



# TEST CENTER REGENSBURG HIGH-TECH LABORATORY FOR ON-LOAD TAP-CHANGERS.

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# UNPARALLELED ANYWHERE IN THE WORLD: OUR TEST CENTER.

Our high-tech test center in Regensburg has yet to find its equal anywhere in the world: this is where we submit the on-load tap-changers to the most stringent tests in high-voltage, power and mechanical laboratories. Nowhere else in the world the whole spectrum of stresses that these devices are subjected to during their service life can be comprehensively simulated in such a manner.

## Progressive. Competent. Secure.

On-load tap-changers are a central element for a safe power supply. They are installed in power transformers and regulate the voltage by switching from one transformer tap to the next suitable one within a few seconds when energy consumption varies. Therefore they ensure that the power supply remains stable.

In order to manage its task properly, a tap-changer must have a long service life and must be able to perform its job even under extreme conditions. It has to survive harsh winters, the heat of deserts, flashes of lightning as well as short circuits due to the failure of other devices in the power supply system.

To ensure precisely this, Maschinenfabrik Reinhausen opened its 4,800 m<sup>2</sup> Test Center in 2008; the only one of its kind in the world. The capability of each type of tap-changer is tested here before first delivery.

MR has invested 25 million Euro in the new test center. It is the largest individual investment in the company's history. "But it has been worth it", says Dr. Axel Krämer, Head of Testing and Simulation. "You won't find this combination of different tests anywhere else in the world."

## Everything under one roof

Fully automated test rigs and test processes running in parallel allow operation 365 days a year, 24 hours a day. MR's aim is not only to satisfy the world's most stringent international standards for tap-changers, for example IEC, IEEE and JEC, but also to continually exceed requirements and keep developing the products to meet customers' needs. Since MR sets standards on a global scale.

### ➔ Facts and figures

38,500	cubic meters of interior space
4,800	square meters of gross floor space
64,000	meters of cabling for measurement and control technology
2,500	meters of bus bars in the power testing facility
16,000	meters of piping for the insulation liquid logistics
23	cranes

It doesn't matter whether electrical, mechanical, chemical or climatic tests are needed: We have all the necessary equipment and procedures in our Test Center. Our tap-changers have to prove here that they operate reliably at all times, at and above service load.

## Certified in accordance with ISO 17025

The Deutsche Akkreditierungsstelle (DAkkS) has certified our test center in accordance with the standard DIN EN ISO/IEC 17025. Accredited testing can therefore be carried out in accordance with IEC 60214-1 with a reference to the DAkkS registration no. D-PL-19739-01-00. For customers, the accreditation means an official confirmation of expertise, independence and confidentiality in accordance with the highest national and international standards. The DAkkS is subject to the supervision of the Federal Republic of Germany and is internationally recognized.



# CONSOLIDATED KNOW-HOW.

The Test Center is the core of our Center of Competence in Regensburg, which sees our global research and development work consolidated under one roof. Highly qualified engineers, technicians and specially trained experts ensure that tests are conducted professionally, and are working continuously on the optimization of testing methods and processes.

## High voltage tests (Area 1)

To simulate such kind of stresses that occur in electric high voltage networks, we are using in our high-voltage laboratories test transformers, able to generate AC voltages up to 700,000 volts. The behavior of on-load tap-changers exposed to lightning strikes in electric transmission lines is tested by using an impulse generator generating voltage spikes of up to 1.8 million volts, built up within a millionth of a second.

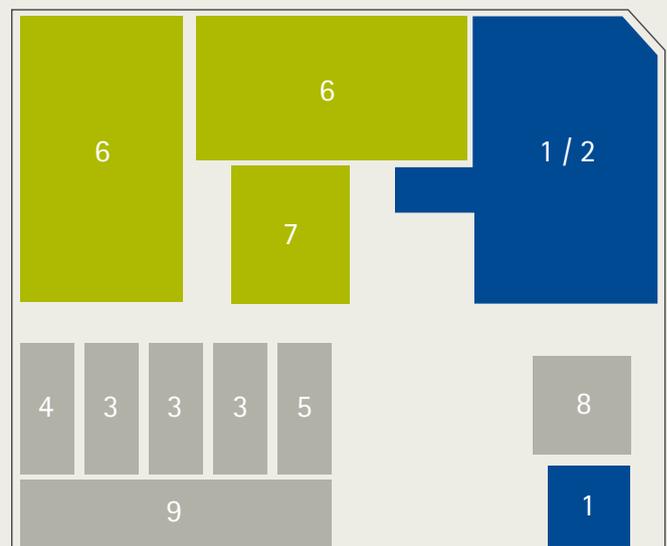
## Partial discharge tests (Area 2)

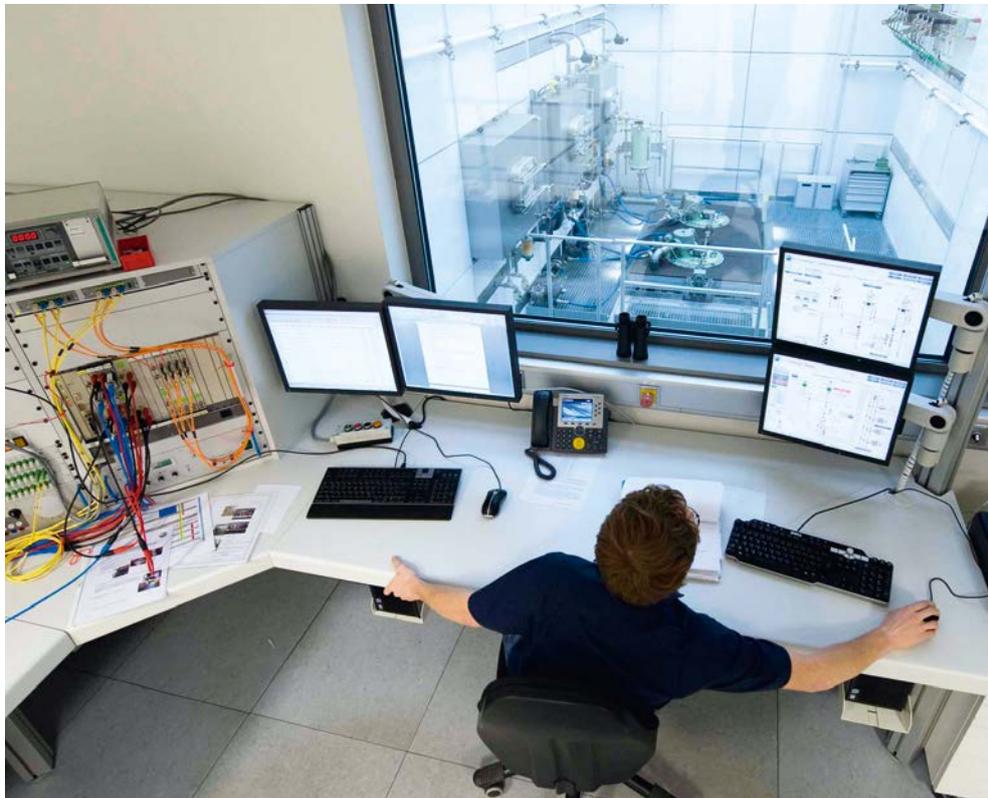
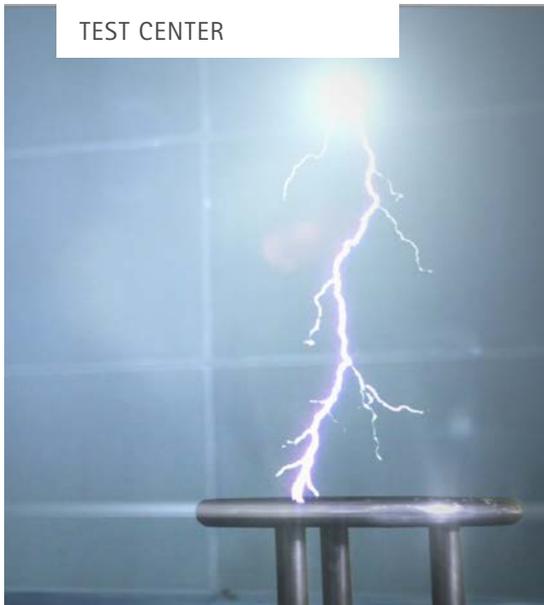
Insulating materials must be free of defects when exposed to high-voltage stresses, to prevent electric discharge occurring in the materials, which can cause long-term damage to the on-load tap-changer and the transformer. We are equipped with special testing technology to verify the suitability of all insulation arrangements.

The digital measuring system for this purpose must be able to sample voltages in a range of millionth of a volt. Such highly sensitive measurements can be distorted not only by radio or television transmitters, but also by ignition sparks from automobiles. To prevent such distortions, the measurements have to be conducted in a laboratory with the highest level of shielding. For this reason the high-voltage testing facility is completely shielded by a metal structure measuring 20 x 13.5 x 12 meters. All gateways and doors are also designed to shield against such influences.

### Different areas in the Test Center:

- 1 High-voltage tests
- 2 Partial discharge tests
- 3 Switching tests
- 4 Temperature rise tests
- 5 Short-circuit current tests
- 6 Mechanical tests
- 7 Temperature tests
- 8 State-of-the-art drying process
- 9 Control room
- 10 Calibration laboratory (in the basement)





### Power tests (Areas 3 and 9)

In our Test Center sophisticated test circuits are employed to simulate the extreme conditions that on-load tap-changers can be exposed to during operation. The power testing facility is designed for load currents of up to 6,000 amperes and step voltages of up to 5,000 volts. The switching process is monitored and analyzed by advanced measuring systems. This allows our engineers to make qualified assessments of the impact on integral properties such as contact erosion, switching speed or arcing times.

### Temperature rise tests (Area 4)

The through-current causes a temperature rise in the current carrying parts of the on-load tap-changer. This phenomenon is analyzed in temperature rise tests in order to optimize the design of elements with current flow. For this purpose thermocouples, capable of measuring the temperature profile continuously, will be mounted at critical points. Similar methods are used to measure the temperature profile of the loaded transition resistor at the moment of diverter switch operation. The temperature of this component, which is the key to the function of the on-load tap-changer, may not exceed certain limit values.

### Short-circuit current tests (Area 5)

Short circuits in high-voltage networks are connected with enormous physical stresses for the equipment. As a result of high mechanical forces and very high current densities, short-circuit currents cause stresses in the on-load tap-changer that must be handled reliably under all circumstances. We are able to generate current amplitudes of up to 100,000 amperes with our test equipment.

### Mechanical tests (Area 6)

Activating the on-load tap-changer actuates an extensive mechanical system consisting of gears, shafts, springs and electric functional elements. To ensure the functional capability and reliability of this complex mechanical system over decades of its service life, we test our on-load tap-changers in specially equipped mechanical laboratories. Such testing includes endurance tests with up to several million tap-change operations – international standards require only 500,000. Endurance tests at average temperatures of 80°C reproduce the loads that transformers are exposed to.



## "WE SATISFY TEST REQUIREMENTS WITHOUT COMPROMISE"

Dr. Axel Krämer

### Mechanical tests with different ambient temperatures (Area 7)

Different temperature cycles are run in temperature chambers in order to simulate the stress caused by external temperature variation. The Test Center is equipped with two test chambers with volumes of 30 and 60 cubic meters. Different load cycles can be run automatically in these chambers with a temperature range from  $-70^{\circ}\text{C}$  to  $+130^{\circ}\text{C}$  with a rate of change of 1 degree per minute and hydrostatic pressurization of up to 2.5 bar. It is possible to perform switching operations with the test object at these temperatures. A high number of measurements with automatic evaluation of the measured values ensures accurate and comprehensive analysis of the behavior of the on-load tap-changer.

### State-of-the-art drying process (Area 8)

As a rule, transformer insulation is dried with the most effective and state-of-the-art process: the vapor-phase drying technology. With this process the objects to be dried are placed in a vacuum-sealed container and then heated. Hot vapor of a special medium is blown into the container to reduce the heating-up time. This vapor condenses on the cold components and the heat of condensation that is released causes them to be heated up. Humidity is effectively removed from the insulation materials by reducing the vapor pressure with a vacuum pump. Two tanks, with a capacity of two and nine cubic meters respectively, enable the on-load tap-changer to be exposed to the conditions present in the transformer while drying.

### Use of control technology (Area 9)

The Test Center is throughout equipped with state-of-the-art control technology, right down to the oil supply. This is vital for the automatic configuration of testing equipment and to conduct fully automatic test cycles. The technology in use controls all procedures quickly and faultlessly. Any faults that occur are indicated immediately and can be remedied quickly.

### Calibration laboratory (Area 10)

The Test Center is equipped with an air-conditioned calibration laboratory to check the measuring devices and –systems used in the tests regarding their required specific accuracy. Here the measuring devices are calibrated in compliance with a special test plan and reference devices are used for calibration traceability to standards of the National Metrology Institute of Germany (Physikalisch-Technische Bundesanstalt (PTB)). The calibration laboratory complies with the requirements of the standards ISO 9001.

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THE POWER BEHIND POWER.

