Reaching new levels

ABB's new ultra high-voltage (UHV) test center is the most advanced high-voltage DC test facility in the world

RALF HARTINGS, THOMAS K. LARSSON – One of the challenges facing many economies is the efficient transmission of clean and renewable energy over long distances. The use of HVDC at 800 kV has been one way of addressing this challenge, especially in countries like China, India and Brazil. However, the global demand for power continues to grow and meeting it means facing up to enormous challenges from all fronts, from getting more power to those difficult-to-reach places to adherence to strict environmental regulations.

For many years ABB's high-voltage center in Ludvika, Sweden has been leading the way in the development of high-voltage transmission technology. High-voltage testing is a prerequisite to qualify all new equipment and therefore significant investments have been made to ensure the proper facilities are in place. However, in early 2007 it became clear that there was an urgent need to increase the ultra high-voltage (UHV) testing capacity at the center. The development of a new 800 kV DC transformer and wall bushing had just been successfully completed, and with upcoming ultra high-voltage DC (UHVDC) projects in China and India combined with an increasing interest in UHVAC, the testing capacity available to test UHVDC bushings and HVDC valves [1] was deemed to be inadequate. The capacity was insufficient both in terms of the maximum voltage level and the corresponding insulation gaps, as was the time available for testing.

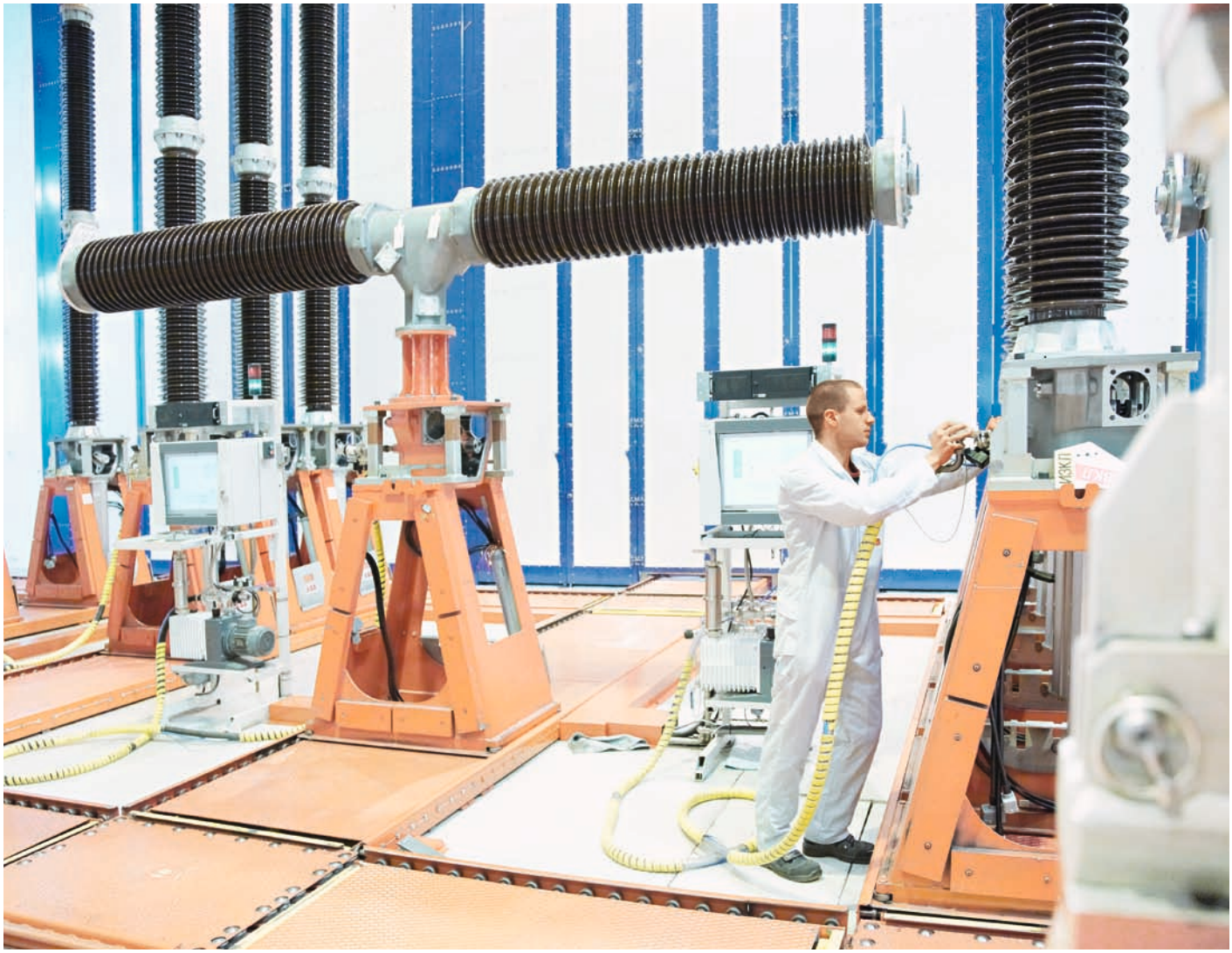
The new test facility was based on future expected market requirements for 1,200 kV AC and 1,000 kV DC transmission systems. These system voltage levels require a certain margin for both type and limit testing. Although not formally required, limit tests help determine the risk of failure when operating at nominal and overvoltage levels so that action can be taken to reduce this risk to an absolute minimum. A failure in such UHV transmission systems has a dramatic impact on the availability of the transmission system and the ability to deliver power to millions of people.

The maximum required testing voltage levels deemed necessary are:
- DC: 2,000 kV
- AC: 1,700 kV
- Switching Impulse: 2,500 kV
- Lightning Impulse: 3,600 kV

Given these voltage levels, the dimensions of the testing facility were determined by:
- The dimensioning voltage stress type, the switching impulse (SI) voltage
- The expected maximum size of a 1,000 kV DC wall bushing
- The air withstand properties defined by various experts around the world and compiled by Cigré.

With inner dimensions of 35 meters in height, a width of 40 meters and length of 60 meters, ABB's "UHVen" [2] has become the most advanced testing facility

High-voltage testing is needed to qualify all new equipment and therefore the proper test facilities must be in place.



A high-voltage testing facility must ensure that testing does not affect the supply of power to the public and is itself not affected by outside disturbances.

in the world for UHVDC. In addition, it can be used for the dielectric testing of AC and DC bushings as well as for testing HVDC valves for the highest rated electric power transmission systems in the world.

A major challenge for any high-voltage testing facility is ensuring it is properly shielded. This means making sure that testing does not affect the supply of power to the public and local industries and in turn is not affected by any outside electrical disturbances.

Test bushings require a background electrical disturbance level of about one to two pico coulombs (pC) as testing needs to verify that a bushing does not generate internal discharges higher than 5 pC. This requirement is extremely difficult to fulfil in a test set-up at such UHV levels without proper electrical shielding. Poor or inadequate shielding will enable the connections between the test object and the voltage sources, which act as huge antennas, to pick-up even the smallest electrical disturbances from the outside. To ensure this doesn't happen, a Faraday cage is built inside the external building. Although the concept of a Faraday cage is simple in theory, for an industrial testing facility of this size – equipped with three cranes and many doors – it is quite a challenge to assemble. The cage is electrically insulated from the external building by thousands of small insulators and grounded separately via an interconnected grid consisting of long rods (16 meters in length) driven into the soil/rocks underneath the testing facility.

The facility has been in use since March 2009 but was officially inaugurated in June 2009.

Ralf Hartings
Thomas K. Larsson
ABB Components
Ludvika, Sweden
ralf.hartings@se.abb.com
thomas.k.larsson@se.abb.com

Footnotes

1 Both are developed and produced in Ludvika. UHVDC bushings are produced by ABB Components and the HVDC valves by Power System, Grids. Without the new UHVDC testing facility ABB would not have been able to provide solutions for UHVDC (800 kV DC and above).

2 UHVen is a combination of UHV (ultra-high voltage) and the Swedish word for an owl (uven), which is common to the region of Dalarna in Sweden where the test center is situated.