UPGRADING POWER

HPP Whakamaru, New Zealand

by Tony Mulholland

One of a cascade of several power stations on the Waikato River, after more than half a century of operation Whakamaru Hydroelectric Power Station has now been upgraded. Whereas the limited flow capacity through the station had previously required bypass spilling to allow sufficient flow to the downstream stations, new ANDRITZ turbines from ANDRITZ Hydro substantially increase the flow capacity of Whakamaru. This significantly reduces the spill volume and enables optimized operation of the river's hydropower chain.

Introduction

With up to 80% of its electricity coming from renewables and the third highest renewable energy capacity in the OECD, New Zealand is one of the world's renewables leaders. Mercury NZ Ltd is a 100% renewable energy company based in New Zealand. It owns and operates several geothermal power stations as well as all of the nine hydropower stations located along the Waikato River that starts in the middle of New Zealand's North Island at Lake Taupo and ending at its mouth on the west coast. The nine stations have a combined capacity of 1,080 MW.

Originally commissioned in 1956, the Whakamaru HPP comprises a concrete dam with short penstocks connected to four Francis-type turbines. At 136 rpm and a net head of 37.5 m, each machine is rated at 26 MW. As commissioned, the original turbines were delivered by Dominion Engineering (Canada), now part of ANDRITZ Hydro.

A new tender was opened in 2012 with a primary objective of modernizing the power station and maximizing the flow and power production at Whakamaru. Within environmental limits, the aim was to reduce spill and optimise the operation of the downstream power stations.

ANDRITZ Hydro was awarded the contract to upgrade the turbines at Whakamaru in August 2013. The agreed scope of supply included four Francis turbine runners, head covers, bottom rings, guide vanes, and complete replacement of the governing equipment with a new high-pressure system.

High Flow Francis Turbines

The replacement turbine runners were expected to be challenging to design, particularly given the relatively low head and the importance of stable draft tube flow. Included in the contract with ANDRITZ Hydro was a comprehensive model testing package that was undertaken in Linz, Austria.

During the model test program a number of issues were identified and a significant number of iterations were necessary to obtain the best technical solution. The result was an outstanding design with a turbine rated at just under 32 MW, a 22% increase. Furthermore, no significant modifications to the embedded parts of the station were required. In addition, at the model test stage the turbine significantly out-performed the guaranteed model efficiency.

Installation and Operational Solutions

A staged design process was included in the contract that saw several design reviews undertaken. This process allowed the customer to check the design would meet their requirements and identify where there were choices to evaluate and decide on the best solution.

One of the solutions was a head cover levelling system. In older machines the head cover flange may be found to be not level on disassembly. In New Zealand, this would typically mean bringing offshore insitu machining contractors to the site. During the design phase, ANDRITZ Hydro selected one of several solutions to provide a way to adjust the head cover to level without requiring machining. Adopting this design solution reduced the risk of finding the head cover flange out of level, a situation that would extend the outage and increase the associated costs.

The digital part of the governor provided for the project was also customized for Mercury NZ during the design stage in order to provide governor performance data from the governor touch

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screen. This functionality included automated step response, stability and servo motor force testing. The governor PLC was programmed to perform the standard test sequence for each test and record the data without needing external data loggers. This reduces operational costs and allows efficient and rapid testing of the governor during maintenance as no additional set-up time is required to undertake the test.

Manufacturing and Delivery

All the new components for the project were manufactured by ANDRITZ Hydro at a number of European locations. Following an extensive program of factory inspections and the final factory acceptance testing, the first unit arrived in New Zealand in late September 2016 ready for a planned shutdown starting the following month.

Delivering on promises

After installation, commissioning of the first unit was completed in May 2017. The site efficiency testing that was undertaken during commissioning could be compared with an equivalent test before the unit was taken out of service. This testing showed a significant gain in efficiency over the old turbines and more than had previously been expected based on the model testing of the new unit.

Post upgrade and the Whakamaru hydro station is performing better than expected. Mercury NZ hydro and wholesale general manager, Phil Gibson, says “On paper we get about a 6% efficiency increase, but I think we’ve got about 8%.” Noting that such an increase will produce about 40 GWh per year of additional energy from the station, Gibson further noted “We are optimistic we might get 124 MW out of the station.”

The next three units are expected to be installed at a rate of one per year during the summer months through until 2020.

Market Outlook

In New Zealand, electricity demand is expected to increase at a modest pace over the coming years, with hydropower expected to continue to perform an important role in stabilising an electricity supply dominated by renewables. Of particular interest is the rapid growth in electric vehicle uptake, well ahead of expectations. This development is sure to factor in future demand growth in New Zealand and worldwide.

ANDRITZ Hydro has a significant fleet to support in New Zealand, mainly through brands it now owns. These brands include the former General Electric Hydro, Kvaerner, Boving, Tampella and Dominion Engineering. The service and refurbishment sector will continue to be an important part of the hydro market in New Zealand as the major hydro installations developed from the 1950s through to the 1980s come up for refurbishment and modernization. ANDRITZ Hydro has the local team and technical backing to provide appropriate, efficient and economical solutions for a wide range of projects, from service work to major modernizations. We look forward to supporting our customers long into the future.

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