STI Vibration Monitoring Inc.

Field Application Note

Turbine Supervisory Instrumentation TSI

Specification of a Turbine Supervisory Instrumentation (TSI) system can be an exacting process when the individual parameters must be specified. This application note is supplied to provide a guide to be used in selecting an appropriate TSI system. TSI systems not only measure bearing vibration levels, but also can include shell expansion, differential expansion, valve position, turbine speed and acceleration, thrust position, phase angle, and bearing temperatures.

When an existing TSI system is being retrofitted the immediate indication is that a one-for-one replacement of each original parameter is sufficient. This approach may be adequate if the original system was a complete package.

Recent experience with retrofitting TSI systems has brought to light that many of the existing systems could be enhanced with additional parameters. Also, certain parameters should be considered for complete replacement with a different type sensor.

General

The information required under this topic will define and describe the turbine generator along with who will perform and/or supply the various tasks and parts of the TSI installation. The time frame for the system installation should get consideration at the point.

Describing the turbine generator involves listing the number of bearings, type of bearings, turbine/generator manufacturer, the number and function of each rotor segment, etc. This information may be obtained from the OEM operation and maintenance manuals and is required whether a retrofit or an entirely new installation is being specified.

Documentation of the proposed TSI should include who supplies the individual components and service of the new system, along with the number of operation and service manuals and/or drawings required.

For more information about installation services see the STI Application Note, Field Service, FS. STI Application Note, Field Wiring Installation, FWI covers many topics of particular concern prior to and during the electrical system installation.

Monitor

Selecting the monitor follows the process of detailing the turbine generator layout. The monitor selection generally involves deciding what the monitor should do and how the user will interface with it.

The monitor can be specified to be a stand-alone output with user interface or to interface with an existing output device such as PLC or DCS.

Radial Vibration

Radial vibration is usually the heart of the TSI system. It gets the most attention and generally gives the first indication of out of specification conditions. Most OEM TSI systems utilized a shaft rider transducer system to monitor vibration with a shaft absolute output signal. An exact replacement transducer system can be supplied, but most customers and OEMs are specifying an Eddy Probe Systems. A complete vibration system would install two sensor systems per bearing with the sensors located 90° from each other.

For more information about Eddy Probe Vibration Sensors and their application see the STI Application Note, Eddy Probe Transducer Installation, Part 1-Radial Vibration.

Thrust Position

Thrust position indication includes one or two Eddy Probe Systems to observe the position of the thrust collar within its bearings. This system is an internal installation and need not replace the existing system because many original installations utilize a differential pressure system that interfaces with the turbine hydraulic control system.

For more information about thrust position sensors and their application see the STI Application Note, Eddy Probe Transducer Installation, Part 2-Thrust Position.

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Shell Expansion

Shell expansion is the measure of a turbine case or shell moves in relation to a fixed location usually measured with a Linear Variable Differential Transformer (LVDT). Some existing OEM systems still use spindle micrometers or dial indicators that are subject to mechanical damage and human error. Although many systems installed with only one LVDT are adequate, a complete TSI system specification should consider two LVDTs located at each corner of the turbine shell. A second sensor will monitor shell cocking or uneven thermal growth, which is a fairly common occurrence during startup when the sliding feet may have inadequate lubrication.

For more information about shell expansion systems and applications see the STI Application Note, Shell Expansion, TSI Part-4.

Differential Expansion

Differential expansion measurements are an important parameter receiving much attention during turbine startup and warming. This parameter measures how the turbine rotor expands in relation to the turbine shell, or casing.

A new differential expansion system using Eddy Probes can be retrofitted to any existing system. An Eddy Probe is more reliable and robust than OEM supplied induction coil systems.

For more information about differential expansion systems and applications see the STI Application Note, Differential Expansion, TSI Part-3.

Valve Position

Correct valve positioning is required to efficiently operate a steam turbine. Some turbines may require several throttle valves be monitored and some turbines will instrument the main stop valve(s) to determine when they crack from their seats.

Retrofit valve position measurements use DC LVDTs or DC Rotary Potentiometers. All OEM TSI systems include valve position measurement(s) as a startup and operation parameter. Some OEM systems utilized AC LVDTs while others use mechanical linkages and scales for indication.

A retrofitted system can be installed in the same position or at relocated to a more accessible or protected position.

For more information about valve position systems and applications see STI Application Note, Valve Position, TSI Part-2.

Eccentricity

A rotor which has been sitting idle during overhaul or has been inadvertently stopped during coast down for an extended period will develop a bow or bend. This condition must be corrected by turning gear operation and, possibly, with auxiliary heating prior to high speed operation to prevent internal clearance rubbing.

Eccentricity systems installed by OEMs monitor the turbine stub shaft or a shaft collar using induction coils. A retrofit Eddy Probe system will monitor the same location and many times use the same bracketry.

For more information about eccentricity systems and applications see STI Application Note, Eccentricity, TSI Part-1.

Speed

Turbine speed indication supplied by OEMs come in many forms: observing a gear wheel located inside the front standard, electrically converting the generator output frequency, or monitoring the turning gear. A retrofitted system using Eddy Probe's can be specified to observe any multi-toothed gear wheel. Applications monitoring generator output frequency without an integral turning gear may require installation of a custom gear wheel.

Speed indication may be specified as an analog display or as a digital display and can be interfaced to a zero speed system for turning gear engagement.

Rate of Acceleration

The rate of acceleration parameter is usually monitored during startup to prevent over-torquing the rotors, as the turbine approaches critical speeds, and as the operating speed is reached prior to line synchronization. Once the generator has been synchronized and is being controlled by load dispatchers the acceleration rate is not monitored.

Acceleration rate measurements use a speed input to derive its output display. Eddy Probe systems can be installed as a replacement or supplement an existing application. See STI Application Note, Eddy Probe Transducer Installation, Part-1 Radial Vibration for relevant information about this type of sensor.

Phase

Phase, or phase angle, is a measure of the relationship of how one vibration signal relates to another vibration signal and is commonly used to calculate the placement of a balance weight. This parameter is not usually displayed continuously but is monitored periodically to determine changes in the rotor balance condition, deviations in system stiffness such as a cracked shaft.

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Phase angle measurements are sometimes not supplied by OEMs, but can be installed using an Eddy Probe system. Installation involves locating or installing a once-per-turn event such as a key or notch that the Eddy Probe will view. An Eddy Probe viewing a notch is easier to install and adjust, but the installation of the notch requires special tooling to cut the notch. Keys are easier to apply using glues or epoxies and are subject to coming off due to centrifugal forces.

Temperature

Bearing temperature is a measure of the how hot a bearing is operating. It may be due to overloading, miss-alignment, improper lubricant pressure and/or flow.

Nearly all turbine generator bearings were originally installed or retrofitted with bearing temperature sensors. These sensors may be thermocouples or RTDs. This parameter is often overlooked possibly due to the OEM output display located at some other panel not within the vicinity of the retrofitted TSI system. Any bearings that were not originally equipped with temperature sensors can be retrofitted to accept thermocouples or RTDs.

Custom Cabinet

Congested control boards may preclude installing the TSI rack requiring a stand-alone cabinet. This cabinet can house auxiliary equipment associated with the new TSI system, such as power supplies, termination strips, external relays, etc.

The cabinet can be configured to many differing designs depending upon the user's requirements. Cabinets should be sturdy enough withstand environmental conditions, such as moisture content, explosive atmospheres, temperature, etc.

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