GenMAP Condition Monitoring System

Score ***Energy Limited***

Intelligent Gas Turbine Solutions

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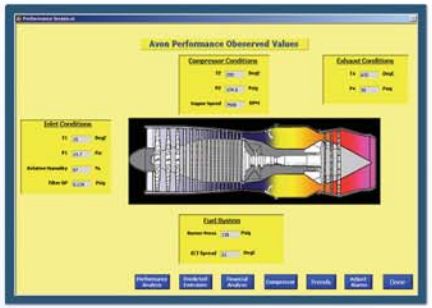
Intelligent Gas Turbine Solutions™

GenMAP - Online Monitoring System

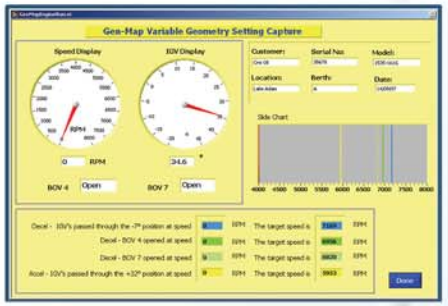
Performance Monitoring

Key performance parameters are monitored and trended against baseline values in order to quantify machinery deterioration.This supports engine fault / determination diagnosis and performance / economic management. The potential savings from performance management can be significant. Parameters can include:-

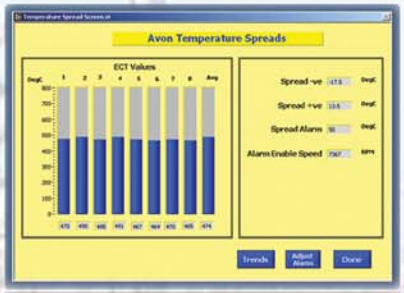


- ***Power output***
- ***Efficiency***
- ***Pressure ratios***
- ***Individual component efficiencies***
- ***Correction to ISO conditions eliminates ambient effects***
- ***Data reduction algorithms removes transient effect and spurious data***

Compressor Variable Geometry Schedule Monitoring

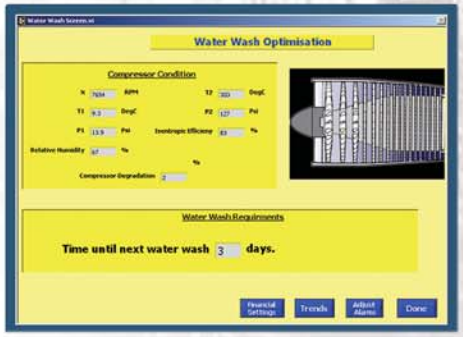


Variable geometry is widely used in gas turbine compressors. Typically combinations of blow off valves, inlet guide vanes or variable stators are used. Irrespective of the methods, correct operation of these elements is vital to protect against catastrophic surge to ensure optimal efficiency. GenMAP can incorporate algorithms which will automatically check the scheduling of these vital elements and alert operators when they fall outside acceptable limits.



Compressor Wash Optimisations

By monitoring key parameters the condition of the compressor can be assessed and compressor washing recommended at the appropriate time to restore performance. Power and efficiency losses through compressor fouling are highly recoverable through compressor washing.



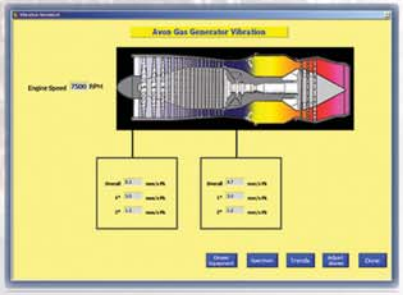
Compressor wash optimisation helps:-

- ***Minimise unnecessary downtime for washing***
- ***Optimise engine power & efficiency***
- ***Identify unrecoverable compressor performance loss such as erosion***

Mechanical Monitoring

Careful monitoring of mechanical parameters allows early fault detections. Mechanical parameters are continuously logged to a database but only updated on significant value change. This approach ensures a high data collection density where mechanical events or transients are occurring:-

- ***Speeds***
- ***Vibration***
- ***Pressures***
- ***Temperatures***
- ***Burner spreads***
- ***Lube oil debris***
- ***Compressor geometry***



GenMAP

The Case for Condition Monitoring

Aeroderivative gas turbines are widely used for power generation and mechanical drive throughout a range of industries. Their unmatched power to weight ratio makes them the power plant of choice for offshore applications. This high power density is achieved at the cost of complexity and demanding operating conditions, particularly in the 'hot' section of the gas turbine.Complex machines subject to extremes of speed, temperature, centrifugal force and corrosive gases invariably present serious maintenance challenges. In many of the high value processes where gas turbines are used the economic consequences of downtime or lost efficiency can be dire. Lost revenues resulting from machinery failures can run into millions.

Condition monitoring can help by detecting failures during the incipient stages. So that costly downtime can be minimised through careful planning of appropriate maintenance intervention. Many condition monitoring programs fail to deliver their fullest potential cost savings because although a problem can be readily detected, often it can not be promptly diagnosed. Score Energy can provide a complete solution where condition monitoring is combined with machinery expertise to ensure maximum return on investment.

GenMAP Online Monitoring System

GenMAP is an online condition monitoring system which is fully scalable to accommodate the chosen level of sophistication. An open architecture allows easy interfacing with a wide range of control systems, using industry standard protocols. GenMAP is designed to facilitate online support from Score Energy's engineering team. This team has extensive aeroderivative gas turbine experience. Features available for integration into a GenMAP system include:-

- ***Monthly status reports***
- ***Vibration analysis***
- ***Performance monitoring***
- ***Compressor wash optimisations***
- ***Compressor variable geometry***
- ***Mechanical monitoring***
- ***Predictive emissions monitoring (PEM)***
- ***Online lube oil debris geometry***

Gen-Map

MetalSCAN

Even though the reliability of modern equipment is often extremely high and the potential for equipment bearing failure is relatively low,catastrophic failures still do occur; and at very high cost to the operator. MetalSCAN is a break-through in-line sensor technology that can help reduce operating costs by removing the likelihood of equipment suffering a bearing system failure leading to expensive secondary damage and extended unplanned outages.

Originally developed for some of the world's most advanced aircraft engines, MetalSCAN is now available for application to virtually any aeroderivative gas turbines. MetalSCAN is designed to detect and quantify metallic particles in the oil system that are tell tale signs of damage hidden deep within the engine. Able to detect early damage long before vibration monitors or oil analysis, MetalSCAN's quantitative debris measurement correlates directly with the degree of damage on the bearing and is an effective indicator for triggering maintenance alerts tens or even hundreds of hours before the equipment has to be taken out of service.

MetalSCAN is unique in the marketplace as the only full flow, on-line oil debris monitor able to detect non-ferrous as well as ferrous metal particles. This capability can help identify specific component damage within the equipment, providing even more diagnostic detection capability.

MetalSCAN notifies operators long before the equipment needs to be shut down and enables them to plan the corrective maintenance actions in the most cost effective way. The cost savings for planning the maintenance versus having to react to an unexpected failure can amount to hundreds of thousands even millions of pounds.

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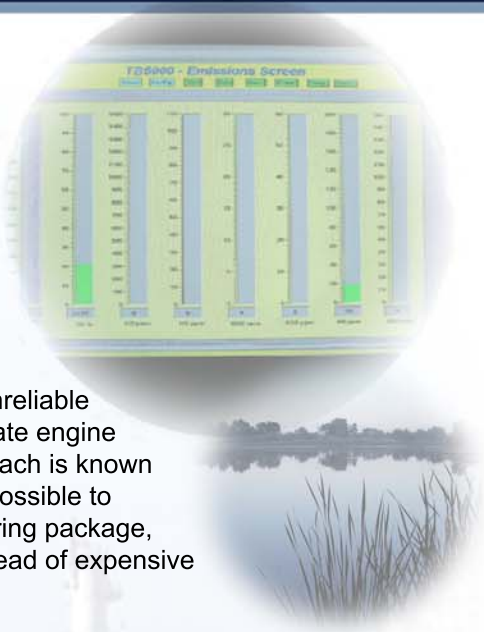
Predictive Emissions Monitoring

Gas turbine operators are under increasing pressure to improve emission levels in order to comply with governmental legislation or internal company environmental policy. However existing emissions monitoring equipment is expensive, unreliable and requires frequent calibration.



It is now possible to remove the need for such unreliable equipment using a mathematical model to correlate engine emissions with operating parameters. This approach is known as Predictive Emissions Monitoring (PEM). It is possible to integrate a PEM model into the GenMAP monitoring package, so that existing instrumentation can be used instead of expensive and troublesome stack emissions analysers.

PEM models are available which can predict the following pollutants O2, CO, CO2, O2, NO, NOx and unburned hydrocarbons. All values are available in concentrations or exhaust mass flows and can be corrected to standard conditions as per ISO-11042. The PEM methodology is widely accepted by environmental regulatory bodies as a suitable means of compliance conformation, data can also be used to support emissions trading.

PEM compares favourably with the alternative continuous emissions monitoring (CEM):-

- ***Lower cost***
- ***Higher reliability***
- ***Similar accuracy***
- ***No need for regular calibrations***
- ***Verify regulatory Compliance***
- ***Emissions trading***

GenMAP - Online Monitoring System

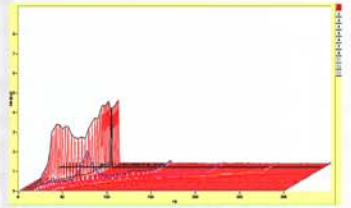
Monthly / Event Status Reports

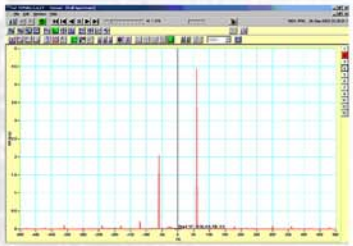
Regular engine status reports can be produced. These reports compile all the relevant data into a single source facilitating efficient machinery management. Reports can include:-

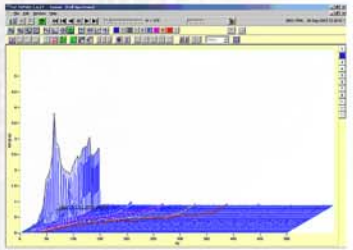
- ***Performance deterioration***
- ***Mechanical integrity deterioration***
- ***Recommended maintenance interventions***
- ***Emissions output***
- ***Lube oil debris***
- ***Starts/stops and running hours***
- ***Component lifetime consumed***
- ***Unexpected events or anomalies***

Vibration Analysis

Analysis of the frequency domain data of vibration allows much more sophisticated condition monitoring and fault analysis to be carried out than is possible with an overall value. Spectral data from existing vibration analysis systems can be incorporated into a GenMAP system. Alternatively new FFT analysers can be added to an existing installation, or regular manual surveys can be carried out using portable vibration analysers. A wide range of signal analysis techniques can be applied to a vibration signal, some of the most common are:-







- ***Order tracking***
- ***Spectrum charts***
- ***Waterfall/cascade charts***
- ***Cepstrain***
- ***Enveloping***
- ***Full spectrum***