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# Wide Operating Range Design Applied to Hoover Dam Hydroelectric Plant Units A1, N5, N6 & N8 Overhaul

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## Abstract

In 2010, ANDRITZ HYDRO was awarded a contract from the U.S. Bureau of Reclamation (USBR) to develop a replacement runner for units A1, N5, N6, and N8 of the Hoover Dam hydroelectric power plant, located on the Colorado River, close to Boulder City, Nevada.

The greatest challenge of this project was the wide operating range both in head and in power, especially given the low specific speed of the machine. Normal head range varies from 396 ft (120.7 m) to 511 ft (155.9 m) and temporary head range varies from 350 ft (106.7 m) to 575 ft (175.3 m), which give head ratios of 1.29 and 1.64 respectively. As the powerplant operates as a regulating plant, each unit operates at power output continuously changing from 5% to 100% maximum power with long period in synchronous condensing mode. The maximum turbine output is 179100 hp (133.6 MW) and the rated power is 143300 hp (106.9 MW). The runner throat diameter is 130.7 in (3.32 m) for a rotational speed of 180 rpm.

The other challenge set by the USBR was to deliver a modern Francis turbine design with a high efficiency level, excellent stability behavior and a peak that is well positioned considering the application range requiring cavitation-free operation. Static and dynamic stresses at normal and exceptional operating conditions, including rotor-stator interactions, have been checked and fulfill ANDRITZ HYDRO requirements to ensure that the replacement runner will last for its expected lifespan. An additional challenge was the efficient coordination of work activities across multiple sites within ANDRITZ HYDRO and external suppliers in order to execute the project on a tight schedule and budget.

This article overviews the different phases of this project: hydraulic runner design, runner development in the hydraulic laboratory, mechanical design and commissioning of the first unit in June 2012.