



(Photo: Axpo)

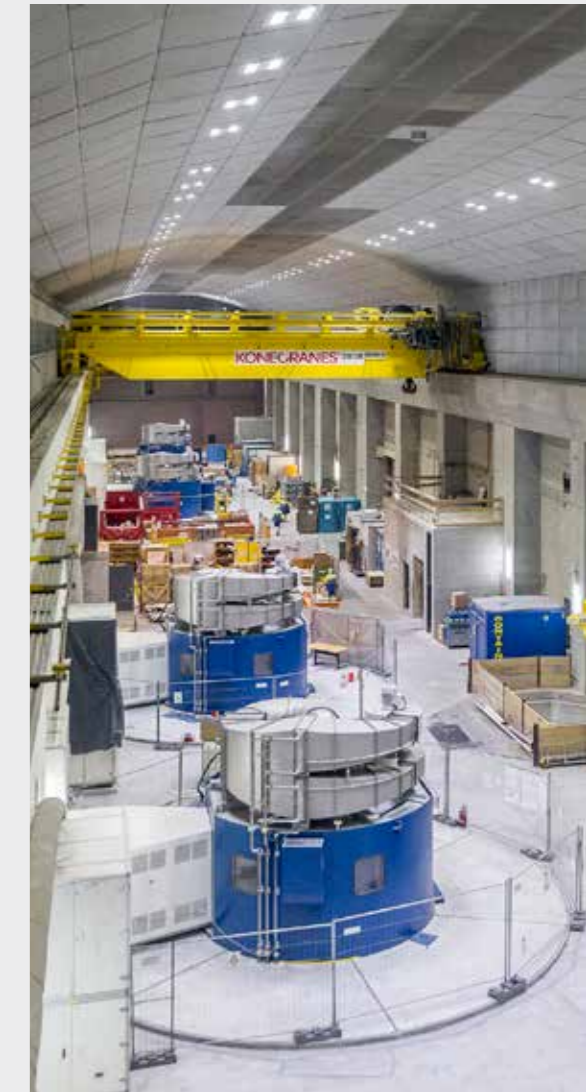
FROM THE JOBSITE

Armaflex on one of Europe's
highest alpine construction sites

 **armacell**[®]



At an altitude of 2474 metres Lake Mutt is Europe's highest reservoir
The machine cavern houses the four machine groups with an output of 250 MW each
(Photos: Axpo)



SUPERLATIVE CONSTRUCTION

One of the most spectacular projects of our times is currently underway in the Glarus Alps: the "Linthal 2015" project will increase the performance of the Linth-Limmern pumped-storage power plant many times over and allow flexible electricity generation. Halogen-free NH/Armaflex insulation was installed on all refrigeration equipment and the flexible fire protection system Armaflex Protect was used for pipe penetrations.

Switzerland does not have any fossil raw materials and so it relies heavily on hydroelectric power for its energy supply. Over half of the electricity generated in Switzerland comes from hydroelectric power stations. Indeed it is one of the foremost users of this technology, topped only by Norway and Austria. Around a hundred Swiss reservoirs are used for generating electricity, but only 15 of them have a pump system.

At the moment, the most significant expansion project in the Swiss hydroelectric sector is "Linthal 2015", in which the Swiss energy group Axpo holds 85 per cent and the Canton of Glarus 15 per cent. 2.1 billion Swiss francs are being invested in this superlative project. A new, underground pumped-storage power plant will pump water from Lake Limmern back up to Lake Mutt, which is 630 metres higher, and use it to generate electricity as required. The new plant will have a pump and turbine capacity of 1000 MW each (4 x 250 MW), making it the most powerful pumped-storage power plant in Switzerland.

The lower lake, Lake Limmern, was dammed half a century ago and is situated at an altitude of 1857 metres. For the upper basin, Lake Mutt, a new dam was built, increasing the previous storage volume almost three-fold from 9 to 25 million m³. At an altitude of 2474 metres, Lake Mutt is Europe's highest reservoir. The most spectacular element is undoubtedly the over one-kilometre-long gravity dam – the highest-altitude dam in Europe and the longest in Switzerland.



Base station in Tierfehd (July 2016)



Paolo Bencivinni, Sales Manager at Regisol AG (Busswil, Bern):

“In such a huge project at an altitude of 1700 metres, logistics are an enormous challenge. But in the end it all comes down to coordination. We received exact instructions from Suter when which insulation materials were needed for which construction stage. To protect the material against wind and rain, the full pallets were shrink-wrapped, additionally packed in weather-proof foil and stored separately. They were then transported in containers by cableway from the base station in Tierfehd to an altitude of 1700 metres. Apart from the building materials and components, excavators, cranes and giant tunnelling machines were also transported by the cableway. A spectacular sight.”

LOGISTICAL TOUR DE FORCE

Logistics presented one of the greatest challenges: excavators, lorries, cranes, construction materials, installations – everything had to be transported up in a precise order, at exactly the right time. Some 2.1 million tonnes of material were driven up in 530,000 journeys to supply the 500 workers on the construction site. Here the principle of container logistics was used, similar to that in sea ports. At the base station a team of over 70 logistics and transport specialists

worked 24 hours a day, seven days a week. Weighing 200 tonnes each, the four transformers were much too heavy for the transport cable car which can carry a maximum load of 40 tonnes. So for their transport an additional four-kilometre-long underground cableway had to be built, requiring a tunnel to be cut into the mountain. After a two-week journey by ship, rail and lorry from Bonn to Linthal, the transformers were brought to their final destination by cableway.



[Photos: Axpo]

MACHINES IN THE ROCK

At the heart of the project are two huge caverns which were blasted out of the solid rock. At 150 metres in length and 53 metres in height, the machine cavern is larger than the concourse of Zurich train station. The most important components of the hydraulic machines include four powerful pump turbines, spiral housings, intake pipes and ball valves. The generator was assembled from the electric motor, stator and rotor on site in the machine cavern. All the components were painstakingly coordinated with each other – in quadruplicate. The innovative induction machines with adjustable revolution speed were developed especially for this project and allow the output of the pumped-storage power plant to be controlled. Depending on how much excess electricity is in the grid, the generators allow the output to be increased or decreased in pump mode.



The machine cavern is larger than the concourse of Zurich train station.

[Photo: Axpo]



The statements of those involved in the project can also be found on www.armacell.eu

Karl Podhradsky, Overall Project Manager at ENGIE Services AG Zurich:

“The Linth-Limmern power station has a total electrical output of one gigawatt. So it’s a very, very big plant. At ENGIE Service AG we were responsible for planning and installing the entire refrigeration and heating equipment. This included the insulation of the installations. NH/Armaflex, Armacell’s halogen-free insulation material, was installed on all the cold installations. In this way we could rule out the risk of aggressive substances forming in a fire and damaging the equipment. All penetrations were insulated with Armaflex Protect. Because all walls and ceilings are fire compartments and the penetrations must be sealed in line with the regulations of the fire authorities.”

The transformers were installed in the slightly smaller transformer cavern. Before they are taken into service, they will be connected to the cooling plant and filled with oil, reaching a total weight of 250 tonnes. They will transform the generator voltage of the new pumped-storage power plant from 18 kV to 400 kV.



The machine transformers à 280 MVA each are housed in the slightly smaller transformer cavern.

HALOGEN-FREE INSULATION

All refrigeration pipes and other installations in the machine cavern, the transformer cavern and the four tunnels connecting the caverns were insulated with halogen-free NH/Armaflex. NH/Armaflex has low smoke development in both burning and smouldering conditions. The product displays good practical fire behaviour: it is self-extinguishing, non-dripping and does not propagate flame in a fire.

For insulating the cooling and cold-water pipework with temperatures of 10/17°C and -1/+4°C only a closed-cell insulation material came into consideration. Elastomeric insulation materials such as NH/Armaflex provide installations with reliable protection against condensation and energy losses. Armaflex insulation materials do not need an additional vapour barrier. Unlike conventional materials where the vapour barrier is concentrated on a thin, easily damaged foil, in the case of Armaflex products the high resistance to water vapour transmission is built up throughout the entire insulation thickness – cell by cell.



NH/ARMAFLEX SHEETS

The tried-and-trusted elastomeric insulation material for particularly high safety requirements contains no chlorides, bromides or PVC. NH/Armaflex is UL-approved and IMO-certified.



NH/ARMAFLEX TUBES

NH/Armaflex minimizes the risk of secondary damage which can often result in much greater costs than the actual fire damage. In a fire the product does not release corrosive gases which could form aggressive acids in combination with fire-fighting water.



ARMAFLEX PROETCT

Insulation and fire protection rolled into one: combining the proven properties of the flexible elastomeric foam with an intumescent fire-proof component, rules out fire spread and prevents energy losses and condensation.



Dirk Lummitsch, Installation Supervisor at Suter isoliert (Baden):

“Suter is responsible for technical insulation on one of the highest alpine construction sites in Europe. Because our company has very high quality standards, it was only natural for us to work with the very best materials – with NH/Armaflex and the Armaflex adhesive. The advantage of Armaflex is clear: it is easy to install, and if you work neatly, it looks good, too. In my opinion it’s one of the best materials there are. Our supplier, Regisol, supported us really well in this spectacular project by delivering the materials to the construction site on time. I’m very satisfied with our work.”



All refrigeration equipment was installed by ENGIE Services AG of Zurich and insulated by Suter of Dietikon. Suter insulated pipes with diameters up to 600 mm, circulation pumps, heat exchangers, valves, shut-off flaps, strainers, vibration dampers, shut-off ball valves, distributors and other components. NH/Armaflex tubes and sheets in insulation thicknesses ranging from 13 to 32 mm were installed, the majority of the equipment was insulated with material in the thicknesses 25 and 32 mm.

RELIABLE FIRE PENETRATION SEALS WITH ARMAFLEX PROTECT

To prevent flames spreading in the event of a fire, wall and ceiling penetrations had to be sealed properly. ENGIE Services AG (Zurich) had specified Armaflex Protect for this purpose. With the fire protection barrier almost all types of pipe can be sealed achieving a fire resistance of 90 minutes without the need for any additional measures. Fire spread is ruled out by combining the proven properties of the

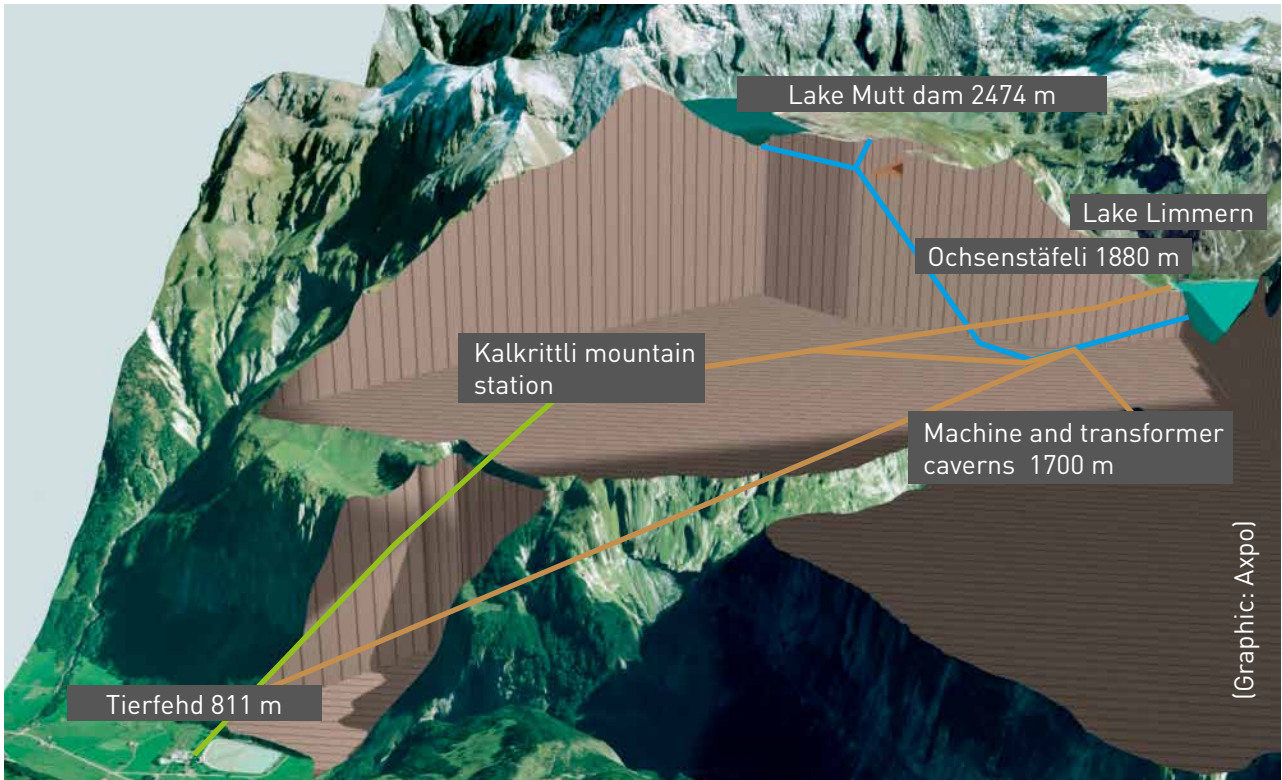
flexible elastomeric foam with an intumescent insulation layer. At the same time, the highly flexible seal system ensures effective thermal insulation and reliable condensation control. Armaflex Protect is just as easy to install as all Armaflex products. To seal pipes with diameters of 22 to 89 mm the insulators at Suter used 25 mm-thick Armaflex Protect tubes. On pipes with diameters larger than 89 mm a double layer of 13 mm thick Armaflex Protect sheet material was installed. After the lengthwise seam had been glued, the Armaflex Protect sheets were additionally secured with winding wire.

All in all insulation wholesaler Regisol delivered around 5,000 m of NH/Armaflex tubes and 5,200 m² of NH/Armaflex sheets as well as some 450 m of Armaflex Protect tubes and 425 m² Armaflex Protect sheets to Europe's highest alpine construction site. From spring 2014, there were always four insulators from Suter on site installing the Armaflex insulation materials.



Would you like to know more about Armacell's product range? Information on all aspects of technical information can be found on www.armacell.eu

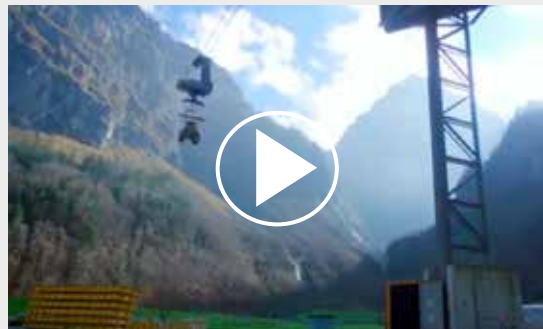
PUMPED-STORAGE POWER PLANT LINTH-LIMMERN: THE CONSTRUCTION PROJECT AT A GLANCE



The first machine group was synchronized with the grid in 2015. In summer 2016, the new Lake Mutt dam wall was tested against the official storage plan and in the middle of 2017 machine groups 3 and 4 will go on line. Then the Linth-Limmern pumped-storage power plant will officially commence commercial operations.



A video showing the low-temperature insulation work in this superlative project can be found on www.armacell.eu



Watch a time-lapse video of the construction of the Linth-Limmern pumped-storage power station (Video Axpo)

