ENERGY

HIGHLIGHT

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NEW CONVENER OF MT36 FOR CIRCUIT BREAKER STANDARD IEC 62271-100

NON-CONVENTIONAL INSTRUMENT TRANSFORMERS IN KEMA LABORATORIES

KEMA LABORATORIES INNOVATION CENTRES

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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Technical entrepreneurship

Early January I attended a presentation of an INSEAD professor, who had been advising Elon Musk on his innovation processes. The professor told us that Mr. Musk never hires MBAs and does not prefer experienced managers as these kinds of people are all trained on minimizing organizational risks so that the likelihood of reaching the companies' objectives is maximized. Innovation on the other hand, requires other people who like taking risk, are accepting of failure and enjoy constantly learning.

This also requires a culture where different behaviors, like exploring new ideas or developing a long-term vision, should be encouraged. Being an MBA myself, I did not immediately like this story, but to be fair I think that the professor and Elon Musk have a valid point, as successful innovation in an existing organization proves to be difficult. KODAK is an example that is often mentioned and unfortunately there are many more….

At KEMA laboratories we try to foster laboratory innovation through "technical entrepreneurship" as much as possible. When we are not working on customers' equipment we will be developing new measurement techniques. At the same time, many of our technical staff spend time in the working groups of the Electrical standard committees, to ensure that new standards are workable and will indeed ensure long term reliability and resilience of certified components.

If you are curious, please let us know, we are happy to help!

Best regards,

Jacob Fonteijne,

Executive Vice-President KEMA Laboratories

CONTENT

NEW CONVENER OF MT36 FOR CIRCUIT BREAKER STANDARD IEC 62271-100

Testing is an important part of the development of electrical equipment. It is even more important to define how the components should be tested.

The Maintenance Teams (MT) of the IEC are working hard to define requirements on the circuit-breakers as close possible to the grid conditions. The MT's consists of members who in their daily jobs designing equipment or are users of the equipment. Also, the test institutes play a part in these teams. This unique mixture of specialists can define new test conditions or improve existing ones. MT36 is the Maintenance Team working on the IEC 62271-100. This standard describes tests that verify if the circuit breakers being tested, can withstand the extreme conditions in the grid.
In 2017 a new amendment was published. Below a short overview:

- New test procedure for three phase asymmetrical tests (T100a).
- Introduction of a test procedure for circuit breakers with a rated voltage below or equal to 52 kV in an effectively earthed neutral system.
- A lot of changes were made to make the standard clearer. For example, the sub-clause describing capacitive tests is completely rewritten.
- A new definition has been made for the first-pole-to-clear factor As a result, the TRV tables have been moved to the testing part of the standard.
- Some annexes and some explanatory text has been moved to the TR IEC 62271-306.

This was the last job of Piet Knol as convener of MT36. After 8 years working as convener of MT36 Piet decided it was time to retire.

Adriaan Hofstee has worked as a test engineer in KEMA Laboratories since 1997 and became a member of MT36 in 2009. With his 20 years of experience in the largest High-Power Laboratory of the world, it was a logical next step to become the new convener of MT36.
In April 2017 Adriaan Hofstee was appointed as the new convener of MT36 during the general IEC meeting in Frankfurt, Germany.

Now MT36 is preparing a new edition 3. This is mainly an editorial job to get in line with the new IEC 62271-1, but also some new items will be included.
The work in the MT's of IEC is a never-ending job with the aim to further improve the transport and distribution of electric energy worldwide in a safe and reliable way.

NON-CONVENTIONAL INSTRUMENT TRANSFORMERS (NCITs) IN KEMA LABORATORIES

Instrument transformers are used to measure current and voltage in the power system. Without them, a power system cannot be operated. Therefore, particularly high requirements are demanded for the accuracy, reliability and safe execution of a measurement.

Figure 1 - KEMA Laboratories' transformer test-site as seen from above

Traditionally, instrument transformers consist of an iron core and two isolated windings. Thus, their measurement outputs are analog with sufficient power to directly operate e.g. protection relays. Nowadays, rapid advances in the fields of electronic and material science allow more and more the use of non-conventional instrument transformers (NCIT). They can be separated in two main categories: optical ones (based on the Faraday and Pockels effects) and hybrid type ones (Rogowski coils, capacitive and ohmic dividers) [1]. In contrast to conventional instrument transformers, NCITs are usually equipped with electronic processing units (EPU). Based on the type of NCIT, EPUs are an essential part of the measurement (e.g. light source for optical methods). However, their main purpose is the treatment of measured values (e.g. compensation of non-linearity). EPUs are usually equipped with a digital or a low-power electronic measurement output. Therefore, NCITs must be tested in different ways. For example, while traditional current transformers for measurement purposes can and must saturate (results in a distortion but protects the measurement display), this is physically excluded with NCITs. However, in NCITs the electronics can clip which also results in a distortion of the measurement. Thus, KEMA laboratories is in the process of developing test- and analysis methods for this equipment in various projects with customers, but also plans to make use of these in its own installation.

Especially for high-power laboratories, where short-circuit currents and large switching over-voltages occur hourly, an optical measurement method is of great interest. This has, among other things, the advantage that the connection between the sensor and the EPU is optical. Thus, high-voltage bushings are not needed which reduces costs and results in smaller space requirements. At the same time, disturbing ground loops are physically impossible. It is for this reason that the new current measurement for the transformer test bay is realized with (optical) NCITs. The tested transformers are located on a barge while the NCITs will be located at an elevated

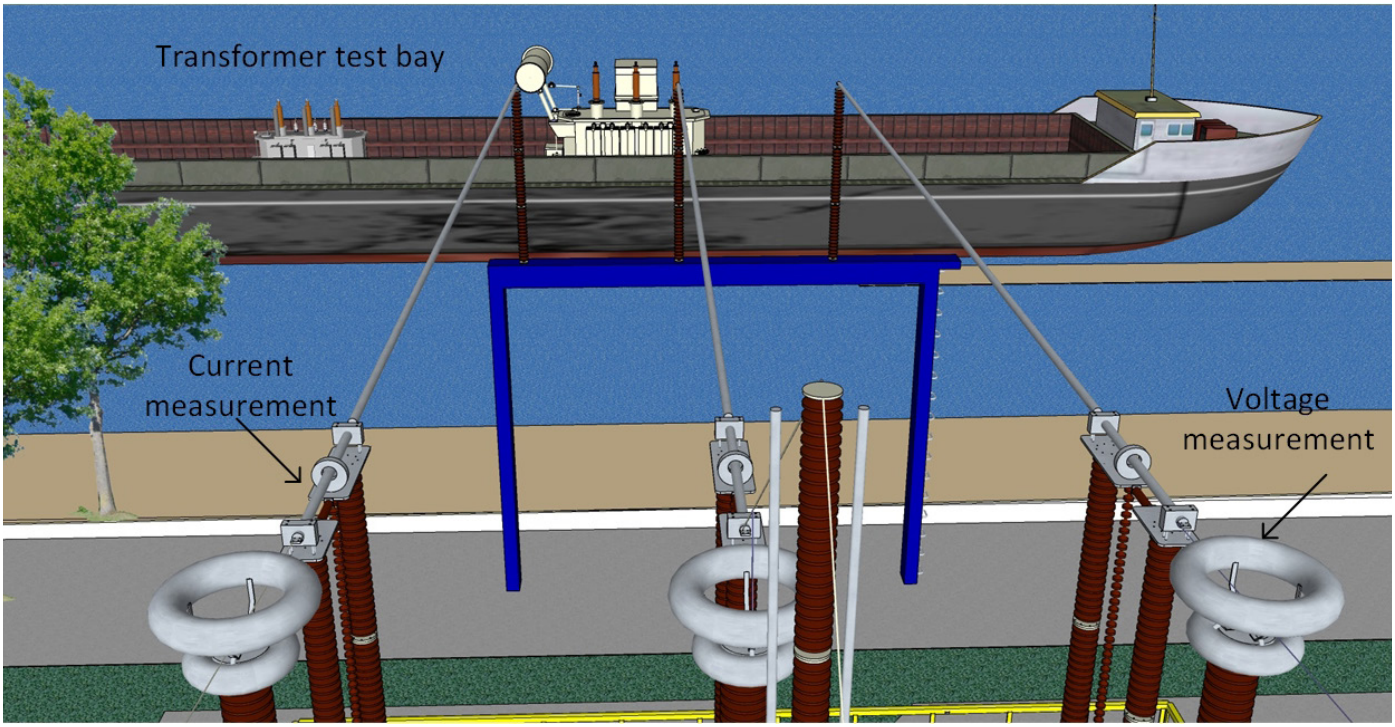

Figure 2 - NCIT at transformer test bay

platform close by (see figure 2). Due to the NCIT's small dimensions, space on the platform will be saved which provides the possibility of an additional voltage measurement. With these investments, the utilization and efficiency of the high-power laboratories are increased.

At present, the electrical power system is undergoing a fundamental change. Like with all technical components, a gradual digital transformation into an Internet of Things (IoT) is happening. Consequently, it will change the way how tests of individual (digital) substation components are executed in the future. For the first time, it also enables the possibility to test control, supervision and protection of whole power systems. One of the core features of this transformation is the use of a BUS system instead of dedicated individual lines between components. Hereby, especially the maintenance effort is reduced and the interoperability increased. The latter is achieved by standardized communication protocols. For power systems, this standard is IEC 61850. Besides a standardized communication, a modern BUS system requires time synchronization to identify when a data package is sent. The drawback is a higher vulnerability for cyber-attacks and physical damage to the BUS, the spine of the control system.

The necessary IEC 61850 infrastructure is currently implemented step-by-step into the existing measurement and control infrastructure of KEMA Laboratories. As part of the digital transformation, the new NCITs are purchased with an IEC 61850 compatible interface. Through these steps, the groundwork for the future of testing digitally controlled and communicating equipment is laid.

[1] State of the art of Non-Conventional - Instrument Transformers - CIGRE Working Group - A3.15

KEMA LABORATORIES INNOVATION CENTRES

Several trends can be observed regarding T&D equipment technology:

- Higher ratings of voltage and current, including UHV up to 1200 kV and generator circuit breakers for extreme current.
- Digitalization and electronification of control and communication of equipment.
- Smart sensor technology for protection, monitoring and asset management.
- HVDC, in particular HVDC grids for large scale off-shore renewables, impacting cable and switchgear technology.
- Application of equipment off-shore, leading to new requirements of performance and reliability.
- Use of power electronics in distribution grids, notably for PV and storage equipment.
- The move away from SF6 gas, implementation of alternative gases and development of high-voltage vacuum switchgear.

Figure 1 - PV inverter under test in the FlexPowerGrid Laboratory

In order to be prepared for testing the next generation of equipment, KEMA Laboratories has set up an innovation team, aiming to introduce the testing trends listed above into its laboratories.

Technology centres have been defined around the following themes:

Digitalization and smart sensor technology

This includes the testing of equipment digitally controlled and digitally communicating with the outside word. An example of this are test-methods for non-conventional current transformers (see page 4-5) and digitally controlled switchgear.

Advanced equipment performance assessment

New methods enable a glimpse into the heart of equipment during critical processes[1]. Digital data and models are provided from tests in order to fine-tune manufacturer's models used in the design phase of equipment.

[1] R.P.P. Smeets, B. Baum, R. Nijman, D. Petropoulos, T. Ohtaka, "High-Voltage Circuit-Breaker Test Statistics 2011-2016 and Test Analysis Tools", CIGRE Conference, paper A3-102, 2018
[2] H. He, W. Sloot, "Testing a 320kV HVDC XLPE Cable System", INMR World Congress, 2017
[3] N.A. Belda et al, "Full Power Short-circuit Tests of HVDC circuit breakers using AC generators operated with reduced power frequency", CIGRE Conference, paper A3-115, 2018

High Voltage DIrect Current (HVDC)

Dielectric development at the new KEMA Laboratories HVDC laboratory in the Kleefse Waard, focuses on the dielectric testing (type tests, pre-qualification) of HVDC cable systems and GIS[2]. Regarding power testing of HVDC equipment, test methods have been established to test HVDC circuit breakers with low-frequency AC generators[3] and test-methods for more conventional HVDC switchgear are currently under development.

Power electronic equipment

Full use is made of KEMA Laboratories FlexPowerGrid Lab, creating a full range of non-standard MV system conditions. With the commissioning of a 1.2 MW DC source in early 2018 and the advent of a 200 kVA power amplifier, a wide range of testing converter equipment for renewable energy application is now available. The hardware-in-the-loop method enables real-time power system transient simulation to be combined with full-power testing.

For more than a year now, each of the centres have been live and deal directly with customer projects, aiming to bring short-term innovation into the laboratories.

Introducing Muammer Levent Celikel

Sales & Business Development Manager, KEMA Laboratories, Dubai/UAE

The Middle East region is important to KEMA Laboratories, so being close to our customers and the utility sector is of great value. Therefore we announce with pleasure that Muammer Levent Celikel has joined KEMA Laboratories as a Sales and Business Development Manager based in Dubai/UAE. As of August 2016, he is responsible for sales and marketing activities in the Middle East region.

Muammer has a Degree in Electrical Engineering and a Masters of Business Administration (MBA) and has been professionally active in the Middle East since 2008. Muammer is stationed in our DNV GL – Energy Office in Dubai BurJuman Business Tower and can be contacted at Levent.Celikel@dnvgl.com and +971 56 520 6450.

Introducing HyungHee Yoon

Sales Manager, KEMA Laboratories, Korea

HyungHee, Yoon has been working as a sales manager for KEMA Laboratories and as a country manager for Energy Advisory in Korea for the past five years.
Before joining DNV GL, he had worked for over 30 years for KEPCO, mainly in the field of underground cable and substations. He has a lot of experience as project manager and as a project sponsor in not only the energy sector but also the renewable energy sector in DNV GL.
Mr. Yoon can be contacted at Hyung.Hee.Yoon@dnvgl.com

EVENTS

ELECRAMA 2018
10 - 14 March 2018
Greater Noida, India

IEEE PES T&D Conference & Exhibition
16 - 19 April 2018
Denver, CO - USA

4th Advanced Cable Middle East
8 - 9 May 2018
Dubai, UAE

TESTING ACTIVITIES

ABB AB, SWEDEN RECENTLY TESTED THEIR CAPTHOR DEVICE

CapThor is an encapsulated bypass device that protects Series Capacitor banks (SCs). SCs used within electric power transmission provide enhanced power transmission capability over long lines. The CapThor consists of a forced triggered spark gap and mechanical fast-acting switch used in conjunction with a non-linear Metal Oxide Varistor (MOV).

For KEMA laboratories Arnhem this was a special test requiring a circuit of 31,5 kA direct current at 60 Hz, in combination with 100 kA peak inrush current at a frequency of 800 - 1000 Hz. For the CapThor closing on this combination of high-frequency inrush current and direct 60 Hz current was successfully done numerous times.

PLN (INDONESIA) SIGNS COOPERATION AGREEMENT FOR QUALITY IMPROVEMENT OF T&D COMPONENTS

A senior management delegation from PLN (Indonesia) visited KEMA Laboratories for the signing of a cooperation agreement. The agreement is a corner stone for the quality improvement of T&D components purchased by PLN requiring impartially tested and certified components.

KEMA TYPE TEST CERTIFICATES ISSUED TO ARTECHE DYH ELECTRIC CO. LTD. CHINA

In the period from June to September 2017, Arteche DYH Electric Co., Ltd., from China, tested a 550 kV current transformer and 550 kV capacitor voltage transformer in our KEMA Laboratories Arnhem in accordance with IEC 61689-2 and IEC 61689-5 respectively. The tests were also witnessed by representatives of NTDC, Pakistan. Both objects passed the test and therefore, KEMA Type Test Certificates have been issued.

FEDERAL TRANSFORMERS AND SWITCHGEARS LLC, RUSAYL, SULTANATE OF OMAN

One 1000 kVA three-phase oil-immersed distribution transformer from Federal Transformers and Switchgears LLC., Rusayl, Sultanate of Oman, has successfully completed the short-circuit testing (including the routine tests, temperature rise test, sound level and chopped wave lightning impulse test) at KEMA Laboratories Arnhem. With these results they are entitled to receive the KEMA Type Test Certificate of complete type tests according IEC 60076.