ENERGY

HIGHLIGHT

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IEC 61850 AT KEMA LABORATORIES

TESTING OF A PROTOTYPE 320 KV HVDC GAS INSULATED SYSTEM

EXPANDING CAPACITY FOR MEDIUM-VOLTAGE TESTING

SAFER, SMARTER, GREENER

Highlight is the quarterly newsletter of KEMA Laboratories.

KEMA Laboratories are part of DNV GL – Energy. Our expertise spans from proficiency in onshore and offshore wind power, solar, conventional generation, transmission and distribution, smart grids, and sustainable energy use to innovative involvement in the energy markets and regulations.

Our 2,300 energy experts support clients around the globe in delivering a safe, reliable, efficient, and sustainable energy supply.

We have over 90 years of experience in testing, inspections and certification – and the KEMA brand is renowned globally as the gold standard for quality. Our Testing, Inspections and Certification (TIC) activities are internationally recognised for their quality and integrity.

Our main product is the KEMA Type Test Certificate, which is issued if a component successfully passes an internationally recognised type test program in our laboratories. For our customers, the award of a KEMA Type Test Certificate is a respected indicator of the reliability and safety of their products. KEMA Laboratories are located in the Netherlands, USA, and the Czech Republic.

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It is the economy, stupid!

Recently I was guiding a group of visitors through our lab when one of them asked, why is there still a need for testing and certification of electrical equipment, like we do here every day at KEMA laboratories. He asked: "You know – you electrical engineers have been making electrical equipment for the last 100 years, for sure you must have figured it out by now! How come you lab guys are busy every day with these complicated tests? " One of my younger colleagues was eager to impress and replied, "Well sir, it's the constant innovation in our industry that is leading to this need - you are aware that 25% of all equipment we test, fails to meet the appropriate standards" Then a test engineer from the lab rather abruptly added "it is the economy stupid!" Fortunately, our guest recognized this famous phrase from Bill Clinton – and understood after a short conversation that the constant focus to lower the cost of components also provides constant pressure for improving current and new designs and of course the need for testing!

However, innovation of course is very important as well – therefore we are very happy to let you know that recently we extended our research team with two additional PhD students from Delft University of Technology focussing on future grids under the leadership of our own professor ir. Peter Vaessen. If you are interested in what we are doing, please visit our website or send us an e-mail!

Best regards,

Jacob Fonteijne,
Executive Vice-President
KEMA Laboratories

CONTENT

IEC 61850 AT KEMA LABORATORIES

In the wake of the digitalization trend in the power system, KEMA Laboratories is implementing a network supporting IEC 61850. The latter is a standardized communication protocol for intelligent electronic devices. This network is currently extended across the high-voltage, high-power and flex-power grid laboratory.

This way is the first step towards testing of entire power systems rather than focusing only on individual components. So far, the relevant parts of IEC 61850 for testing purposes have been realized. These are the generic object oriented substation events (GOOSE), the sampled measured values (SMV) and a time synchronization via IEEE 1588 (PTPv2). In combination with DNV GL's protocol analyzing tools, first (type) tests of T&D components with IEC 61850 interfaces have been performed.

The initial spark for this network was given 2016 with the necessity to test low-power (non-conventional) instrument transformers (LPIT, formerly known as NCIT). In the meantime, two three-phase systems of LPITs[1] with SMV interfaces have been purchased and commissioned on site in Arnhem. The first one is permanently installed at the transformer test bay (see figure 1, left). The second one is a mobile device and currently installed in series with an existing inductive current transformer (see figure 1, right). The reason for the latter is to gain experience with this new technology (accuracy, data handling, etc.) and to educate personnel.

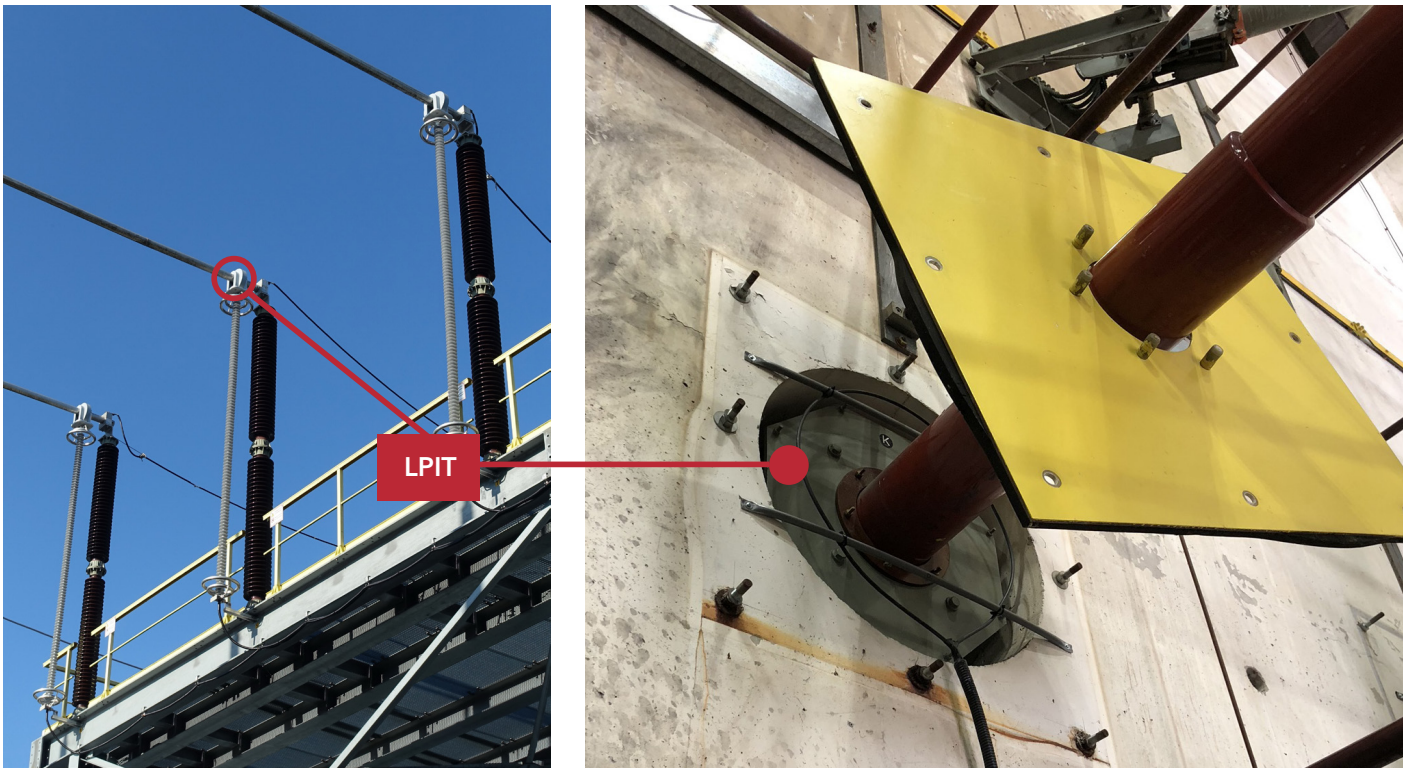


Figure 1 - LPITs at KEMA Laboratories (left: permanent installation, right: mobile system on top of the existing inductive current transformer)

[1] See Highlight no. 72

THE WORLD'S FIRST PROTOTYPE INSTALLATION TEST OF A 320 KV HVDC GAS INSULATED SYSTEM

Nowadays, HVDC systems have become a common solution for long distance power transmission. On the other hand, gas-insulated switchgear (GIS) is a proven technology in high voltage AC systems mostly driven by space saving and immunity to extreme weather conditions.

The combination of these properties makes it attractive for offshore HVDC application. Up to now, only a few HVDC GIS are in operation in Japan. Consequently, little service experience and limited information about the long-term capability of this type of technology is available. International standards describing the requirements, methods and test procedures of HVDC GIS have not been developed yet. Additionally, due to lack of operational experience with HVDC GIS, a long-term test to prove the dielectric performance of a HVDC GIS prototype under service conditions is requested by the utilities.

PROMOTioN is a European Union project which seeks to enable meshed HVDC offshore grids based on cost-effective and reliable technological innovation in combination with a sound political, financial and legal regulatory framework. One of the aims of PROMOTioN is to demonstrate technology that overcomes hurdles, nowadays considered an obstacle for the deployment of meshed HVDC offshore grids. One of such demonstrators is the long-duration dielectric testing and performance evaluation of HVDC GIS under thermal load, a common task of ABB, DNV GL, Delft University of the Netherlands, Supergrid Institute of France, SHE Transmission of Scotland and TenneT TSO.

To define dielectric tests for HVDC GIS, the distinguishing characteristics of HVDC GIS have to be identified. In fact, a DC electric field is different from an AC field within a GIS. While in AC systems an electric field pattern based upon capacitance is established directly upon voltage application, in DC systems long transition periods are required to reach a steady state field whilst charge accumulation phenomena occurs in the insulating materials and on their surfaces. In addition, DC electric field patterns depend strongly on temperature.
The difference of the dynamics of electric field between AC and DC GIS determines the context for defining

dielectric test requirements of DC GIS. DNV GL takes the role of completing test requirements, methods and test procedures of the HVDC GIS based on the results of CIGRE WG D1/B3.57 and will perform a long duration prototype installation test on a 320 kV HVDC GIS in KEMA Laboratories' HVDC test facility.

A comprehensive document on test requirement will be made available to the PROMOTioN project (see https://www.promotion-offshore.net/) by WP 15 (Work Package). In a later stage, it will be combined with test results to contribute to pre-standardization of HVDC GIS, as for example has already been started in IEC AHG 37 of IEC TC 17.

The prototype installation test is proposed to demonstrate the long-term performance of the complete HVDC GIS and should normally be carried out after the type test has been carried out. The purpose of this test is to verify the reliable dielectric performance of an HVDC GIS under service conditions. Due to long periods that are required for obtaining steady state dielectric field and charge accumulation, a long duration test is recommended for a reliable representation of in-service dielectric stresses.

Participants in the TSO workshop

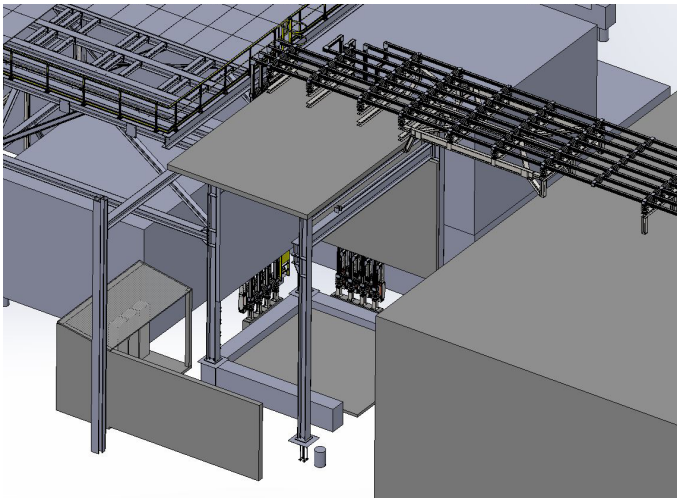
The recommended test will be performed on a complete 320 kV HVDC GIS, designed and assembled by ABB in KEMA's HVDC laboratory. This GIS contains all the standard components, including fast acting earthing switches, earthing switches, disconnectors, a RC divider, a current sensor, two bushings, multiple PD sensors and (for the sake of this test) embedded heating transformers. A duration of more than one year is foreseen for the performance of such a test. It includes dielectric pre-tests, heating cycle voltage test and subsequent dielectric tests. This demonstrator will be subjected to load cycles based on SHE Transmission's load pattern and intended to draw a full picture of the long-term performance of HVDC GIS. During this project, each partner has its own tasks covering various aspects of performance such as novel online PD monitoring and evaluation (Delft University), the impact of various SF6 gas alternatives (Supergrid Institute), temperature monitoring, discharge detection sensing, gas pressure/density monitoring etc.

Mid-September, DNV GL hosted a workshop to facilitate an open discussion between GIS manufacturers, TSO's and research institutes on applications, specifications, test requirements and standardization of gas insulated HVDC systems. Over 25 participants discussed and paid a visit to the installed demonstrator, see photo on page 4.

EXPANDING CAPACITY FOR MEDIUM-VOLTAGE TESTING

Expanding capacity for medium-voltage testing

DNV GL is opening a new test bay at our dedicated medium-voltage testing facility within the KEMA High-Power Laboratory (HPL). The new test bay will expand our capacity and enable more flexible scheduling for testing medium-voltage components.



Distribution networks are continuing to grow to meet the increased demands of industrial and domestic customers. Consequently; the market for medium-voltage components remains high – and so does demand for testing them. However, with these components increasingly seen almost as a commodity, manufacturers are often under pressure to have their products certified within very tight timeframes to take advantage of commercial opportunities.

To support this demand, DNV GL is planning a second test bay at Lab 6, our dedicated medium-voltage testing facility within the KEMA HPL in Arnhem, the Netherlands. Fed by two short-circuit generators, Lab 6 is the leading facility for testing all kinds of medium-voltage components up to 38 kV, such as transformers, circuit breakers, cables, switches and auto reclosers. The lab's set up and operations are optimized for medium-voltage testing, allowing us to complete a short-circuit certification in the shortest possible time.

The new outdoor test bay will enable us to efficiently run two test shifts daily. While a component is being tested on one bay, the second bay can be used to prepare another component for the next shift. This will result in a significant increase in testing capacity. For example, pre-heating cables prior to short-circuit test, which currently requires a significant amount of test bay time, could now be carried out in one bay while testing continues in the other.

Additional testing capacity brings benefits beyond increased availability. It gives us greater flexibility to support short-term requests from our customers. Moreover, if manufacturers so desire, they could choose to use both bays for testing their products to reduce the total time required for a certification program. This also means their engineers and staff spend less time in the laboratory.

The new test bay is scheduled to be commissioned by the end of this year and will be available for commercial testing in January 2019.

Internal arc testing

Dedicated facility improves efficiency for internal arc testing
Last summer, KEMA Laboratories Prague opened a dedicated bay for internal arc testing of current transformers, oil-filled bushings and cable terminations. The new facility helps us improve efficiency and flexibility for these increasingly important, safety-critical tests. Through our global network of KEMA Laboratories, DNV GL offers a complete portfolio of tests for transmission and distribution (T&D) components. Most of these tests aim to verify how components will operate under standard and extreme grid conditions.
But even when all possible precautions are taken, failures can still occur.
And network operators increasingly want reassurance that, if a component does fail, it won't do any damage to other components or harm nearby people.

That's where internal arc testing comes in. An internal arc typically causes catastrophic destruction of the component, leading to a pressure wave, a release of hot oil and gases, fire and explosion. Testing behaviour under these conditions is common for components such as current transformers and is well established by international standards such as IEC 61869-2. It is a more recent development for bushings and cable terminations, but is increasingly requested – as evidenced by the specifications drawn up by Italian transmission service operator (TSO) Terna.

Performing internal arc testing presents some unique challenges for testing houses: withstanding the spread of oil, fire and intense pressure waves, catching flying parts and the disturbance to neighbours from the noise of an explosion.
Hence in 2017, DNV GL took the decision to open a dedicated internal arc test bay at our KEMA Laboratories Prague site. This explosion-proof test bay is designed to minimize the impact on our neighbours, while enabling efficient and reliable testing. Test voltages up to 31 kV and test currents up to 63 kA allow robust testing under realistic conditions that meets any specific requirement. Moreover, measuring 20 m x 20 m it ensures testing is performed safely, no matter how violent the explosion. And because it is dedicated to internal arc testing, we can offer greater flexibility in scheduling tests and manufacturers can prepare their component for testing without disturbance which reduces the overall time required for the test.

Energy storage at the KEMA Flex Power Grid Laboratory (FPGL)

Verifying energy storage systems under all conditions
The rise of renewable energy such as wind and solar is driving development of grid-connected energy storage. As in any emerging sector, ensuring performance and safety is vital for user confidence. The FPGL helps manufacturers build that confidence through independent testing and verification of energy storage systems under realistic yet controllable conditions.

Complementing battery testing at our BEST Test & Commercialization Center, the FPGL offers testing of complete energy storage systems. This system-level testing is vital as experience shows that that the inverter plays a major role in determining the grid performance of energy storage systems. Testing is carried out according to the GRIDSTOR recommended practice, developed by a global consortium of industry partners led by DNV GL.

Bredenoord energy storage system under testing at FPGL's outdoor test bay

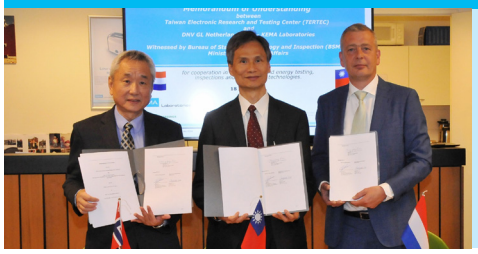
The FPGL's flexible grid connection allows us to mimic real-life grid conditions and vary parameters such as frequency and voltage. Hence the behaviour of systems can be verified during both standard operation and extreme scenarios such as frequency variations, over- and undervoltages, grid pollution and more. A second outdoor bay offers a standard grid connection for long-term reliability testing.

KEMA Laboratories is glad to announce extending their Inspection Services to India

To meet the Testing, Inspection and Certification needs of the continuously growing Indian electrical industry, KEMA Laboratories has now placed two of their technical inspectors in India. This will help the customers in availing themselves of our services at their convenience and at an affordable cost. The scope of our inspection services includes all Transmission and Distribution Equipment such as Transformers, MV & HV Switchgear, Cables, Capacitors, Reactors, Instrument transformers, Surge arrestors, Rotating Machines, Insulators, Insulating bushings and Energy meters. Mr. B.V. Govindappa joined KEMA Laboratories with a rich 26 years of testing and certification domain experience along with Mr. Shirish Sathe having 38 years of design, development and certification experience in switchgear domain. These two experts are dedicated to serve the needs of our customers in India by assuring our best services. In the KEMA Laboratories Inspection service scheme, tests are performed at the customer worksite or at a third party test lab under the strict supervision of the KEMA Laboratories inspectors in accordance with ISO/IEC 17020 and upon successful completion of the testing, a KEMA Inspection report is issued.
To avail our Inspection Services, customers are advised to contact: inspection.powertic@dnvgl.com

TESTING ACTIVITIES

TAIWAN ELECTRIC RESEARCH AND TESTING CENTER (TERTEC) SIGNS MOU



Taiwan Electric Research and Testing Center (TERTEC) and KEMA Laboratories signed a Memorandum of Understanding (MoU) for testing, inspection and certification.
The purpose of the MoU is to establish a cooperative relationship between both parties in the Transmission and Distribution (T&D) segment and wind energy. The MoU was signed in Arnhem on July 18th 2018 after an excellent technical workshop and tour in the KEMA Laboratories Arnhem.

KEMA TYPE TEST CERTIFICATES ISSUED TO SAN JIANG ELECTRIC MFG. CO. LTD.

In June 2018 KEMA Laboratories in Arnhem was hosting officials from San Jiang Electric Mfg. Co. Ltd. with their headquarters in Taiwan. They performed with a positive outcome all tests required to achieve Type Test Certificate of complete Type Tests in accordance with IEC 60076. The three-phase distribution transformer had a power rating of 1000 kVA and its core was made from amorphous alloy. It was manufactured by Jiangsu Dingmao Amorphous Technology based in China.

FOSTER RELATIONS WITH HYOSUNG

KEMA Laboratories is very pleased that on October 18th Hyosun Heavy Industries Corporation, one of the leading manufacturers in the field of heavy electrical equipment in South Korea, and KEMA Laboratories signed a framework agreement.
By signing this agreement both companies have the intention to work more closely together. By doing so this will result in a win-win situation for both parties.

DC SHORT-CIRCUIT TESTS ON AIRBUS E-FAN X WIRING SYSTEM

KEMA Laboratories Prague has recently performed a series of successful DC short-circuit tests on the wiring system for hybrid-electrical aircraft developed by Airbus company. The aim of this test was to define the clearances link to short-circuit between wiring system (3000 VDC) and metallic structure and other harnesses. In the frame of this test campaign, several parameters were taken into account to determine their influence on damage caused by thermal/arcing effects during a short-circuit event.