

SUCCESSFUL TROUBLE-SHOOTING OF MIGRATING SECOND CRITICAL SPEED ON A 240MW STEAM TURBINE

Maurice Adams Michael Adams
Machinery Vibration Inc. (MVI)
Chagrin Falls, Ohio 44022

Nicholas Anderson Daniel Rossero
First Energy Corporation
Akron, Ohio 44325

Melbourne Giberson
Turbo Research Incorporated
Lionville, PA 19353

ABSTRACT

Excessive rotor vibration was consistently experienced on a 240MW steam turbine HP-IP turbine rotor during load cycling in the 150MW-190MW load range. Although this load cycling vibration characteristic was reported to exist in this unit from its original commissioning several years earlier, it was only after the most recent scheduled refurbishment outage that this vibration increased to levels that were deemed sufficiently excessive to require root cause identification and substantial attenuation. MVI undertook rotor vibration measurements on this unit employing its 16-channel digital tape recorder to facilitate flexibility in extensive post processing analyses of the measured vibration time-base signals. MVI's initial analysis of these vibration measurements strongly suggested a critical speed (unbalance excited resonance) as the root cause of the excessive vibration. MVI concluded that there was a strong possibility of a rotor-bearing 2nd critical speed whose center frequency migrated up or down across 3600rpm as a function of HP-IP journal bearing static force load variations caused by varying the partial emission impulse control stage nozzle openings to match load demand on the unit. That is, the 2nd critical speed transitioned through 3600rpm as the unit load cycled within the 150-190MW load range. The fundamental theory explaining this critical-speed migration phenomenon is the attendant variation in journal bearing oil-film stiffness as a function of the variation in journal bearing static force loads.

MVI developed a rotor vibration response computer model of the turbine which verified this preliminary conclusion. With the root cause thus identified to a high degree of confidence, MVI's recommendation for the optimum fix to eliminate this vibration problem was to install improved journal bearings on the HP-IP rotor. Specifically, MVI recommended the Turbo Research Inc. (TRI) Tilt-Align 6-pad tilting-pad journal bearing configuration, since its oil-film stiffness is substantially higher than that of the original OEM bearing configuration, and also its oil-film stiffness is virtually insensitive to the variations in bearing static force loads when the unit is load cycled. MVI's subsequent (April 2004) vibration measurements on this turbine confirmed that the TRI retrofit has completely eliminated this vibration problem.