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Grid Stability and Effect of Flexible Operation on Francis Runners

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Abstract

Energy market deregulation and arrival of new players, such as solar and wind turbines, led to increasing demands for flexible operation of hydraulic turbines to contribute to grid stability. Instead of continuous close to peak operation, it is nowadays common to see turbines being operated over the whole range, with many start/stops, extensive low load operation, synchronous condenser mode and power/frequency regulation.

Although hydraulic turbines are among the most robust and reliable structures and equipment ever produced, such operating arrangement increases drastically the number of high and low amplitude dynamic cycles the machines have to go through. The turbines have now to withstand strong vibrations induced by higher pressure pulsations at part load, low part load, speed-no-load and during the more frequent start and stop cycles. These vibrations, on their side, produce dynamic stresses which do not come without cost on the machine life expectancy. To assess machine reliability, it therefore becomes critical for the owner to understand the real effects of these dynamic phenomena.

This paper will demonstrate how this new flexible operation pattern affects the lifetime expectancy of Francis runners. Runner blade strain gauge measurements performed at various sites will be used to achieve this objective.