Turbine Blade Temperature Measurement System (TBTMS)

IMPROVE OPERATING EFFICIENCY - PREVENT PREMATURE DAMAGE AND BLADE FAILURES IN UTILITY GAS TURBINES.

The Land Turbine Blade Temperature Measurement System is designed specifically to provide accurate, responsive, non contact temperature monitoring of gas turbine blades in power stations.

TBTMS is based on over 25 years experience in turbine blade pyrometer technology. Applications have covered a wide spectrum, from small aircraft engines to large utility power plants, from basic research projects to in-flight deployment on production fighter aircraft.

BENEFITS OF THE NEW TURBINE BLADE TEMPERATURE MEASUREMENT SYSTEM (TBTMS)

- Continuous on line measurement of blade condition.
- Improved engine firing rate.
- Detection of blocked cooling channels in blades.
- Reliable, accurate average blade row temperatures.
- Gives early warning of potential blade failure caused by over-temperature operation.

Some of Land's accomplishments include:

- Over 2 decades experience of supply to all major ground-based and aero turbine manufacturers for engine development and pass-out testing.
- The world first turbine blade pyrometer used on an operational fighter aircraft - more than 6000 pyrometers manufactured, in excess of 5 million flight hours.
- The world first radiation pyrometer specified for operational use on a civil aircraft engine - the General Electric GE90.

Improved control of engine firing rate

Using the close coupling between blade temperature and inlet gas temperature, a radiation pyrometer can provide greater control of engine firing rate through improved average rotor temperature measurement. Benefits include:

- Overfiring Monitoring - gas turbine OEM's do not normally provide operating guidelines for when
a gas turbine is pushed beyond its normal operating limits. TBTMS provides valuable information for the assessment of the effects of such operations.

- Efficiency Improvements - by direct monitoring of blade temperature, the uncertainty associated with back calculations is eliminated, offering the possibility of increased firing temperature.

**Prevention of blade failures**

Cooling integrity is critical - stress creep life is a strong function of temperature, and operation at over-temperature conditions can lead to damage or even catastrophic failure in the multi-million dollar range.

The Turbine Blade Temperature Measurement System was developed to provide early indication of blade conditions which could ultimately lead to blade failure.

**Monitoring of blade coating condition**

There is a close relationship between blade temperature and the condition of the thermal barrier coating (TBC) on the blade. TBTMS provides early warning of breakdown and subsequent loss of coating integrity.

**Detection of over-temperature blades**

Modern engine designs achieve improved efficiency through higher inlet gas temperature, made possible by the introduction of blade cooling.

The cooled blades are exposed to temperatures well above their operating limit, and rely upon unimpaired cooling flow for thermal protection.

Experience with TBTMS has shown that blade-to-blade temperature differences can be very significant for cooled blades.

In addition, blade cooling introduces new life-limiting processes, such as oxidation blockage of cooling channels, which are not detectable by traditional instrumentation methods. TBTMS is a vital tool for:

- **Blade Life Management** - by direct monitoring of individual blades, it is possible to refine blade life predictions and improve ‘hot section’ maintenance scheduling.

- **Hot Blade Detection** - detection of an overheated blade gives early warning of potential failure, enabling corrective action to prevent unnecessary and costly engine damage and downtime.

**The System**

The Turbine Blade Temperature Measurement System comprises up to 32 high speed, high precision pyrometers and a multichannel Data Acquisition System or a portable Data Acquisition System.

The pyrometer produces an optical scan of the entire rotating blade array by collecting thermal radiation emitted from the blades, converting it to temperature and transmitting it to the Data Acquisition System (DAS) for digitization and storage.

The pyrometer also outputs stand-alone continuous 4 to 20mA analog linear signals of average rotor, hottest blade and average peak temperatures.
signals of average rotor, hottest blade and average peak temperatures.

The stored data from the DAS contains a thermal signature of each blade in the form of evenly spaced temperature readings.

Blade temperature analysis is performed in the LAND TBTMS ANALYZ for Windows NT analysis software.