

Turbine Supervisory Instrumentation (TSI) – an overview

By Greg Ziegler and Chris James • SKF

Turbine Supervisory Instrumentation

Turbine Supervisory Instrumentation (TSI) or Turbine Supervision Equipment (TSE) is a generic term used in the power generation industry. TSI refers to instrumentation systems that specifically perform measurements of critical control parameters on large steam turbine generator trains. The size of the machines can range between 50 and 1 200 MW and their age can often be in excess of 30 years. TSI systems are normally a mandatory requirement.

The same technology is employed on other turbine types and in other industries, such as the hydrocarbon-processing sector.

However in these areas, different terminology tends to be used.

This application note briefly introduces Turbine Supervisory Instrumentation. A detailed examination of each specific TSI measurement can be found in related SKF Reliability Systems application notes.

Turbine Supervisory Instrumentation benefits

The use of, and experience with, TSI assists in reducing operating costs of the generation units by:

- **Reducing turbine roll time**

During the run-up and coast-down of large turbines, there are extensive soak periods to ensure stationary and rotating parts thermally expand equally. These periods are usually of a conservative length, but times can be further reduced with continuous and accurate measurement of key expansion clearances (and related parameters) available with TSI systems.

- **Time between overhauls**

By using precise TSI measurement information, in an outage, the exact amount of work can be scheduled with reduced risk of unknown problems occurring after the overhaul is completed.



Figure 1. A TSI monitor module.

- **Diagnostic and troubleshooting**

The trending of TSI data provides the user with the machine's basic operating characteristics. Early detection of changes in trended data and comparison to normal conditions allows decisions to be made more quickly and inexpensively. More advanced analysis methods of this same raw data can diagnose problems like mass unbalance, misalignment, loose or broken parts, shaft cracks, seal rubs, and bearing instabilities caused by improper lubrication or bearing design. Early identification of these problems allows for corrections to be made at a time that is convenient to both the work force and system load.



Figure 2. A Steam turbine generator train.

- **Automatic shutdown**

Sometimes unanticipated problems arise quickly, however, TSI has the capability to limit damage to the machine and protect against total destruction or catastrophic failure. Confining damage flagged by vibration can make the difference between a two-week outage and three to six months of down time.

Turbine Supervisory Instrumentation retrofits

The turbine generator and boiler units are comprised of a complex group of control elements that require constant, reliable, and accurate measurement and control. Hence, TSI measurements of varying scope and technology exist that are as old as steam turbines themselves. However, state-of-the-art instrumentation with its associated technological benefits develops far more quickly than the turbine itself. Over the lifetime of a typical steam turbine (which can be up to 50 years), the instrumentation may be upgraded by retrofit several times in order to further maximize the above-mentioned TSI benefits. Some points to consider are:

- What information will the new system provide?
- How is this information displayed to the operator?
- How is analytical information displayed?
- How will this system interface with other systems?
- What type of transducers should be used?
- Should the system use absolute or relative measurements?
- How will the installation be completed?
- How reliable is the existing instrumentation?
- Are spare parts and service readily available?

- Will the installation meet the requirements of the outage schedule?
- What makes a given TSI system different from any other?
- How can the cost of the TSI system be justified?

To answer these questions, the machine in question should be scrutinized in detail: design, service, normal operating conditions, bearing type and design, and history should all be factored into the equation.

Although no TSI system available will prevent 100% of machinery malfunctions, reliability of the system is a must. Operations and maintenance personnel must be able to depend on the information generated by the system. The reliability and accuracy of this information eliminates second-guessing and assures that sound decisions are made with confidence.

Turbine Supervisory Instrumentation measurements

TSI system measurements can be broken down into four major categories:

- **Motion measurements**

Eddy current (proximity) probes, case mounted velocity (seismic) transducers, shaft riders, and/or accelerometers can be used to monitor vibrations. Monitoring points may include vibration on main turbine generator and exciter, boiler feed pump and turbine, and FD and ID fans. Eddy current probes may also be used to measure rotor eccentricity.

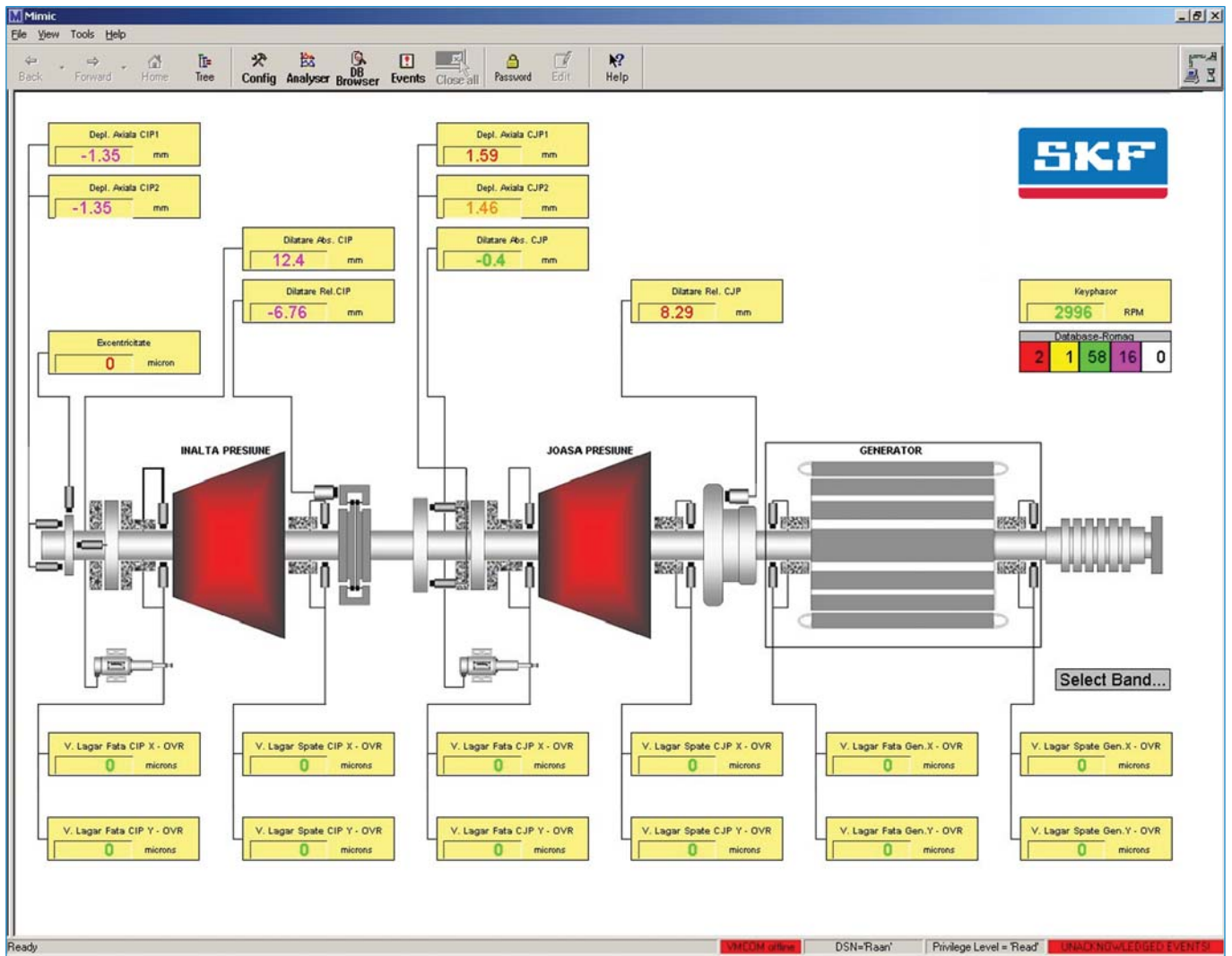


Figure 3. An example TSI system HMI display.

- **Position measurements**

Eddy current probes, LVDTs and linear/rotary potentiometers can be used to monitor thrust bearing wear, rotor position, casing (shell) expansion, differential expansion and control valve position.

- **Speed measurements**

Active or passive electromagnetic or eddy current probes can be used to monitor main turbine speed and acceleration, over-speed detection, zero speed detection, boiler feed pump speed, FD and ID fan speeds.

- **Process measurements**

Thermocouples or RTDs can be used to monitor bearing white metal temperature, shell differential temperature, and lube oil temperature. Piezoelectric or strain gauge pressure transducers can be used to measure oil and hydraulic pressures.

Each measurement component plays a key role in the success of the overall system monitoring. The correlation of these different measurements may also show the effects of one parameter to the other.

To maintain safe and efficient operating conditions, it is essential that the user be able to apply all available information in determining the condition of the machine.

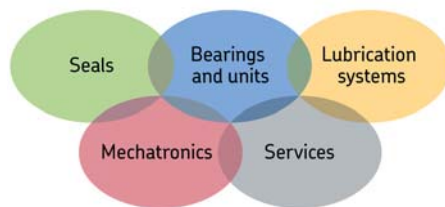
Here, a good HMI (Human Machine Interface) is essential (Figure 3).

TSI measurements have their own conventions and technical nuances, and are generally challenging for most users to both understand and implement. The relative difficulty of TSI is the main reason why this measurement technology is often, but not exclusively, provided by the vibration monitoring industry, which is accustomed to using complex sensor signal conditioning.

The following parameters are considered in detail in separate SKF application/technical notes:

- Eccentricity
- Differential expansion (straight, complementary, ramp)
- Casing (Shell) expansion
- Valve position
- Rotor axial position
- Absolute bearing cap vibration
- Relative shaft vibration
- Absolute shaft vibration
- Speed (zero speed, rotor acceleration, over-speed, phase angle)

This family of SKF Reliability Systems application and technical notes are designed to help in detailing a solution to the above TSI challenge.



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For additional information on SKF Reliability Systems products, contact:

SKF USA Inc.

5271 Viewridge Court • San Diego, California 92123 USA
Telephone: +1 858-496-3400 • FAX: +1 858-496-3531

Web: www.skf.com/cm

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