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# Upgrading of Hydraulic Turbines with and without Model Test

Christof Gentner, Simon Weissenberger, Normand Désy

## Abstract

About 50% of the equipment installed in hydropower plants worldwide is older than 40 years. Therefore, modernization and upgrading of existing hydropower plants and improvements in reliability and availability of generation capacity become increasingly important. The service and rehab (S&R) division of ANDRITZ HYDRO is specialized in adaptation of existing hydropower equipment to changing market requirements, such as maximization of energy production, extended operating range or increased life time of equipment.

Considering the lower environmental impact compared with the resources required to manufacturing new equipment, upgrading is a competitive alternative from an economic and ecological perspective. In order to maximize the effect/cost ratio of a rehab, it is necessary to identify the key components, the replacement of which will lead to the most significant improvement of performance. After the refurbishment, the characteristics of the machine have to be close to those of a new machine. A process to assess the upgrading potential of existing power plants has to regard their variety in size and complexity. Whereas the upgrading of a power plant with an installed capacity of 1000 MW or more easily justifies the expense for a model test, these costs would render many smaller projects not feasible. ANDRITZ HYDRO has developed a procedure to identify upgrading potential and to design the hydraulic profiles of the components to be replaced that considers the specific boundary conditions of each upgrading or rehab project. Using this procedure, the company has modernized turbines with a power output between 900 kW and 800 MW. This process is adapted depending on the specifics of the projects. ANDRITZ HYDRO delivers about 50% of all Francis runners for upgrading projects directly from CFD to the prototype without model test. Examples from recent projects, including developments with and without model testing, will illustrate how the described upgrading procedure is successfully put to practice for axial and radial machines.