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IN DEPTH

Big new thyristor valves meet big new test centre

Meeting huge needs *06/10/2012 - 3.49 pm*

HVDC MESHED GRIDS POWER CONVERSION

Brazil's Rio Madeira hydro project will be using new thyristor valves designed by Alstom Grid and tested in a gigantic new test facility in China that is one of the few places in the world capable of carrying out such complicated work.

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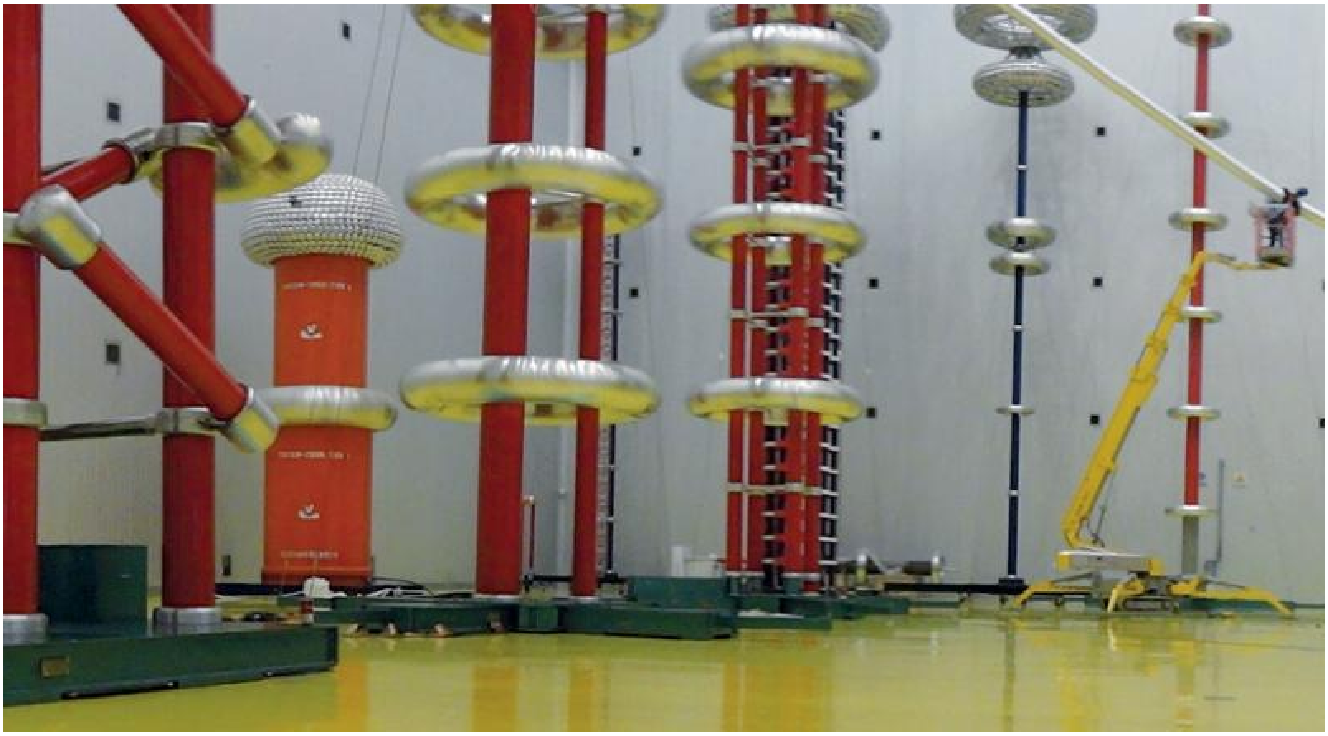


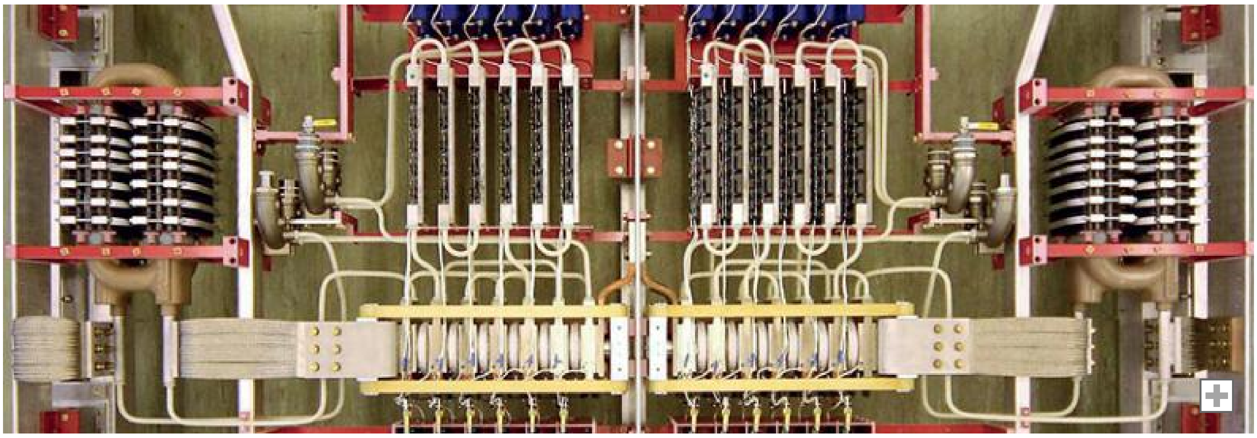
China and Brazil have a lot in common. Both economies are growing fast, both countries cover huge areas, and both have considerable hydroelectric potential. Unfortunately, in both cases the hydro dams are thousands of kilometres away from the economic powerhouses. That is why the world's longest HVDC transmission line is in China, bringing power from the Xiangjiaba dam to Shanghai, 2,071 km away. But China won't hold the record for much longer, since next year the 2,375 km Rio Madeira line will carry electricity from the Amazon region to São Paulo, the world's tenth largest city in GDP terms. As a world leader in hydro equipment and services, Alstom is a key player in both the above projects, designing and implementing solutions for the challenges such vast networks pose.

« Six-inch thyristors have recently become commercially available. »

And as Russell Preedy, leader of Alstom Grid's Valve Design group in Stafford, UK, points out, it is not just the distances that are growing: the transmitted power of HVDC schemes is increasing rapidly too, with both current and voltage now at levels never seen before in the market. "This has a considerable effect on the design of the main items of high voltage equipment in the HVDC station," he says, "not least the high voltage thyristor valves that form the heart of the converter. Until recently few HVDC converters had operated at current ratings above 3,500 Adc because the largest-diameter silicon on which thyristors could be based was 125 mm (5 inches). However, 150 mm (6 inch) thyristors have recently become commercially available and are changing the rules with respect to current ratings."

1__New thyristors, new challenges

As thyristor sizes increase, the HVDC valves need to be modified to accommodate larger devices to utilise the new technology. Alstom's H400 series of thyristor valves has been designed to take advantage of both 125 and 150 mm thyristors. The H400 consists of a number of liquid-cooled valve modules, each comprising 2 "valve sections" of up to 6 thyristors, together with assemblies of damping capacitors and damping resistors to provide voltage grading, plus limiting reactors for rate of current change (di/dt) and gating electronics. The 5 or 6 thyristors within a valve section are held together between high-efficiency liquid-cooled heatsinks as one clamped assembly. Glass-Reinforced Plastic (GRP) tension bands are used to tightly secure the assembly and to provide the high clamping load necessary for good electrical and thermal contacts between thyristors and heat-sinks. The clamping system facilitates replacement of a thyristor without opening any power or coolant connections.



A number of such modules are connected in series to make up a complete valve. For a typical large back-to-back installation, three modules are required per valve and the Multiple Valve Unit (MVU) consists of four valves associated with one phase of the AC system (a “quadrivalve”). To accommodate larger thyristors in the H400 valve, the thyristor heat-sinks, clamping mechanism and damping components all had to be up-rated. The higher clamping load requirement (up from 135 kN to 200 kN) meant that the clamping system needed to be redesigned, notably the GRP tension bands, the disc springs and the end spreader-plates (end-cheeks).

Designing systems to transmit DC over long distances poses numerous technical problems, for instance how to deal with ohmic losses. However, as Preedy points out, “the sheer size of the equipment involved also creates its own problems, not least how to test components weighing several tonnes.”

2__Testing, testing

Alstom Grid's Valve Test Facility (VTF) in Stafford can perform all periodic fi ring and extinction tests required by the standards, as well as limited dielectric tests up to 300 kV. The new €47 million China Technology. Centre (CTC) in Shanghai focuses on UHV transmission up
to 1,200 kV AC and 1,100 kV DC, and smart grids. The facility has been designed to accommodate very large electrical equipment such as the new valves, with a UHV testing hall and R&D platforms that include scientific simulation tools, climate chamber, a temperature rise testing lab and material testing labs.

One of the most striking things about the CTC test hall is that it covers 54,000 square metres, but most of the space seems to be empty. Preedy explains why. "The equipment to be tested is extremely bulky to begin with, so you need a big building just to accommodate it. You're testing valves weighing over 20 tonnes, suspended from the ceiling. That's why you see those large cranes. Then you have to add the cooling equipment, auxiliary test equipment and all the cables running back to the control cubicle. And there are very stringent requirements on clearance too, several metres in each direction, including above the test object in the case of the thyristor valves, and all that requires space." The combination of architectural requirements, safety considerations, demanding specifications for HV power supply, and the vast amount of expensive supplies and auxiliary components means that very few test facilities in the world are actually capable of carrying out full dielectric valve type-tests on large valves.

« The equipment to be tested is extremely bulky. »

Preedy and his team are doubly satisfied, first because the tests prove that their design is capable of operating well beyond real operating conditions, and the new thyristor valves successfully underwent testing to criteria exceeding the requirements of IEC 60700. And second because the new test facility was being used for the first time, and it too passed with flying colours.

Taking power from where it is to where it's needed

Alstom Grid has completed manufacture and testing of the first nine (of 28) HVDC converter transformers for Brazil's $15 billion project to harness the hydro power of the Rio Madeira, the Amazon's biggest tributary.

The project is the cornerstone of the Brazil-Bolivia-Peru hub of the Initiative for the Integration of South American Infrastructure proposed by the governments of South America, and supported by Brazil's National Development Bank. The Rio Madeira project, started in 2008, is designed to help the country meet growing energy needs without boosting greenhouse gas emissions.

The converter stations will be integrated into the world's longest DC transmission line, covering 2,375 kilometres, to connect the new hydro power plants of the Madeira River (Santo Antonio and Jirau) to Brazil's south-eastern region, which has the highest energy consumption in the country.

The Alstom Grid bi-pole converter station will allow transmission of 3,150 MW over a 600 kV DC line, and will be integrated into a much larger power transmission system, connecting the Madeira Jirau and Santo Antonio hydro power plants to the Brazilian national grid.

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Russell Preedy

Leader of Alstom Grid's Valve Design group in Stafford, UK

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