Saxon hydroelectric power checked:

Siempelkamp gives the "green light" for pumped-storage power plants

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Niederwartha pumped-storage power plant

The accelerated phasing out of nuclear energy in Germany has been decided – a radical change with regard to power supply is the consequence. What will the energy mix of tomorrow be made up of? Pumped-storage power plants will play an important role here and breathe fresh life into the almost forgotten power source of "hydroelectric power". Here, Siempelkamp demonstrates its testing and surveying expertise, as a glance at Saxony illustrates.

What the new energy mix will look like as of 2022 is still unknown at the moment. However, the fact is that enormous investments will have to be made in the period running up to this date, e.g. in grid expansion, in new fossil fuel power plants, in wind turbines, photovoltaic and biogas plants, in storage technology and, last but not least, in pumped-storage power plants. Furthermore, the power supply companies must also increasingly invest in the servicing of their current plants, as they will obviously be granted a longer service life.



Severe plate rust and shell deposits on pumped-storage power plant components: fastening element, guide roller and rivet connection of section and sheet

Pumped-storage power plants: history – and a race against time between Saxony and Westphalia

- 27 November 1929: The first large-scale pumped-storage power plant to be realized in Niederwartha (Dresden) partially goes on the grid after three years of construction.
- January 1930: Full commissioning of the 132 MW Koepchenwerk pumped-storage power plant located in Herdecke an der Ruhr, Westphalia – as a result, two technical masterpieces are on the grid that were celebrated for their innovation and size.
- March 1930: Final completion and complete commissioning of the Niederwartha pumped-storage power plant with six hydroelectric generating sets and a total output of 120 MW
- Following the Second World War: Dismantling of the Niederwartha pumped-storage power plant as a reparation payment to the Soviet Union.
- 1960: Gradual reconstruction of all six turbines, each with 20 MW
- 2002: Setback in Dresden caused by flooding of the River Elbe – today, only two of the turbines at Niederwartha are in use as a result of the damages
- The operator is currently planning the installation of larger turbines of up to 120 MW – a new future for the power plant!

This is where Siempelkamp Prüf- und Gutachter-Gesellschaft comes into play: its service focus is directed towards the condition analysis during overhauls / plant inspections – as well as towards the measures to be derived concerning the preventative repair and monitoring of power plant components that determine the overall plant's service life. The Siempelkamp subsidiary has already successfully demonstrated its expertise in Germany's oldest pumped-storage power plant.

Energy generation from hydroelectric power: an almost forgotten power source rediscovered

In Germany, hydroelectric power is an almost forgotten power source – however, pumped-storage power plants are doing a great job here: to date, these energy suppliers represent the sole technology ready for the market that can store a surplus of power – from renewable energies, for instance.

The trick: Excess power is used to pump large amounts of water from a lower reservoir to a higher reservoir via large pressure pipelines. As soon as the demand for power increases, the water located in the higher reservoir is allowed to flow down into the valley. In doing so, the water drives a turbine that is coupled to a generator. Currently, over 30 pumped-storage power plants bunker 40 GWh of power in Germany – as much as the whole country consumes within a period of only 35 minutes.

Germany's largest pumped-storage power plants, each with an output of 1,000 MW, are located in Goldisthal, Thuringia and in Markersbach, Saxony. Following the change in energy policy, the

demand for storage capacity will be many times that of the current output, meaning that the search is on for further alternatives. New constructions of pumped-storage power plants are difficult to implement in Germany. Obstacles include a lack of possible locations, high investment costs and citizen's protests.

However, there are currently plans for Atdorf in Hotzenwald (1,400 MW), Riedl in Bavaria as well as locations in Trier, Ulm and Forbach. The construction of the world's first underground pumped-storage power plant at the Auguste Victoria colliery is planned to be completed by the end of 2015. In this respect, a renaissance is in the offing for the pumped-storage power plant that may include the strengthening of the existing plant technology or the expansion of the turbine output. This for example is illustrated by Germany's oldest pumped-storage power plant in Niederwartha, located on the outskirts of Dresden (see box).

Hydraulic engineering structures & turbine technology made in Saxony: the Siempelkamp check

The characteristic of a pumped-storage power plant is the reversible plant operation. A Francis or Pelton turbine, a motor generator set and a pump are mounted on to a shaft and form a unit that permits two modes of operation.

When power is needed, the motor generator set is driven via the turbine, works as a generator and supplies electricity. In the event of a surplus in power, the motor generator set works as an electric motor and drives a pump that pumps the water back into the upper reservoir. Pressure surges are created when closing the shut-off valve in the pressure pipelines or in the event of switching between the two modes of operation. If the flow rate is changed, high acceleration and braking forces occur in the pressure pipelines. The so-called surge tank, a high-volume reservoir that is open on the top, subdues the effect of these shocks by collecting and diverting the quickly flowing water. Inside, the water level can change freely in order to provide pressure compensation. The Niederwartha pumped-storage power plant has three of these surge tanks.

Here, there are three penstock pipelines with 3,500 DN (Diameter Nominal) located above ground, tapered to 2,500 DN with level and steep part. In total, the pressure pipelines measure 1.9 km in length, the head of water amounts to 143 m. The four outer turbines including the associated penstock pipelines are currently decommissioned. The central machines that are supplied from the central pressure pipeline are in operation.

Valley-side pipelines on the Niederwartha pumped-storage power plant

Pipeline supplies to the turbine house

Upper reservoir emptied for inspection

Inlet gate on upper reservoir

A dam has been constructed each on the higher and lower reservoirs in order to serve as retaining structure.

Plant inspection tasks

In 2005, SPG examined the condition of the penstock pipelines for the four outer turbines that had not been in operation since 2001. The comprehensive test program consisted of corrosion examinations, wall thickness measurements as well as crack, radiographic and hardness testing on the numerous assembly welding seams. Although the original coating system had been severely affected by underlying rust, both surface erosion as well as individual corrosion pitting only displayed low depths. The welding seam testing did not show any manufacturing or operating-related faults.

A similar examination program was planned for the central penstock pipeline and associated surge tank still in operation. The client determined five pipeline sections as areas of focus for the tests. Some pipe sections could only be accessed with the aid of fall protection devices due to the steep incline of 30° to the mountain.

The job included services such as the inspection of the penstock pipeline, participation during the determination of defined testing areas, grinding works on test sections, test execution as well as the evaluation of the results and subsequent condition assessment. In addition to this, the inlet gate* belonging to this pipeline on the upper reservoir was to be tested. For this purpose,

* In the field of hydraulic engineering, inlet gate describes a device used to control the water flow of pipelines / for blocking and retaining of waterways or locks. Larger systems of this kind are referred to as "weirs".

Upper course of the inlet gate

Tests on the welding seams of the penstock pipelines

the upper reservoir was made "dry" for six weeks in order to ensure that the steel structure and its mounting were accessible.

Visual findings were a part of the job that the Siempelkamp testing and surveying team addressed. Furthermore, the task was to investigate the material condition and various material characteristic values such as the chemical composition and mechanical strength on sections, sheeting, bolts and rivets. In the lower part of the lock, the sections and mountings displayed severe plate rust due to the decade-long contact with water.

The main focus of the inspection was the central pressure pipeline used for operation, the associated surge tank as well as pipeline sections at the turbine house. Here, the condition of the longitudinal and circumferential welding seams was put through its paces by means of ultrasonic, magnetic powder and radiographic tests as well as hardness testing and metallography.

The non-destructive tests displayed no indications that are subject to registration. However, individual repairs are indeed required: given appropriate operation, we were able to give the operator the "green light" for the further operation of their penstock pipeline. The customer was thoroughly satisfied – and we were able to demonstrate once again our expertise and performance in the field of plant inspection.

Map sections with pipeline route and the associated structures