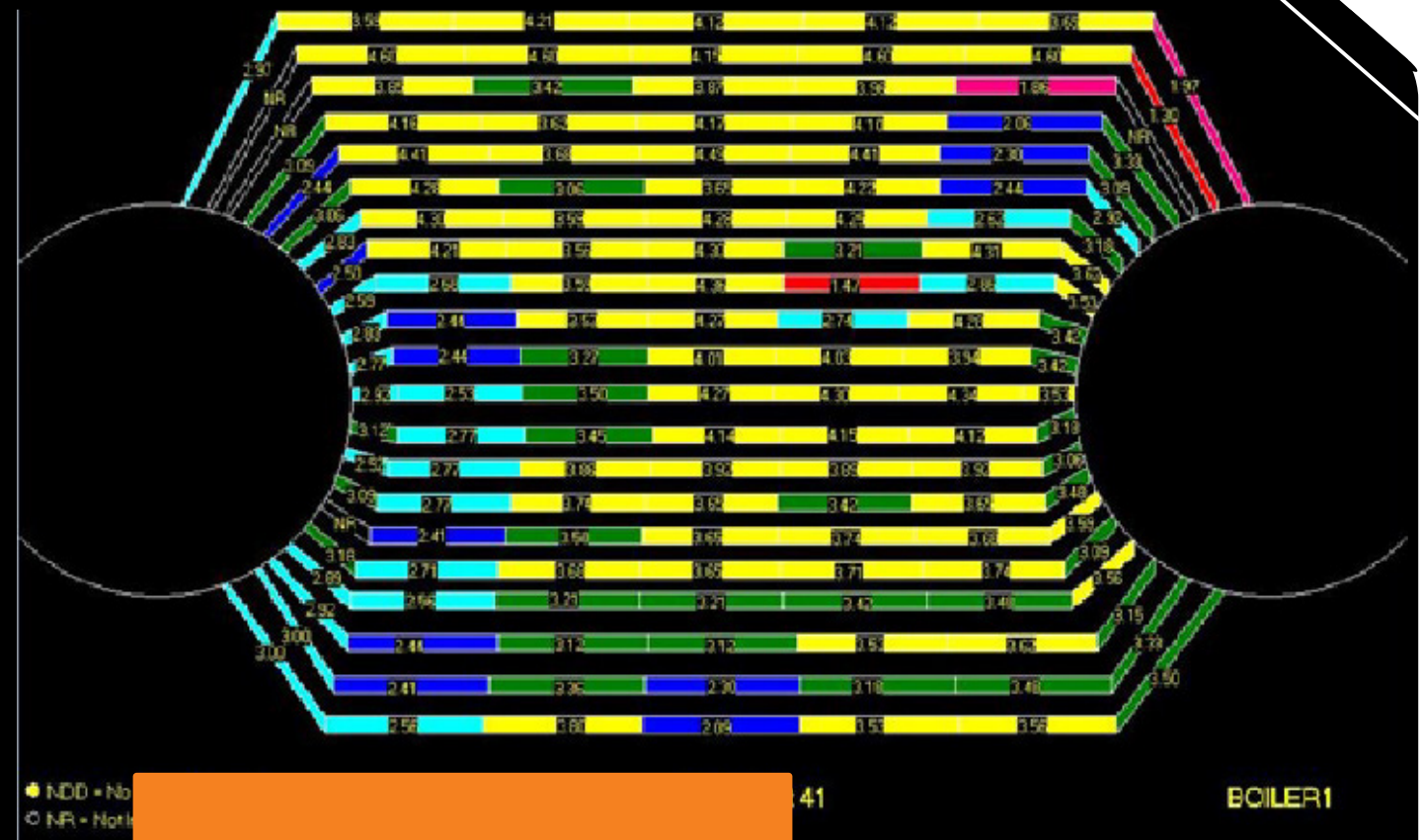
SPECIALIST PACKAGE

BOILER & HEAT EXCHANGER TUBE INSPECTION

SONOMATIC

THE PURPOSE

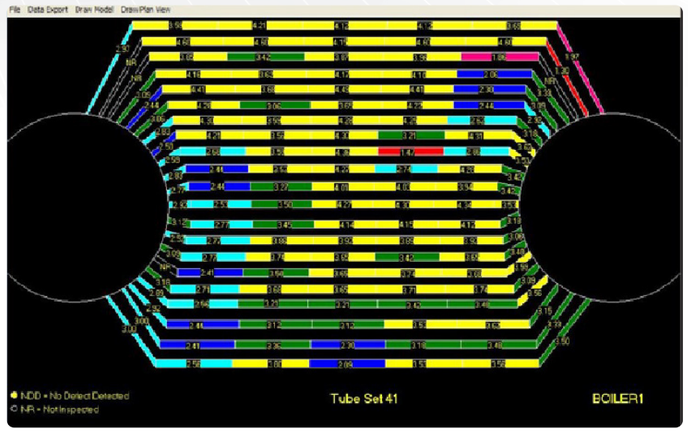
This document is composed to assist our clients and the supply chain with a high-level understanding of the technical capabilities, benefits and services associated with Boiler & Heat Exchanger Tube Inspection.



BOILER & HEAT EXCHANGER TUBE INSPECTION

Boiler and Heat Exchanger tubes are subject to various biological, chemical and physical stress causing a number of defect mechanism such as erosion, corrosion, cracking and other forms of material loss to occur.

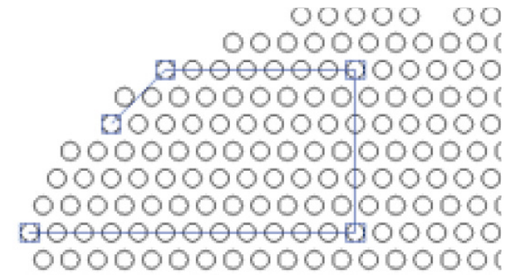
Frequent iinspection of these tubes can reduce unplanned shutdowns as well as other more serious breakdowns. By utilising advanced methods of reporting the engineers are able to make adjustments to the process and extend the life of these and other units in the plant.

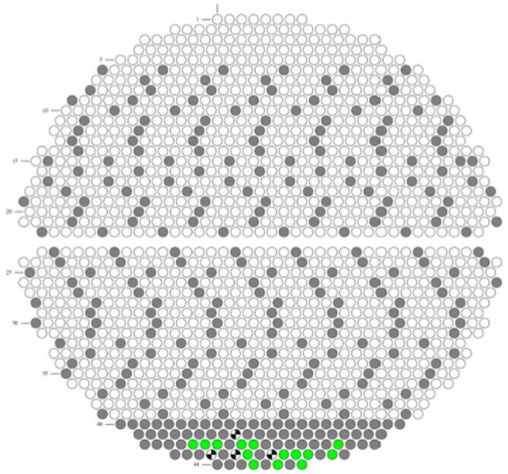


STANDARD REPORTING

The client is issued with a interim report when the inspection is completed. This will contain a tube map displaying the deepest defect indication found in each of the tubes inspected and will be divided into defect depth ranges of 20%. The interim report will also include a description of the defect indications found during the inspection as well as information regarding the unit inspected.

A final report will be issued from the Sonomatic office containing more detailed information of the inspection, the technique used and the results from the inspection. Photos of the unit and tube sheet will also be included when available.

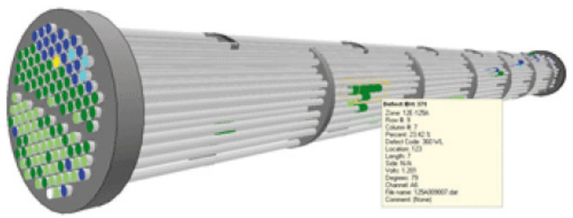


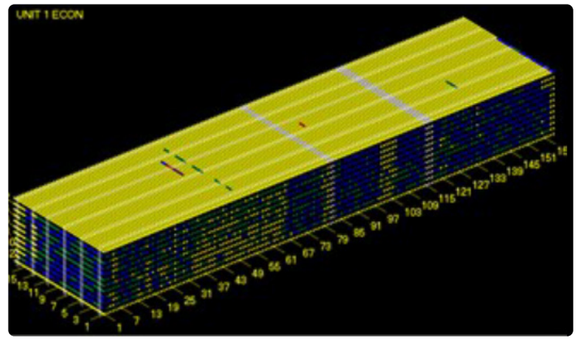


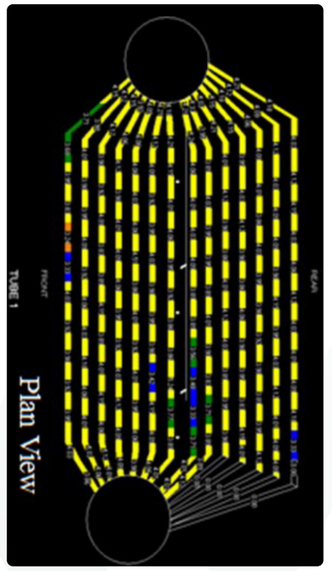
ADVANCED REPORTING

More advanced reporting options are also available. These can include from spreadsheets with minimum remaining wall thickness measurements from IRIS inspections to detailed 3D representation of the results showing defect indication positions in each tube.

Due to the time required for 3D inspections and 3D reporting various options are available at different resolution and levels of information.







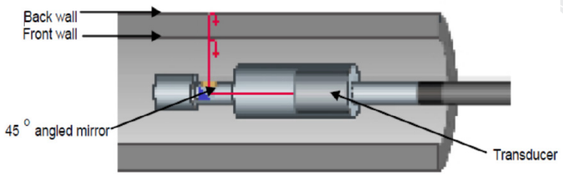
TECHNIQUES & APPLICATIONS

Application	Boiler Tubes		Heat Exchangers and Chillers				Fin Fan Coolers		
Technique	**Remote Field Eddy Current**	**IRIS**	**Eddy Current**	**Magnetic Bias Eddy Current**	**Remote Field Eddy Current**	**IRIS**	**Eddy Current**	**Magnetic Bias Eddy Current**	**IRIS**
Ferromagnetic Material	✓	✓		✓	✓	✓		✓	✓
Non Ferromag-netic Material			✓			✓	✓		✓
Capability of Detection	General Wall Loss and Large Volume Corrosion	General Wall Loss and localised Pitting	General Wall Loss, Localised Pitting, Baffle Wear and Cracking (Orientation Dependant)	Localised Pitting and Cracking (Orientation Dependant)	General Wall Loss and Large Volume Corrosion	General Wall Loss and localised Pitting Results may be limited in thin tubes.	General Wall Loss, Localised Pitting, Baffle Wear and Cracking (Orientation Dependant)	Localised Pitting and Cracking (Orientation Dependant)	General Wall Loss and localised Pitting Results may be limited in thin tubes.
Normal produc-tion average for 12 hours	300-500 tubes	75to100 tubes 150to300 tubes when the boiler is flooded with water	400-600 tubes	300-500 tubes	300-500 tubes	100to150 tubes	400-600 tubes	300-500 tubes	75to100 tubes
Cleaning Require-ments	70% Fill Factor is required for the probe and scale needs to be non magnetic.	100% as this is an Ultrasonic Tech-nique.	90% Fill Factor is required for the probe and scale needs to be non magnetic.	90% Fill Factor is required for the probe	70% Fill Factor is required for the probe and scale needs to be non magnetic.	Bare Metal as this is an Ultrasonic Technique.	90% Fill Factor is required for the probe and scale needs to be non magnetic.	90% Fill Factor is required for the probe	100% as this is an Ultrasonic Tech-nique.
	Always remember that better tube cleaning ensures higher quality inspection with lower equipment wear and less chance for delays due to probe failure.								

IRIS (INTERNAL ROTATING INSPECTION SYSTEM) TECHNIQUE

Principles of the IRIS inspection technique for Tube Inspection

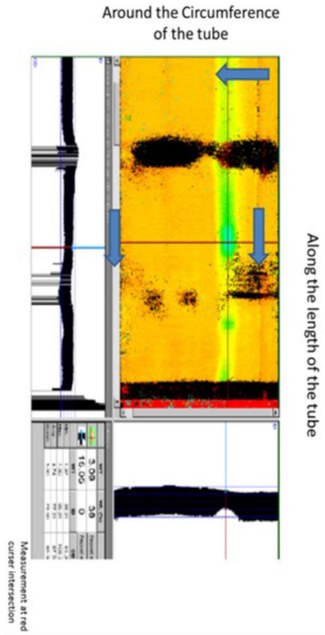
A beam from an ultrasonic transducer is reflected from a mirror set at 45 degrees so that the reflected ultrasonic beam impinges on the tube I.D. at right angles. Part of this beam is then reflected from the tube I.D., while the remainder is transmitted through the wall thickness and is reflected from the tube O.D. The time difference between the two reflected signals is then used to measure the tube wall thickness.



Advantages of IRIS Inspection

It is a very accurate technique. Wall thickness of measurements can be made to an accuracy within 0.1mm. It is a fairly sensitive technique. The sensitivity achieved will depends on tube dimensions and tube cleanliness. In general it can be stated that it should be possible to detect a 1.5mm defect in up to 1inch tubing that has been properly cleaned.

Athree dimensional picture of the defect is obtained, thus the defect profile in addition to its depth is obtained.



Disadvantages of IRIS Inspection

It is a relatively slow technique as it is only possible to test an average of 100 to 150 tubes in a day.

As IRIS is a ultrasonic technique, very high levels of tube cleaning is required prior to the inspection.

Due to Probe Blanking the minimum measurement possible with IRIS is between 0.4 and 0.8mm depending on the software setup. This would mean that any defect deeper than 67% in a 1.2mm wall thickness will show as 67% and any defect deeper than 80% in a 2mm wall thickness will show as 80%.

STANDARD EDDY CURRENT

Principles of the Standard Eddy Current inspection technique for Tube Inspection:

When a coil excited by an alternating current is brought in close proximity to a conducting material, eddy currents are generated in the material by the process of electromagnetic induction. The magnetic field associated with the eddy currents gives rise to an impedance change in the coil. The introduction of a defect into the conducting material results in a reduction and redistribution of the eddy current field and hence a further change I coil impedence. It is these changes in coil impedance, which are measured, and form the basis for defect location and analysis in eddy current inspection.

Advantages of Standard Eddy Current Inspection

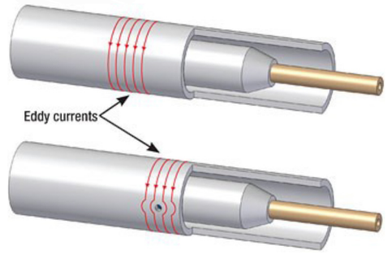
It is a very accurate technique. The eddy current technique can measure variations in generalised wall thickness down to 0.05mm, while located defects (pits) as small as 1mm can be detected and sized to an accuracy of ± 10% of the wall thickness.

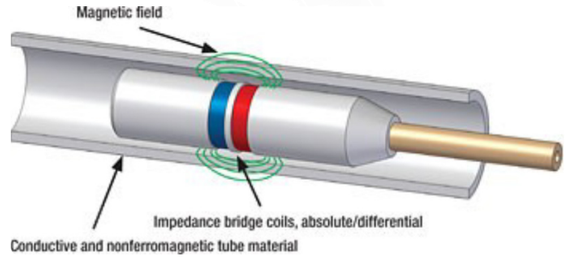
- 400 to 600 tubes inspected per shift
- Flexible probes for inspecting U bends.
- Range of 8mm to 150mm ID can be inspected.

Disadvantages of Standard Eddy Current Inspection

The only real limitations are the defects within the tube sheet and circumferential cracking can be missed. Although these limitations can be overcome by the use of specially designed probes.

Probe Fill Factor is required to be above 80%

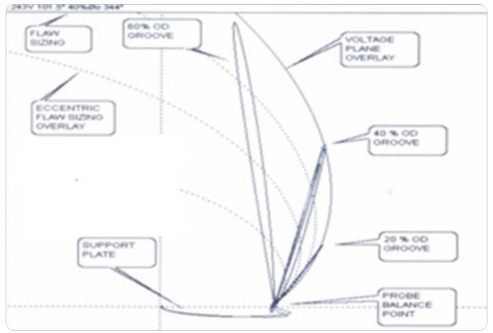




REMOTE FIELD EDDY CURRENT

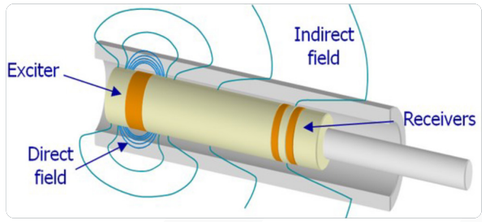
The RFT system uses the principle of the 'Remote Field Effect'. The phase response of an input signal is changed in proportion to the wall thickness. Exciter and detection coils are typically separated by 3 to 5 times the tube diameter.

THE DISTANCE BETWEEN COILS IS SUCH THAT WE ARE OPERATING OUTSIDE THE 'DIRECT FIELD' IN THE 'INDIRECT FIELD'.



Advantages of Remote Field Eddy Current Inspection

- About 300 -500 tubes inspected per shift.
- Very effective in detecting Generalised wall loss.
- Ideally suited for thick wall tubing as in boilers.
- Flexible probes for inspecting bends in boilers
- Range of 10mm - 150mm ID can be inspected



Disadvantages of Remote Field Eddy Current Inspection

- Not sensitive to small defects.
- Not sensitive to defects at tube ends or under baffle plates.
- Over sensitive to fins. Defect are masked by fin signals so fin tubes cab't be tested.

MAGNETIC BIAS EDDY CURRENT

Principles of the Magnetic Bias Eddy Current inspection technique for Tube Inspection:

When standard eddy current is applied to ferrous tubes the eddy current field is affected by the magnetic properties of the material. The Magnetic Bias probe creates a magnetic field in the material and is set to exactly the correct intensity in order to limit the effects of the magnetic properties of the material. This allows enough of the eddy currents to bypass the skin effect and penetrate the material. Defects in the material will cause a change in the permability of the material as that position as well as the amount of eddy currents at that point. The detector coil will then pick up this change in eddy currents and the system will then visually present that information on the computer screen.

Advantages of Magnetic Bias Eddy Current Inspection

- It is a very quick screening technique for Ferro Magnetic Materials. The Magnetic Bias eddy current technique can measure localised defects (pits) as small as 2mm can be detected and sized to an accuracy of ± 10% of the wall thickness.
- 300 to 500 tubes inspected per shift.
- Although cleaning is still required only a 90% fill factor is required for the inspection.

Disadvantages of Magnetic Bias Eddy Current Inspection

- The Technique is only sensitive to localised defects such as pitting. Generalised wall loss can't be detected.
- Defect Indication need to be backed up by other techniques as spurious indications can be caused by inclusions in the material.
- Tube sizes are limited to internal diameters between 12mm and 32mm and wall thickness less than 3mm for ID's greater than 17 and 2.11 for ID's smaller than.

QA AND HS&E

Sonomatic operate under an integrated QHSE management system and are committed to the highest quality and safety of service provision | ISO 9001: 2015: 00007140 | ISO 14001:2015:00037371 | ISO 45001:2018:00037372 | ISO 17020: 2012: 4276 | Achilles FPAL Verified: 076712 | SEQual 1988 | British Safety Council Member: S0388440 |

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