Switching gears at Muddy Run

A major generator switchgear upgrade is being undertaken at Muddy Run pumped storage scheme in Pennsylvania, US

WITH a generating capacity of 1100MW, Exelon Power's eight-generator Muddy Run pumped storage facility in southeastern Pennsylvania helps the mid-Atlantic power grid meet peak demands. Built in 1966, the plant is undergoing a major generator switchgear upgrade that is phased over several years to minimize the impact on output capacity.

As part of the scheme, four earthen dams form a 359ha lake that holds up to 42.5Mm^3 of water fed by the Muddy Run and a few other small tributaries that traverse Pennsylvania Dutch farmland on their way to the Susquehanna River.

During peak periods, water from the project's reservoir is sent 104.5m through four intake shafts, each 7.6m in diameter, and is shunted through eight tunnels to the turbines. Off-peak, the turbines are reversed to pump water up to the reservoir from the river 122m below. Twenty hours of full-load operation causes the surface of the reservoir to drop 15m.

By design, Muddy Run is not far (upstream and across the river) from the Peach Bottom atomic power station – two nuclear reactors operated and partly owned by Exelon Power's parent company Exelon Generation. The nuclear plant is in constant operation, so Muddy Run makes use of the excess power generated by the reactors at night to double its output the next day as needed.

Replacement units

In service for about 40 years, the Muddy Run generator units, each of which includes a generator circuit breaker and a set of switchgear, require two days of maintenance after every 500 operations (on/off cycles). Since the number of operations depends on the demand for electricity, there are days in the spring and fall when demand is low and some of the units are idle. But demand is higher in the winter and higher still in the summer, when it is not unusual for every unit to run at least twice a day. The facility's eight 140MW turbine generators have already been replaced, but the aging switchgear is becoming expensive to maintain.

The first of the eight replacement high-current switchgear units was commissioned in April 2007. Two more units were commissioned in the spring of 2008, and all three of the new units are performing well. The upgrade plan calls for three more units to be installed next spring (2009) and the last two in the spring of 2010.

Exelon's multi-year contract for the eight sets of generator switchgear is with ABB Inc. At the heart of each replacement unit is the company's SF6 high-current generator circuit breaker, manufactured in Switzerland. For the rest of the gear – high-voltage switches, control systems, and hundreds of feet of copper cable and buswork – ABB turned to its Boston-based supplier, Phoenix Electric Corporation.

Inside the Muddy Run pumped storage facility in southeastern Pennsylvania, a technician checks newly installed Phoenix Electric switchgear prior to commissioning

Switchgear cubicles

Phoenix Electric designed and is building the massive stacked switchgear cubicles (six per generator) that house ABB's circuit breakers as well as the new Phoenix gear. Each of the eight six-cubicle units is approximately 18.5ft x 20ft x 7.5ft (5.6m x 6m x 2.3m) and weighs about 15 tons. Each unit is rated for 6000 amps continuous duty at 15,000V and is capable of interrupting 100,000 amps short-circuit – among the highest-rated equipment of its kind in the world. When each unit is completed, it is shipped from Phoenix's Massachusetts assembly plant to Pennsylvania in three sections strapped to semitrailer flatbed trucks.

'These are the largest units we have ever built, and they are rated 20% higher than the units they replace,' notes Stephen Simo, Vice President of Phoenix Electric. 'The complexity of what Exelon needed, combined with the challenge of fitting more powerful switchgear into the limited available space, was a true engineering challenge.'

The design/development phase, in which Exelon, ABB, and Phoenix engineers worked together, took many thousands of hours of calculations and testing to ensure the new equipment would interface properly with the ABB breakers as well as the generators.

Above: Designed and built by Phoenix Electric Corporation for one of the Muddy Run facility's eight generators, this six-cubicle switchgear/circuit-breaker unit stands approximately 5.6m high and weighs about 15 tons

ABB and Phoenix Electric have enjoyed a 30-year partnership working on several projects together. Recently they collaborated on a project for the US Army Corps of Engineers involving 109 generator circuit-breaker retrofits (each with customized Phoenix switchgear) for 11 hydroelectric dams in the Pacific Northwest. But the new units for Muddy Run are more than three times larger than any in that project.

'This project has been an ambitious and successful collaboration, resulting in a much higher level of reliability and a reduction of maintenance costs to our customer,' notes Ed Sharp, ABB's product development manager for North American switchgear retrofits.

'The design worked out wonderfully,' agreed Charles Tuttle Jr., Muddy Run's senior electrical engineer supervising the project. 'At the first installation, everything fit together. At the end of the day it all had to work, and it did.

'We're quite pleased with the way things are going – the entire process to this point has been very smooth,' adds Tuttle.

The new switchgear units are expected to last another 40 years, but William Conley Jr., P.E, director of contracts for ABB, thinks they may actually last longer. All of the original Muddy Run circuit breakers are General Electric air-blast models, but Conley points out that because the new ABB SF6 breakers make use of a newer, more reliable gas-insulation technology, they are rated for 40,000 on/off cycles with minimal maintenance – more than 54 years of service at two cycles per day. IWP&DC

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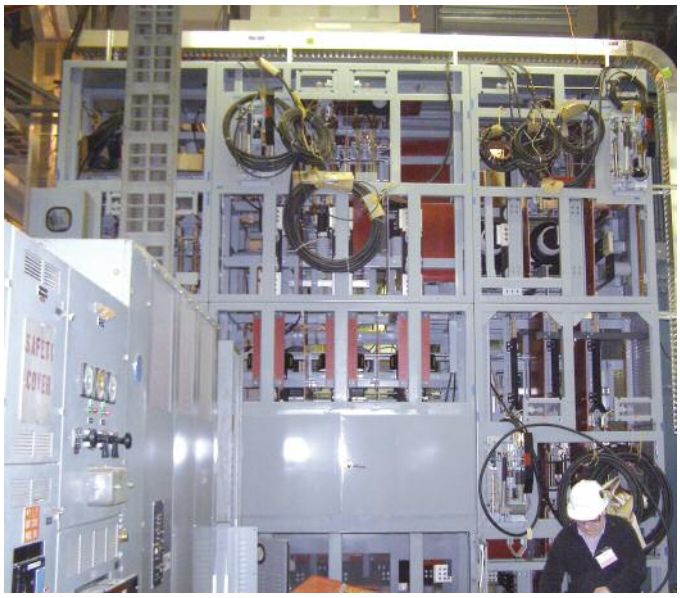

Above, top: Located in Amish country, the Muddy Run Pumped Storage Facility generates hydroelectric power used to meet peak load demands by releasing water from a 359ha lake. The lake is replenished during off-peak hours. Middle: Among the highest-rated equipment of its kind in the world, the new, more powerful switchgear cubicles for the pumped storage facility are rated 20% higher than the ones they replaced, yet fit in the same space. Bottom: The switchgear retrofit is phased over several years to minimize the impact on output capacity. Installations are done in the spring, when electricity demand is relatively low