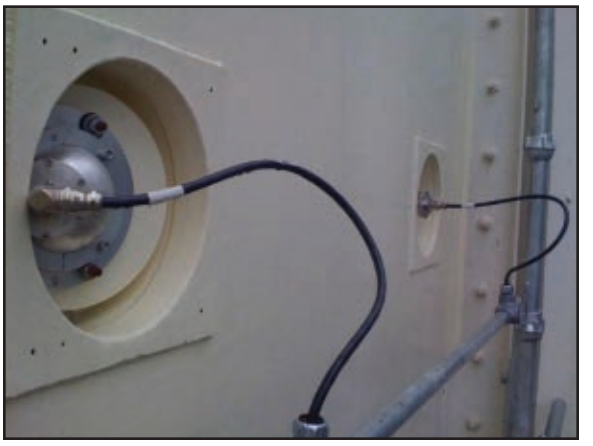


Two of the four installed ultrasonic probes mounted on the side wall of the air intake duct.

Real-Time Monitoring, Prediction and Optimization of Gas Turbine Performance

The Sentinel product line from Real Time Power is a hardware- and software-based solution for monitoring, predicting and optimizing the performance of power generation gas turbines in real time. The system delivers significant benefits to both power plant operators and energy traders.

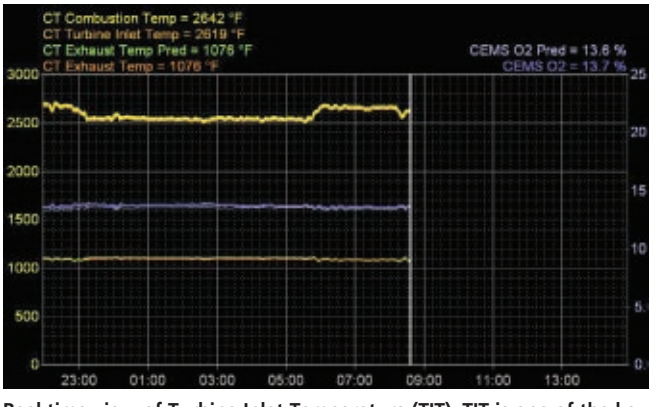
The benefits of the technology to energy traders are highly accurate forecasts of high and low operating loads (HOL/LOL) and daily updated incremental heat rates based on real-time plant performance. Power plant operators will see improved heat rate and power output, reduced maintenance costs through the ability to more precisely locate engine performance issues, and the potential to extend their maintenance outage intervals with Turbine Inlet Temperature measurement. On a typical 2-on-1 combined-cycle unit, these benefits will generate savings in the range of US$400 000 to US$600 000 per year. Based on these savings, the Sentinel system will pay for itself within six to 12 months after commissioning, according to the company.

The novel technical feature of the system is the accurate, 0.5% total uncertainty measurement of compressor inlet air mass flow rate. The accuracy of this reading reduces the uncertainty in the estimate of the Turbine Inlet Temperature (TIT) by a factor of at least four times in comparison to conventional heat and mass balance approaches, which do not utilize a direct measurement of air mass flow rate.

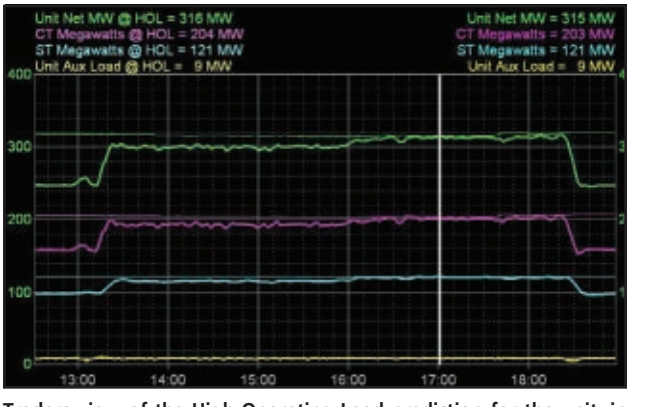
TIT is one of the key indicators of a gas turbine's performance. An accurate absolute estimate allows users to avoid increased maintenance costs caused by overfiring and increased fuel costs resulting from underfiring. The estimate of TIT obtained from the air mass flow rate also allows more accurate monitoring of the efficiency of the Combustion Turbine (CT) yielding better predictions about how it will perform. Best TIT estimation accuracy is obtained in conjunction with an online fuel gas calorimeter or — better still — an online fuel gas chromatograph. In addition, the accuracy of the air mass flow rate will give improved monitoring and prediction of the heat recovery steam generator (HRSG) and steam turbine (ST) performance on combined-cycle units.

The compressor inlet air mass flow rate is determined using an array of four ultrasonic probes mounted through the side walls of the air inlet duct, usually at center line level. The advantage of the ultrasonic measurement technique is that it provides absolute values of air speed and air density in the plane of the probes and never needs recalibration.

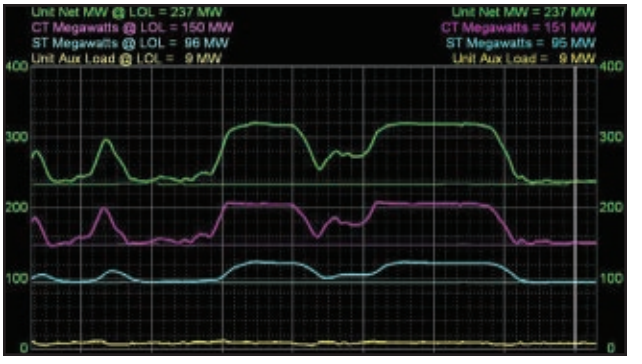
The system has been designed from the outset to work with typical gas turbine duct geometries, and to also function with the levels of sonic and ultra-



Real time view of Turbine Inlet Temperature (TIT). TIT is one of the key performance indicators of a gas turbine's performance.



Traders view of the High Operating Load prediction for the unit, in order to sell the maximum amount of power to the market.



Load prediction used by traders to run through the night without shutting down while avoiding penalties and maintaining compliance with emissions permits.

sonic noise and vibration that are present close to the compressor bellmouth.

Sentinel combines the air mass flow rate measurements with data read from an existing control system to complete the heat and mass balance around the CT. The system's overall accuracy can be verified through inspection of the predicted values for CT exhaust gas temperature and exhaust gas oxygen content. These predictions are typically within ±3°C and 0.1% vol., respectively.

The scope for optimization comes from the ability to monitor turbine inlet temperature in real time at all ambient conditions and at all loads. This information is of great value to engineers when tuning variable inlet guide vane (VIGV) schedules and getting the most effiency out of your engine. It is also critical when modifying cooling air mass flow rate curves and setpoints, or commissioning new low load control schemes.

As far as the energy trader is concerned, the main advantage of the Sentinel system is that it continuously tracks the performance of the unit, and any HOL/LOL forecasts produced by it reflect the actual status of the unit. Once the trader has gained confidence in the forecasts, he/she can confidently reduce margins of error and benefit from selling every megawatt during price spikes, and get the unit turned down to absolute minimum during the lows. According to the company, these benefits can, in themselves, create an additional cash flow of US$400 000 per annum on trading a 2-on-1 combined-cycle unit. For more information, visit www.realtimepower.net.

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Real Time Power is located in Katy, Texas, U.S.A.

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