HRSG user's group

Invited to

The HRSG User's Group Conference

Montego Room B

Mirage Event Center

Las Vegas, NV.

Friday April 26/2019

9:30 am - 10:00 am

Detecting Flame Lick with Infrared Technology

BOILERWATCH® MMP-II-SSX

Acoustic Pyrometer - Combined Cycle Applications
Simultaneous Sampling - Bidirectional - Leak Detection

Master Distributor
Greenbank Energy Solutions Inc
185 Plumpton ave
Washington Pa 15301
724-413-4021

Acoustic Pyrometer

The BOILERWATCH® MMP-II-SSX acoustic pyrometer is an advanced industrial instrument that provides fully automatic measurement of high combustion-gas temperatures, permitting fuel trimming control within heaters, boilers and HRSG. The system is completely non-intrusive, and operates on the principal that the speed of sound in a gas is proportional to the temperature of that gas. Acoustic transceivers are mounted on the outside of walls of the heater/boiler/HRSG, and a high intensity acoustic signal is launched through the gas stream. Since the distance between the sound source and receiver is known and fixed, the average temperature of the gas along the acoustic path is computed from an accurate measurement of the sound signal's transit time.

BOILERWATCH® MMP-II SSX Provides temperature measurement in groups of 5 paths. Increases speed of processing 80%. Also reduces air consumption 80%.

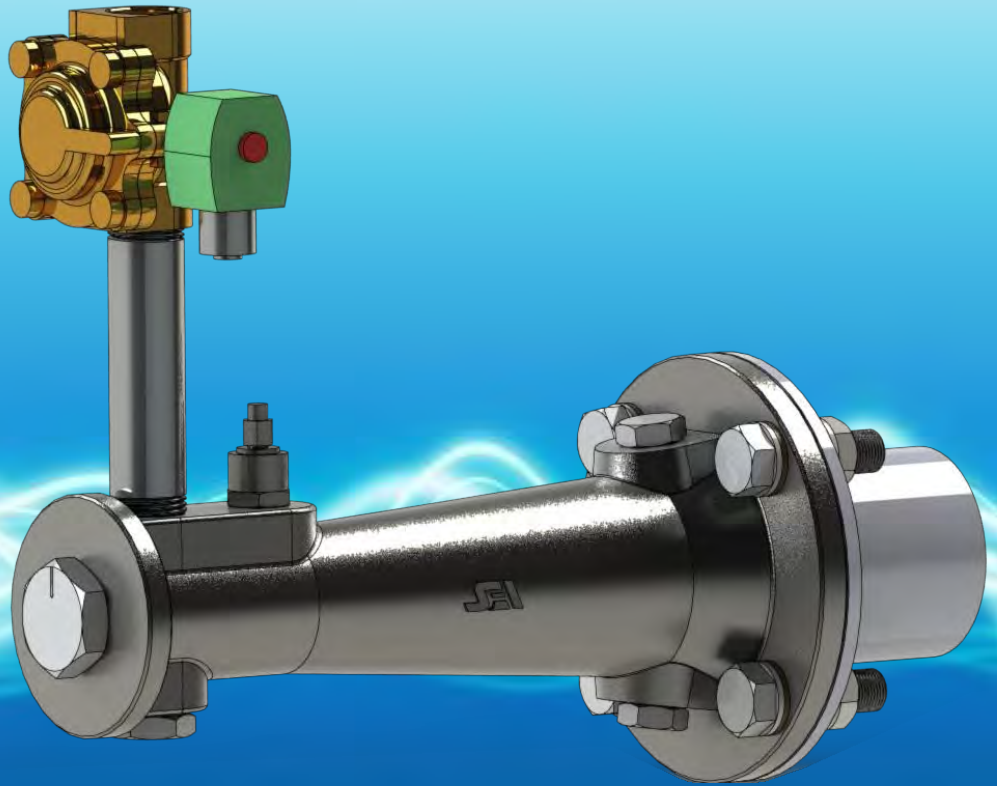
BOILERWATCH® MMP-II-SSX systems are available in a variety of configurations. With up to 24 individual path temperatures available, systems may be configured for spatial 2 dimensional temperature mapping, independent temperature measurements, or a combination of both. BOILERWATCH® MMP-II-SSX systems are easy to install, commission, and operate.

With our Acoustic Pyrometer you can measure the gas temperature in any kind of furnace/boiler/HRSG and get a distribution map temperature, all in real time. The waveguide can be located in 2, 3 or 4 wall of the furnace/boiler/HRSG.

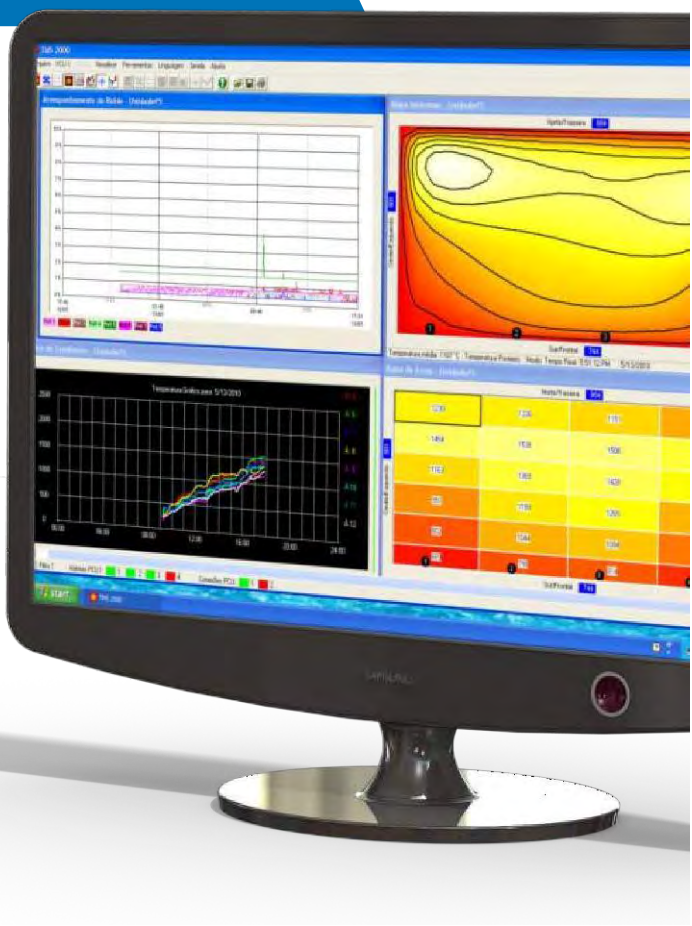
Using real-time gas temperature and spatial temperature distribution profile maps from a BOILERWATCH® MMP-II-SSX Acoustic Pyrometer System to reduce out-of balance gas temperature conditions within the horizontal and vertical furnace exit plane of a furnace/boiler/HRSG, provides a number of highly cost effective benefits.

It has been shown that excess O2 can be reduced by at least 0.5%, which results in a vastly significant increase in fuel efficiency and heat rate. The cost savings from this benefit alone pays for a BOILERWATCH® MMP-II-SSX system in very short time.

By reducing temperature imbalances and eliminating hot-spots in the FEGT plane, NOx production is cut down at the source. More uniform temperature distribution also reduces thermal stress and increases the service life of critical pressure parts including wall tubes, superheaters and reheaters.



Software
Gas Temperature Measurement



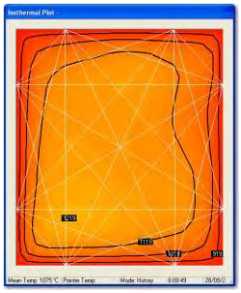
TMS-2000 displays gas temperature measurement data in a number of highly effective and useful presentations that provide critical and timely temperature related information on the furnace, boiler or HRSG thermal process being monitored. TMS-2000 presents operations and performance personnel with straightforward, yet powerful, visual information on current and historical gas temperatures. Spatial temperature distribution profiles (i.e. temperature as a function of position within a planar area), individual path average temperatures, path and area statistics, path temperature/time trends, and average gas temperatures within user-defined zones are available from TMS-2000. Both rectangular and circular planar geometry's are supported.

The PCU sends real-time temperature information to TMS-2000, which processes, stores, and displays the measurement data in a variety of user-selected formats.

The multiple sets of path temperatures, from which the various displays and presentations are derived, may be stored (archived) on hard disk or on a network drive for later offline display and analysis.

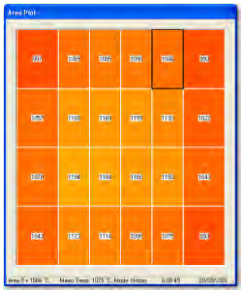
TMS-2000, like all of our software is menu driven for ease of use. In addition, it has soft key buttons to quickly move between screens, or to open and close screens.

Isothermal Map



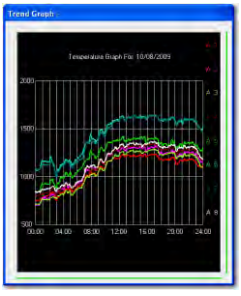
The Isothermal Plot screen displays spatial temperature distribution profiles in the form of color isothermal contours for a given furnace application. TMS-2000 supports two geometries, circular and rectangular. One presentation provides isothermal contour lines at a user defined temperature contour interval, with the temperature of the contours displayed. Smaller intervals provide a greater number of lines, and hence, more detail, while large intervals result in fewer lines within the planar area. By moving the cursor to any given point within the plane, the numerical value of the temperature at that point is displayed in the status bar at the bottom of the window. This status bar also displays the mean temperature, the mode (real time or history), as well as the time and date of the last data acquisition. In "history mode", data between specified starting and ending times may be played back in a slide-show style to visualize dynamic temperature changes over a period of time.

AreaMap



TMS-2000 can compute and display the average gas temperature within user-defined areas (or zones) of the mapping plane. Up to twenty-four (24) zones within the plane may be defined by the user. The system will then calculate and graphically display the average temperature within each of these zones. Area plots are especially useful for plant control systems such as a DCS.

Trend Graph



Path temperature graphs show up to 8 Areas and/or path temperature values. Both minimum and maximum temperature scale values may be selected for optimum resolution of the trace display. Time periods may be selected from the previous 24 hour periods up to 365 days. Each pen is color coded, any pen may be assigned to 8 paths and/or areas. The Time and Temperature are displayed by moving the mouse over the graph.

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The TMS-2000 presents a system for the detection of noise in the combustion zone of the furnace/boiler/HRSG.

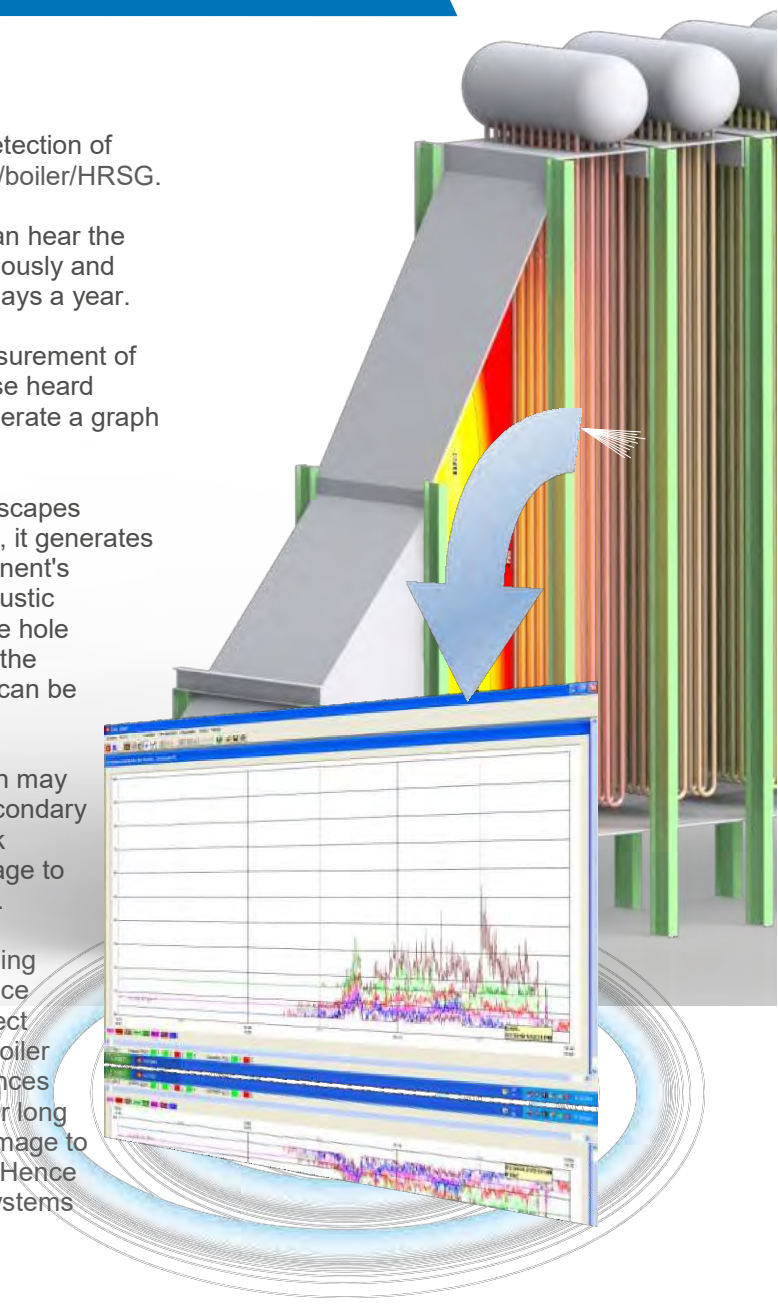
The microphone that is located in the waveguide can hear the normal noise of the boiler / furnace / HRSG continuously and displays a graphical trend for 24 hours a day, 365 days a year.

Before our equipment generated noise for the measurement of temperature, the microphone in the waveguide noise heard inside the boiler / furnace/ HRSG, allowing it to generate a graph of noise.

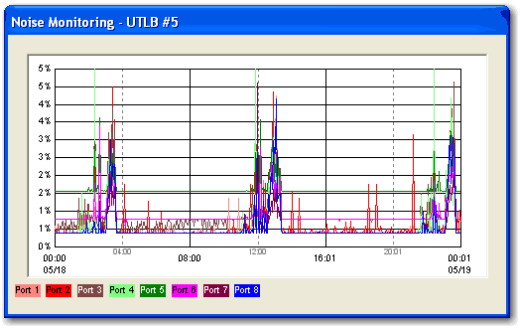
When a pressurized fluid such as steam or water escapes through a leak in piping, valves, or feedwater tubes, it generates acoustic emissions which travel through the component's structure. Small holes generate high frequency acoustic emissions (above the audio frequency range) as the hole increases in size the low frequency complement of the acoustic emission increase and the airborne noise can be heard.

BOILERWATCH® MMP-II-SSX with Leak Detection may be used to detect early boiler tube leak to avoid secondary damage to pressure parts. Boiler acoustic tube leak detection system must be used as it prevents damage to costly boiler parts and it is very much cost effective.

Traditional leak detection system such hearing hissing sound by ear or monitoring feed water flow or furnace vacuum is not much reliable because it cannot detect small leak so damage to vital costly equipment of boiler may not be avoided. Operators noticed many instances where thermal power plants boiler allowed to run for long time due to confusion which caused permanent damage to many boiler tubes, refractory and boiler structures. Hence importance of acoustic monitoring leak detection systems sincerely felt.



Sootblower



Early detection by BOILERWATCH® MMP-II-SSX with Leak Detection results in substantial reduction of repair times and costs with a consequent increase in plant availability and profits. The early detection of a boiler tube leak will give financial savings which will easily exceed the initial capital cost of the detection system even at the very first event.

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Components

1 3020TR Transceiver Unit · Wave Guide and Preamplifier

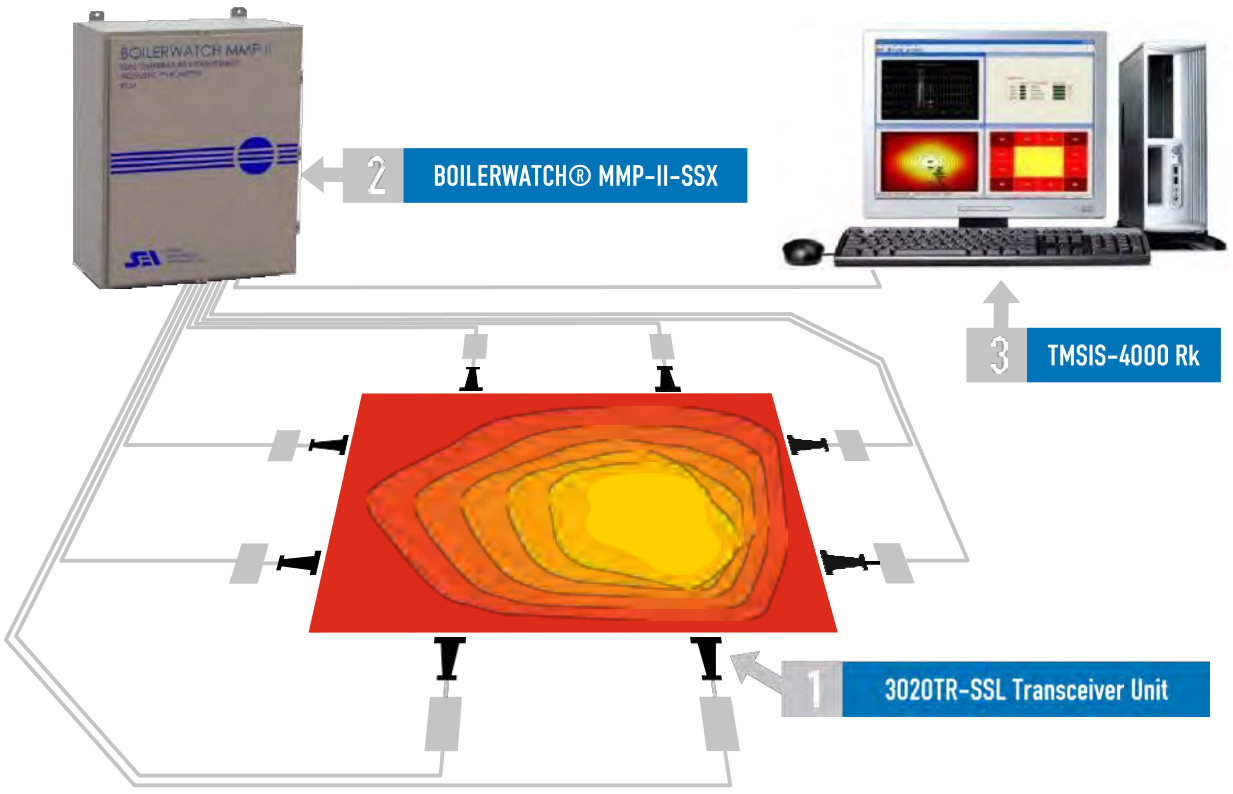
Pneumatically driven acoustic sound source and receiver. Mounts on exterior wall of the furnace/boiler/HRSG. The maintenance of these sensors is practically none because the same air that use to generate the sound, also serves for cleaning and cooling. It consists of a microphone and solenoid valve.

2 BOILERWATCH MMP-II-SSX · Processor Control Unit (PCU)

Sound spectrum used for reliable detection is from 500 Hz to 3,500 Hz. Simultaneous detection is available to sample all paths in less than 15 seconds. Provides temperature measurement capacity for up to eight (8) independent paths (requires 2 model 3020TR Transceiver units per path), or up to a twenty-four (24) path array for spatial temperature distribution mapping (using up to 16 model 3020TR Transceivers)

3 TMSIS-4000 Rk

The TMSIS-4000 utilizes the TMS-2000 software to convert path temperature data provided by the BOILERWATCH PCU into area data for planar temperature distribution mapping applications. The spatial temperature gradients are displayed in the form of an isothermal map and accurately represent a planar temperature gradients. Additionally, the complete two-dimensional (2-D) (planar) isothermal map is sectioned into 24 areas forming an array of area temperatures, which constitute a single spatial temperature plane. The area temperature data is then fed directly into the plant Distributed Control System (DCS), Data Acquisition System (DAS), for data presentation and archiving.



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Specifications

1 3020TR-SSL Transceiver Unit · Wave Guide and Preamplifier

Wave Guide

Material:	Stainless Steel 316L
Dimensions:	200mm flange diameter, 325mm length
Flange:	In accordance with ASTM standard 3-inch 150 lb. pipe flange
Weight:	26 lb. (11.8 Kg.)
Temperature Environment:	Flange: +450ºF (+232ºC) max.; Ambient Air: +130ºF (+54ºC) max.
Noise generated:	Inside: 126dB.
Air Pressure to Sound Source	Air Service. 80 - 120 psig (5.0 - 8.3 Bar).
Air consumption	5 bar = 2.26 m3/min (Not Constant)

Preamplifier

Ambient Air Temperature:	+ 140 ºF (60ºC) maximum, No solar loading on cabinet
Enclosure:	343H x 288W x 130D mm
Weight:	14 lb (6.4 Kg)
Industrial Standards:	NEMA/EEMAC Type 4. IEC 60529, IP66

2 BOILERWATCH® MMP-II-SSX · Processor Control Unit (PCU)

Ambient Air Temperature:	+ 130 ºF (54ºC) maximum, No solar loading on cabinet
Enclosure:	762H x 610W x 356Dmm
Weight:	110 lb (50Kg)
Industrial Standards:	NEMA/EEMAC Type 4. IEC 60529, IP66

3 TMSIS-4000 Rk

Number of Ports:	Two minimum and up to sixteen maximum
Number of Paths:	Up to twenty-four (24) paths
Warranty:	Two (2) years.

TMS-2000 Software

Measurement Range:	32ºF to 3500 ºF (0ºC to 1927 ºC)
Temperature Units:	English or Metric (ºF or ºC)
Accuracy:	Better than 0.5%
Measurement Acquisition Time:	Less than 30 Sec.
Data Output:	OPC/Ethernet
Data Saved:	Unlimited (Isothermal Map, Trend Graph and Noise Detection).
Remote Connection:	VPN or Remote IP.

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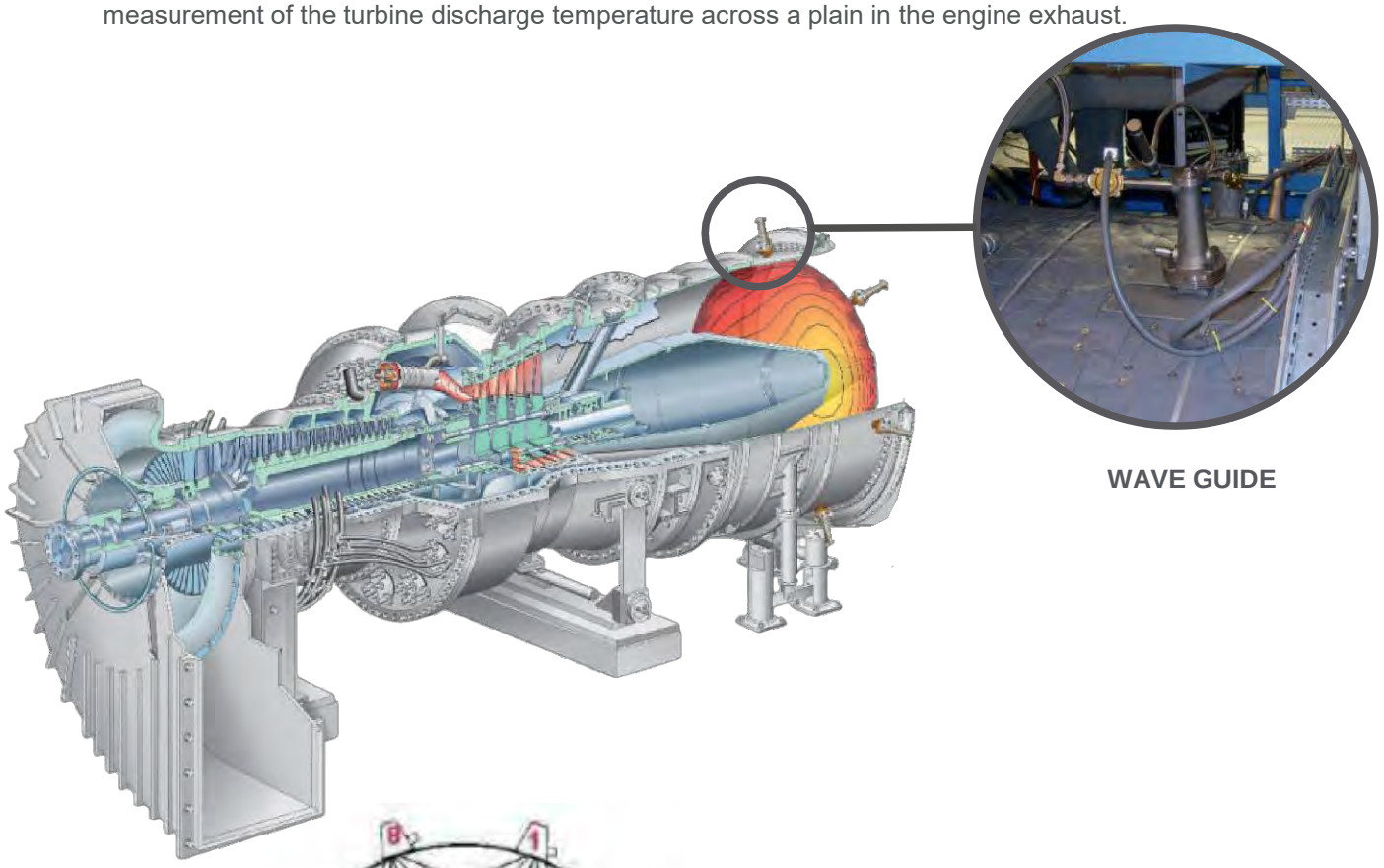
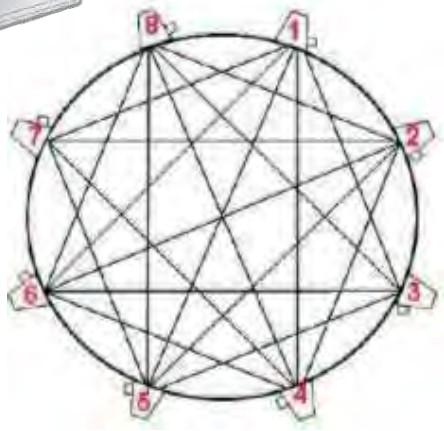
GAS TURBINE EXHAUST TEMPERATURE

The exhaust gas temperature (EGT) is typically defined as the gas temperature at the exit of the turbine; the sensors used to measure this parameter are considered the most vulnerable elements of the entire turbine engine instrumentation. EGT measurement is considered a key parameter for optimizing fuel economy, diagnosis and prognosis. The reason is that turbine blade temperature is a good indicator for normal life consumption of that blade. Currently, direct sensor measurements made on turbine modules are limited due to the extremely hot environment.

The acoustic pyrometer is a non-contact measurement device that obtains highly accurate instantaneous gas temperature data from any location within the turbine engine. An acoustic pyrometer measures the average gas temperature across a space of known distance, especially turbulent, high temperature gas. The goal of the SEI BOILERWATCH® MMP-II-SSX Acoustic Pyrometer System is fast and accurate measurement of the turbine discharge temperature across a plain in the engine exhaust.



WAVE GUIDE



Eight sets of sound wave transmitters and receivers are placed equally spaced around the perimeter of the engine exhaust duct.

The transceivers were installed at the end of the exhaust diffuser approximately 5 diameters downstream at about a 1.5 times the exhaust diameter being the diameter at the cross section.

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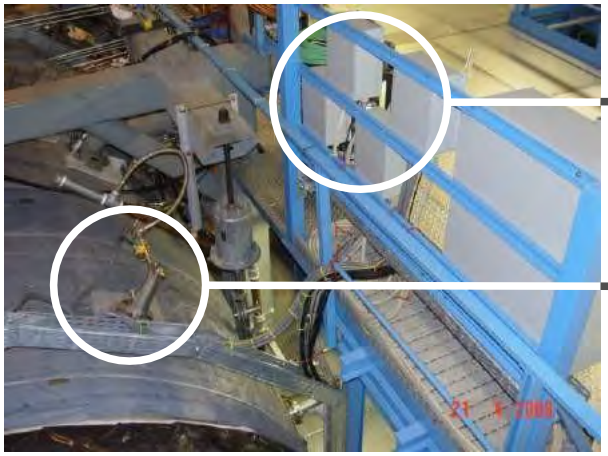
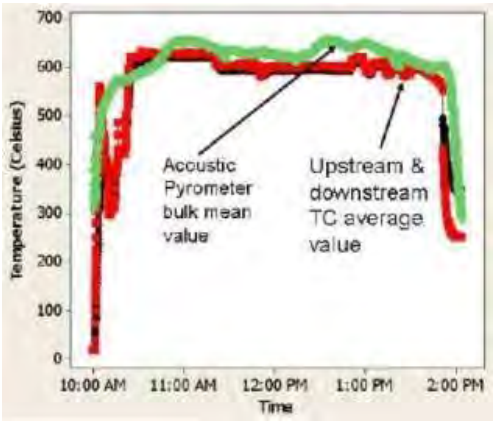
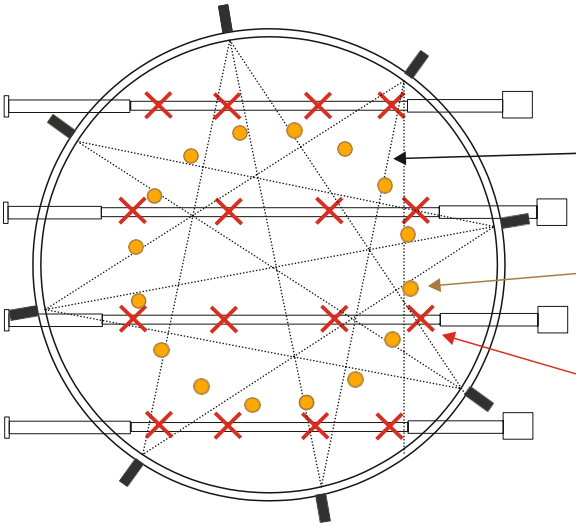


PREAMPLIFIER

WAVE GUIDE

For comparison there were thermocouple grids mounted on the exhaust on each side of the acoustic pyrometer plane. On the upstream station there were 16 thermocouples mounted on the same radial location symmetrically distributed around the cross section more than 1 diameter upstream. On the downstream location, there were 16 thermocouples mounted in a grid across the exhaust flow approximately 1.5 diameters downstream of the acoustic plane. A sample result obtained from this test is shown in the graphic. The graphic shows spatially averaged thermocouple data compared to spatially averaged acoustic pyrometer data.





Acoustic Path Lengths (x24)

Upstream thermocouples (x16)

Downstream thermocouples (x16)

One issue with using thermocouples to measure EGT is associated with the fact that the thermocouple is immersed in the flow path. Turbine passages tend to be very small, which means that the cross sectional area available to the flow is limited. Thus immersing a thermocouple inside the gas path introduces a relatively large flow disturbance in the form of blockage. As a result, the thermocouple may be affecting the very quantity that it is trying to measure.

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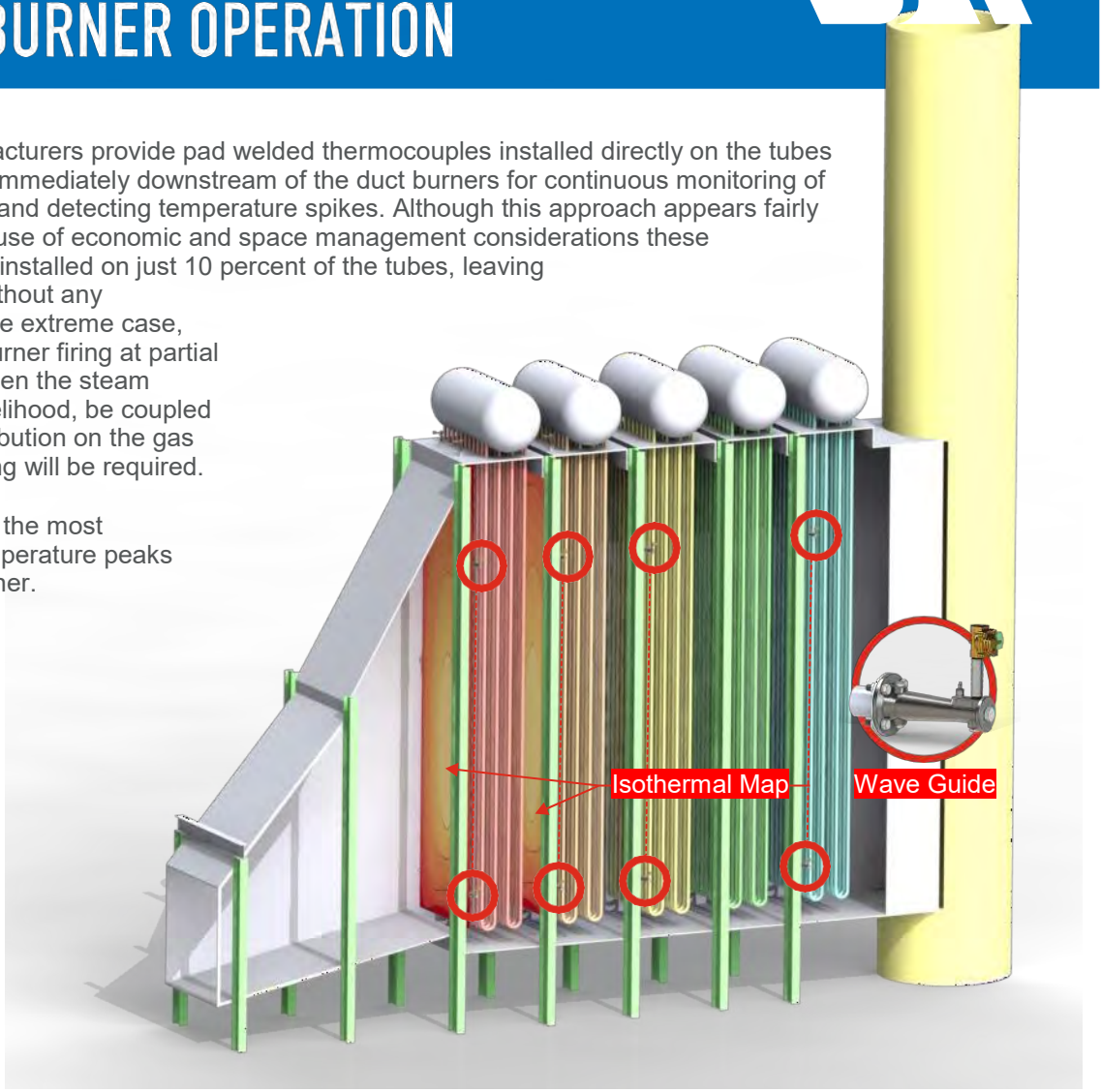
DUCT BURNER OPERATION

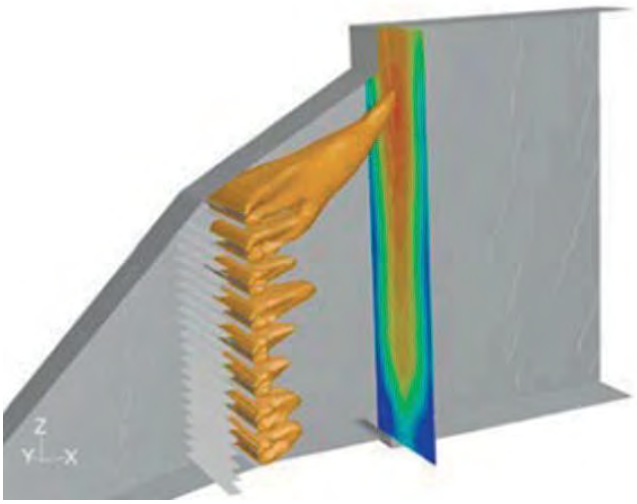
Typically, the HRSG manufacturers provide pad welded thermocouples installed directly on the tubes of the heat transfer section immediately downstream of the duct burners for continuous monitoring of the tube metal temperature and detecting temperature spikes. Although this approach appears fairly reliable at first glance, because of economic and space management considerations these thermocouples are typically installed on just 10 percent of the tubes, leaving the remaining 90 percent without any temperature indication. In the extreme case, such as 100 percent duct burner firing at partial combustion turbine load, when the steam maldistribution will, in all likelihood, be coupled with a temperature maldistribution on the gas side, more reliable monitoring will be required.

It is very important to obtain the most reliable indication of the temperature peaks downstream of the duct burner.

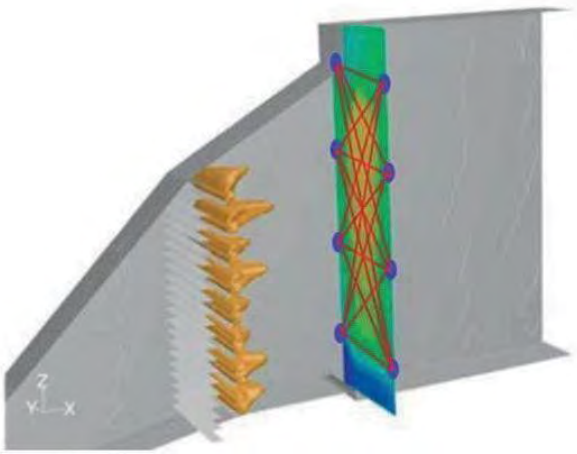


BOILERWATCH® MMP-II-SSX may be installed after the duct burner and before the HRSG. Advantages of this type of installation is the protection of the shock tubes in the HRSG and assurance of correct temperature for the NOx control. Thermal distribution is important for the obtainment of heat transfer in the different regions of the HRSG.

BBOILERWATCH® MMP-II-SSX display to the operators a thermal distribution in front of the superheater tubes thereby eliminating flame inpingement. Single path measurements can at the same time monitor temperature differences for timely NOx additives Injections. Amoniac slip will be reduced.



UNBALANCED



BALANCED

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BOILERWATCH® MMP-II-SSX

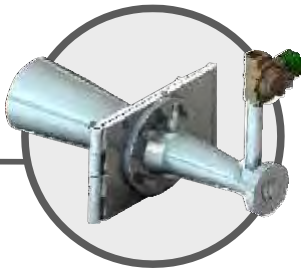
The BOILERWATCH® MMP II-SSX is composed of three parts:

3020TR SENSORS MMP-II-SSX

The 3020TR Sensors are used in the MMP-II-SSX. It is used both as a sound transmitter and as receiver. When it is operating as a transmitter, it uses compressed air to generate the acoustic signal for temperature detection along a specific path. When it is connected as a receiver, the 3020TR acts as a microphone to measure the received signal. Each sensor has a shut off valve that must be opened for correct operation of the equipment.

The 3020TR Sensor assembly consists of a waveguide, a separate pre-amplifier assembly. The waveguide horn is mounted to a 3 inch schedule 40 pipe, 6 inches in length. With standard 3 inch flange which is rated at 150 lb. A 3 to 6 inch diameter cone is casted into the refractory of the furnace.

The waveguide contains a solenoid air valve that uses plant air to produce an acoustic signal. The solenoid valve is supplied for: 120-240VAC/50-60HZ. The piezoelectric transducer is mounted to the waveguide, and is used as a microphone to detect acoustic signals.



Wave Guide

Preamplifier

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PCU BOILERWATCH® MMP-II-SSX

The PCU is the heart of the Boilerwatch® MMP-II-SSX system. It provides all control, processing, I/O and data storage functions necessarytoobtain andstore pathtemperature measurements. Containedina rugged NEMA-4welded steel wall- mountenclosure,the PCUfeaturescapacityfor upto8independent temperature pathsorupto 24 pathsin aspatial temperature mapping array. Measurement results for all paths are communicated to an external PC with TMS-2000 software viaaserial port.

The BOILERWATCH® MMP-II-SSX Processor Control Unit (PCU is mounted at the button of the Boiler in an electronic equipment room. The temperature information is supplied to the control room via RS-422.

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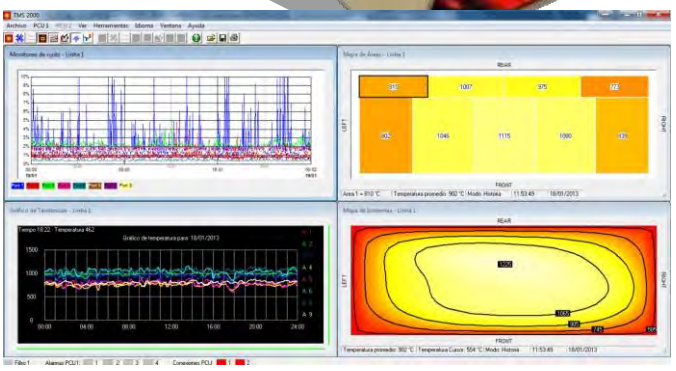
Installation-Injection

Waveguide Preamplifier

PCU located beside of boiler



TMSIS-4000 with TMS-2000 Software located at Control Room

BOILERWATCH® MMP-II SSX is measuring the real gas temperatures in the combustion chamber cross-section near the injection points and determining temperature profiles.

With several combined transmitter/receiver units installed on one level multiple path configurations are obtained to determine the two-dimensional temperature distribution on one level immediately and without delay. The temperature profile is divided into sections and can be assigned to individual lances or groups of lances which can be changed to another level depending on the flue gas temperature measured.

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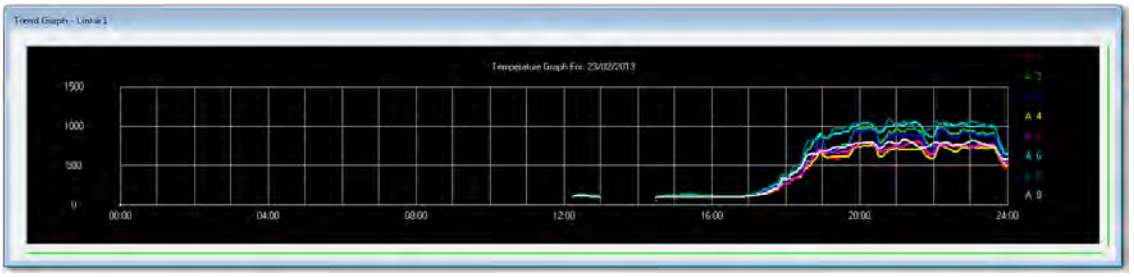
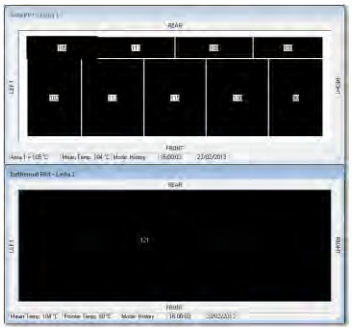
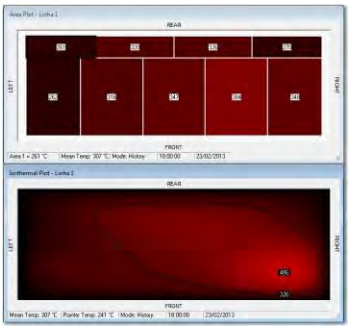
Boiler Start-up

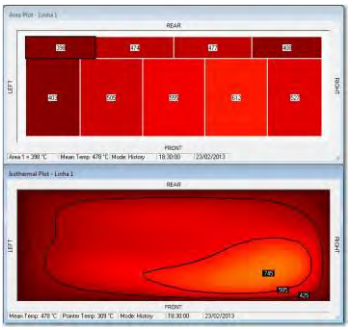
The Boiler Start-up

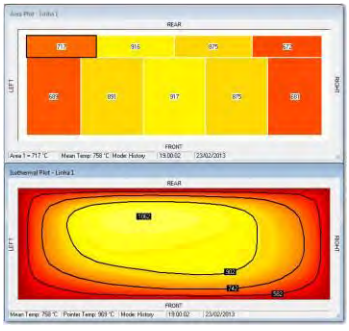
To prevent condensation of the flue gas, the Boiler and the Economizer require preheating before incineration is started.

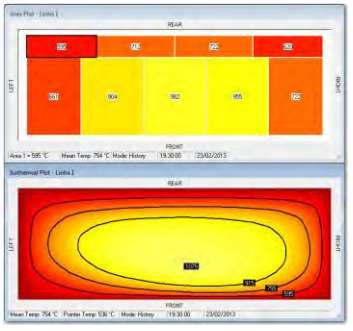


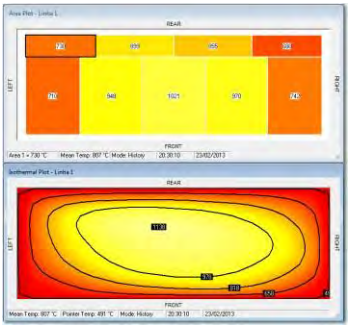


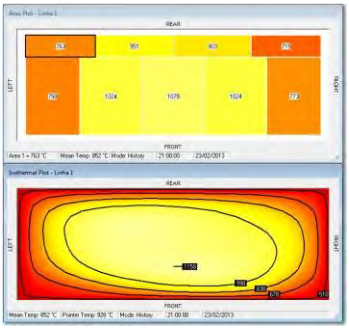


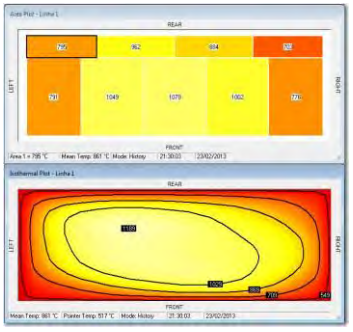


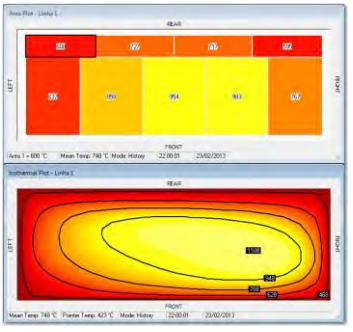












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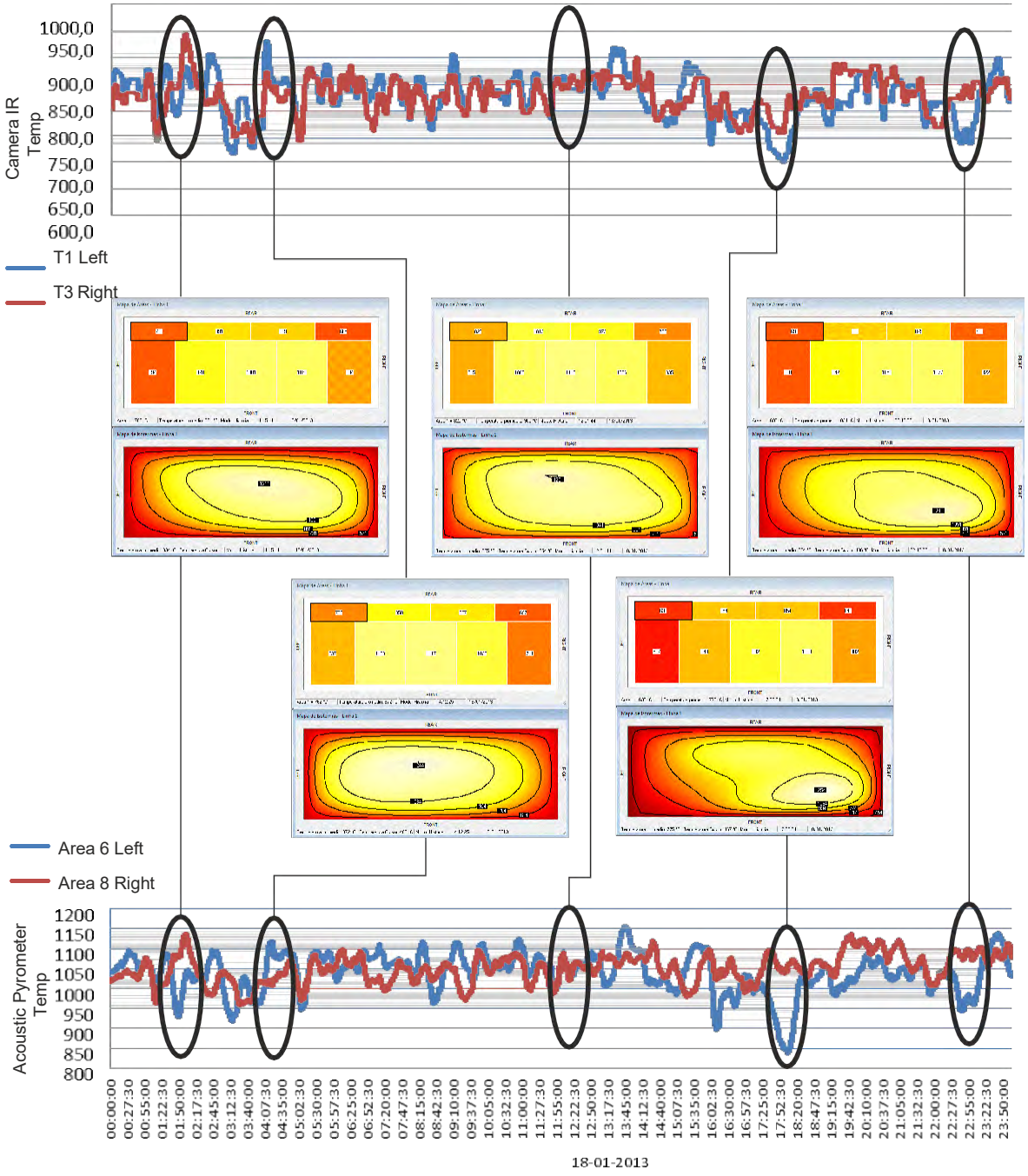
Gas Temperature Distribution



Depending on the fuel type, fuel distribution and air supply, temperature imbalances are typical. The common furnace exit temperatures measured by means of IR Camera and averaged can be used as reference temperatures to a limited extent only as these average temperatures do not say anything about the temperature profile or the imbalances within the injection levels.

The constantly varying composition of the fuel in waste incineration plants results, for instance, in rapid and major changes of the heating value and the ignition behavior of the fuel, causing considerable variations in the heat release and as a consequence the furnace temperatures. Moreover, the temperature window moves further upwards due to the increasing degree of deposits on the heating surfaces in the combustion chamber during operation.

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Notes

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NTPC

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