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Abstract

Optimized Use of Sensors to Detect Critical Full Load Instability in Large Hydraulic Turbines †

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Nowadays, hydropower plants are of paramount importance for the integration of intermittent renewable energy sources in the power grid. In order to match the energy generated and consumed, Large Hydraulic Turbines have to work at off-design conditions, which may lead to dangerous unstable operating points involving the hydraulic, mechanical and electrical system. Under these conditions, the stability of the power grid and the safety of the powerplant itself can be compromised. For many Francis Turbines, one of these critical points, that usually limits the maximum output power, is the full load instability. Therefore, these machines usually work far away from this unstable point, reducing the effective operating range of the unit. In order to extend the operating range of the machine, working closer to this point with a reasonable safety margin, it is of paramount importance to monitor and to control relevant parameters of the unit, which have to be obtained with an accurate sensor acquisition strategy.

In the frame of a large EU Project, field tests in a large Francis Turbine located in Canada (rated power 444 MW) have been performed. Many different sensors were used to monitor several working parameters of the unit for all its operating range. Particularly for these tests, more than 80 signals, including ten types of different sensors and several operating signals that define the operating point of the unit, were simultaneously acquired. The present study focuses on the optimization of the acquisition strategy, which includes type, number, location, acquisition frequency of the sensors and corresponding signal analysis to detect the full load instability and to prevent the unit from reaching this point. In this way, the operating limits of the unit can be more accurately defined and therefore the effective operating range increased.

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