inspecta
ACOUSTIC STEAM LEAK DETECTION

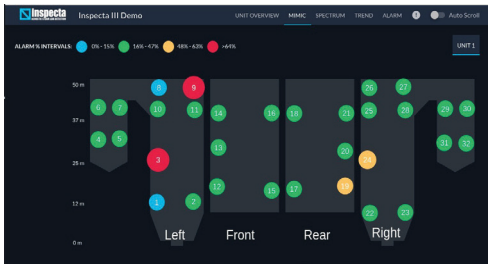
Designed, Engineered and Manufactured in South Africa

Inspecta III

www.instrotech.co.za

Inspecta Acoustic Steam Leak Detection

An advanced acoustic leak detection system designed for the early detection and progressive monitoring of steam leaks within coal fired boilers and subsequently minimising boiler outage and repair time.



SCAN ME

Inspecta III

Inspecta Acoustic Steam Leak Detection

The Inspecta III Acoustic Steam Leak Detection System (Inspecta ASLD) was designed to detect boiler steam leaks in large thermal coal fired boiler installatons ranging between 200MW to 900 MW but customizable to be used in smaller facilities to detect tube leaks at an early stage (1mm to 2mm in diameter). The Inspecta III's extensive diagnostic features enable maintenance to be planned and scheduled appropriately.

Features and benefits of the Inspecta III

- Very early detection of steam leaks and trend analysis of the potential tube leak progression, assisting in scheduling when best to plan a boiler shutdown.
- Complete capture and logging of all field sensor data, enabling post-event analysis.
- Strong system access security through a sub-system of various user levels; System Administrator, Supervisor and Operator. Each of these has a dedicated list of allowed operations.
- Standard 19" rack mechanical equipment practice.
- Modular expansion of up to 64 field sensor channels per system.
- The Inspecta III system makes use of industry standard communications protocols to communicate to utility information and control systems and networks.
- The standard communications output is serial RS-232. As an alternative output option, Modbus RS-485 may be utilised instead, please contact supplier for more information.
- Recording of Trend progress for potential steam leak monitoring and analysis.
- Backward compatibility connecting to existing sensor networks and plant facilities using the purpose designed Inspecta Plant Interface (PIU).
- Digital inputs to enable relevant power station conditions to be input to Inspecta (e.g. soot blowing)
- Digital outputs for audible alarm conditions such as critical (steam leak) and low level alarms.

Cost saving case study

The Inspecta ASLD system has been shown to reliably detect steam tube leaks less than 2mm. To achieve this accuracy, the system must be correctly calibrated and the 'listening' pipe-sets kept clear of any obstruction that will reduce the sensitivity of the system. Experience has shown that if there is any obstruction such as fly-ash that reduces the sensitivity by more than 10%, it will result in a measurable degradation of the Inspecta ASLD and a delay in the detection of a tube leak.

Early leak detection gives operational management staff time to consider and evaluate different options so that effective action can then be taken to minimise boiler downtime and loss of electricity production.

Case 1: Early Detection of Tube Leak

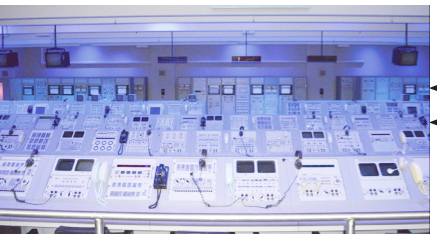
In this case the tube leak was detected promptly, and the boiler shut down before significant secondary tube damage had occurred. From the literature (EPRI, 2003), this resulted in an outage time of 2 days before the boiler was brought back onto line.

Case 2: Delayed Detection of Tube Leak

The tube leak was detected, and the boiler shut down 2 hours after case 1.
In this case, it is assumed that a tube leak has occurred and rapidly created significant secondary damage so that upwards of 40 tubes have been damaged, (similar to the case described in Combined Cycle Journal, 2020) .
From EPRI information (EPRI, 2003), the boiler outage time increases steeply as secondary damage increases.
From this information, the time taken to repair the boiler was 11 days, which means 11 days of lost electricity production.

Inspecta III System Setup in Power Station

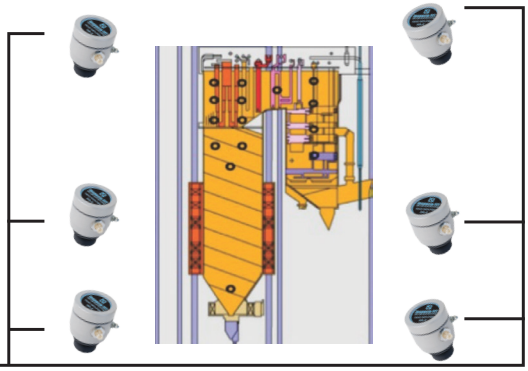
The Inspecta III system is connected to the coal-fired boiler in the field and the power station's Distributed Control System (DCS) in the following arrangement:



Power Station DCS

Alarm relay OUTPUT, Digital INPUT

Serial RS-232 output



Up to 32 microphone inputs

Inspecta PIU

LAN ethernet connection

Inspecta server

Display, keyboard and mouse

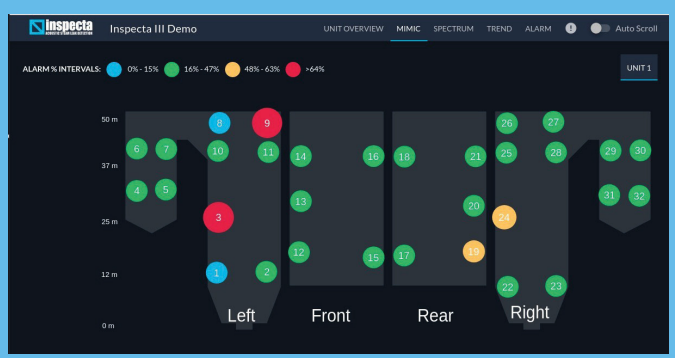
Optional wireless router

Unit overview

Indicates the alarm level % for all channels of the Inspecta system. Up to 32 field sensors can be displayed as bar graphs on the same screen in order to provide an overview of the system's condition. Each bar level is 0-100% indication of the processed audio spectrum. When the sound is at a normal background pattern, the bar will remain in the green zone, 16-47%. Should one or more inputs increase in volume and change their pattern to indicate an abnormal condition, the bar will then rise into the yellow/amber zone, 48-63%. As the leak increases the bar will rise into the red zone, 64-128%. If the bar remains in the red zone for longer than a pre-set time(default is 1min), an output relay is initiated which, if connected, is able to activate remote alarms at the Power Station control panel. The blue zone, 0-15%, indicates that the relevant field sensor is not working. This may be due to fly-ash blocking the stub pipe or no sensor is connected.

Mimic view

The Mimic view indicates to the plant operator the physical position of each Sensor point on the boiler. The numbered input points(shown as circles) are sized according to alarm severity and change colour as the alarm Bar Graph increases.
Once a danger level has been exceeded and timed out, the point will
pulsate in red. An abnormally low level will pulsate in blue to signify a system malfunction. During initial commissioning, the boiler plant layout showing the position of the sensors should be designed and uploaded to the new Inspecta system.

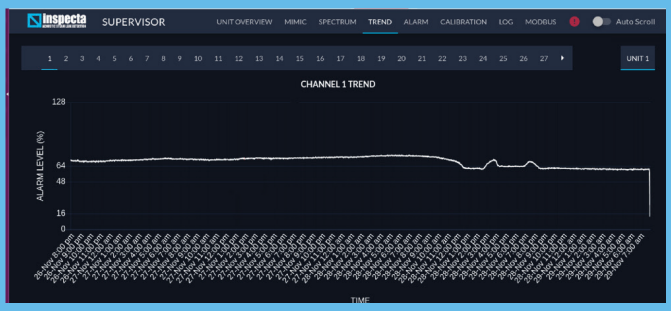


Spectrum view

Displays the frequency spectrum for each selected channel as well as the alarm % level for that channel. On the Audio Spectrum display, the sound level is indicated as decibels vs. frequency. Inputs are sampled at least once every five seconds and digital averaging is incorporated into the programme to allow for any spurious noise. This sound signature has a particular shape for the normal background sounds such as burners, induced draft and forced draft fans. The background sound patterns can be saved for future comparison against the patterns generated by steam leaks. When a steam leak occurs, the patterns alter and are displayed in the form of an alarm on the Unit Overview. The Spectrum Display also shows the time & date, boiler and sensor number.

Trend view

By using the Trend view, operators are able to visually interpret the alarm % level for a selected channel over a 32 hour period. The Trend view is useful for analysing the progression of possible steam leaks over time. This vital information assists the boiler maintenance staff in making crucial decisions regarding when to shutdown and action the repair work within the boiler.



Inspecta III retro fitting

The Inspecta III acoustic steam leak detection system is BACKWARD COMPATIBLE with all existing Inspecta sensor networks and plant facilities. If an Inspecta FFT Muxbox(s) is being used, it is simply replaced with the purpose designed 19” rack-mount Plant Interface Unit (PIU) which is plug & play. All existing plant wiring remains the same. Some minor wiring changes within the Control room may be required.

Reference List

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ACOUSTIC STEAM LEAK DETECTION

Inspecta III System Information

1 Introduction

Instrotech, a South African high technology company, has introduced a new boiler steam leak detection and location system, the **Inspecta III**.

The new system has been totally locally designed and engineered, based on over 35 years of boiler steam tube leak detection experience in South Africa, India, Australia and Europe.

The first 10 systems were sold to Eskom Matla & Duvha in 1985.

Major features include:

- **Backward compatibility with existing Inspecta field sensor arrays and plant interfaces.**
- **Providing a new platform using current industry-standard technologies with modern capabilities.**
- **New sensor array that minimises installation work and modification to the boiler (future).**
- **NEW Multi-Stack modular platform increases number of field sensors to 64!**

The Inspecta III is aimed at large thermal boiler installations in the range 200 MW to 900 MW but can also be tailored for smaller facilities.

Its extensive diagnostic facilities enable tube leaks to be detected at a very early stage (1mm to 2mm) and the leak progression to be followed. This allows maintenance to be planned and scheduled at an appropriate time instead of suffering an unplanned breakdown and its many bad consequences.

The Inspecta III has been designed to evolve from a basic steam leak detection system with new modern features to an advanced expert system. This will provide effective management information to enable plant operators to efficiently plan and implement required shutdowns and necessary repairs.

The system implements various utility and power station Distributed Control System(DCS) interfacing requirements. These are standard industry protocols such as Serial RS232 & Modbus RS485.

2 Features

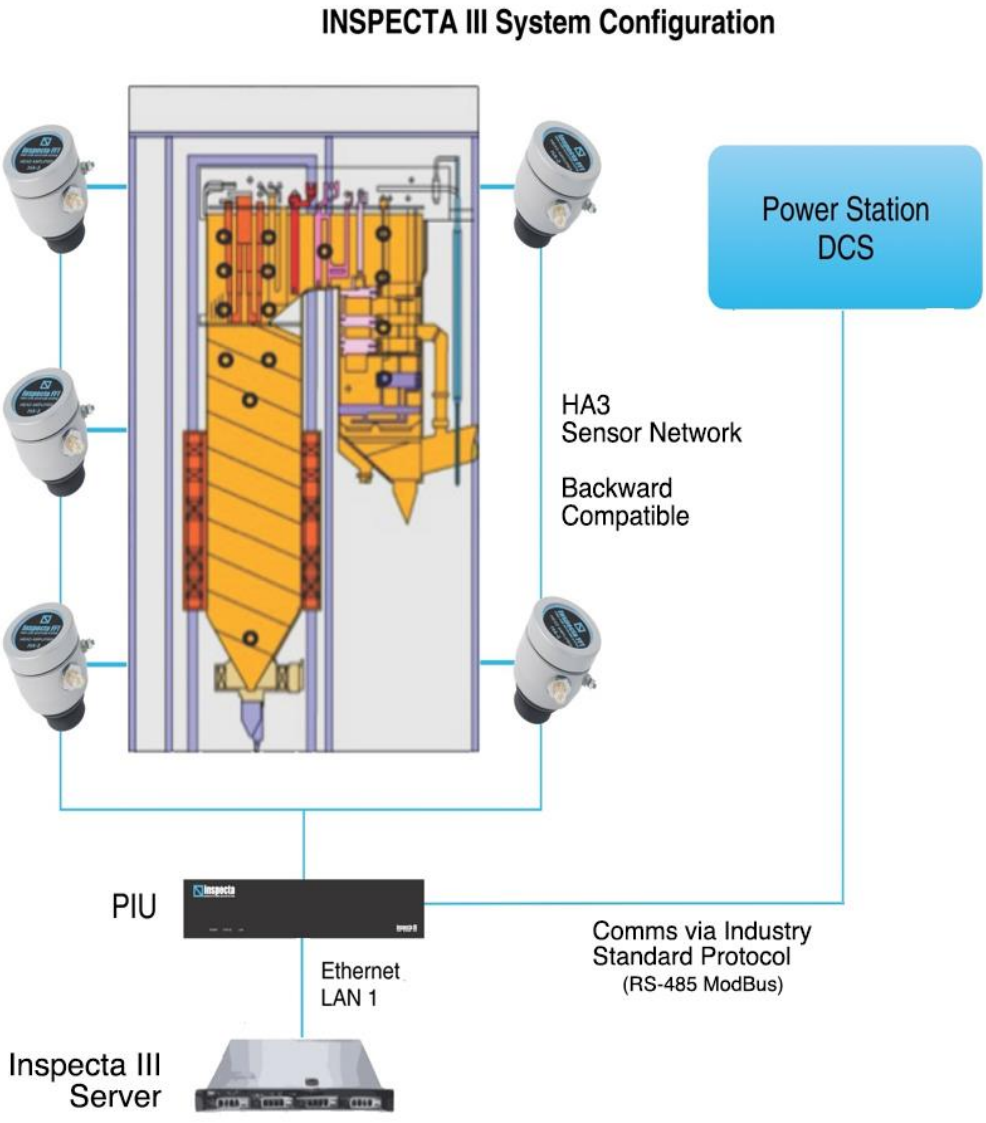
The following are the main features of the new Inspecta III system:

- Very early detection of steam leaks and trend analysis of the tube leak progression, which will enable prediction of when the boiler shutdown will be necessary.
- Complete capture and logging of all captured sensor data, enabling post-event analysis.
- Strong system access security. The security sub-system caters for various system user levels; System Administrator, Supervisor and Operator.
  Each of these has a dedicated list of allowed operations.
- Standard 19” rack mechanical equipment practice.
- Modular expansion up to 64 sensor channels per system.
- Full VPN encrypted remote access. This will allow software upgrades, log files access and system configuration to authorised users. (OPTIONAL FEATURE)

- Thin client user access makes the system accessible to all authorised, connected modern platforms; PCs (OPTIONAL FEATURE). *Tablets and Smartphones future release*.
- The Inspecta III system makes use of industry **standard communications protocols** such as Serial RS232 to communicate to utility information and control systems and networks. Modbus RS485 is available as an additional option.
- **Backward compatibility**. Inspecta III will connect to existing sensor networks and plant facilities using the purpose designed Inspecta Plant Interface Unit (PIU) with Digital Inputs & Outputs.
- Simplified Maintenance. The Inspecta III has been designed with built-in diagnostic features and guides to simplify system maintenance.

3 Advanced System Configuration

The figure below shows the Inspecta III system configuration. Built using standard 19”rack technology, the system can either be fitted into a standard 19” rack or used as a desktop version.



3.1 Sensor Network

The acoustic sensor network is fitted to particular points on the boiler. These are selected to ensure adequate boiler coverage.

The Inspecta III system utilises sophisticated sensors specifically designed for this application. Sensors can also be fitted with automatic air purging systems to reduce routine maintenance to clear acoustic waveguides of boiler fly ash. *See Inspecta APS system, 5.3.3.*

Connection to the sensor network is via a cable network connection.

3.2 Inspecta III Server

The sensors connect to a central computer (PIU & Server), which captures, analyses and displays the received data based on the information captured by the sensor network.

The industry standard server runs a variation of the Linux Operating System.

Captured data is stored in a database, processed and conclusions appropriately displayed to the operator.

3.3 Connection to Power Station Information System

Connection into the facility or power station information system, in the case with an existing DCS, is via an industry standard interface such as the Serial RS232 or Modbus RS485 serial protocol.

This allows the Inspecta III to interface to both modern and older existing utilities as necessary.

3.4 Backward Compatibility

Realising that many existing installations will want to upgrade to the new Inspecta III Server and take advantage of the many new features, without incurring unnecessary costs, the new system has been specifically designed to interface with an existing Inspecta sensor network.

By means of an Inspecta Plant Interface Unit (PIU), analogue signals from existing sensor networks are digitised and connected to the Inspecta III Server via Ethernet.

Diagnostics that are built into the Inspecta III allow for effective remote fault location via boiler plant mimics.

3.4.1 Inspecta III System Release 1

The first release of the system will result in a system that meets the functionality of the current Inspecta system plus features such as:

- Modern, standard operating system software
- Standard hardware platform for the Inspecta III server
- Enhanced, layered security
- Standard 19” mechanical equipment practice
- Easily expandable to 64 channels
- Thin client accessible to authorised users enabling remote access (OPTIONAL FEATURE)

3.4.2 Transition from Inspecta Mk I and Mk II to Inspecta III

Provision has been made to effectively transition from Inspecta Mk I / MkII to Inspecta III, using the existing sensor network.

This is enabled by using an Inspecta III Plant Interface Unit (PIU).

This is a purpose engineered 19" rack mount unit enabling backward compatibility connection to a legacy sensor network.

It consists of re-engineered interface circuitry, power supplies, etc. to an existing Inspecta leak detection sensor network (i.e. analogue microphones).

It converts the incoming analogue sensor data to a digital format and translates it onto an Ethernet connection. This Ethernet connection connects directly to the Inspecta III server.

4 Overview System Description

The Inspecta III will provide the following overall basic functionality:

- Detection of steam leaks
- Prediction of progress of steam leaks
- Recording of trend of steam leak
- Alarm raising

Key characteristics of the system will be:

- Backward compatibility with existing Field Sensor network
- Thin client accessible optional
- Uses industry standard communications
- Equipment room installed system
- 19" rack mounted

5 Product/System Configuration

The Inspecta III product has the following configuration:

5.1 Inspecta III Server Unit

The Inspecta III application software runs on the Inspecta Server.

The server is a Commercial off the Shelf (COTS) PC platform in either a desktop or rack mounted form. The operating system is an Ubuntu implementation of Linux.

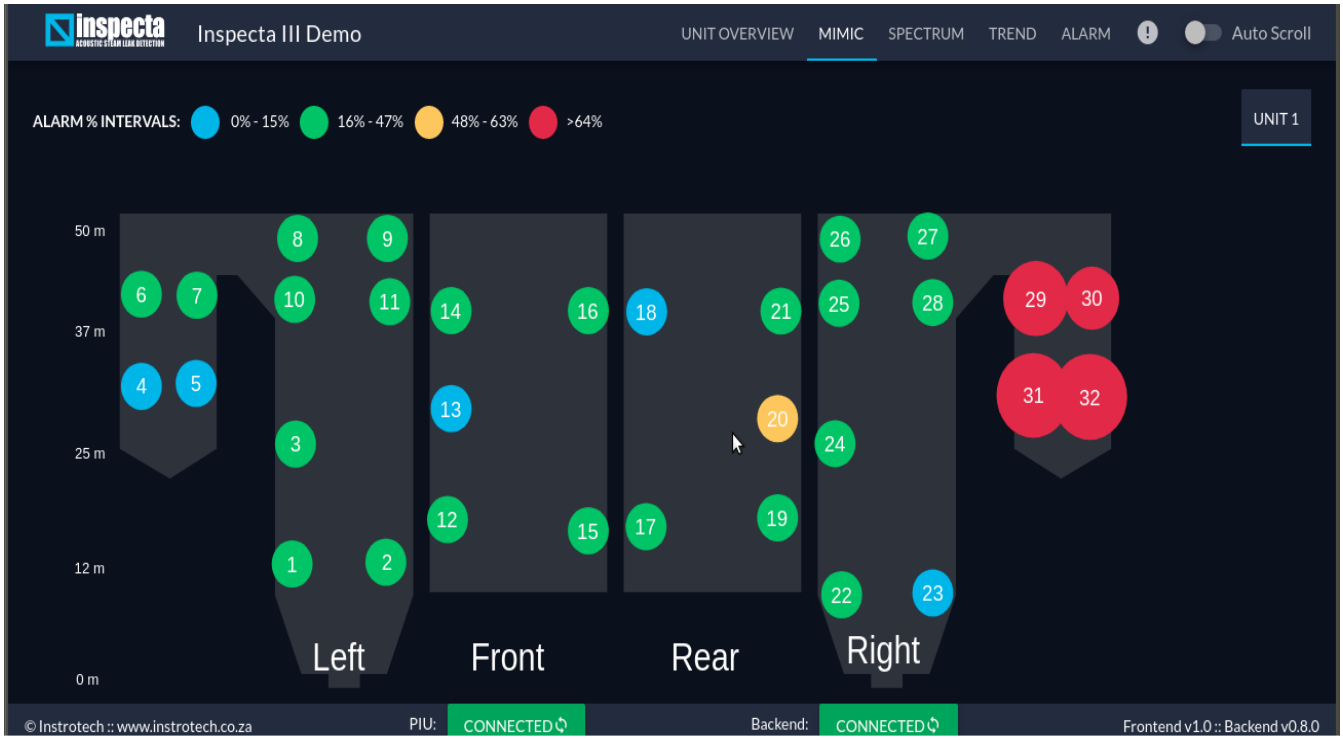
The server capabilities include high processing power and long term data storage.

*The 2 corresponding pictures show the **Mimic** and **Unit Overview** displays viewed on the Inspecta server software.*

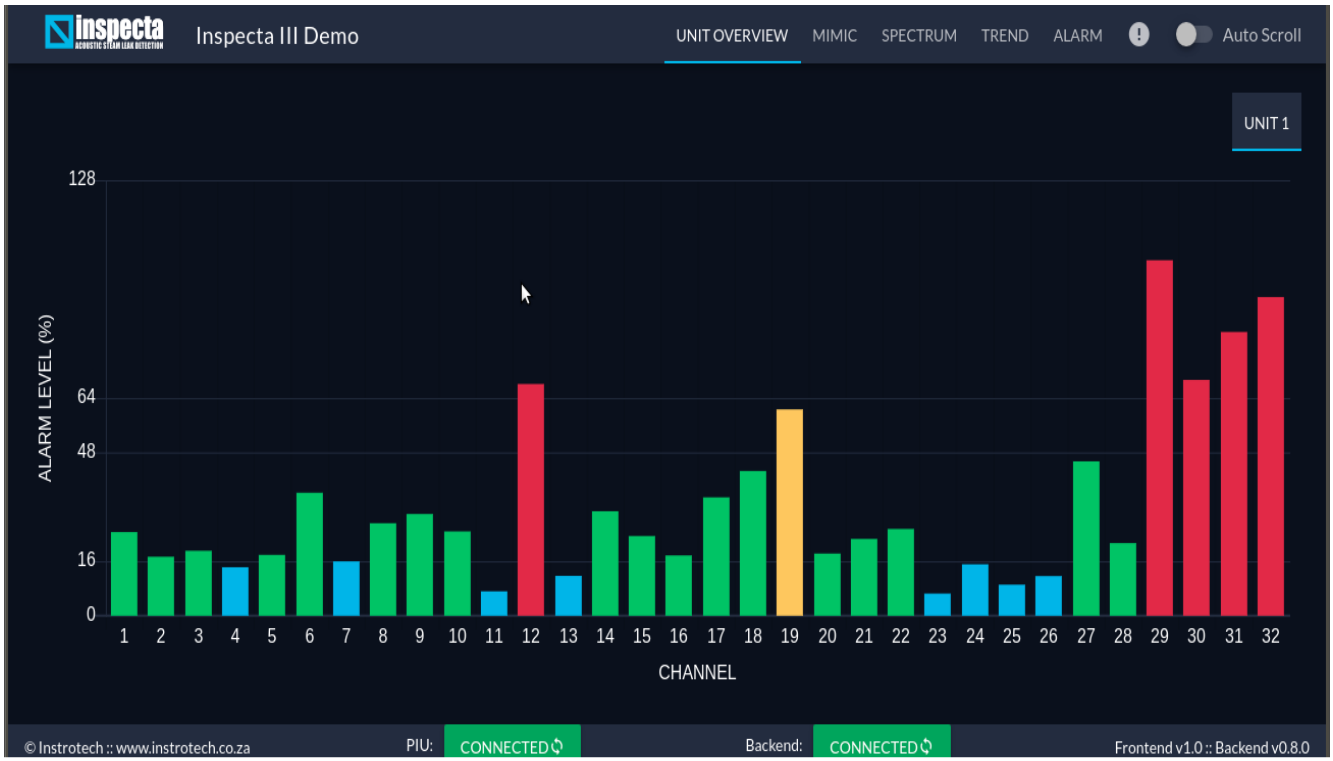
***Spectrum**, **Trend** and **Alarm** views (not shown here) provide further information of the individual channels 1- 32 and system status.*

*The **Auto Scroll** feature cycles through the 5 main activity data screens providing a constant update on these critical displays.*

Mimic Overview



Unit Overview



5.2 Inspecta III Plant Interface Unit (PIU)

This is a 19” rack mount unit enabling backward compatibility connection to a legacy Inspecta sensor network.

This unit consists of re-engineered interface circuitry, power supplies, etc. to enable connection to an existing power station Inspecta leak detection sensor network (i.e. analogue microphones).

It converts the incoming analogue sensor data to a digital format and translates it onto an Ethernet connection. This Ethernet connection connects to a dedicated Ethernet port on the Inspecta III server.

In addition to the above, the PIU also has:

- Digital inputs to enable relevant power station conditions to be input to Inspecta (e.g. soot blowing)
- Digital outputs for audible alarms.

The Inspecta III 19” rackmount Plant Interface Unit (PIU)

5.3 Analog Sensor Network

The sensor network consists of transducers mounted at selected points on the boiler structure. Acoustic sensors are typically mounted on boiler inspection doors for convenience.

5.3.1 Wired Acoustic Sensor (HA3 Audio sensor)

This is the existing legacy product installed at existing Inspecta system sites.

FFT-HA3 Headmount Amplifier

