

Increase of Francis Unit Peaking Capability through In situ Start-up Optimization

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Abstract:

In order to accommodate the variable load demands of the grid, hydroelectric generating units often need to operate with several start-stop cycles per day. Due to potentially high level of runner dynamic stresses developed during unit start-up cycles, the start-up is recognized as one of the events most detrimental to the fatigue life of turbine runners. Theoretical prediction of runner dynamic stresses during a start-up transient event is a real challenge because the currently available numerical technology is unable to give a reliable prediction. In this context, in situ start-up optimization using the runner strain gauge measurements is a more reliable approach to minimizing fatigue damage on the runner, while maintaining a reasonable duration to bring the machine up to synchronous speed.

This paper presents how Andritz Hydro and BC Hydro jointly performed a runner strain gauge measurement campaign on one of the two new Francis runners supplied and installed by Andritz Hydro at Mica Generating Station, located in British Columbia, Canada, and owned by BC Hydro. The instrumentation set-up allowed for the data to be measured on the rotating parts and be downloaded for analysis while the unit was in operation. Various start-up scenarios with different guide vane opening sequences and durations were evaluated using specific analysis tools developed for in situ live optimization of start-ups. As runner stresses during the start-ups are of stochastic nature, fatigue calculation is done using a rainflow-cycles-counting algorithm. With this optimization, the runner start-up stress ranges have been reduced, leading to a much longer runner fatigue life with an acceptable duration of the start-up time to reach synchronization. As a result of the efficient collaboration of Andritz Hydro and BC Hydro, Mica's new units achieved reliable peaking operation capability with reduced risk of fatigue-related forced outages.