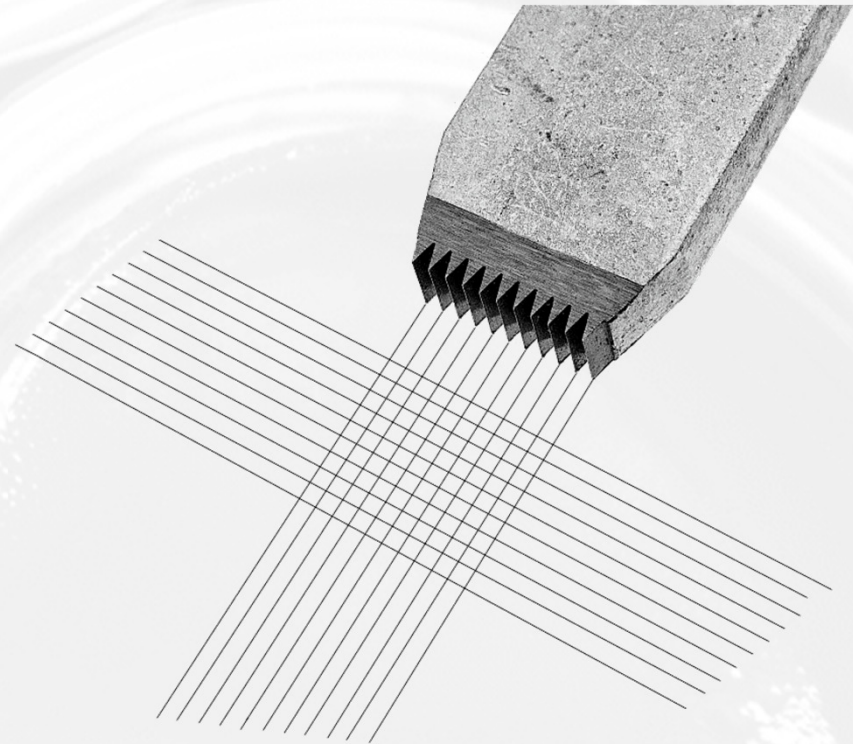


St Andrews Cross

- Assessment chart
- Use for exposure and accelerated stress testing of coatings
- Fast low cost method
- Maximum thickness 125 μm

Elcometer 1540 Cross Cut Tester

- ▶ 1 mm cutter 11 teeth
- ▶ Gives 100 squares
- ▶ Easy to assign adhesion percentage



Elcometer 107 Cross Hatch Cutter Kits



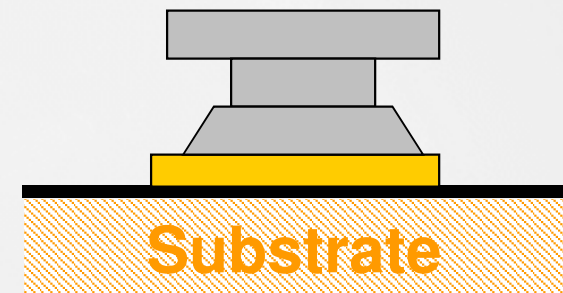
Elcometer 1542 Cross Hatch Adhesion Tester

- Ideal for test panels
- Wheeled carriage for greater stability

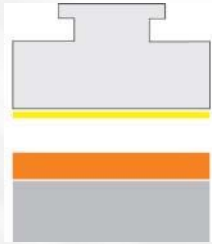


Pull-off Methods - Common Issues

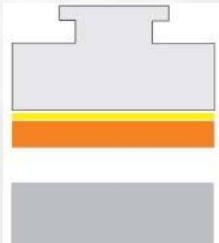
- Use adhesive to attach dolly to coating
- Measure force to remove coating
- Ensure dolly face is rough for good contact
- Choice of adhesive



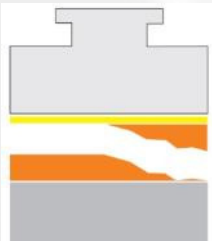
Adhesion Test Failure Modes



- Glue Failure
 - Failure of the applied adhesive
 - Not an Admissible Test unless failure occurs above test specification



- Adhesive Failure
 - Coating to substrate or undercoat mechanical bond failure
 - Admissible Test



- Cohesive Failure
 - Coating chemical bond failure
 - Admissible Test





Adhesive
Failure

Partial
adhesive
Failure

Cohesive
Substrate
Failure

Glue
Failure

Types of Pull-Off Testers

- ▶ ASTM Type II - Fixed Alignment Manual Adhesion Tester



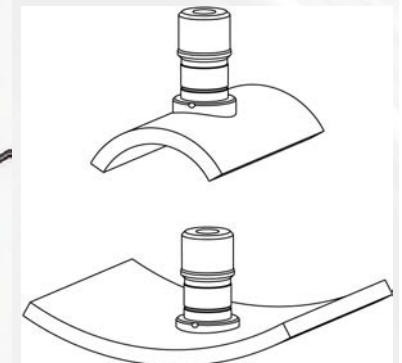
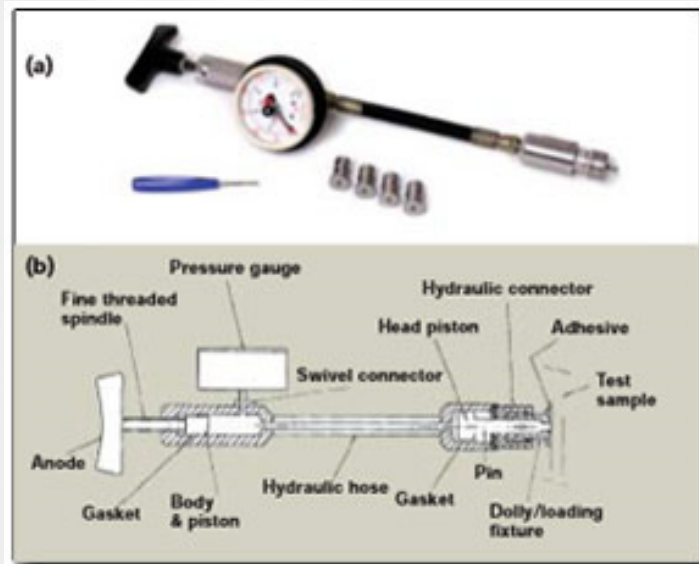
Mechanically load applied by
Compressed Spring



Mechanically load applied by
Compressed Washers

Types of Pull-Off Testers

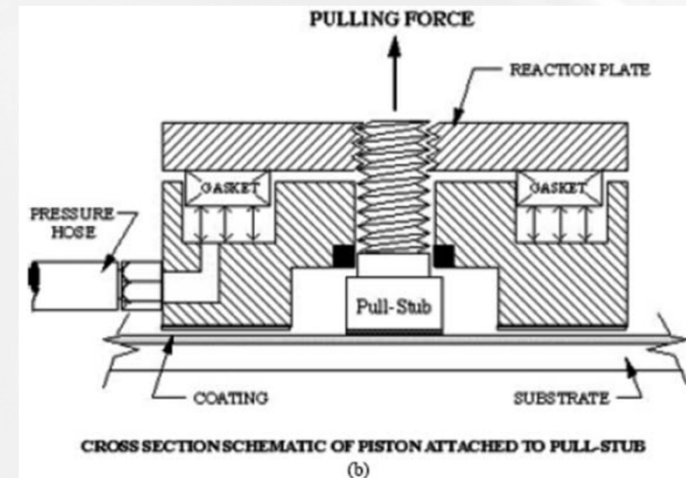
- ASTM Type III - Self-Alignment Hydraulic Adhesion Tester
 - Operated by manually applied hydraulic pressure
 - Often called Push-Off or HATE Testers
 - Available with Flat or Curved dollies



Curved Dolly Options

Types of Pull-Off Testers

- ▶ ASTM Type IV - Self-Alignment Pneumatic Adhesion Tester
 - ▶ Operated by pneumatically applied pressure



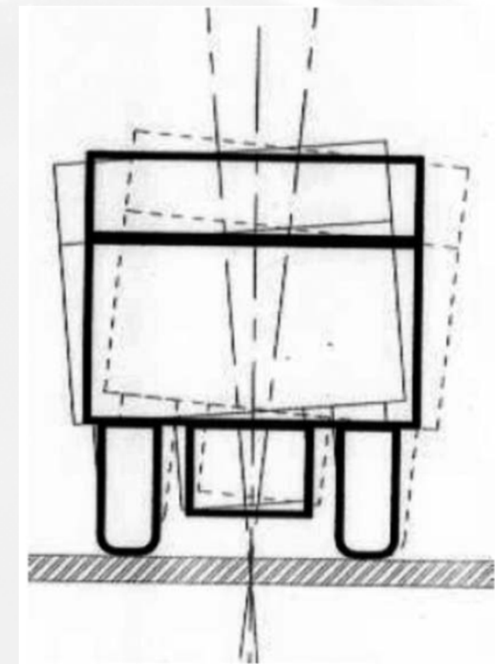
Types of Pull-Off Testers

- ▶ ASTM Type V - Self-Alignment Adhesion Tester
 - ▶ Operated by manually or automatically applied hydraulic pressure
 - ▶ Undesired Shear Load can occur under certain conditions



Types of Pull-Off Testers

- ▶ ASTM Type VI - Self-Alignment Adhesion Tester
 - ▶ Operated by manually or automatically applied Hydraulic Pressure
 - ▶ Features 'self-aligning' test head
 - ▶ Often called PAT Testers






ASTM Testing



- ASTM D4541 Comparison Testing
 - Five Types of Portable Adhesion Testers (Type II to Type VI)
 - 20 mm diameter dollies used
 - Force Application Rate – 1 MPa/s or less
 - Force applied in a continuous and smooth manner
 - Cutting round the dolly ?

ASTM Test Results

- Repeatability and Reproducibility results ASTM Testing
 - averaged across coating types for each instrument

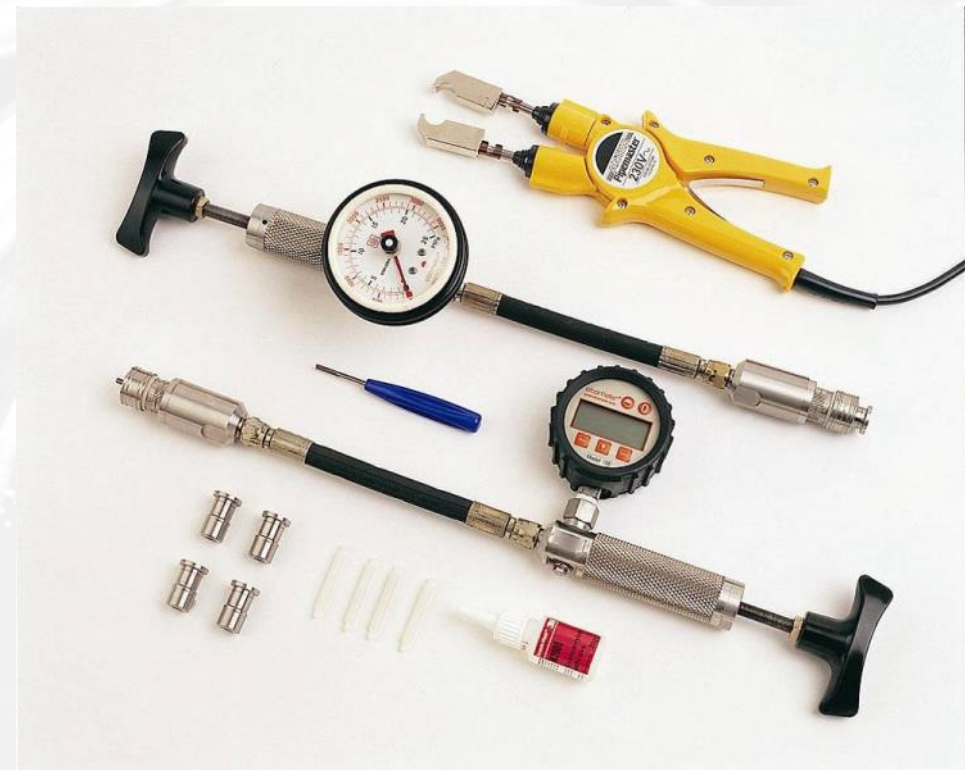
		Repeatability	Reproducibility
Method B (Type II)		64.7%	76.0%
Method C (Type III)		33.8%	65.9%
Method D (Type IV)		14.8%	28.4%
Method E (Type V)		27.8%	34.1%
Method F (Type VI)		17.5%	23.0%

- Elcometer 106 - ASTM type II - Pull-off Adhesion Tester
 - 5 Scales
 - 2 types – hand wind or ratchet
 - Ideal for general applications



Elcometer 108 ASTM type III -Hydraulic Adhesion Tester

- 0 - 18MPa range
- Dolly has a hole through the centre
- Through hole force pushes dolly away from surface
- Curved dollies available
- Supplied with heated tongs to clean dolly
- Designed for use on pipework and cylindrical surfaces



Elcometer 506 – ASTM type V -Analogue Adhesion Tester

- Manual hydraulic operation
- Measures up to 50MPa
- Compatible with 14.2, 20 & 50mm dollies
- 25MPa & 50MPa range display
- Course adjustment screw



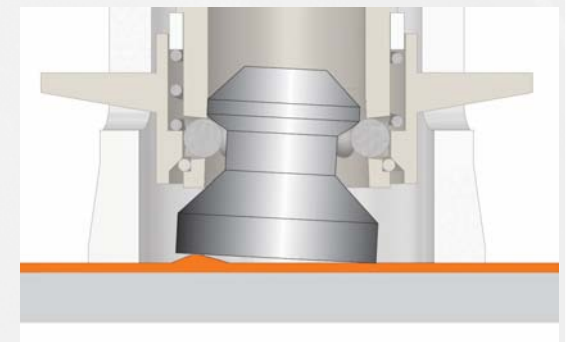
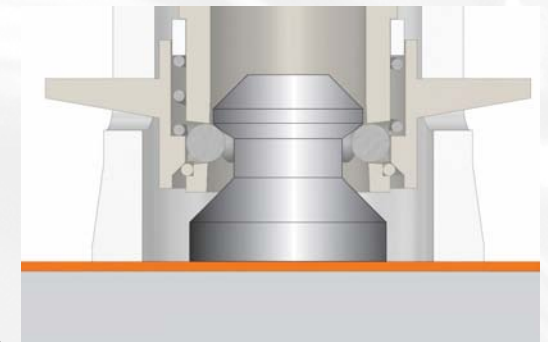
Elcometer 506 Digital Adhesion Tester

- Manual hydraulic operation
- Measures up to 50MPa
- Compatible with 14.2, 20 & 50mm dollies
- Dolly size selection button auto-ranges
- Course adjustment screw



Elcometer 506 Adhesion Gauge

- Designed to orientate load to minimise shear effects
- Digital and Analogue versions available
- Actuator skirt options available for thinner substrates
- Usable on metal, wood, concrete and other substrates
- Available with field verification unit



Elcometer 506 Adhesion Tester



- ▶ Different 'skirts' available
- ▶ Large skirt for 50mm dolly
- ▶ Narrow skirt for thin substrates
- ▶ Standard skirt for 14.2 & 20mm

Elcometer 510 - ASTM type V -Automatic Adhesion Gauge



The Model Range

elcometer®
inspection equipment

➤ Elcometer 510:

➤ Model S

- An entry level gauge
- Battery Powered
- Defined pull rates
- 60 reading memory
- USB output to ElcoMaster 2.0;



60 years of excellence
www.elcometer.com

The Model Range

elcometer®
inspection equipment

➤ Elcometer 510:

➤ Model T

- Battery and Mains Power
- USB & Bluetooth (Android and iPhone, iPad, iPod)
- Up to 60,000 readings in 2,500 alphanumeric batches
- Cohesive/ adhesive attribute information,
- Pull rate graph
- Pull to Limit setting



60 years of excellence
www.elcometer.com

510 kit

elcometer®
inspection equipment



60 years of excellence
www.elcometer.com

Elcometer 510 – Key Features

elcometer®
inspection equipment

Variable pull rates 0.1 – 1.4MPa/s (15-203psi) to meet national and international standards

Smooth and continuous pressure application for consistently repeatable results

MPa, psi, N/mm²
and N

Store up to 10,000 readings, 2,500 alpha numerical batches with attributes and pull rate graphs

10mm dolly: (14400psi)	<100MPa
14.2mm dolly: (7200psi)	<50MPa
20mm dolly: (3600psi)	<25MPa
50mm dolly: (580psi)	<4MPa

Pull to maximum or to a pre-defined limit (non-destructive test)



Optional thin substrate skirt



ElcoMaster™ 2.0
data management software

ElcoMaster™
mobile app

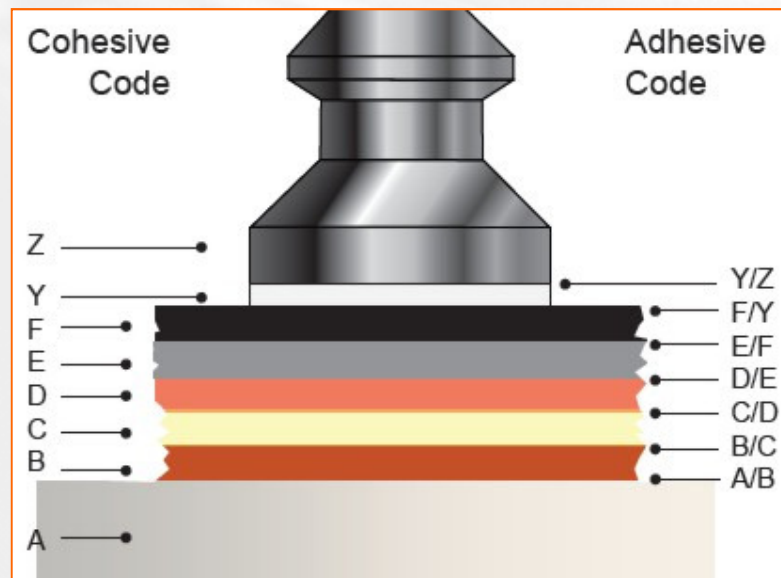
Suitable for use in
Cloud Computing

Made for
iPod iPhone iPad

Android™

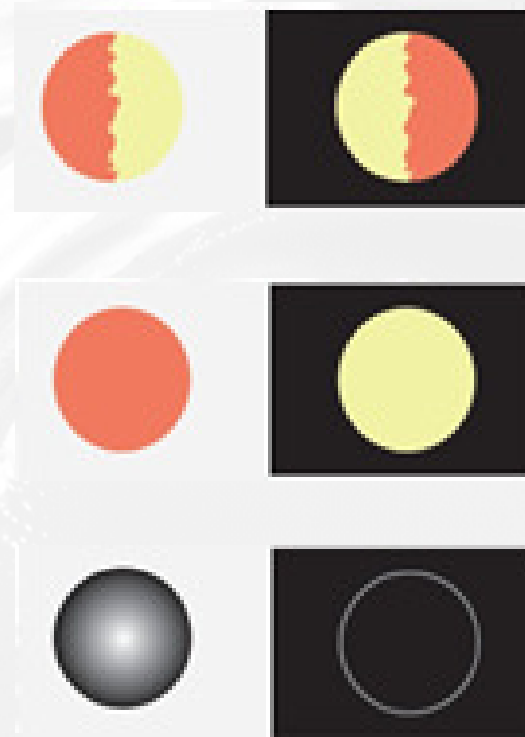
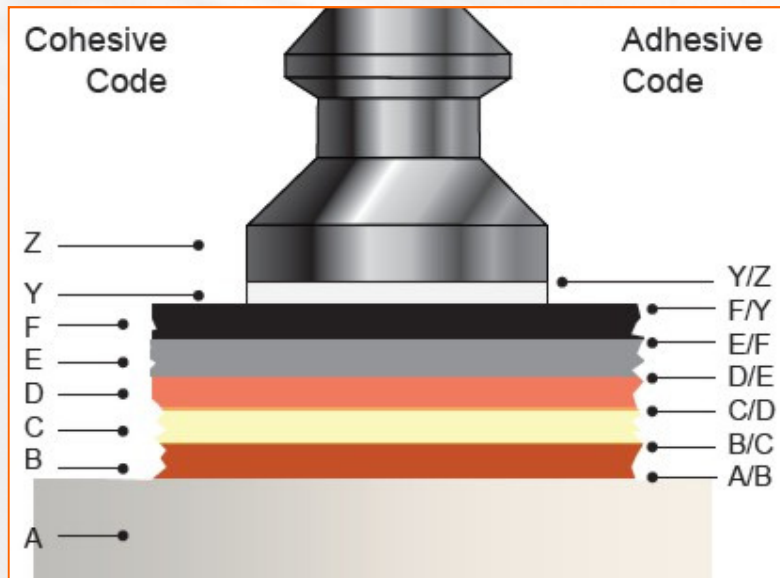
www.elcometer.com

Cohesive / Adhesive Failure Attributes



Cohesive Failure Layer ^d		Adhesive Failure Layers	
Code	Description	Code	Description
A	Substrate	A/B	Substrate & Layer 1
B	Layer 1	B/C	Layer 1 & Layer 2
C	Layer 2	C/D	Layer 2 & Layer 3
D	Layer 3	D/E	Layer 3 & Layer 4
E	Layer 4	E/F	Layer 4 & Layer 5
F	Layer 5	F/Y	Layer 5 & Glue
Y	Glue	Y/Z	Glue & Dolly

Cohesive / Adhesive Failure Attributes



- What have we learnt ? ...
 - What methods are available ?
 - What instruments do we offer ?
 - How do you interpret the results ?
 - Why can different instruments give different results ?
 - Which instrument and methods should we use ?

Porosity Detection in Coatings

- What are we going to learn ? ...
 - What holiday detection is
 - What methods are available
 - What instruments we can offer
 - How to operate the units safely

Definition of Porosity

A flaw or defect in the cured coating that reduces the effectiveness of the coating as a protection against corrosion.



Porosity Test Methods

- Low Voltage (Wet Sponge Method)
- High Voltage (DC / Pulsed DC) Holiday Detection
 - (Also known as spark testing)

- ONLY USE ON NON CONDUCTIVE COATINGS !!!

Elcometer 270 Pinhole Detectors

- Low Voltage Method
- Wet Sponge Pinhole Detection (wet sponge & squeeze out)



Summary - 270

- Suitable for non-conductive coatings on a conductive substrate
- 9V for coatings up to 300 μm
- 90V for coatings up to 500 μm

High Voltage Holiday Detection

High Voltage Holiday Detection is a method of locating flaws in electrically insulating protective coatings on conductive substrates.

elcometer®
inspection equipment

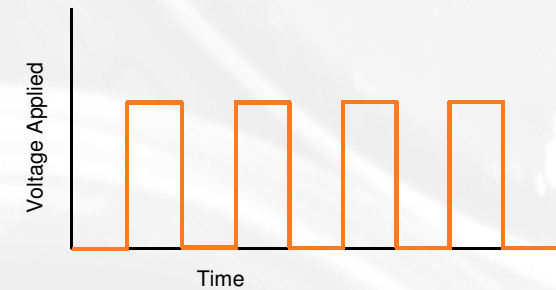


60 years of excellence
www.elcometer.com

Pulsed DC & Continuous DC Explained

Pulsed DC

The Elcometer 280 operates using this principle



Continuous DC

The Elcometer 236 and 266 operate using this principle



Elcometer 266

- ▶ Continuous DC
- ▶ 5kV, 15kv & 30kv options
 - ▶ Interchangeable handles
- ▶ Auto/Digital voltage and sensitivity settings
- ▶ Safety features
 - ▶ For operator
 - ▶ For coating



Elcometer 266 – Operator Safety

- Rugged and waterproof to IP65
- Safety pressure switch on handle
- Current limiting
- Specialised extended ribbing
- 12V cable from base unit to handle
- Two handed rubber adaptor



Elcometer 266 – Coating Safety

- Current limiting
- Voltage Calculator with digital standards library
- Integrated jeep tester



Elcometer 266

- Accessory adapters for
 - Tinker and Razor
 - Spy
 - PCWI
 - Legacy Elcometer equipment



Elcometer 266

- Probe Options
 - Band Brush
 - Right Angle Brush
 - Right Angle Conductive Rubber
 - Internal Pipe Brush
 - External Pipe Rolling Spring



Elcometer 280

- ▶ Pulsed DC
- ▶ 0.5 – 35kV range
- ▶ Standard Gauge or Top Kit
- ▶ Trailing earth lead
- ▶ Auto/Manual digital voltage setting



Elcometer 280 Safety features

- Operator
 - Safety switch
 - Specialised extended ribbing
 - Energy limit
- Coating
 - Voltage calculator with digital standard library
 - Integrated jeep tester



The 2 Key Advantages of the Pulsed DC System

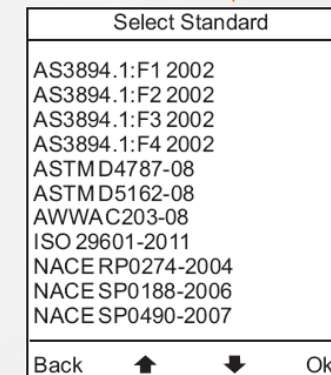
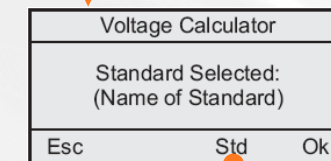
- The pulsed DC system does not need the direct metal-to-metal ground contact and therefore can be used with a trailing lead.
- The Elcometer 280 can be used to test for holidays over slightly conductive coatings, or dirty or damp surfaces up to 25mm thick



The Voltage Calculator (266 & 280)

This function automatically calculates the test voltage using the specified international standard and the specified dry film thickness.

1. Switch the gauge on
2. Select the required standard from the list available
3. Adjust the dry film thickness to the required value
4. Press Ok to set the instrument voltage to the calculated value

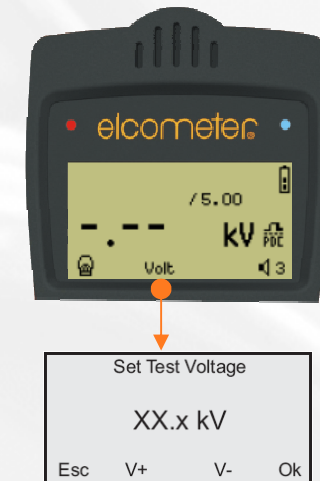


Elcometer 280 Key Features Explained

The Voltage Calculator

Alternatively, the voltage can be adjusted manually (Models S & T).

1. Switch the gauge on
2. Adjust the voltage to the required level
3. Press Ok to set the instrument voltage



Elcometer 280 Pulsed DC Holiday Detector

Flashing display, bright LED and a user adjustable volume alarm indicates detection of a holiday

probe accessories available – compatible with all Elcometer holiday detectors

Safety trigger integrated inside the handle cuts power if released

Ideal for testing clean, damp, dirty or slightly conductive coatings



Voltage calculator

Rugged, shock proof and water resistant design to ensure long life – even in harsh environments

Internal jeep tester ensures that the selected voltage equals the test voltage

Accessories for Elcometer High Voltage Detectors

A wide range of electrodes and accessories is available :

- Band Brush Probes
- Wire Brush Probes
- Internal Pipe Brush Probes
- External 'C-type' Brush Probes
- External Pipe Rolling Springs
- Conductive Rubber Probes
- Grounding Mats



- What have we learnt ? ...
 - What is holiday detection ?
 - What methods are available ?
 - Which instruments can we offer ?
 - How do we operate the instruments safely ?

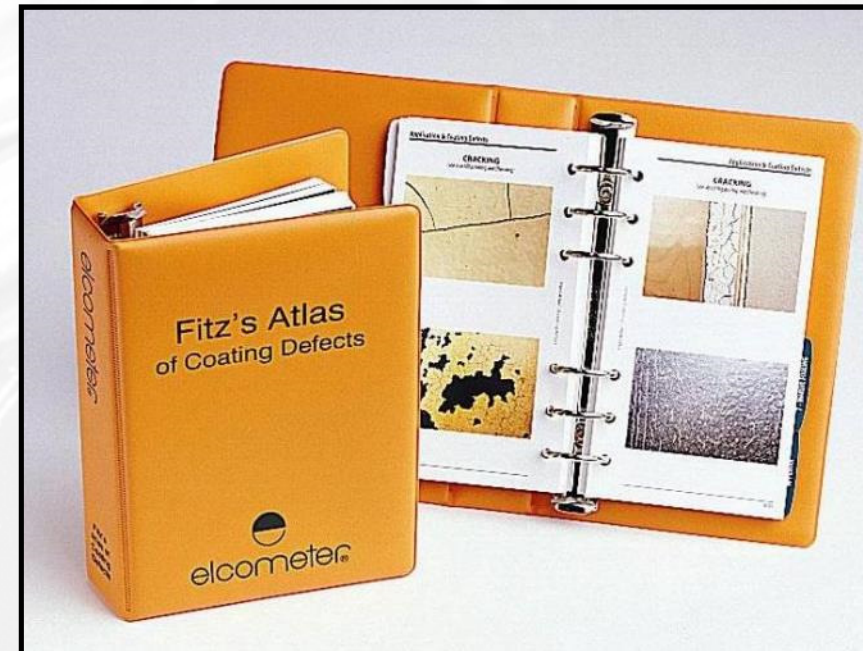
Inspector's Accessories

Publications

- Fitz's Atlas
- Macaw's Pipeline Defects

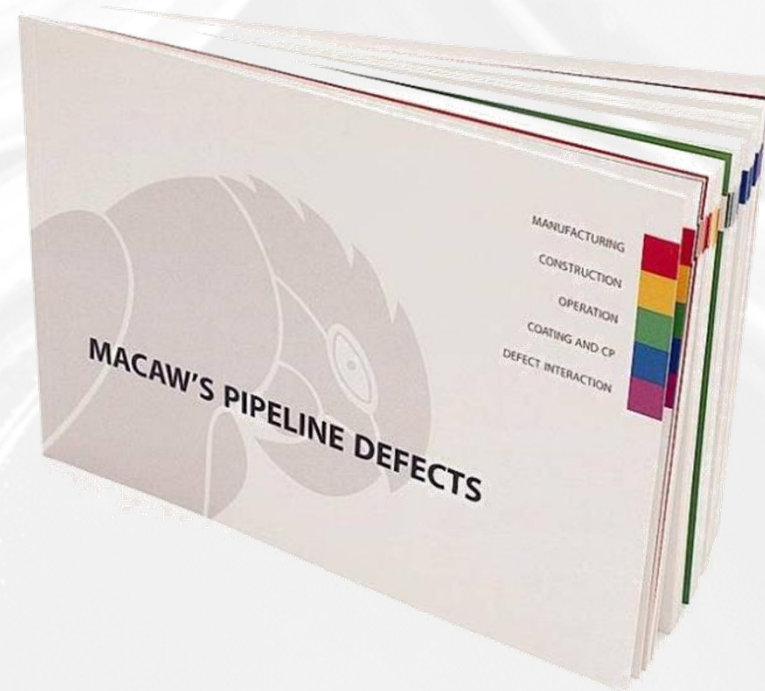
Fitz's Atlas

- Coating Defects with probable cause
- Prevention & repair suggestions



Macaw's Pipeline Defects

- 200 pages
- Colour illustrations
 - Manufacturing
 - Construction
 - Operation
 - Coating & CP
 - Defect Interaction



Elcometer 131 Inspection Tools

- Mirrors
- Magnifier
 - x 8 Magnification



Inspection Tools

- Safety Torch (132)
- Illuminated Magnifier (137)
 - x 10 Magnification



Elcometer 7210 Pocket Microscope

- 30 x magnification
- Built-in light source



Elcometer 7210 Microscope

- Graduated Reticule for measurement
- Choice of x 20 to x 300 magnification



Elcometer 900 Concrete Crack Microscope

- 50 x Magnification
- Integral light source
- Crack width 0.2 to 1.5 mm
- Also used for Elcometer 141





elcometer®
inspection equipment

Inspection Kits

60 years of excellence
www.elcometer.com

Inspector's Kits



Certification

CERTIFICATE OF CONFORMANCE

elcometer

Customer: Sellars Electronics Ltd
Edge Lane
Droylshole
Ruddwiser
HEX 680

Order No: 016215

Customer Order No: 016215

Invoice No: C31211

Account No: 20303

DATE: 03/07/97

PRODUCT CODE	DESCRIPTION/SERIAL NO.
SI14C---J	BACKPACK SETING HYDROMETER
A134SP102	DIGITAL DIG 31.100V STARS
0213---M12	DIGITAL THERMOMETER - 5000
SI14---J	DEW POINT CALCULATOR (DPS)
T114441-	SI14A DIGITAL THERMOMETER
T114447-	SI14C SPARE THERMOMETER DS
SI14335W	DREEL KEY TYLE COOH 17400
CITY L130 P	KEY L130 P
	(Item 2 Serial No M05665 0)
	(Item 1 Serial No M05665 0)
	Despatched by City L130 P

TEST CERTIFICATE

elcometer

Customer: Sellars Electronics Ltd
Edge Lane
Droylshole
Ruddwiser
HEX 680

Order No: Elcometer: 054302

Customer: 46/06/1997

Model: Serial No: Description:

343P7H 3P7A27-519 Coating Thickness Gauge

FULL VALUE		INSTRUMENT READING	
1342 um	1341 um	1341 um	1341 um
1090	1090	1090	1090
349	349	349	349
178.8	178.8	178.8	178.8
122.2	122.2	122.2	122.2
50.0	50.0	50.0	50.0
26.5	26.5	26.5	26.5

The product described above and supplied against the defined has been tested in accordance with Elcometer's procedures and is verified as being compliant with the requirements of the relevant specification.

Signed: *A.R. Smith*
A.R. SMITH
Quality Assurance Engineer.

CERTIFICATE OF CALIBRATION

ISSUED BY LAMBDA CALIBRATION LTD

DATE OF ISSUE: 10 June 1997 SERIAL NUMBER: X 2311

SPECIMEN

CRM: Bode-Low
Order: Lonsdale 902 478
Tel: 01202 380000/04084

FACE: 3 (UP)

APPROVED/SERIAL: P.M. DAVIES
S.T. MADRISALL

ITEM No:- 62704-720

DESCRIPTION:- A set of 5 Paint Thickness Setting Foils

CURRANT:- Sellars Electronics Ltd, Droylshole

DATE OF CAL:- 20/06/97

RANGE:- Lambda Procedure No. C.I.B.-1A Part 13

RESULTS:- Each of the Setting Foils was calibrated at 20°C ± 1°C measuring force equal to that of the Elcometer Paint Th Meter. The measured results, which are tabulated below, were in the limits specified by Elcometer Testprocedures Ltd.

Foil No.	MEASURED THICKNESS (um)	REQUIRED TOLERANCE (um)	ELCOMETER STANDARD LIMITS	
			LOWER	UPPER
497	12.0	12.1	12.0	12.1
498	28	28.4	28	28.4
499	49	49.1	49	49.1
495	120	120.2	120	120.2
496	175	175.0	175	175.0

The maximum variation to the thickness of any foil was 1.1µm

EQUIPMENT USED:- LM-59-02, LM-3-01, LM-1-14
ESTIMATED UNCERTAINTY OF MEASUREMENT:- ± 0.001µm

The uncertainties are for a confidence probability of not less than 95%

This certificate is based in accordance with the requirements of the United Kingdom Accreditation Scheme as to the NPLAS Accredited Standard and UKAS Regulation. It provides documentary evidence of compliance to national standards, and to the needs of measurement related to the National Physical Laboratory or other national standards laboratories. The certificate may not be reproduced other than in full, except with the express approval of the issuing laboratory.

SIGNED: *A.R. Smith*
MR A. R. SMITH
QUALITY ASSURANCE ENGINEER

CALIBRATION CERTIFICATE

20 June 1997

elcometer

Customer: Sellars Electronics Ltd
Edge Lane
Droylshole
Ruddwiser
HEX 680

Order no: Elcometer: 054302

Customer: 46/06/1997

Calibration Certificate no: 29499

Calibration date: 20/06/97

Order no: Elcometer: 054302

Customer: 46/06/1997

Item set measured foils to 1000um

COLOUR	FOIL IDENTITY SERIAL NO.	THICKNESS (MICROMETRES)	
		MEASURED	TOLERANCE
GREY/BLUE	PE4719	951	1000
BLACK	PF0940	528	500
WHITE	PF0280	211.6	150.0
BROWN	PF1100	130.5	125.0
DAKE BLUE	PF3901	49.4	50.0

THE FOLLS SUPPLIED ARE ACCURATE TO WITHIN 2% OR +/- 0.5µm WHICHEVER IS THE GREATER OF THE STATED MEASURED VALUES.

THE EQUIPMENT USED IN FOIL CERTIFICATIONS ARE TRACEABLE TO NATIONAL STANDARDS VIA THE FOLLOWING:-

NPLAS CERTIFICATE NO.	SERIAL NO.	DESCRIPTION
04129	QM0082/583	Electronic gauge & probe
021884	QM0081	Set of slip gauges
031056	QM0089	Set of slip gauges

SIGNED: *A.R. Smith*
MR A. R. SMITH
QUALITY ASSURANCE ENGINEER

Types of Certificate

- Certificate of Conformance
 - Goods are as described on the order
- Test Certificate
 - Results of testing to Elcometer procedures
- Calibration Certificate
 - Standards and Fixed Calibration Gauges only
- UKAS Certificate of Calibration
 - Independent Laboratory

Besides Coating Thickness, Certification can also apply to:

Gloss

Force (Adhesion)

Temperature

Dimensions

Colour

Viscosity (Oils)

Voltage (Porosity)

Humidity

Weight

Time