MARINE INSURANCE – MEETING THE CHALLENGE OF THE NEW DECADE

12 – 15 September

Non-Destructive Testing in the Yachting industry. Smoke and Mirrors?

Inland Hull, Fishing Vessels and Yachts Workshop

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My presentation is going to be in five main sections.

1. What is Non-Destructive Testing (NDT)?
2. What is needed for successful Testing?
3. Some NDT techniques used on yachts.
4. How do most industries ensure that NDT is done properly?

5 NDT in the yachting industry.

Summary.

What are "Your" Conclusions?

Section 1: **What is NDT?**

NDT can be defined as:

The use of one or more non- invasive techniques to:

- determine the integrity of a material, component or structure

or

- quantitatively measure some characteristic of an object

i.e. to inspect or measure without detriment to the product

The Modern NDT Inspectors "Tool kit".

There are now a lot of different NDT methods and sub-techniques, but each has limited applicability!

These are but a few.

Ultrasonic Array

'Phased

Acoustic Microscopy

Magnetic Particle

Liquid Penetrant

Ultrasonic 'A' Scan

X-ray & Gamma Ray

Visual

Eddy Current

Acoustic Emission

Thermography

Ultrasonic 'B & C' Scan

Laser Shearography

Flux Leakage

Tap Testing

Microwave

NDT Applied in Virtually All Industry Sectors
Construction and In-service Testing











Is it the correct Test for the structure?

- Testing is essential but a suitable test method must be chosen and then properly applied

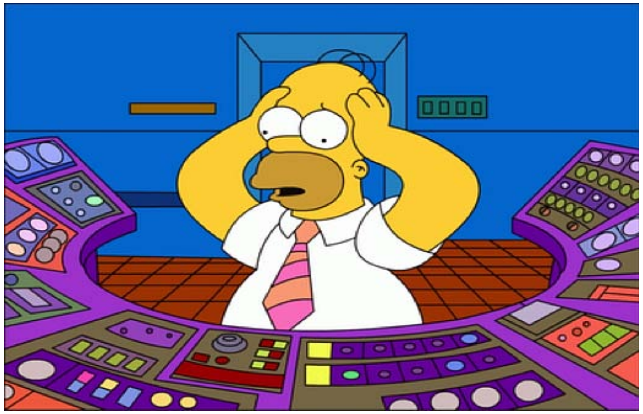
A LOAD TEST

- "This method" of testing "this Structure" may NOT give you the result you are looking for!

Selection of the correct method and its application is critical!

Section2:
What is needed for successful testing?

- No one technology or technique will detect all types of defects in all types of structure. Careful selection of the technologies is required, based on the structure to be tested as well as the size, geometry and the nature of the defects potentially present.
- Danger!! The wrong technology selection will usually provide a negative result – perhaps falsely indicating No Defects and hence a Safe structure!
- Danger!! The right technology but applied by inadequately trained and non-certified engineers can provide a false result.



When testing is unsuccessful.

- "Young America" Contender in a previous America's Cup series.
- Broken Deck and topsides damage due to un-bonded skin to core sandwich construction, which any applied testing had failed to detect.

So just because it "looks good" does not mean it is good!

Young America "looked good" before her back broke!

- THE REALITY - there are a variety of possible defects conditions arising from all types of manufacturing and in-service conditions.

CORRECT **TESTING IS ESSENTIAL!**

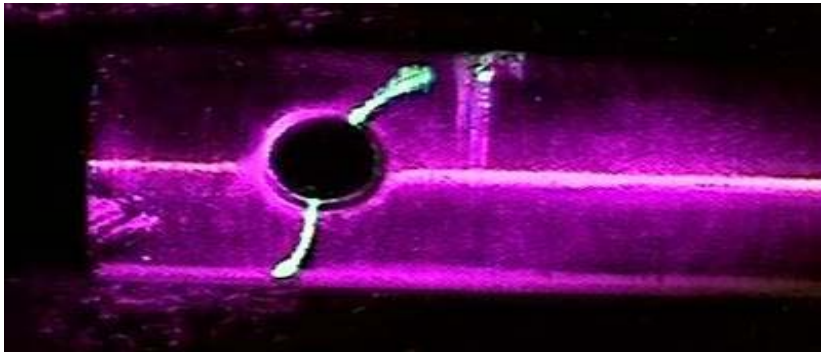
- In virtually all industry sectors, especially those manufacturing composite structures, Non –Destructive Testing is a integral part of the manufacturing and in-service monitoring process.

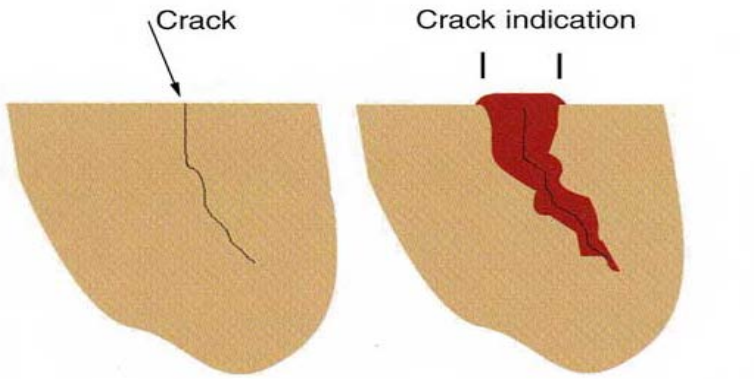
- Are we able to say this about the Yachting Industry?

Section 3:
Some NDT techniques used on yachts

- Liquid Penetrant Inspection.
- Magnetic Particle Inspection.
- Ultrasonic Examination.(Various Techniques)
- Radiographic Examination.
- Specialist Techniques for Bond Integrity.
- Infrared Thermographic Examination.
- Laser Shearography examination.

Liquid Penetrant Inspection.

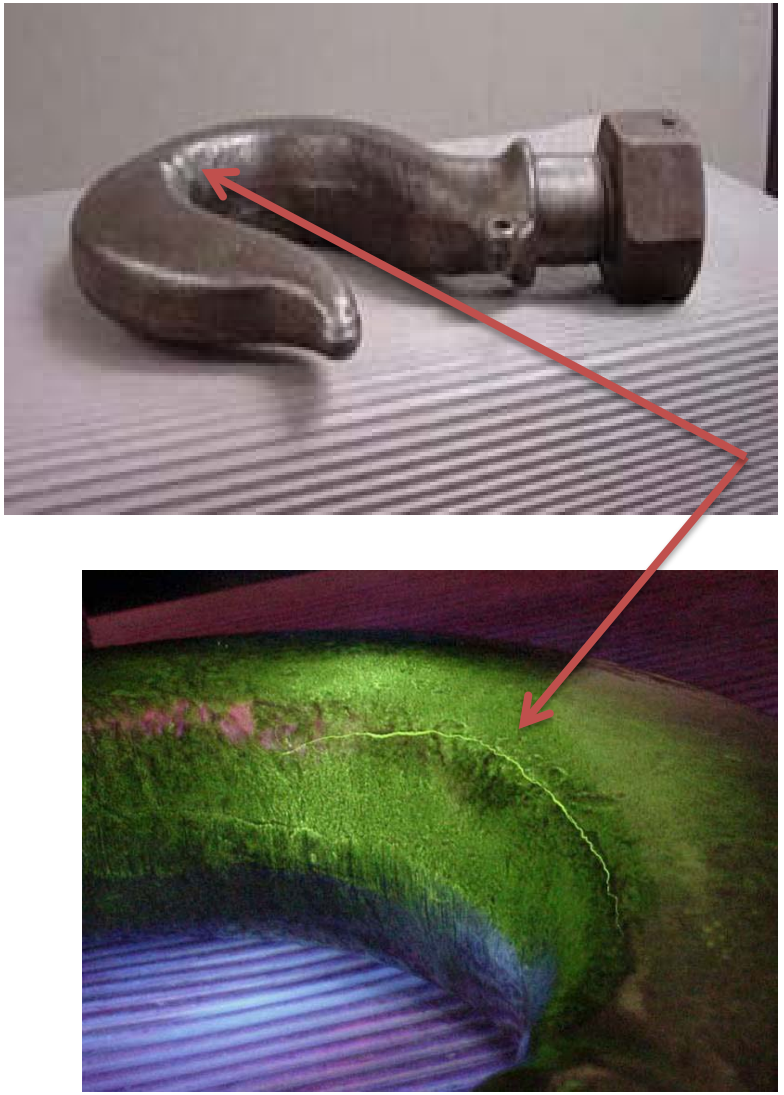




- Reveals surface breaking defects only (i.e. defects open to the surface)
- Applied on non – porous materials only
- Should be implemented as a controlled chemical process – can easily be abused. Correct application is CRITICAL
- However – properly applied – is ideal for the complete inspection of large metallic areas for surface breaking defects.
- Suitable for, for example, checking rigging components.

Magnetic Particle Inspection.

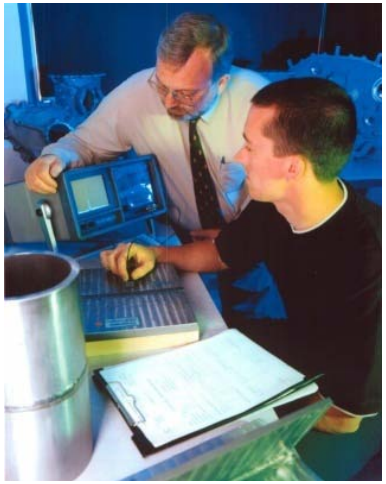
- For Ferromagnetic Materials only
- Reveals otherwise invisible surface or slightly sub-surface defects
- Can be applied through thin non-magnetic surface coatings
- Magnetism can be induced or applied by a variety of techniques –the correct technique selection and orientation of application is CRITICAL.
- Ideal for steel welds, components and structures
- Is sometimes the only useful technique – e.g.. Fillet welds on steel keels.



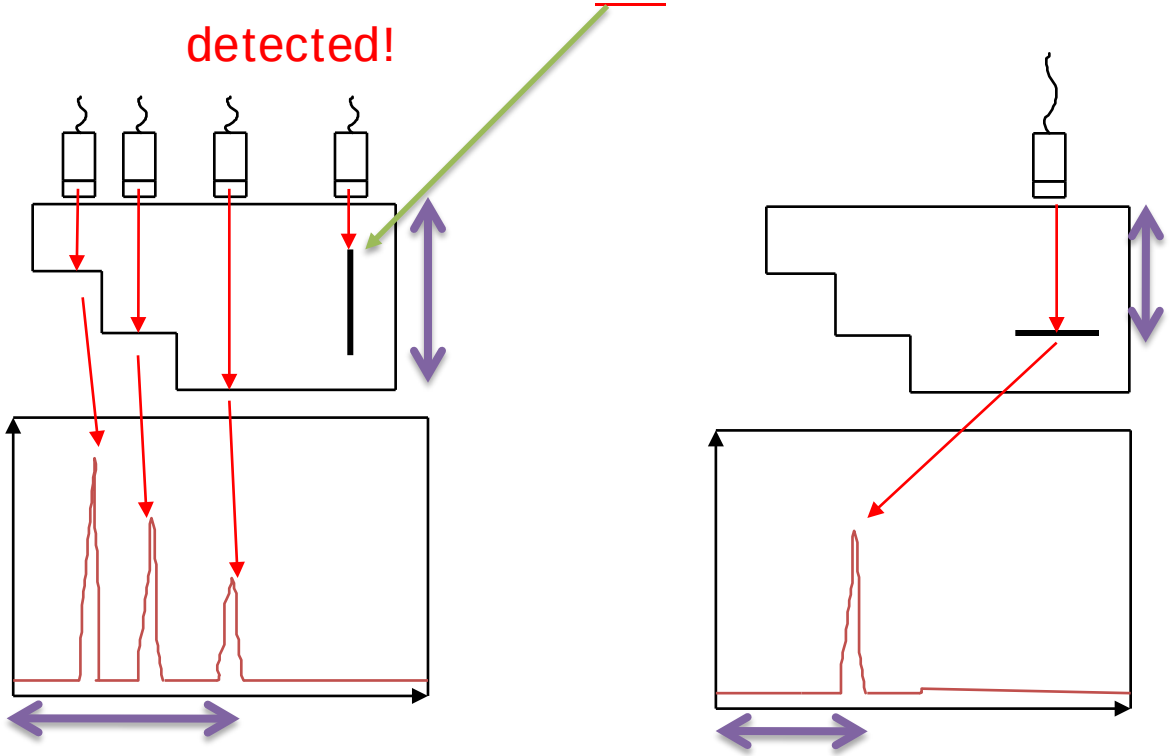
Ultrasonic Examination.

- Extremely flexible both in materials that can be tested and types of defects sought
- However, success is totally dependant on the technique/the transducer/the instrument selection and the application and skill of the NDT engineer
- Whilst it can applied to find types of surface defects, it is normally used to detect sub-surface defects
- Can be used to inspect when only one surface is accessible

Ultrasonic Contact Testing "Pulse Echo" Technique

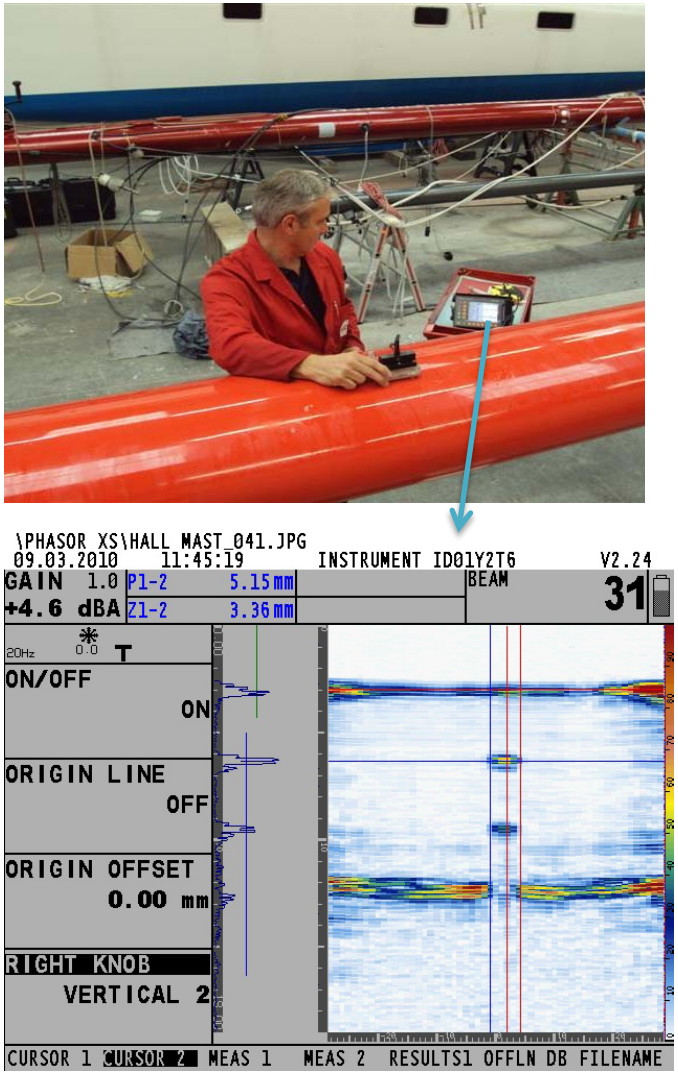


- Defect Detection depends on defect orientation and material structure.
- IT CAN BE MISSED!
- This Defect would not be detected!



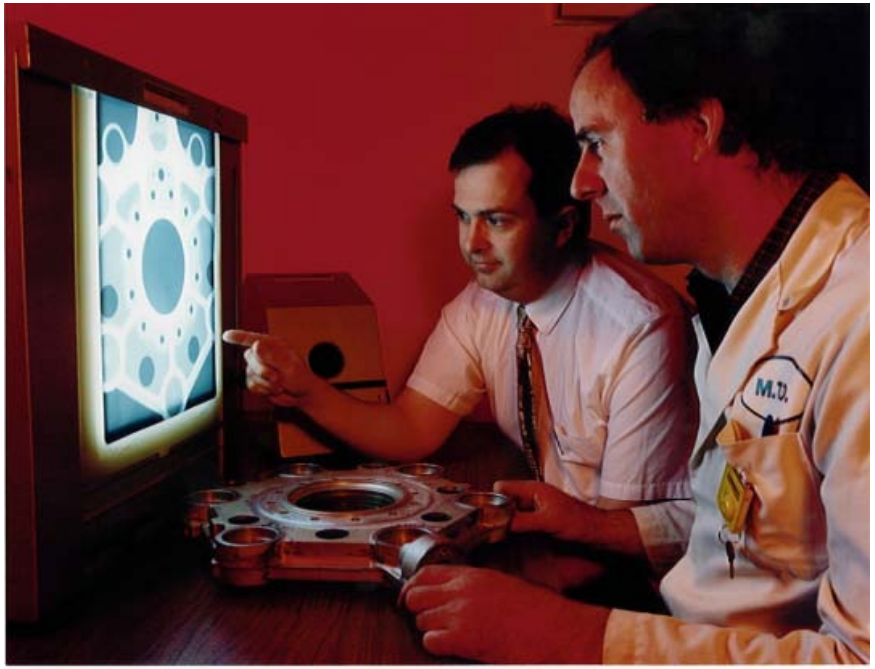
Ultrasonic “Phased Array” Technique

- Uses transducer arrays (Multi element).
- Computerised control of element sequencing and sound beam profile and focusing.
- Multi view displays of the inspection available.
- Increased inspection confidence and speed.
- Particularly good for carbon fibre masts.



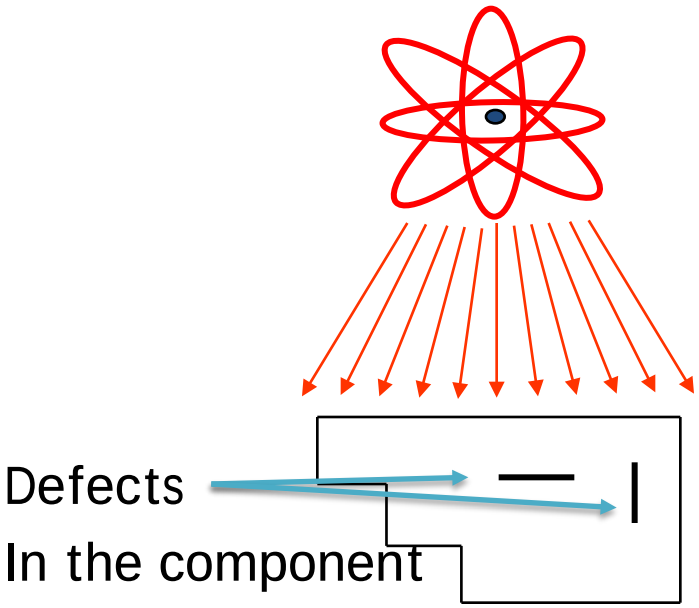
Radiographic Examination

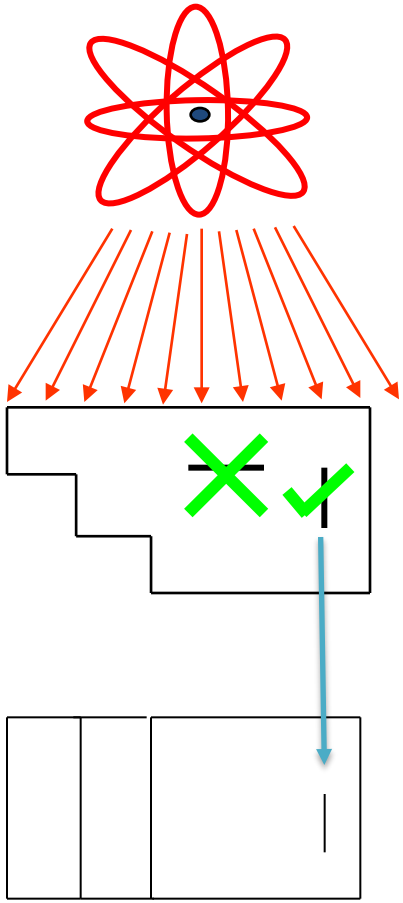
Expensive Equipment and extensive Training and Experience are required. Increasing Health and Safety restrictions



Application is critical for defect detection

IT CAN BE MISSED!





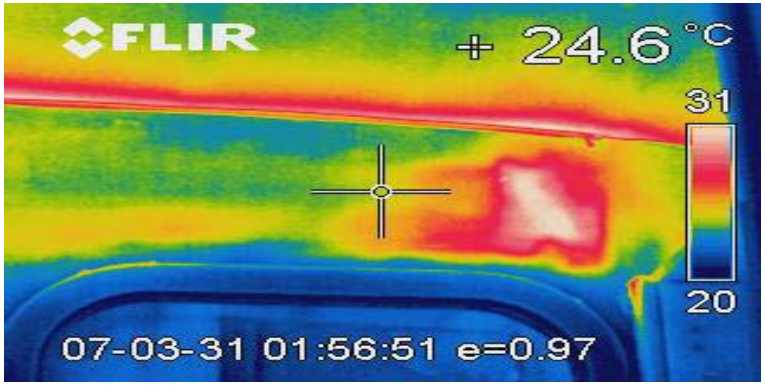
Review again slide14.

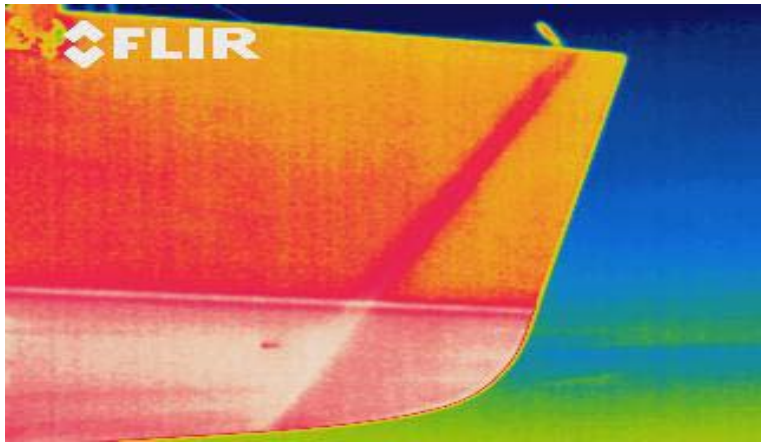
Specialist Techniques for “Bond” Testing

- Sonic Mechanical Impedance analysis
- Ultrasonic Resonance/impedance analysis
- Ultrasonic pitch and catch analysis
- Specialist techniques developed for bond testing metal to metal and composite honeycomb structures, for example parts of composite hulls.

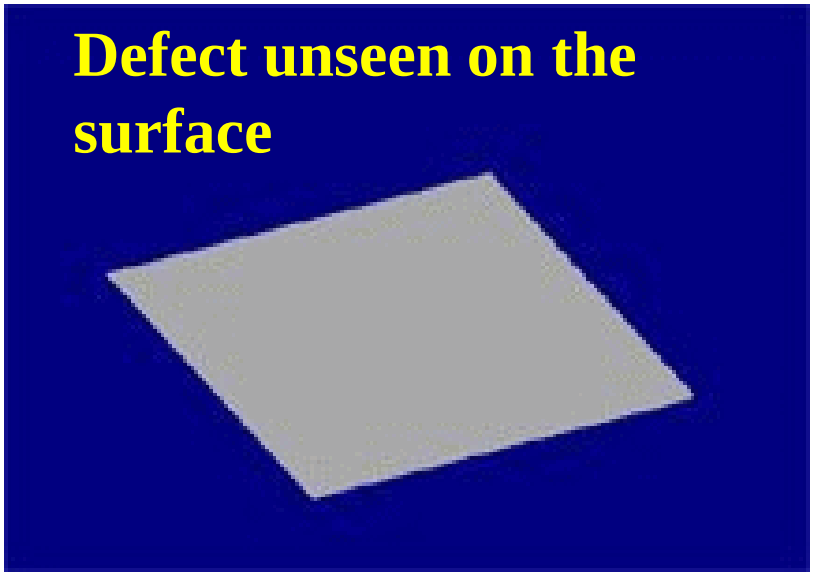
Infrared Thermography Examination

- A general survey tool which can highlight “potential” problems with the correct product knowledge.
- Cameras not difficult to use but open to serious interpretation mistakes unless diagnostics are made by very experienced personnel with understanding of both the technology and the structure.
- Cameras only see radiation from the surface. They cannot see internal problems directly.

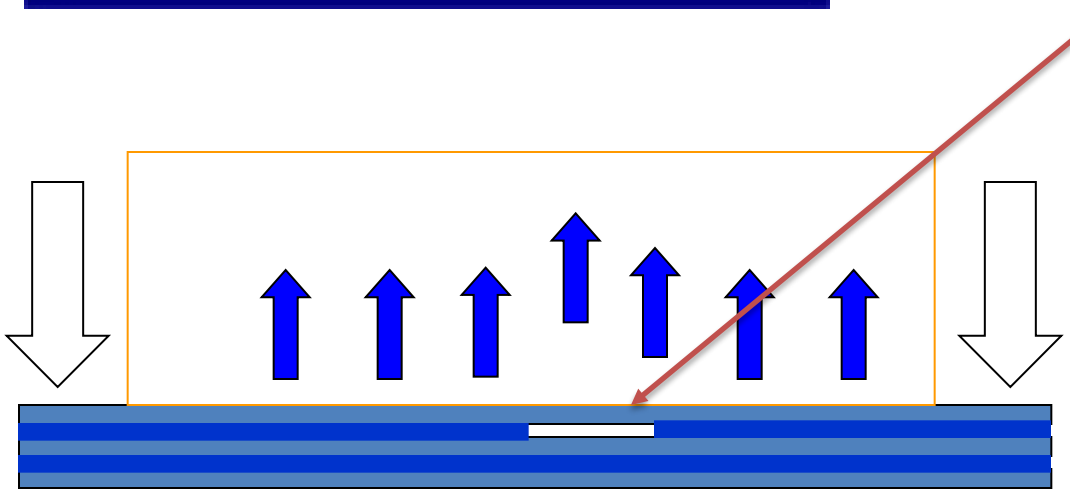


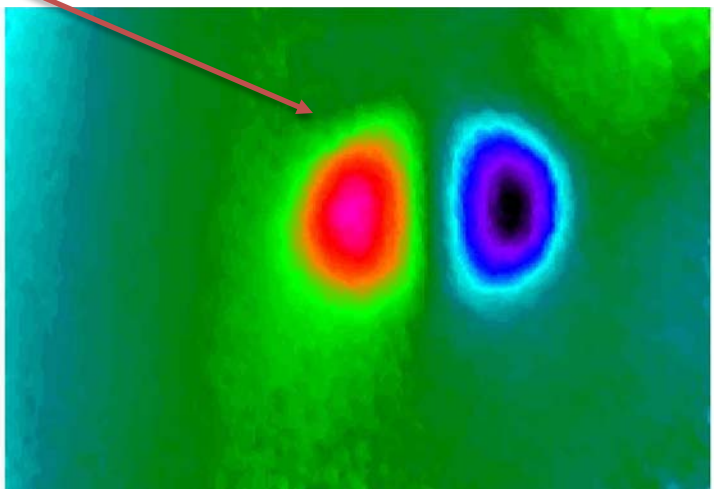


Laser Shearography Examination



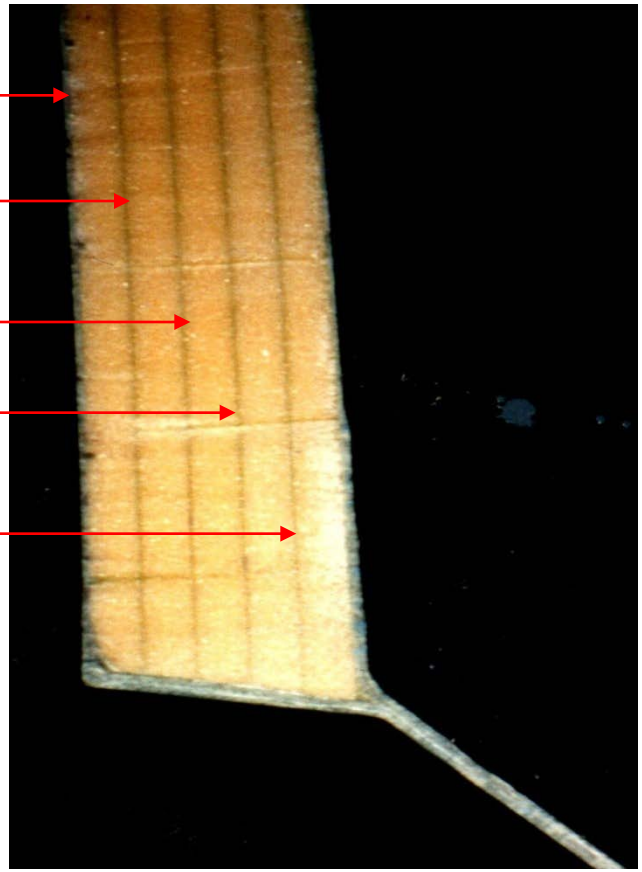
- Reference image of laser illuminated surface taken with a shearing camera.
- Component lightly stressed using a Vacuum (or other Stress methods - Heat, Ultrasound)
- Disbond revealed.





Multi Core Hull Topside Inspection RNLI Life boat – Tamar class

- Skin to core
- 1st Core to core
- 2nd Core to core
- 3rd Core to core
- 4th Core to core



Vacuum Stressing Laser Shearography can inspect up to the 4th core

Large area scanning possible using Laser Shearography

- Overlapping scans ensure 100% inspection
- 250mm by 300mm every 25 seconds

Section 4: How industries ensure that NDT is done properly.

Other industries have recognised that there are three steps that must be taken to ensure that NDT is performed properly.

COMPETENCE IS THE KEY!

- Ensure that a **Competent person** who understands the material to be tested, the defects that may be present and the **suitability of the different test methods** chooses the method/methods to be utilised.

- Ensure that a testing protocol is laid down by a **Competent person**.

- Ensure that the testing is performed to the protocol by a **Competent person**.

They do this by **Training**, **Examination** and **Certification**.

What is required to be recognised as a Competent person?

There are 4 essential elements leading qualification in **each** **NDT** method/technique.

1. A minimum period of formal documented technical training by an accredited body.
2. A minimum period of documented on the job experience in the application of the method.

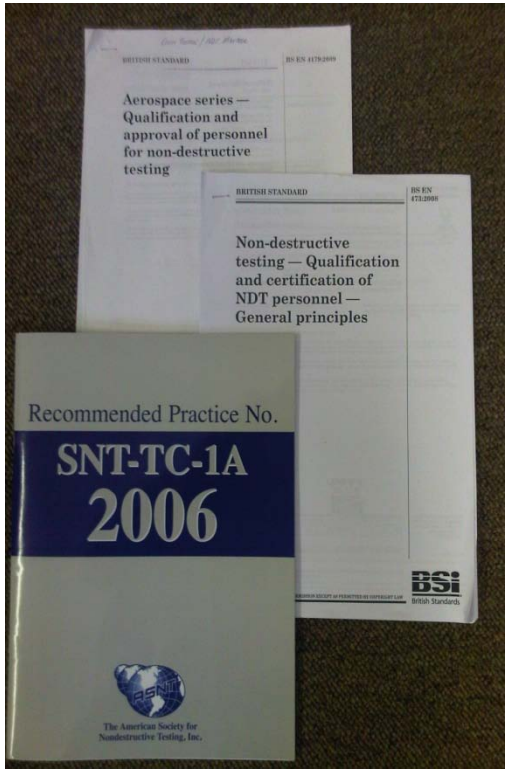
3. Successful completion of qualification examinations by an Accredited body comprising Theoretical, Practical and vision requirements
4. Re-examination in the method every 5 years

Comparison of the qualification requirements for NDT personnel in different industries.

There are a variety of governing standards covering NDT training and certification in the different Industry sectors. Each require the 4 essential elements as discussed.

- Aerospace and Defence: EN 4179/NAS 410
- Nuclear: EN 473; ISO 9712
- General Manufacture/Fabrication: EN 473; SNT TC 1A
- Pressure Vessels: EN 473; SNT TC 1A
- Medical: SNT TC 1A
- General Marine: EN 473; SNT TC 1A

- Yachting: Uncontrolled!



Section 5: NDT in the yachting industry.

NDT as often practiced in the yachting industry.

- There is no requirement for NDT engineers to be trained, examined or certified.

  No assurance of Competence.
- Consequently NDT is usually performed by untrained and unqualified staff.
- These people are often yachtsmen or yacht surveyors who have purchased a simple/single piece of test equipment.
- They pick the test that they are able to perform with the equipment they have and recommend it for everything, regardless of its suitability!

  One tool in the tool kit.
- They then interpret their perhaps inadequate results and sentence the part tested without appropriate knowledge.

Of course there will be exceptions.

Examples of the consequences of the yachting industry's approach to NDT

Mis-understanding the capability of techniques.

Surveyor's shooter

Last September in his Leading Edge column Matthew Sheahan wrote about the benefits of thermal imaging for surveying. International Yacht Surveys now sell the German-made Testo 880 portable camera and say it's the best equipment for survey work on yachts – in particular, for detecting delamination and water in composites, and rotten fasteners and planks.

Water content meters, for example, won't work on carbon hulls. This takes safe, non-contact temperature measurements on mechanical, electrical, composite and wooden materials by detecting thermal anomalies, making it easy to identify potential problems.

The Testo 880 comes in three different versions, each with a range of functions and features tailored to the respective area of application, and uses removable SD cards so you can load up to 1,000 pictures onto your computer and use the software provided to produce reports.

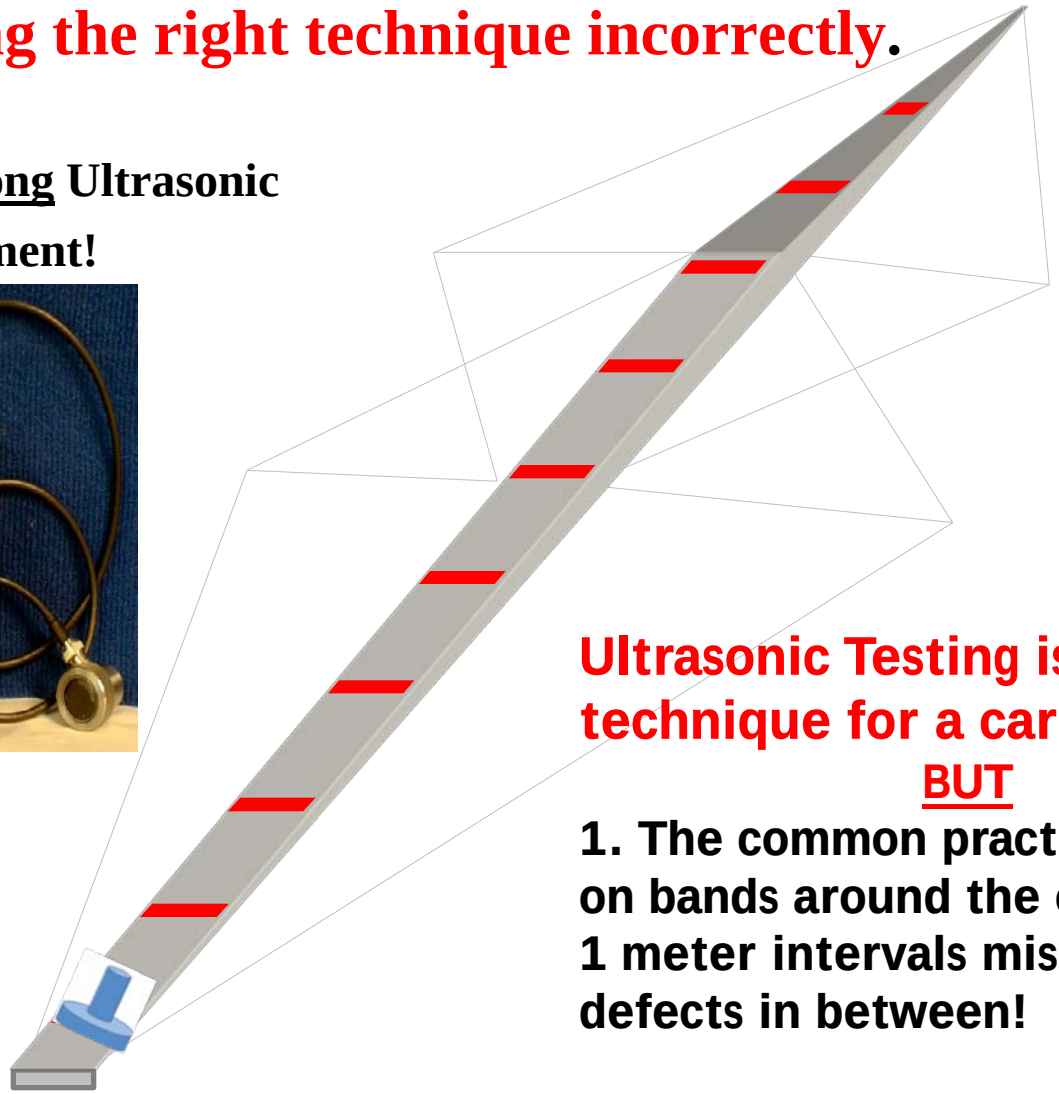
You can tell if your boat's sinking for just £3,726 ex VAT. **www.intys.co.uk**

!!!!!!!!!!!!!!!!!!!!!!????????????????????!!!!!!!!!!!!!!!!!

Examples of the consequences of the yachting industry's approach to NDT.

Applying the right technique incorrectly.

2. The wrong Ultrasonic instrument!



Ultrasonic Testing is the right technique for a carbon fibre mast.

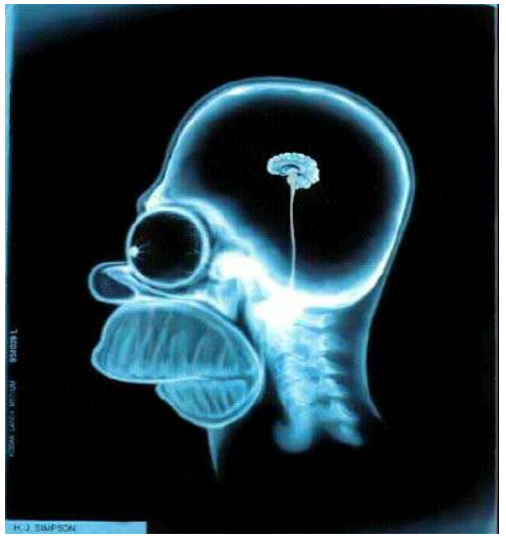
BUT

1. The common practice of testing only on bands around the circumference at 1 meter intervals misses all potential defects in between!

Examples of the consequences of the yachting industry's approach to NDT.

Sentencing the part tested without appropriate knowledge.

- In most industries the level of defect acceptable and unacceptable is laid down in standards relating to the components to be tested. This is not the case in the yachting industry .
- Instead the "NDT engineer" is often invited to, and does make, the decision.
- For example he may have found de-lamination in a carbon fibre mast or dis-bonds in a composite hull and report them as significant or insignificant on his own judgement.
- We query on what possible basis can such judgement have been made. The engineer is highly unlikely to be a stress calculation engineer or to have significant experience of similar fractures in the same part.
- In **our view**, without a standard specifying tolerable defects there is no alternative but to refer the issue to a qualified stress engineer, normally the original designer. This is not the practice of the industry and attempts to apply such good practice are often resisted.



Summary

- Many different NDT methods (technologies) and sub-techniques are available. None are universally applicable although some may overlap. The NDT engineer needs access to a 'toolbox' of techniques.

- They must always "selected and tailored" based on the material, structure, geometry, and potential defect. Surface or Sub-surface. size, shape, type and orientation.

- Inspection Engineers need to be "competent and qualified" in a wide range of NDT technologies in order to **select and apply** a successful product inspection. This is not the case in the yachting industry.

- There is no requirement for certified NDT technicians in the yachting industry. This must be changed and the power to do so is in the hands of the users, including underwriters.

Conclusion.

NDT in the yachting industry is often unreliable, being conducted by uncertified technicians often using inappropriate techniques and in any event without proper protocols having been established and validated.

Parts, including hulls and masts are being sentenced satisfactory or unsatisfactory based on these inadequate tests by the testing technicians who are not experienced or competent to make such decisions.

"NDT in the Yachting Industry".

Smoke and mirrors? What is your conclusion?