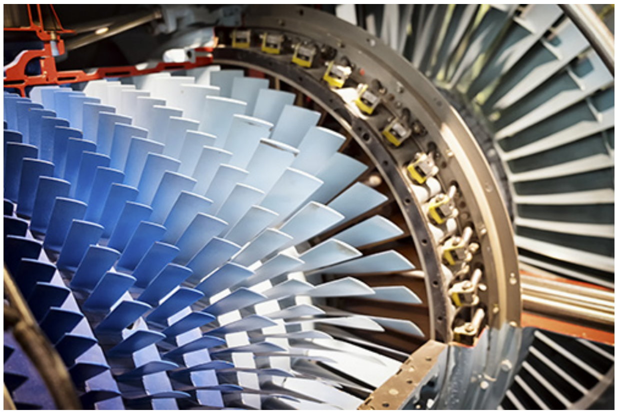
Electronic Turbine Overspeed Protection

Features

- Provides fast and reliable overspeed protection
- Prevents excessive turbine speeds
- Independent of turbine speed governor
- Fully redundant
- On-line testing
- Uses standard Ovation™ speed detector I/O modules
- Includes full DCS integration, system diagnostics, alarming, and testing



Justification

Most insurance companies require tests to ensure proper operation of mechanical overspeed bolts. Testing of the overspeed bolt consists of running the turbine up to the trip point (typically 112% of rated speed); however this is a risky operation for several reasons.

First, there is no guarantee that the turbine will actually trip at 112% until the testing has been completed. Second, running the unit to 112% of rated speed needlessly stresses the unit. Third, there have been several documented incidents of failures that have occurred during this type of testing. These failures alone have caused insurance carriers to start recommending the electronic overspeed protection systems as a replacement for the mechanical systems.

Additionally, if during the testing the unit trips at a speed other than the OEM recommended trip setting, some corrective action must be taken to adjust the setting. This adjustment requires the front standard cover to be removed and a mechanical adjustment to be made to a spring pre-load. It should be noted that there are no “tick marks” or scales on the equipment to determine the exact amount of adjustment required for the mechanism. Once an adjustment is made, the front standard cover is re-installed and the unit is again rolled to the overspeed setting. If additional adjustments are required, the process is repeated until the unit trips at the correct speed. This process is time consuming as it can easily take a full eight-hour shift to complete and test one adjustment, and could possibly result in lost generation.

Emerson’s electronic overspeed system does not require the unit to be rolled to the overspeed setting to prove correct operation of the system. This saves time and money, avoids lost generation, and lowers exposure to potential damage of valuable assets.

Overspeed Protection Overview

The Emerson electronic turbine overspeed protection system (OSP) prevents excessive turbine speed that could lead to equipment damage.

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Overspeed protection is achieved by using a two-out-of-three voting trip system. This system is completely independent of the turbine speed governor.

Three speed signals are processed and interrogated on separate speed detector I/O modules. In the event of a turbine overspeed, the hydraulic trip header is depressurized through a testable dump manifold (TDM). The TDM is used to trip the turbine by rapidly depressurizing the turbine hydraulic trip header. The manifold assembly is fully redundant and testable while the turbine is online.

The Ovation governor controller communicates with the speed detector I/O modules (located in the overspeed protection cabinet) for set point configuration and test purposes. The speed detector module operates independent of the Ovation controller.

Electrical Description

The electronic design is built to be completely fail-safe, with no single source of failure. Redundant 24VDC power supplies are diode auctioneered to provide two sources of power to the Ovation speed detector modules, relay modules, and TDM solenoids. The TDM is designed to use 24VDC de-energize to trip solenoids.

Three independent 24V powered speed sensing channels are configured for “fail safe” and “fault tolerant”. The relay contacts can be exercised to test individual channels of the trip manifold. The TDM provides a two-out-of-three hydraulic voting scheme.

The Ovation speed detector module is used to determine the rotational speed of the turbine generator by measuring a speed sensor output signal. The speed sensor output can be sinusoidal or a pulse train frequency. The speed detector module reads the frequency and provides a 16-bit speed digital output at an update rate of 5 milliseconds for overspeed protection.

The speed detector onboard microcontroller is preconfigured with the overspeed set point. The microcontroller provides the computational power required to compare the actual turbine speed to the overspeed set point. The microcontroller machine language instructions have execution times of 500 nanoseconds, 1.0 microsecond, or 2.0 microseconds. An EPROM provides the microcontroller with 32 Kbytes to store program memory. The program memory stored in the EPROM consists of machine language instructions and configuration data. If an overspeed condition is detected, the speed detector module is configured to de-energize the onboard dual form C relay coil.

Redundancy and Failure Modes

Redundant power sources supply 24V power. A common power point is designed utilizing diode-auctioneered sources. Loss of one supply or power feed will not trip the unit. Each of the three OSP channels is individually fused.

The Ovation controller is constantly monitoring the speed detector module signal status for failure modes. Failure of a speed detector module will not trip the associated channel because of the two-out-of-three fault tolerance.

There are three separately powered I/O branches within the overspeed protection cabinet. Each branch constitutes and independent trip channel consisting of a speed detector/relay module pair. Failure of two branches/channels will result in a turbine trip.

OSP Channel Testing

Each OSP trip channel can be tested online by activating a single OSP channel without causing a unit trip. This test automatically exercises each OSP channel to verify circuit integrity. Actual trip setpoints are verified during system commissioning, eliminating unnecessary circuitry.

Hydraulic Description

TDM Assembly

The TDM is designed to rapidly depressurize the turbine trip header. The manifold assembly is fully redundant and is fully testable while the turbine is

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online. The operator users a graphic interface to initiate the testing sequence of the TDM solenoid/cartridge valve sets. The Ovation controller automatically steps through a three-channel test, and verifies successful completion of each step before proceeding. The operator is notified of a successful test or alarm indicating any test failures. The Ovation controller monitors the intermediate chamber transmitter pressure during normal operation and alarms if it varies more than a preset percentage from the expected value for more than five seconds. This condition would be indicative of a faulty cartridge valve or a blocked orifice.

The TDM is supplied in a two-out-of-three hydraulic manifold format. This triplex design provides two out of three voting, within the hydraulic circuit. The triplex design uses three solenoid valves; any two of the three solenoid valves will initiate a turbine trip.

Manifold Component Description

The hydraulic manifold is machined from a solid 6061-T6 aluminum block. All field connections are SAE standard o-ring seal type ports. Each port is uniquely identified with metal impression engravings. The engravings on the manifold correspond to the text description of the ports as documented by the dump manifold operation and maintenance manual. Four tapped mounting holes are located on the bottom surface of the manifold for mounting. The manifold may be mounted in any orientation.

Solenoid Valves

The solenoid operated valves direct the hydraulic fluid to open or close the logic valves. The solenoid valves use a poppet type operating mechanism to resist silting, even during extended pressure periods. These valves offer virtually leak-free closure in the checked condition.

Pressure Transmitters

Pressure Transmitters are used on the TDM as feedback to the Ovation controller for both testing purposes and online diagnostics of the manifold condition.

Performance

Performance Chart	
Speed detector OSP contact Update Rate	5 ms
TDM response time	30 ms
Total mechanical OSP replacement response time	35 ms

Preventative Maintenance Schedule

Component	Every 6 Months	Yearly	Every 5 Years
Solenoid Valves	Inspect for leaks		Replace
Cartridge Valves	Inspect cover for leaks		
Orifices		Check for contamination during outage	Replace
Transmitter		Verify calibration	

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