# INSPECTA® FFT

## ACOUSTIC TUBE LEAK DETECTION SYSTEM

## SYNOPSIS

Inspecta FFT audio spectrum analysers are field proven systems developed to detect steam tube leaks in power station boilers. More than 110 systems have been installed and are currently monitoring boilers, gasifiers and oxygen plants in Australia, China, Germany, India and South Africa. Some systems have been in continuous operation since 1985.

The systems are computer-based and provide continuous monitoring, analyses and displays of the sounds within the boiler through the use of Fast Fourier Transform techniques. Field sensors are situated at suitable intervals around the boiler walls, and continually monitor the sound signature in the combustion chamber and on the heat exchange surfaces. Audio signals are converted from these primary sensors into isolated low impedance signals for electrical noise immune transmission to the remote system control. A variation in the normal sound frequency and amplitude is used to detect steam leaks. The computer runs a continuous expert analysis of every field sensor. The monitor displays are digitally averaged, so as provide a true display of the signals, free from any spurious sounds not associated with the steam leak detection functions of the system.

## SHORT-FORM SYSTEM PARAMETERS

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| Sensors channel capability | 16 or 32 channels |
| Filtering method | digital FFT |
| Audio frequency range | 313 Hz to 10 kHz |
| Leak detection ranges | factory algorithm |
| Sound level range | 0 to 120 dB |
| Maximum temperature for audio sensors | 70 degrees C |
| Alarm time delay | 60 seconds |
| Alarm inhibit interlocks | shown on monitor |
| Audible sound available at operator panel | via thumbwheel switch |
| Computer monitor display | SVGA graphics |
| Accuracy of monitor display | 1 dB |
| Display of processed alarm levels | bar graph |
| Audio spectrum displays | logarithmic |
| Monitor update time | ± 5 seconds |
| Optional serial output | RS232 or RS485 |
| Electromagnetic compatibility (EMC / EMI) | CE C-Tick (EN50081 & EN50082) |
| Power supply | 240 or 110VAC 50Hz ± 10% |

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## FIELD CABLING

Four core, 0.5mm, overall screened cables connect the field sensors to the f mounted cable marshalling junction boxes, one on each side of the boiler for acoustic sensors. Overall screened multicore cables make the connections from the junction boxes to the Inspecta FFT multiplexer in the Unit Equipment Room, and are terminated at the plug-in screw terminals located at the backplane of the multiplexer. Isolated low impedance 600-ohm signals are used from the audio sensors to prevent interference from other electrical noise that may be present in the boiler area. Cable connections in the field mounted junction boxes, for signals and for sensor power supplies, are made by way of disconnect terminal blocks.

## MULTIPLEXER WIRING

Power supply is via a standard IEC mains socket, computer type, with 'slow blow' fuse and EMI filter. Supply voltage is factory set by internally selectable solder links. All field wiring is terminated along the lower plug-in rail at the multiplexer backplane. Termination is in blocks of four sensors with a common 24 V DC current limited power supply for each block. Sufficient terminals are provided for a 16 way or a full 32 sensor system, and the initial software set-up procedure will determine how many sensors are functional.

Four potential free inputs and four relay changeover outputs are available with plug-in screw terminals. The input configuration is for INHIBIT ALARM which inhibits all alarm outputs and internal audio alarm, and ALARM ACCEPT which cancels the internal audio alarm only. The other two inputs are spare and can be used for additional special functions such as alarm inhibit by zones. There are relay outputs for POWER FAILURE, TUBE LEAK ALARM, LOW SIGNAL LEVEL, and a PRINTER ALARM to indicate printer off-line. These outputs are all energised in a safe condition, and drop out on a steam leak alarm, electronic, power or printer failure. The control unit hardware comprises one 3U 19” housing, approximately 470mm wide x 155mm high x 315mm deep. Connectors are marked on the backplane of the multiplexer and are supplied with sockets for mains AC supply, VDU monitor and printer outputs.

## OPERATOR PANEL

A dedicated panel allows the operator to select any one of the monitor displays by means of a four position rotary switch :

SPECTRUM mode displays the full audio spectrum with the sound level indicated in dB for each octave, for the selected sensor on the vertical coordinate. The horizontal coordinate displays the frequency of the sound between 313 Hz and 10 kHz. The monitor shows what the sound signature looks like, whilst the computer analyses the spectrum to generate the alarm bar displayed on the right hand side of the monitor.

BAR GRAPH mode has provision to display up to 32 processed sensor alarm signals simultaneously on the monitor. The vertical coordinate is the present alarm level and the horizontal is the sensor number. Under tube leak conditions, the graph climbs from the normal Green zone, to Yellow for caution, and to Red to show a critical situation has been reached. Low Level or Fault Conditions are displayed in Blue.


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MIMIC shows the boiler plant layout giving the position of each sensor. The vertical coordinate is the Boiler Level height in metres, and the horizontal is a pictorial display of the boiler layout. Sensor numbered points change colour on the monitor to indicate alarm conditions.

TREND mode displays the historical level over a period of time for each sensor, each being individually selected by the operator, as required. The trend will indicate the rate at which a steam leak has developed and is, or is not, progressively growing.

AUDIO allows listening to the sound inside the boiler at any acoustic sensor by selecting the required sensor number and pushing the Audio push-button. The audio sound is heard through the speaker built into the operator panel. Pushing the Audio button a second time turns the sound off.

In order to compare sound levels between different points, and also to compare normal with steam leak sounds, no volume control is operator accessible. Under normal circumstances, a gentle hum or hiss will be heard. When steam leaks or sootblowing occurs, the sound is a very loud whistling noise. Rotating sootblowers can be identified by the regular rise and fall in sound.

ALARM ACCEPT push-button accepts the alarm and cancels only the audio alarm produced at the Inspecta FFT system.

PRINT SCREEN prints out the current screen display at any time, during suspected tube leaks or for recording sound signatures, and may be made by pressing the Print Screen button.

SET TIME - Date and time settings are set or altered in the computer by switching the key switch to the Set Time function. The single digit thumbwheel selects the flashing VDU display for seconds, minutes, hour, day, month and year, and the value is entered using the two digit thumbwheel. Pressing the Print Screen button enters the selected values. Switching the key switch back to the Run position sets the current time and date.

AUTOMATIC PRINTOUTS can be set by setting the Bar Toggle Switch to On for Bar Graph print-outs, and/or the Spectrum Toggle Switch to On plus selecting the sensor number via the two digit thumbwheel for Spectrum print-outs. The time interval between printouts is selected on the single digit thumbwheel switch in minutes x 10.

## ALARM OUTPUTS

TUBE LEAK ALARM is the main alarm and turns on one minute after any sensor has gone into alarm condition. This alarm will reset immediately the alarm condition returns to normal.

Besides tube leaks, various other influences and noises can cause the system to display and activate an alarm condition. The most common cause is sootblowing. For this reason, the Inspecta FFT system should be set up so that the two systems can complement each other. The sootblowing process tests that the Inspecta FFT system is functioning correctly and the Inspecta FFT system is used to check that the sootblowers are shut off at the end of their cycle. Many potential leaks have been prevented by detecting faulty sootblowing equipment. The Alarm Inhibit contact is specifically fitted for interfacing during sootblowing, and inhibits the output Tube Leak Alarm contact. The alarm display colour changes from Red to Grey during Alarm Inhibit.


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## MAINTENANCE

Routine maintenance is required to remove soot buildup at the mouth of the stub pipe listening tube. The time it takes to build up varies from boiler to boiler, but is generally four to six weeks. Automatic purge systems operating an air solenoid for 5 seconds per hour are available as options. The Inspecta FFT system has a self-checking facility which monitors the background sound within the boiler. Should the level in the boiler drop to below 6dB, the Inspecta FFT system indicates a system malfunction that could be caused by sensor failure, cable failure, soot buildup or even isolating valves inadvertently being closed. The mimic numbers and alarm bars of any sensor affected change to Blue on the monitor.

At least once per day, preferably after sootblowing when checking that all displays have returned to normal, the operator must also check that no sensors are displayed in Blue on the monitor displays. If any are, the operator must see that the pipework is cleared of soot. This clearing is done by going to the affected sensor point and opening the PVC ball valve to allow air to be sucked into the boiler. Usually one minute is sufficient. When air flows freely into the valve the pipework is clear and the valve must be left closed off. If the pipework does not clear by air draught alone then it must be rodded. This normally only occurs if the pipe has been blocked for a long time allowing condensate to form clinker. A rigid wire is used for rodding, such as electricians' fishwire. Once pipework is cleared the monitor displays should be checked to ensure that the affected sensor has returned from Blue to its normal Green colour. Installations with the optional automatic air purge systems do not require manual valve opening, and would only need attention if a VDU sensor bar was displayed in blue.

## CALIBRATION

Full field calibration is required at initial commissioning and at least once a year thereafter. Routine field servicing does not require this full procedure, but only involves individual sensor settings to the values obtained and recorded during the initial system calibration. For calibration, the boiler should be operating at 75 to 100% of full load. A physical inspection should take place to ensure that every listening pipe is clear and all cleaning / rodding valves are closed, and that there are no sounds of any leaks or abnormal noises. The initial calibration will establish a sound signature which is unique to each boiler. The calibration procedure involves setting the gain of each sensor amplifier to give the required readings to a calibration line on the Inspecta FFT system monitor displays. Two-way radio communications are used between the person at the sensor position and the person at the control panel. Once calibration of all sensor points has been completed, printouts of the SPECTRUM screens are made and filed away as the boiler sound signature records.

## GUARANTEE AND SERVICE

The Inspecta FFT system is built with modular electronic component cards, which, in the event of a failure, are replaced rather than repaired on site. This allows any replacements to be made in a matter of hours. Instrotech guarantee the materials and workmanship of all their products and also provide full service back up facilities for all their products in Australia. For further information and more details, please contact

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