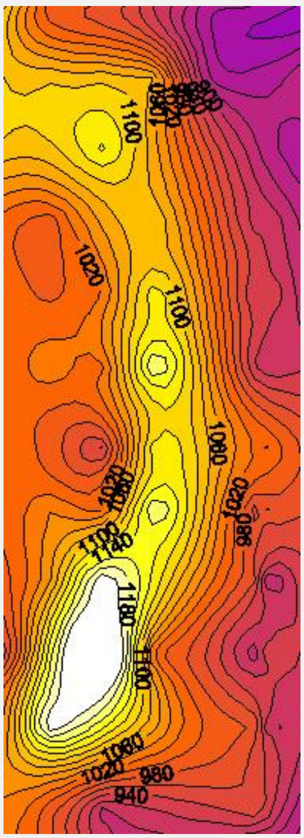
Non-Intrusive Thermal Scanner Systems

NTScan™

Tailored for high heat flux applications such as boiler walls.



Monitoring and mapping of boiler wall tube fireside temperatures and heat transfer characteristics over large areas of boiler wall.

Non-Intrusive technology: sensors are welded to external tube walls.

Monitoring of slagging behaviour and effectiveness of tube cleaning.

Helps identify possible damaging tube wall conditions.

Established technology - now with improved hardware and enhanced software.

Rowan Technologies' scanner systems have been operating on power plant boilers since 1999. The systems use non-intrusive sensors welded to external (air-side) surfaces of tube walls, typically arranged in rectangular matrices. Thermal monitoring is fundamental to the scanner systems and can be combined with resistance monitoring to provide information of tube wall integrity.

ROWAN
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The systems provide:

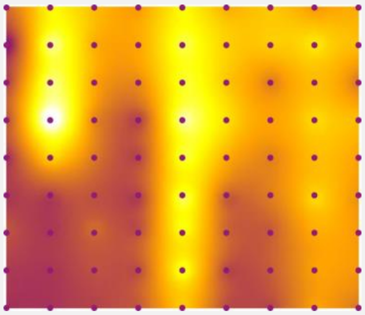
- Monitoring and mapping of real-time or historical data over large areas of boiler wall.
- Mapping of external surface temperatures, tube wall heat flux and fireside tube temperatures, providing information on slagging behaviour, flame impingement, effectiveness of wall cleaning, excessive tube temperatures etc.
- Thermal behaviour correlation with boiler operations, enabling combustion conditions to be optimised to help improve efficiency.
- Absolute wall temperature, temperature differential and thermal cycling data: helping to quantify tube stresses and pinpoint underlying causes of tube damage or failure.

Features

- Electrodes are welded to external surfaces to form rectangular matrices, linear arrays or individual point locations.
- Can be interfaced to plant information systems for data storage and retrieval.
- Dedicated software allows data analysis and presentation in a multitude of ways – historical or real time data, linear traces and 2-D plots.
- Custom-built, robust electrode/sensor assemblies - easy to install.
- Two sensors at each location allow estimation of heat flux and fireside tube temperatures.
- Finite element modeling techniques are used to fine-tune system calibration.

The Mapping Process: electrodes, typically spaced about 1-2 metres apart and arranged in matrices or arrays, are rapidly scanned in sequence to allow 2D map production.

Electrode Matrix

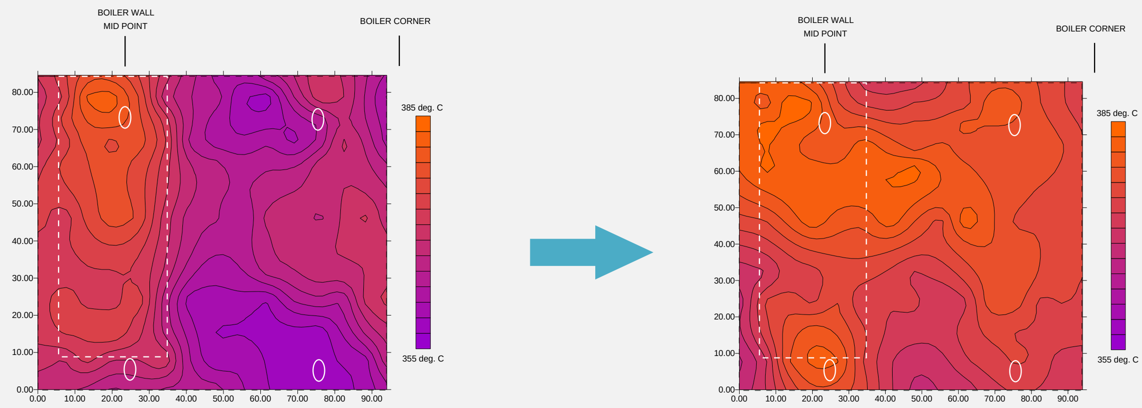


Resulting 2D Maps

EXAMPLE APPLICATIONS

Typical examples, from scanner installations, of thermally-related boiler wall behaviour are presented below. These include the effectiveness of tube cleaning, natural slag shedding, flame impingement and evidence of excessively high and possibly damaging fireside tube wall temperatures.

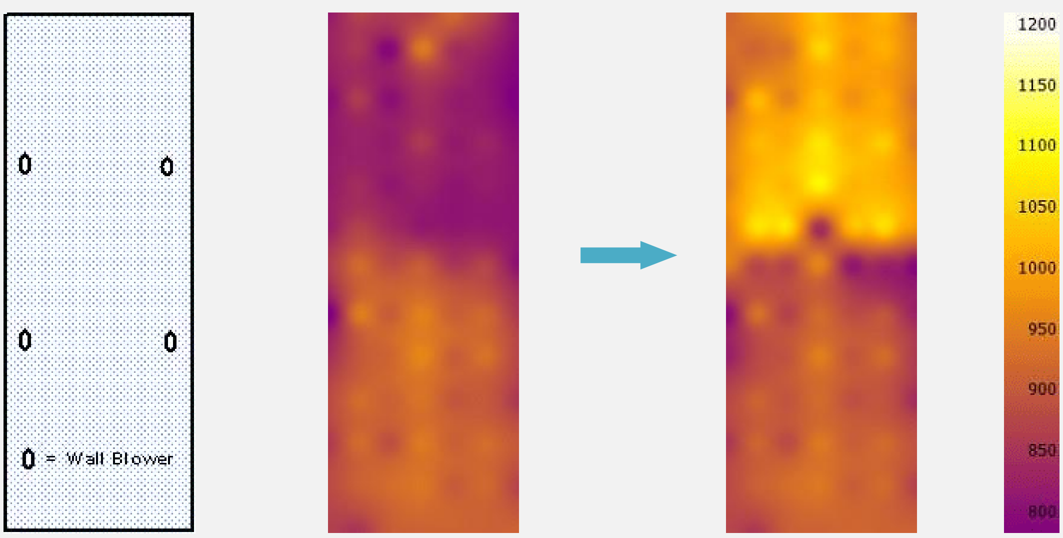
Sootblowing: Tube Wall Heat Transfer - Subcritical Boiler



Before Sootblowing   After Sootblowing

Four sootblower locations are defined by the white ovals - all blowers have been activated. Brighter colours indicate higher heat flux. Maps from array of 8x7 electrode locations.

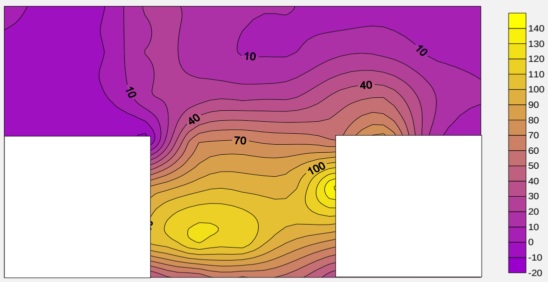
Sootblowing: Fireside Tube Temperatures - Supercritical Boiler



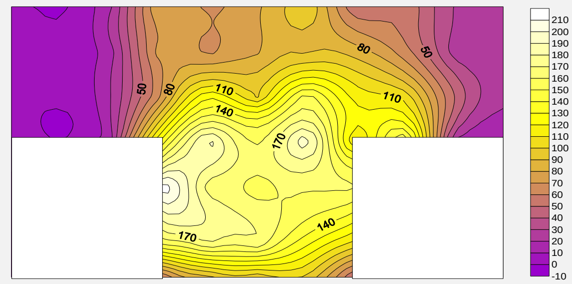
Blower Locations   Before Sootblowing   After Sootblowing

The top two sootblowers have been activated. Maps are four minutes apart. Colour scale is in Fahrenheit. Maps from matrix of 7 x 11 electrode locations.

Water Cannon Activity - Supercritical Boiler



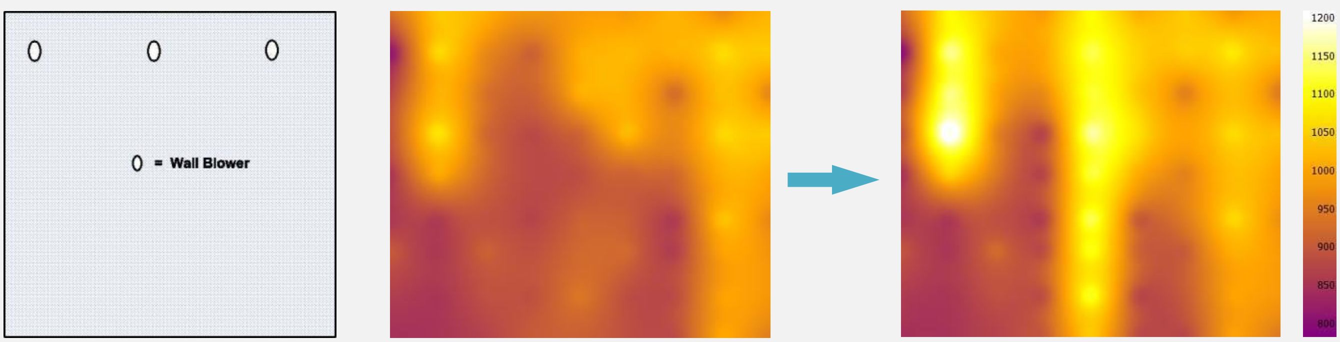
Temperature Change after First Cannon Pass



After Second Cannon Pass - 3 Minutes Later

The above maps show increases in estimated fireside tube temperature resulting from two sequential passes of a water cannon. Monitoring area is located between two over-fired air inlets, defined by the white squares. Maps from an array of 59 electrode locations.

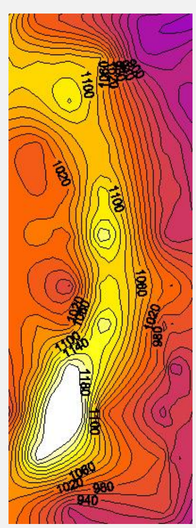
Slag Avalanche - Supercritical Boiler



Activation of the central blower results in a slag avalanche along a localised central tube bundle, whilst adjacent tubes remain largely unaffected. Two minutes between maps. Estimated fireside tube wall temperatures - scale in Fahrenheit. Maps from an array of 9 x 9 electrode locations.

Flame Impingement

This localised arc of high fireside tube temperatures is indicative of flame impingement on the tube walls. Map from array of 7 x 11 electrode locations.



MEASUREMENT SPECIFICATIONS

- Maximum speed approx. 150 ms per sensor measurement. A matrix of 100 nodes (two sensors per node) scanned in about 30 seconds.
- For optimum accuracy, systems are specifically designed for accurate and stable temperature differences between adjacent paired sensors at each sensor location: difference accuracy to within approx. 0.2 ^{o}C (0.4 ^{o}F).
- For (less-critical) absolute values (rather than differences): stability at any one sensor location approx. +/- 1 ^{o}C (2 ^{o}F) and accuracy within approx. +/- 3 ^{o}C (5 ^{o}F).
- Absolute accuracy of estimated fireside tube temperatures and heat flux depends on system application but typical figures estimated to be within approx +/-15%.

Above figures may be subject to change.

SOFTWARE

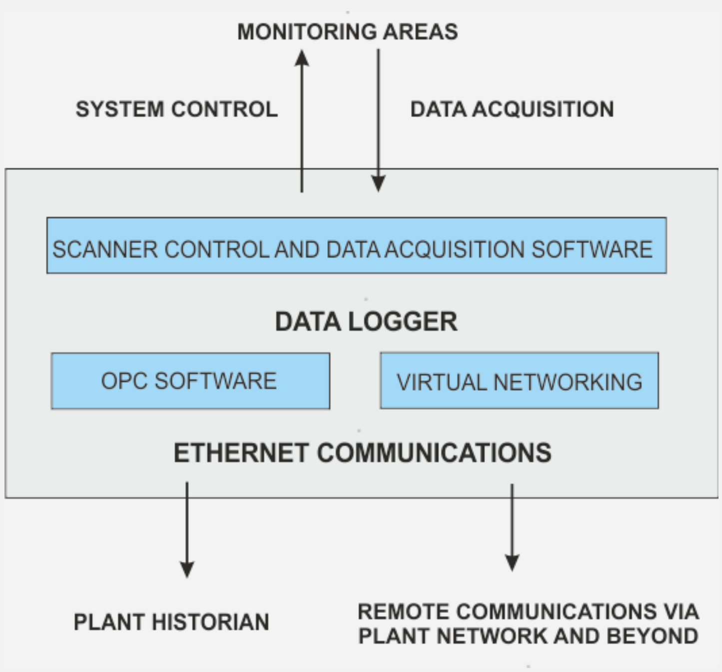
Data Logger Communications

Each system has a dedicated MS Windows - based data logger with Ethernet communications. The adjacent schematic outlines the main features and options for logger communications.

Scanner control and data acquisition software runs continually in the background.

Ethernet communications and optional virtual networking allows remote access to the data logger. Acquired data can be stored locally on the hard drive as well as made available to the plant historian via OPC software.

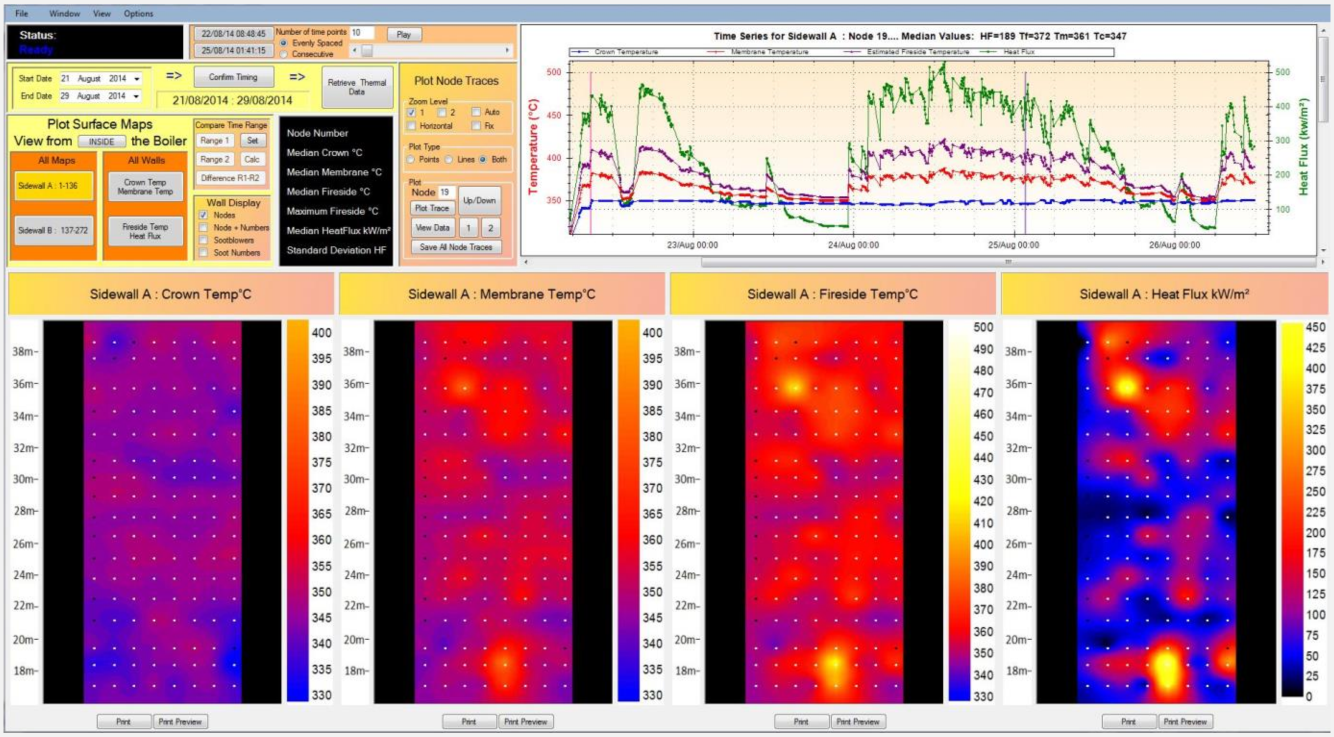
Systems may have a direct Ethernet link from the data logger to a dedicated data analysis and display PC in a control room or office, bypassing the plant network.



Data Retrieval and Analysis Package

This dedicated software package can be used by anyone with network access to the data - from office or control room. The main features are:

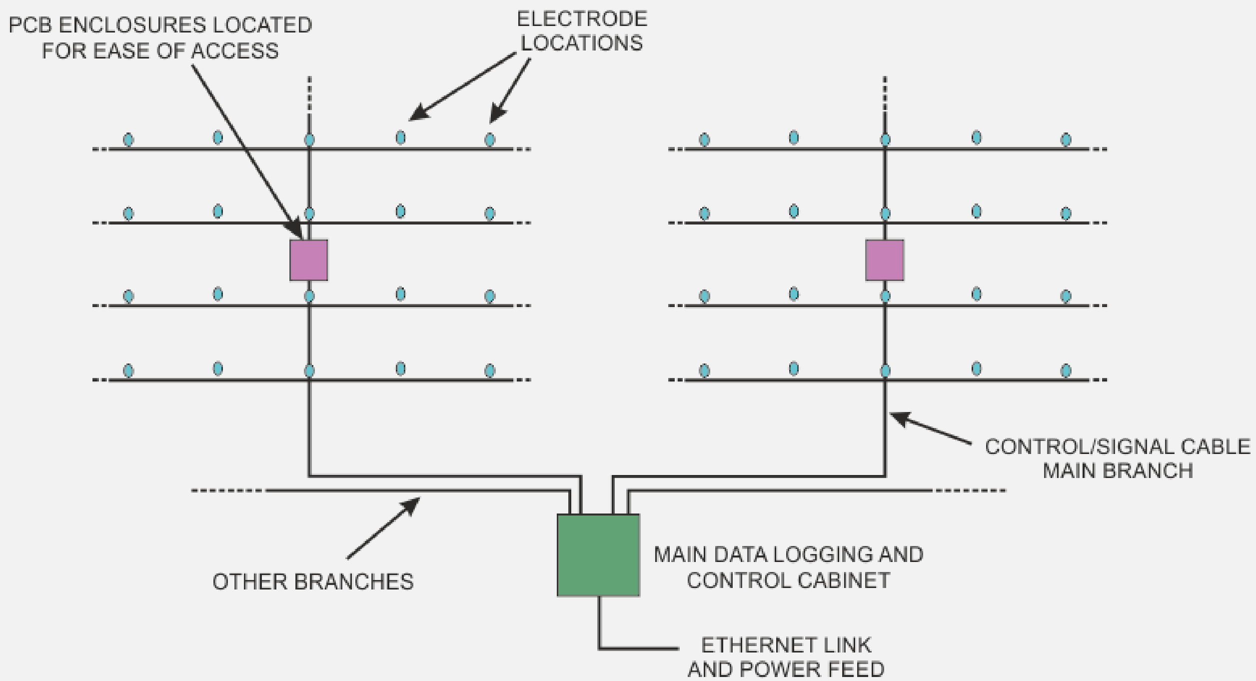
- Real time data capture and analysis or historical data analysis.
- Plot scanner data as time-dependent linear traces for each sensor location.
- Plot 2-D thermal maps: surface temperatures, estimated heat flux or estimated fireside tube wall temperatures. Historical maps or real-time map updates.
- ‘Difference’ mapping to monitor the effect of boiler operations e.g. wall cleaning.
- Print and save traces and plots.
- Create map sequences to identify more subtle changes in thermal behaviour and also allowing rapid visualisation of behaviour over time.
- Statistical analysis capabilities.
- Optional data retrieval from PI using OLEDB code - performs a similar function to other data retrieval packages but with special provision for scanner data.
- Option to save data as CSV files for analysis using standard packages e.g. Excel.



SYSTEM LAYOUT AND INSTALLATION

Systems consist of a main data logging and control cabinet from which several scanner 'branches' originate. Typically each 'branch' might serve one boiler wall and along each branch are located readily-accessible PCB electronics enclosures. Cables from each sensor location (or 'node') run back to the nearest PCB enclosure. Each node has a dedicated electronics PCB.

Up to four branches can run from the main cabinet and each branch can control up to 250 sensor locations. The maximum length of cable runs from the main cabinet data logger to the monitoring areas depends on the number of electrode locations and type of communication cable. This length may be up to hundreds of metres.



Mains power is supplied to the main cabinet whilst low voltage DC power is fed from this cabinet to the PCB enclosures. The main cabinet electronics requires a comfortable operating environment and could be housed in an office or instrument room where suitable. An Ethernet link allows local and remote communications and control.

PCB enclosures are installed in accessible locations near to the sensors, typically alongside walkways and in an environment suitable for test and maintenance purposes.

Electrode assemblies are welded to external tube surfaces; no specialist welding skills are required. Robust connection points allow for quick and reliable connection of cables and, where required, simple covers may be used over the electrode assembles as additional protection.

The systems are normally designed to make system hardware removal and reinstatement quick and straight forward: cables can be quickly disconnected from electrodes.

ESTABLISHED SCANNER TECHNOLOGY

Systems capable of rapid thermal scanning have been operational in boiler plant since 1999. System hardware has gradually been updated over this time to optimise measurement accuracy, allow greater flexibility of system design and to help ensure smooth installation.



Weatherproof and dustproof electronics cabinets are used as appropriate to help ensure many years of trouble-free operation with minimal maintenance.



Early sensors, comprising discrete electrodes, have been superseded by fully-enclosed sensor assemblies. A variety of methods are used to run cables and enclose the electrodes.

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