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MEGGITT

CASE STUDY

Replacement of an unreliable Machinery Protection System to address spurious trips

When faced with a history of **spurious trips** due to unreliable machinery protection systems on the steam turbines at the Sparanise and Rizziconi combined cycle power plants, **Axpo enlisted vibro-meter's expertise and technology** to resolve the problems – once and for all. In this case study, we explore both the problem and the solution along with the economic implications of unchecked spurious trips.

As-Found Situation

The Sparanise and Rizziconi combined cycle plants use identical 1:1 combined cycle configurations consisting of a V94.3 gas turbine (260MW) and a 120 MW steam turbine, both manufactured by Italy's Ansaldo Energia.

Each plant has two of these 1:1 configurations resulting in a total plant output of 760MW. Major auxiliary equipment at each plant includes four feedwater pumps (two per train) manufactured by Sulzer.

When originally built, the gas turbines were equipped with vibro-meter VM600 machinery protection systems providing integrated vibration and combustion dynamics monitoring. Indeed, vibro-meter is the standard and preferred supplier of sensors, machinery protection, and condition monitoring systems for Ansaldo. However, the steam turbines were instrumented with competing products from a regional Italian manufacturer. The solution included both the monitoring systems and the transducers. The feedwater pumps were unmonitored.

Particularly during the last few years, the plants began to experience spurious trips from the systems monitoring the steam turbines. While the economic implications vary somewhat due to the particular contractual obligations for electricity supply from each plant on any given day, a general rule of thumb is that each hour of interrupted supply incurs approximately €50K in losses, and that the minimum interruption imposed by a single spurious trip is at least one hour. Due to the aging of the installed systems monitoring the steam turbines, and the need to improve the reliability of those monitoring systems, Axpo thus began exploring new solutions.

Figure 1: The plants at Rizziconi (shown here) and Sparanise are essentially twins and utilize two 1:1 combined cycle configuration consisting of a 260MW Ansaldo V94.3 gas turbine, a Heat Recover Steam Generator (HRSG), and a 120MW steam turbine. The cooling towers are within the blue structures, the turbines within the green structures, and the HRSGs are the tall structures adjacent to each exhaust stack.

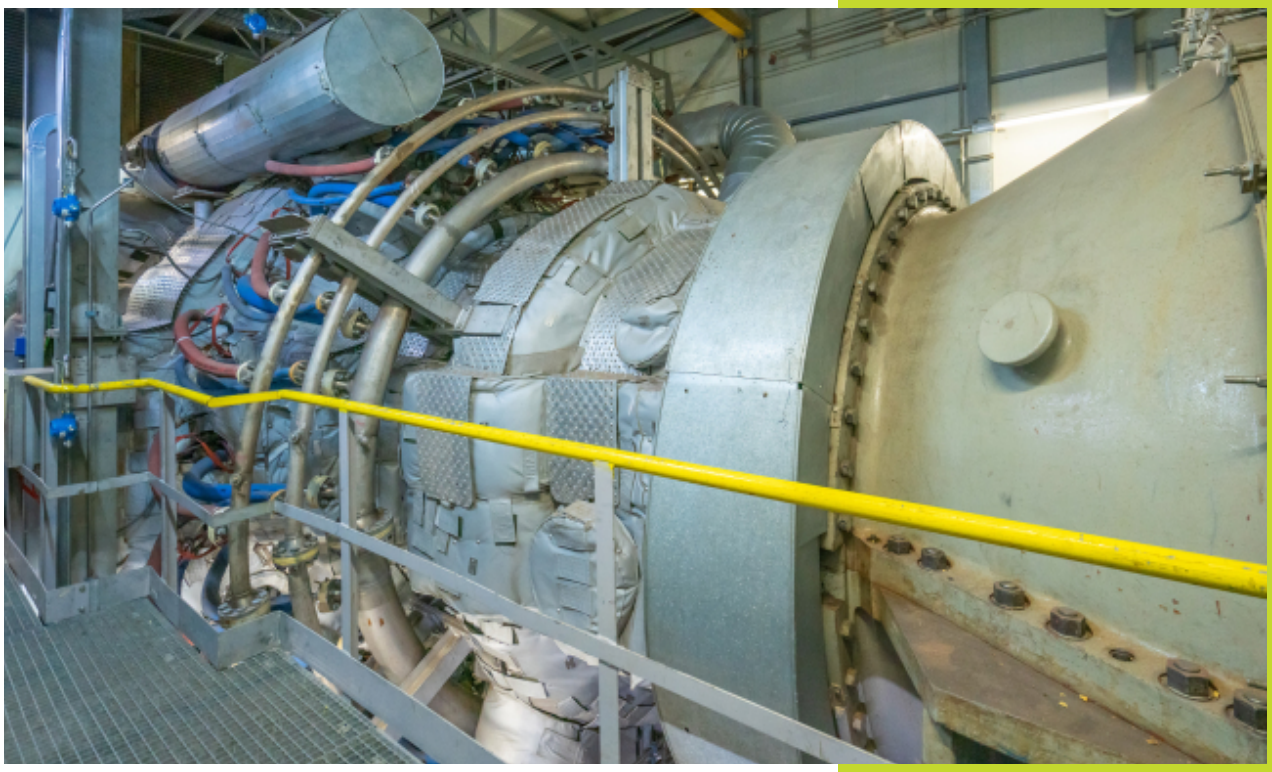

Figure 2: Twin Ansaldo V94.3 gas turbines are at the heart of each combined cycle plant, protected by vibro-meter transducers and VM600 monitoring systems.

Figure 3: Each of the plants' two 120MW steam turbines were originally fitted with a regional Italian competitor's products that emerged as a source of constant problems with spurious trips – and the ensuing costs therefrom.

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Due to Axpo's trouble-free experience with the systems monitoring the gas turbines, and the strong relationship between Ansaldo and vibro-meter, we were the obvious candidate to resolve their spurious trip issues by replacing the steam turbine systems with our VM600 platform.

The decision was also made to replace the steam turbine sensors because it was believed that they may well be the ultimate source of the problems through a high susceptibility to electromagnetic interference. To reduce project costs, vibro-meter field service personnel re-used existing transducer housings and simply retrofit our own products given the universal nature of most mounting accessories such as external probe holders and stems. The steam turbine measurements are shown in Figure 4 and comprise conventional vibration measurements as well as turbine supervisory instrumentation (TSI) measurements.

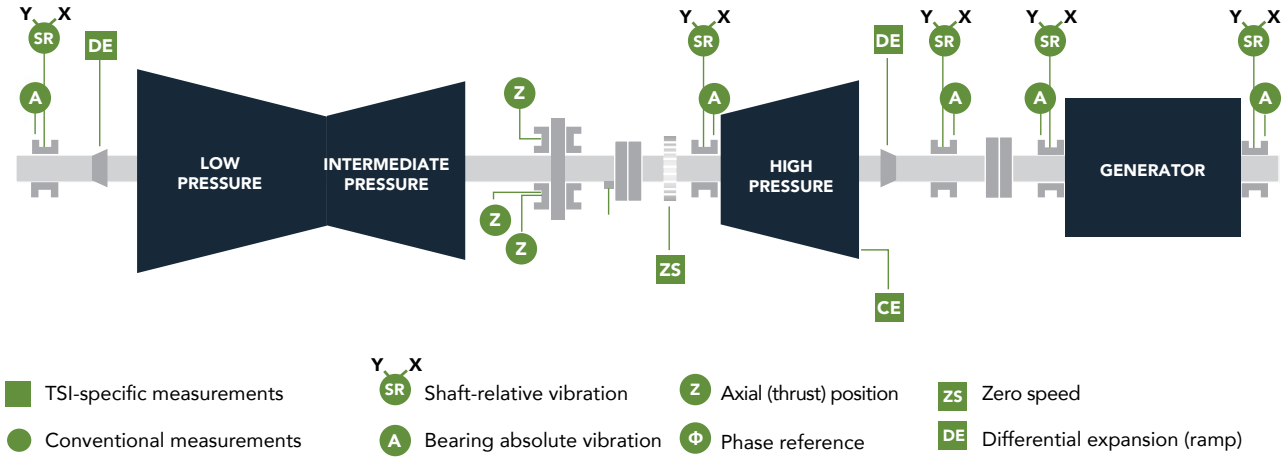

Figure 4: Machine train diagram for steam turbine generator showing arrangement of conventional and TSI measurements.

Lastly, Axpo chose to retrofit monitoring on the four un-instrumented feedwater pumps at each plant as part of the steam turbine instrument upgrade project. The pumps are motor-driven and reflect a mix of rolling element (motor) and fluid-film (pump) bearing types.

Although the OEM supplied the machine trains with provisions for mounting transducers on each bearing cap (surfaces spot faced; holes drilled and tapped), transducers had not been installed when the machines entered service in 2008. Consequently, one accelerometer was mounted on each bearing cap as shown in Figure 5. For monitoring, the VibroSmart system (Figure 6) was selected due to its distributed architecture and corresponding ability to reduce wiring costs by keeping the individual sensor cabling runs short while mounting the modules near each machine.

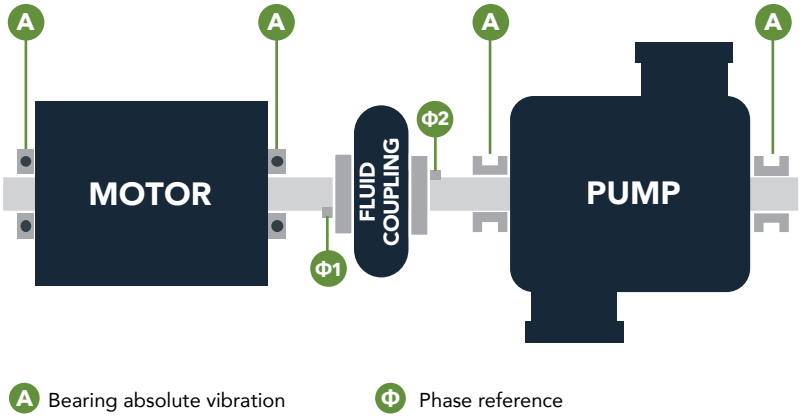

Figure 5: The feedwater pumps have four radial bearings. Those on the motor are of rolling element design and those on the pump of fluid-film design. All are monitored via seismic sensors on each bearing cap. Because a fluid coupling allows the motor and pump to turn at different speeds, two phase reference sensors are installed.

In contrast, because wiring had already been run for the incumbent steam turbine monitoring system, the centralized architecture of the VM600 was a better fit. This illustrates how the complementary VM600 and VibroSmart solutions work hand-in-hand to address customer needs by offering solutions with either a distributed or centralized architecture, but similar functionality and capabilities.

In addition to machinery protection, the feedwater pumps received condition monitoring capabilities. Like the VM600, VibroSmart monitors have integrated condition monitoring capabilities and were thus connected to our companion VibroSight condition monitoring software, providing a comprehensive solution for both protection and condition monitoring. In contrast, on the gas turbines and steam turbines, Ansaldo is used as a service provider for condition monitoring. However, the basis of Ansaldo's condition monitoring solution relies of vibro-meter software and at a future date, all of the condition monitoring in the plant will likely be tied together within VibroSight with capabilities for local access by plant personnel, remote access by Axpo personnel in Genoa, remote access by Ansaldo personnel (also in Genoa), and even remote access by and even remote access by vibro-meter (Fribourg, CH) and its partner in Italy, AESSE (Milan) when support may be needed.

"Like the VM600, VibroSmart monitors have integrated condition monitoring capabilities and were thus connected to our companion VibroSight condition monitoring software, providing a comprehensive solution for both protection and condition monitoring."

Figure 6: The VibroSmart distributed monitoring system was used to address the feedwater pumps.

Complementary Capabilities

vibro-meter works with numerous partners globally to provide sales and service support. In Italy, that partner is AESSE Misure Srl, based in Milan.

As one of vibro-meter's longest lasting partnerships (20+ years), AESSE possesses deep knowledge of our products and have forged a very strong relationship with Ansaldo, allowing them to deliver excellent local sales and service support for this major vibro-meter account. Thus, while vibro-meter products were selected for this project, AESSE provided all installation design services, commissioning, and project management, working closely with vibro-meter's factory-direct personnel based in Switzerland. AESSE also provided engineered enclosures – both cabinets and field junction boxes – used for the instrumentation.
The installation occurred during a series of four separate mobilizations to site during May 2021 and September 2021 – one mobilization for each of the four steam turbines and its corresponding feedwater pumps.

Spurious Trips

Although missed trips can lead to catastrophic machine failure and corresponding costs, spurious – or false – trips can also be very costly. While the operator eventually isolated the problem to the steam turbine instrumentation, machinery trips are always disruptive and spurious trips generate a mistrust of critical measurements such as from the TSI system in this story. Consider the time it takes to rule out a legitimate machinery problem instead of an instrument problem, and consider the implications of restarting a machine like a large steam turbine where differential expansion, rotor bow, and case expansion measurements must all be observed while admitting steam, accelerating the machine, and then synchronizing. With each spurious trip causing at least an hour of lost generation at a cost of at least €50k per hour, the plants were highly motivated to eliminate the instrumentation problems and their attendant costs.

The spurious trips caused by the plants' incumbent TSI systems have now been fully resolved as a result of replacement with vibro-meter VM600 systems and turnkey project execution by vibro-meter's partner in Italy, AESSE Misure, Srl.

Results

The TSI systems have been operational now for more than a year without any spurious trips. Several modifications were made to the prior arrangement which had the signal conditioners for the proximity probes mounted on the machine, rather than several meters away in a junction box as is customary.

Although the machine-mounted signal conditioners had been suspected as the cause of the spurious trips, the operator had never been able to conclusively isolate this. Nevertheless, the project team placed the signal conditioners off the machine in junction boxes where they could be more easily accessed and serviced, while also providing a vibration-free environment that would not contribute to loose wiring connections and corresponding intermittent problems. Also, because vibro-meter transducer systems provide an option for a current-modulated signal output instead of voltage-modulated, a signal that is less susceptible to electromagnetic interference – such as from hand-held radios – was used for applicable transducers. The field wiring from sensors to monitoring systems could all be reused and this made the centralized architecture of the VM600 rack-mounted system the right choice. It also meant that the integrated condition monitoring capabilities of the VM600 can be enabled in the future when the plants begin migrating to VibroSight software as part of Ansaldo's service offering strategy for condition monitoring.

Figure 7: An operator at Rizziconi Energia keeps watch over the two 380MW combined cycle processes from a control room vantage point overlooking the plant.

Conclusions

Both the Rizziconi and Sparanise facilities now enjoy trouble-free machinery protection on their steam turbines, joining the reliable protection and combustion dynamics monitoring that vibro-meter has provided on the plants' gas turbines since the very first MW was generated back in 2008.

Turnkey Solution Portfolio

✓	Replaced protection system
✓	Replaced sensors
	Replaced condition monitoring system
	Upgraded condition monitoring system
	Upgraded protection system
✓	Project Management
✓	Fully instrument "bare" machines
✓	Sensor Installation and Verification
✓	Turnkey Service
	Custom Products
✓	Documentation
✓	Training
	Remote Machinery Diagnostic Support
	Rule Box expert knowledge embedded in Rule Box software

✓ services provided for this project

In addition, the feedwater pumps are now protected and fitted with online condition monitoring – a logical progression given the critical role these machines play in ensuring full plant output.

The work performed by vibro-meter and its partner, AESSE Misure, allowed the plant to maintain its outage schedules and come back up as planned. Replacement of protective instrumentation on critical machinery is an area of particular expertise and the ability to treat this scope in a turnkey fashion was highly desirable for the operator. They could focus on conducting their outage to address other rotating and non-rotating equipment, while vibro-meter and AESSE could completely manage the machinery instrumentation issues.

vibro-meter and its partners around the globe are highly skilled at such retrofit projects, whether to replace the underlying protection system and its transducers, to replace the protection system while reusing the existing transducers, to install transducers on partially or fully un-instrumented machines, or to add (or replace) condition monitoring without disturbing the underlying protection system – regardless of make or model.

You can learn more about these capabilities in our informative webinar, available on-demand when you register on our website. We address the most common scenarios faced by customers and outline our ability to deliver world-class solutions that can be adapted to your specific needs and ranging from complete turnkey scope to mixed scope where customers and vibro-meter personnel work side-by-side.

About The Axpo Group

Axpo is Switzerland's largest producer of renewable energy serving more than 3 million customers with a generation portfolio that consists of more than 50% hydro, solar, wind, and biomass sources. It is headquartered in Baden, Switzerland, and operates in 40 countries around the globe including Italy where it has a majority ownership stake in the Sparanise (85%) and Rizziconi (100%) combined cycle plants and is thus actively involved in their operating and maintenance decisions.

About Calenia Energia SpA and Rizziconi Energia SpA

Calenia Energia SpA and Rizziconi Energia SpA were formed in 2007 to build and operate the combined cycle power plants in Sparanise and Rizziconi, Italy. Calenia is 85% owned by the Axpo Group and 15% by the Hera Group. Rizziconi is 100% owned by the Axpo Group.

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