



**Transmission
& Bearing Corp.**

Technical Notes by Dr. Mel

January 2017

Solving a Sub-Synchronous Rotor Vibration for a Critical Steam Turbine in a Seemingly Small, but Actually, a Large Application

In many applications such as refineries, pulp and paper mills, and mines, a 23 MW steam turbine-generator may not seem like a "big deal". However, the MW generation rating can be quite deceiving when evaluating the importance of a turbine to the overall plant because the turbine is an integral part of a much larger operation. For instance, a steam turbine often is used to drop the pressure down from the boiler pressure at which the steam is made (1000 psi) to the header pressure (180 psi) for use in heating and powering many components of the overall plant. If the steam turbine is not available or is limited in capacity, then the steam pressure must be reduced via a pressure regulation valve and all of this pressure energy is lost. In some cases, the plant is remote and because the incoming transmission line has limited capacity, the plant must have the internal generation to reach maximum production of the primary salable products.

As occurred in this project, for your turbines, generators, and other equipment that experience high amplitude rotor vibrations that are seemingly unsolvable, it is almost a certainty that TRI will be able to provide an effective and workable solution that can be implemented in a short time period.

TRI Align-A-Pad® Bearings have made very significant contributions to a number of these seemingly smaller applications. One of the latest success stories is of a 23 MW extraction steam turbine-generator that was uprated over 15 years ago, and since then, has had a continued history of unacceptably high amplitude rotor vibrations when certain steam valves with high steam flow were opened. The consequence was that the steam flow through the turbine had to be limited to avoid these high amplitude rotor vibrations, and this resulted in the maximum sustainable MW generation being only around 15 MW. This situation represented a considerable financial loss for years to the company for

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this reason: the steam pressure was dropped down through a pressure reduction valve rather than going through the turbine to recover the energy in the form of electrical generation, a loss of 8 MW of generation that had to be purchased from the outside to maximize plant production. In this circumstance, there were times when the steam flow to the header and on to the using components was limited, as well.

Many engineers and companies, including the OEMs, have tried different solutions to this vexing problem without success for over a decade. One company proposed to perform an extensive fluid flow and rotor dynamic study that would take many months to complete. If this path had been taken, an opportunity to use an upcoming planned maintenance outage to install their (future) proposed solutions would be missed.

TRI has solved so many of these sub-synchronous rotor vibration problems that are caused by steam forces acting on the turbine rotor, usually on much larger machines, that when TRI was approached for a solution, TRI was quite confident of being able to solve this problem in "one shot", and to do so in the rapidly approaching outage. TRI proposed to perform a very short engineering analysis of the steam forces acting on the rotor at high steam flow conditions, and then to design and manufacture three TRI Align-A-Pad® Tilting Pad Bearings (both turbine bearings and the outboard generator bearing) to suppress the rotor vibrations. They would be installed in the plant's approaching outage. Plant management agreed to TRI's proposal.

When the outage occurred, the existing bearings were shipped to TRI to take outside "envelope" measurements for installation. The new TRI Bearings were finished and installed. The unit was started, and the unit went right up to 23 MW with full steam flow. There were no complications and the unit has been functioning with satisfactory rotor vibration amplitudes and bearing metal temperatures since this start-up.

Typically for three bearing systems, only bearing #2 needs to be upgraded to a suitably designed tilting pad bearing. Due to the severity of the vibration conditions in this case, all three bearings were redesigned to assure maximum control of rotor vibrations.

Please contact TRI for a review of your circumstances and recommendations for moving forward toward a solution.



TRI plans to participate in the upcoming EPRI Turbine-Generator Users Group Conference and Exhibition on January 16 and 17, 2017, which will be held in the Peabody Hotel in Memphis, TN

We look forward to meeting attendees and discussing any rotor vibration and bearing damage issues that you have, as well as other subjects related to the wide range of TRI Products and Services.