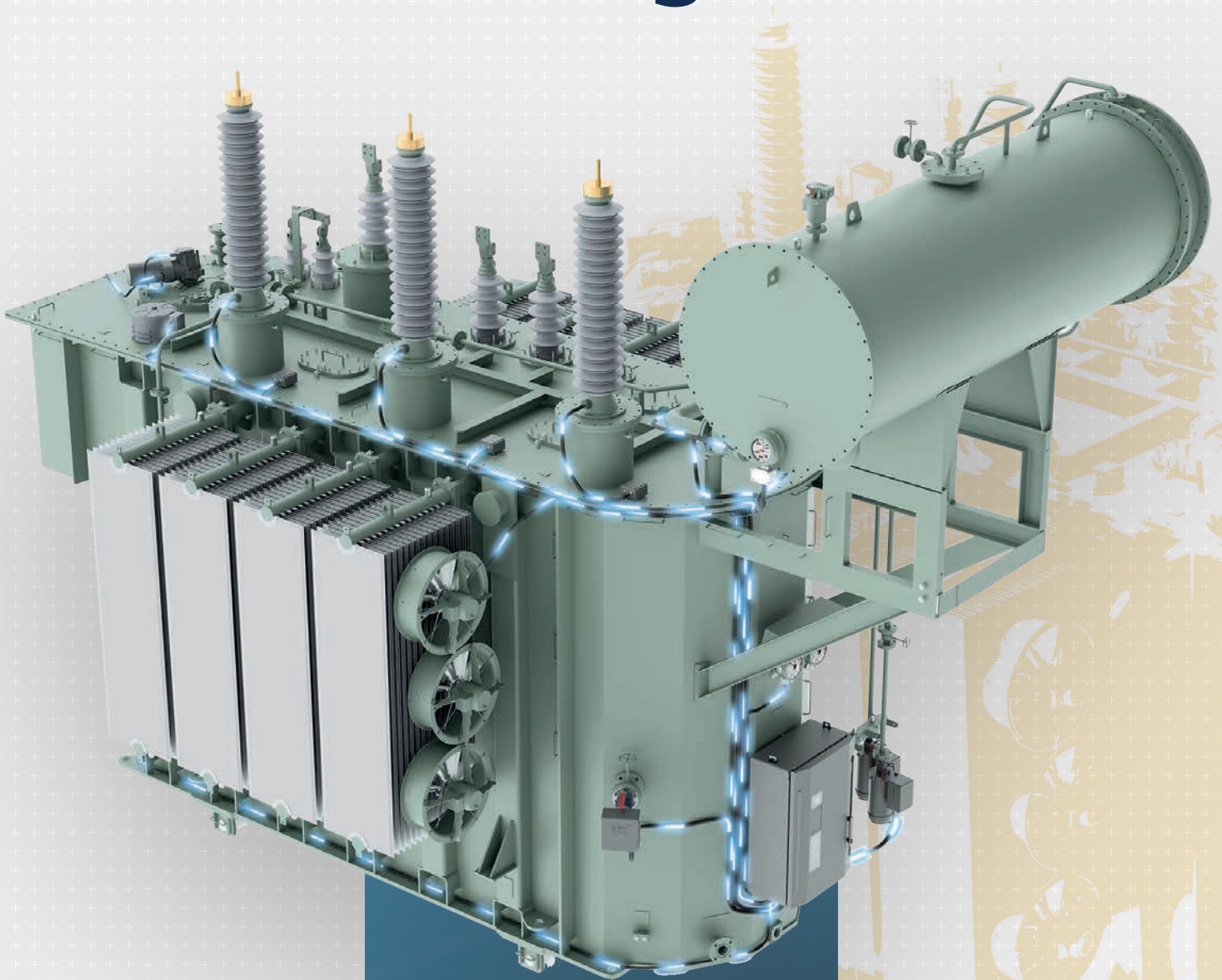


MSENSE[®] BM & ETOS[®] - Bushing monitoring



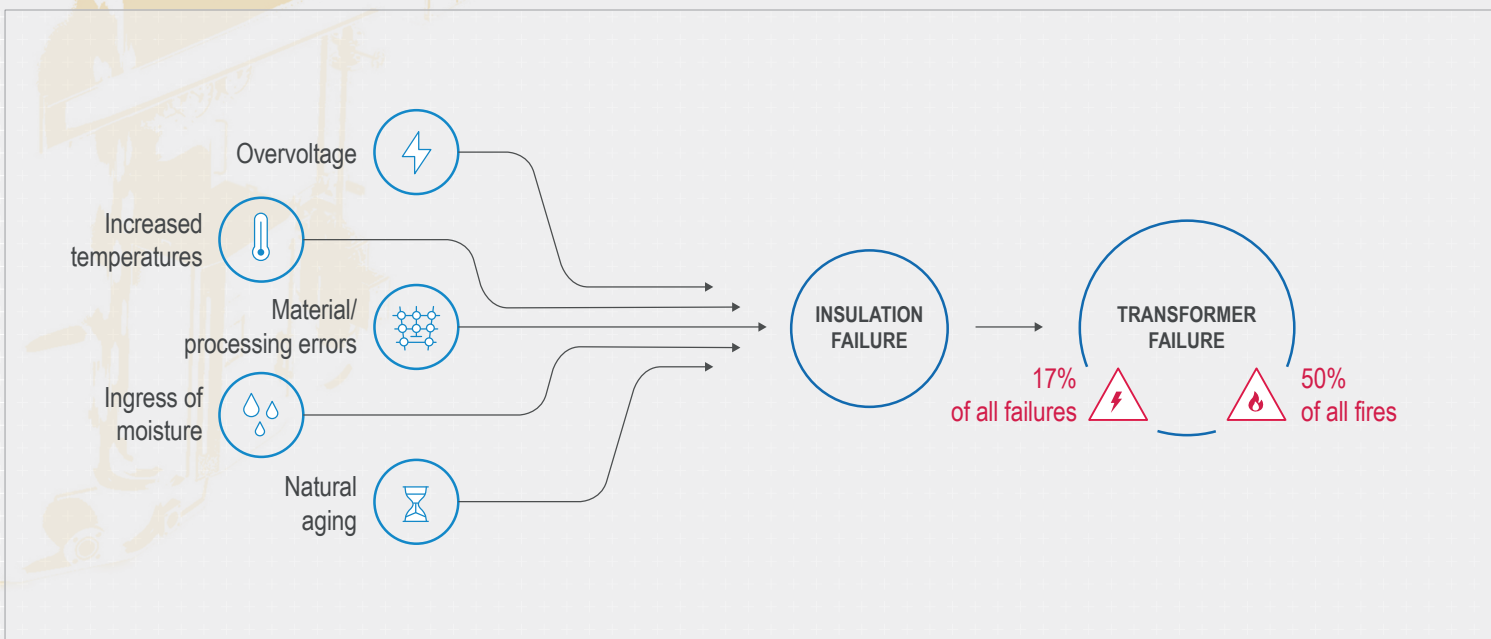
**Early detection
of high-voltage
bushing failures**

The requirements for the availability and reliability of power transformers are constantly increasing – as is the grid load, which can cause critical problems. 17% of transformer failures can be traced back to defective bushings, which are also the main cause of 50% of transformer fires [Cigré A2.37]. A typical manufacturer-specific service life of capacitance-controlled high-voltage bushings is 25–30 years, which is typically less than the service life of transformers. Online condition monitoring and assessment of bushings is therefore recommended. Bushing monitoring from Maschinenfabrik Reinhausen (MR) makes it possible to detect errors in bushings early and derive actions before the transformer is greatly damaged.

For electrical field grading, high-voltage bushings above a certain voltage level are almost exclusively equipped with capacitive grading layers which are exposed to high electrical, thermal and mechanical loads during operation. Bushings can age prematurely due to transient overvoltages, increased temperatures, temperature fluctuations or the ingress of moisture. This can cause partial breakdowns, which can quickly lead to failure of the insulation in the bushing or even serious transformer malfunction.

Bushing monitoring from Maschinenfabrik Reinhausen (MR) makes it possible to detect errors in bushings early and derive actions before the transformer is greatly damaged.

To optimally prevent this kind of damage, the MSENSE® BM online monitoring system and the bushing monitoring function of ETOS® continuously measure condition-related variables directly on oil-impregnated (OIP) or resin-impregnated (RIP) paper bushings, or resin-impregnated synthetic bushings (RIS/RIF) in the voltage levels $U_m = 66 \text{ kV} \dots 420 \text{ kV}$ (more available on request). Continuous online condition monitoring enables early detection of changes in the insulation condition.



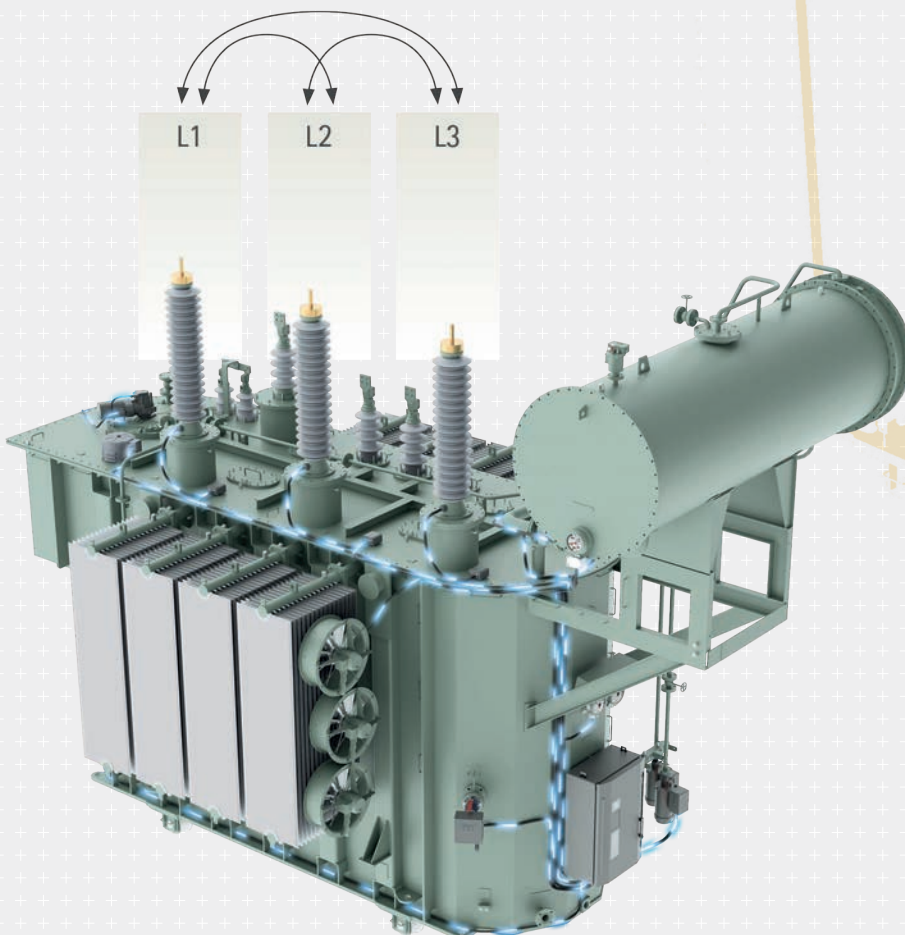
Several methods for online condition monitoring of bushings have been developed in recent years. Along with oil analyses and partial-discharge measurements, the main capacitance (C_1) and the dissipation factor ($\tan \delta$) are the two definitive parameters for determining the insulation condition of high-voltage bushings. For online monitoring, two facts in particular must be noted. Firstly, a suitable reference system that functions under field conditions is needed. Secondly, the dielectric parameters of the bushings are heavily dependent on operating conditions such as temperature. These two factors make it difficult and complex to monitor an individual bushing online using specific temperature reference curves.

MSENSE® BM and the bushing monitoring function of ETOS® use an innovative, field-tested and patented 2/3 reference method which monitors the condition of the inner capacitance linings for bushing field grading in terms of a change in capacitance (C_1) and dissipation factor ($\tan \delta$). The key aspect of

this process is that because the algorithm continuously incorporates all three bushings per field in the mutual monitoring, the temperature dependence on loading or weather is eliminated due to the globally patented 2/3 reference method. Furthermore, the signals of the respective voltage transformers are used as the reference for detecting the symmetry of the three-phase system. The measurement is checked for validity, and grid asymmetries are effectively equalized and eliminated. The 2/3 reference method ensures that the influence of temperature and voltage fluctuations on a bushing monitoring system is effectively limited.

MSENSE® BM and the bushing monitoring function of ETOS® use an innovative, field-tested and patented 2/3 reference method which monitors the condition of the inner capacitance linings for bushing field grading in terms of a change in capacitance (C_1) and dissipation factor ($\tan \delta$).

C and $\Delta \tan \delta$
comparison (L1-L2 / L2-L3 / L3-L1)



Changes to the capacitance and the dissipation factor of the bushings are compared with limit values. Only the measurement of system-side voltage transformers is required to determine the symmetry of the line voltage. Thus, a reliable and clear evaluation of the condition of the high-voltage bushings can be ensured – regardless of grid asymmetries or voltage fluctuations. If the bushing values of one phase (C_1 or $\tan \delta$) deviate from the specifications, the user is alerted via a two-stage limit-value process. This means that faults in the insulation system can be effectively detected and the user can intervene in good time, before a fatal failure occurs.

MSENSE® BM and the bushing monitoring function of ETOS® essentially consist of three or six bushing coupling units (one for each bushing), three or six bushing adapters (one for each bushing) and the evaluation unit. The bushing adapter accesses the measured voltage at the test tap of the bushings. The bushing coupling unit with suitable capacity is responsible for adapting the measured voltage and sends the values to MSENSE® BM or ETOS®.

At Slovenian energy provider ELES, MSENSE® BM has been in operation successfully for about a year on a 600 MVA phase shifter transformer (PST). As part of yearly maintenance, the previous monitoring system was replaced by the new MSENSE® BM bushing monitoring system from MR on both PSTs.

All elements have an IP66 degree of protection. Communication takes place in all common control system standards (e.g. IEC 61850). The modern graphical display and intuitive user interface support the user and make the system easy to use.

At Slovenian energy provider ELES, MSENSE® BM has been in operation successfully for about a year on a 600 MVA phase shifter transformer (PST). As part of yearly maintenance, the previous monitoring system was replaced by the new MSENSE® BM bushing monitoring system from MR on both PSTs.

MSENSE® BM was quickly and easily attached to each of the twelve OIP (oil-impregnated paper) bushings of all phase shifter transformers, and the parameters already stored in the system were individually adjusted as needed. Since then, electricity has flowed between Slovenia and Italy more reliably than ever.

Aleksander Polajner, Head of the High-Voltage Device Department of ELES, explains the decision. **"Overhauling phase shifter transformers is challenging and must be carefully planned. These devices control the flow of powerful electrical loads between two countries, and therefore guarantee the safe, reliable, interruption-free transfer or exchange of electricity. The service technicians' main area of focus during maintenance is the bushings. Bushings are some of the most important parts of the transformer. Fault-free operation of these transformers depends greatly on the various weather conditions, which means that continuous condition monitoring is essential. Because the existing system had to be replaced, we began looking for a new solution, and we chose the MSENSE® BM from MR. Our experience in recent years has demonstrated that MR offers excellent support as well as innovative, reliable and safe solutions. By deciding to implement the MSENSE® BM monitoring system going forward, we are already benefiting today from service from a single source."**



Maschinenfabrik Reinhausen GmbH
Falkensteinstraße 8
93059 Regensburg, Germany

Contact:

Janusz Szczechowski
Product Manager

J.Szczechowski@reinhausen.com
www.reinhausen.com