combustion turbine
blade temperature
analysis
Real Benefits

- Continuous on-line measurement of individual blade condition
- Increased efficiency through improved engine firing rate
- Detection of blocked cooling channels
- Reliable, accurate blade row temperature
- Early warning of potential blade failure caused by over-temperature operation
- Continuous monitoring of blade coating condition

Optical Pyrometry

In utility turbines it has been accepted practice to obtain turbine blade temperature by back-calculation from exhaust gas temperature readings. This method gives only a prediction of average blade row temperature, and uncertainties associated with this approach require the turbine to be operated below it's optimum efficiency. **Turbine Sentry** uses optical pyrometers to measure blade temperatures, giving significantly better accuracy than traditional methods and showing individual blades clearly.

Improved Engine Firing Rate

Using the close coupling between blade and inlet gas temperature, **Turbine Sentry** allows greater control of engine firing rate through accurate rotor temperature measurement.

- Elimination of uncertainty of rotor temperature allows increased firing temperature and rate, hence greater efficiency

Each 0.1% increase in efficiency equates to an annual saving of approximately $20-40k.
Detecting of over-temperature blades

Modern turbine designs improve efficiency through higher inlet gas temperatures. The blades are exposed to temperatures well above their operating limit, made possible by the introduction of blade cooling. Unimpaired cooling of individual blades is critical for their protection. Traditional, generalized temperature monitoring cannot indicate localized blockages. **Turbine Sentry** has shown that temperature can vary significantly from blade to blade. Detection of cooling channel blockages (e.g. by oxidation) are not detectable by traditional methods.

### Prevention of Blade Failure

Cooling integrity is critical - stress creep life has a strong correlation with blade temperature. Operation at over-temperature conditions can lead to damage or even catastrophic failure in the multi-million dollar range. **Turbine Sentry** provides early indication of conditions that could ultimately lead to blade failure. Detection of individual overheated blades gives early warning of potential failure, enabling corrective action to prevent costly engine damage and downtime.

*Turbine Sentry detected an incorrectly cooled blade running on a large utility turbine: potential failure was avoided, saving an estimated $2M in repair and production costs*

(Source EPRI literature ref. IN-101150)

### Predictive Maintenance

All gas turbine blades are coated, usually with an anti-corrosion coating. **Turbine Sentry** can detect coating erosion, hence allowing the user improved planned maintenance. In modern turbine blade designs, increasing use is being made of thermal barrier coatings (TBCs). The relationship between blade temperature and the condition of the thermal barrier coating provides early warning of breakdown and subsequent loss of coating integrity.

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

*Extending the period between replacing a row of blades by one year could save over $100,000: avoiding replacement could save far more.*
The **Turbine Sentry** provides detailed non-contact temperature monitoring of combustion turbine blades for the purposes of engine operation and maintenance. A typical system comprises:

- **Blade Sentry** - Optical Pyrometer, Mounting Kit and KP/PSU
- **Rotor Sentry** - Data Acquisition System
- **Data Sentry** - Analysis Software for Windows NT®

The **Blade Sentry** Optical Pyrometer and Mounting Kit

The pyrometers are engine mounted to view the rotating blades directly through a pressure-proof sight glass assembly (mounting kit).

The optical signal collected by the pyrometer is transmitted through a rugged, flexible, fiber optic lightguide to a remote electronic signal conditioner.

The signal conditioner provides the following linear 4 to 20mA outputs:

- **Profile** - a high speed signal sent to the DAS for data logging
- **Peak** - the highest temperature on the blade array
- **Average** - the average temperature of the blade array
- **Average Peak** - the average of the highest temperature of each of the blades

The **Rotor Sentry** Data Acquisition System controls the capture of the blade 'thermal fingerprints'. Features include

- Fully automatic operation
- Logging of other plant parameters for data correlation
- User definable data storage rate with comprehensive data historian functions
- Redundant data storage with optional rolling deletion
- Alarms
- Automatic data storage rate change on alarm
- On screen trending of temperature
- Hot particle rejection for oil fired gas turbines
- User selectable displays including 24 Hour Rolling Trend, Multi-channel and Single Channel.

*Keyphasor® is a trademark of Bently Nevada Corporation*
**Rotor Sentry** DAS can accommodate up to 32 pyrometers in any combination on multiple turbines. The software captures and displays one revolution of temperature data (thermal fingerprint) comprising approximately 3000 temperature readings equally spaced around the blade array.

One complete fingerprint from each pyrometer is sampled every few seconds and stored to disk, at user-definable rates. The software can also monitor additional plant parameters such as:

- Gas Turbine Output Power
- Fuel Type
- Turbine Inlet Temperature
- Exhaust Gas Temperature

**Data Sentry** for Windows NT™ features:

- **Export** - data conversion routines to other industry standard software such as Excel™ and Lotus 123™
- **Print** - printout of selected data
- **Display** - single or multiple thermal fingerprints
- **Comparison** - up to 10 thermal fingerprints can be overlaid at different times
- **Trend** - allows selectable parameters to be trended
- **Filtering** - data can be filtered according to a range of operating conditions
- **Statistical** - on line analysis can indicate potential problem areas.
- **Pan and Zoom**

The **Data Sentry** analysis software can run alongside the acquisition software on the system PC or on a separate desktop PC under the Microsoft Windows NT™ environment.
Wealth of Expertise

*Turbine Sentry* is based on 30 years experience in turbine blade pyrometer technology. Applications cover a wide spectrum, from small aircraft engines to large utility power plants, from basic research projects to in-flight deployment on production fighter aircraft. Some of Land's accomplishments include:

- 30 years as a supplier to all major ground-based and aero turbine manufacturers for engine development and pass-out testing.
- The world's first turbine blade pyrometer used on an operational fighter aircraft - more than 11000 pyrometers manufactured, in excess of 5 million flight hours.
- The world’s first optical pyrometer specified for operational use on a civil aircraft engine - the General Electric GE90.

*Turbine Sentry* can be used on turbines made by all leading manufacturers. Satisfied customers include major utilities in the USA and Europe, along with many independent power producers worldwide.

The *Turbine Sentry* package gives you peace of mind before, during and after installation.

Custom Design

Land recognizes that, in the field of utility turbine blade pyrometry, each application has specific, often unique, requirements.

Flexibility is a key feature of *Turbine Sentry*. Each system is designed to meet the customer's exact needs. Features such as smaller target size, faster response speed and extended measurement span have all been implemented in *Turbine Sentry* measurement systems.

In addition to the externally mounted *Turbine Sentry* sensor, Land produces small probes designed to mount inside a gas turbine - ideal for use in turbine development programs, or locations where only limited access to the turbine is available.

Product Development

Land's commitment to continuous product improvement ensures that the most recent advances in both software and hardware design are incorporated into all components of the *Turbine Sentry* system.
# Product Specifications

## Blade Sentry

### Mounting Kit
- **Pressure Rating:** 20.4 bar / 300 psi or 40.8 bar / 600 psi
- **Temperature Rating:** 371 °C / 700 °F
- **Weight:** 19 kg / 42 lb or 20 kg / 44 lb
- **Material:** Stainless Steel

### Optical Pyrometer
- **Temperature range:** 650 to 1100 °C or 1200 to 2000 °F (other ranges available)
- **Outputs:** Linear 4 to 20mA outputs over temperature range
- **Field of view:** Optimized for particular gas turbine location
- **Rise time:** Down to 1.5 $\mu$s
- **Accuracy:** ±2 °C/±4 °F*  
  *over electronics ambient temperature range 0 to 50 °C / 32 to 122 °F
- **Resolution:** Better than ±0.2 °C above 800 °C/±0.4 °F above 1470 °F
- **Ambient temperature:**  
  - **Optic Head:** Up to 350 °C/660 °F  
  - **Fibre Optics:** Up to 350 °C/660 °F  
  - **Signal Conditioner:** -30 to 70 °C/-22 to 158 °F (Operating)
- **Power supply voltage limits:** ±18 to 30 V d.c. at 175 mA (max.) 50/60 Hz
- **Spectral response:** 1 $\mu$m (nominal)
- **Sealing:** IP65
- **Certification:** Manufactured to ATEX directive 94/9/EC (CE Ex II 3 G T6)

## KP/PSU Module
- **Inputs:** Optical Pyrometer  
  Unconditioned once per revolution (Keyphasor™) pulse
- **Outputs:** ±24V d.c. pyrometer power supply  
  Conditioned Keyphasor® pulse (or scan valid signal)  
  User connection to DAS  
  User connection to pyrometer outputs
- **Ambient temperature limits:**  
  - Operating: 0 to 40 °C/32 to 104 °F  
  - Storage: -10 to 70 °C/14 to 158 °F
- **Power supply voltage limits:** 160 to 260 V a.c. or 80 to 120 V a.c. 50/60 Hz

## Rotor Sentry
- **Inputs:**  
  Up to 32, 4 to 20 mA Pyrometer  
  Up to 32 TTL scan valid signals
- **Outputs:** Screen display  
  ASCII Data stored to disk/network
- **Data Capture Rate:** Up to 600 kHz
- **Power supply:**  
  90 to 260 V a.c., 50/60 Hz (switchable)
- **Ambient temperature limits:**  
  - Operating: 0 to 40 °C/32 to 104 °F  
  - Storage: 0 to 75 °C/32 to 158 °F
- **PC Specification (minimum):** IBM PC-AT compatible  
  Pentium or higher running at 200 MHz  
  64 Megabyte RAM; 1 Gigabyte Hard Disk Drive  
  1.44 Megabyte 3.5 in floppy disk drive; Standard VGA color graphics  
  Standard AT-style keyboard; Mouse (or trackball)  
  Windows NT Version 4.0 (or better)

## Data Sentry for Windows NT™ features:
- **Export:** data conversion routines to other industry standard software such as Excel™ and Lotus 123™
- **Print:** printout of selected data
- **Display:** single or multiple thermal fingerprints
- **Comparison:** up to 10 thermal fingerprints can be overlaid at different times
- **Trend:** allows selectable parameters to be trended
- **Filtering:** data can be filtered according to a range of operating conditions
- **Statistical:** on line analysis can indicate potential problem areas
- **Pan and Zoom**
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Product Range

- Gas Turbine Exhaust Emissions Monitoring
- Zirconia Oxygen Probes
- Carbon Monoxide Monitors
- Acid Dewpoint Monitors
- Dust & Opacity Monitors
- Portable Gas Analyzers
- Coal Mill Fire Detection
- Turbine Blade Temperature Monitoring
- Data Acquisition Systems

For further details on any LAND product - visit our website

Quality Assurance

Land Instruments International’s Factory Quality Management System is ISO9001 Certified for both Sales and Service.

ATEX Approval

Blade Sentry pyrometer meets ATEX Directive 94/9/EC; coding CE Ex II 3 G T6