

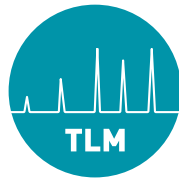


**TRANSFORMER-LIFE-MANAGEMENT
CONFERENCE**

**Continuous condition monitoring and protection
of high voltage transformers**

Francis Fischer
Weidmann





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WEIDMANN ELECTRICAL TECHNOLOGY
A Member of the WICOR Group



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Content

1. Overview of WEIDMANN
2. Importance of Temperature, Moisture and Force elements in HI calculation
3. Smart Insulation™ - using T, M and F sensors
4. Optimum Performance Monitoring™ concept

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Introducing WEIDMANN

Established in 1877, starts production of transformer insulation components in 1914

Invention of Transformerboard in 1925

Global leader in electrical insulation design and production

Engineering services and oil testing services provider

Supplier of monitoring equipment and software

35 locations around the world, HQ in Rapperswil, Switzerland



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WEIDMANN research on correlating temperature, moisture and force

“The change in clamping pressure in transformer windings due to variation on moisture content – Tests with pressboard spacer stacks”

By Ch. Krause, W Goetz - CIGRE SC12 Transformers / Workshop on Short Circuit Performance of transformers, 1999 Budapest Colloquium

“The impact of drying and oil impregnation conditions and of temperature cycles on the clamping force of power transformer windings”

By Ch. Krause, W. Goetz, B. Heinrich - 2002 IEEE International symposium on electrical insulation, Boston, MA, USA

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The impact of T, M and F on transformer's life cycle (1)

- The relative life expectancy of insulation system and the overall life-cycle of the transformer are impacted by three elements: Temperature (T), Moisture (M) and Force (F)
- Over time, as a result of spontaneous thermal and chemical activities and/or as non-spontaneous fault events, critical parameters within the transformer insulation system will deteriorate to cumulatively reduce the ability to withstand stress.
- It has become increasingly important for grid operators and asset managers to understand and monitor these transformer life-threatening elements, in an effort to quantify the overall risk they impose on grid reliability and operating cost.



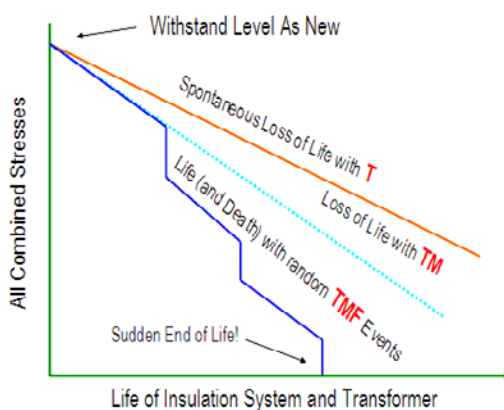
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The impact of T, M and F on transformer's life cycle (2)



Temperature, combined with increasing Moisture and with periodic short circuit forces, combined with system events, will increase risk and/or result in abrupt or sometimes catastrophic failures.



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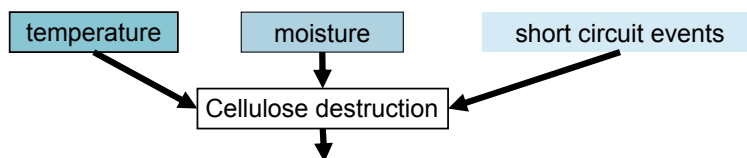
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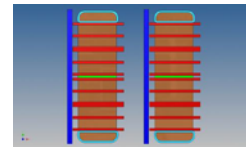
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Remain pre-load force is a high-risk “wild card” in Health Index



Reduction of:

- Clamping force → Loosening of the winding:
 - Vibration
 - Destruction in case of short-circuit
- Mechanical strength of the winding insulation
 - Destruction in case of short-circuit
- Electrical strength (moisture retention)
 - Destruction due to partial discharges
 - Destruction due to overvoltage



TMF = Temperature, Moisture, Force & Gases → TMFG

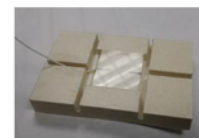
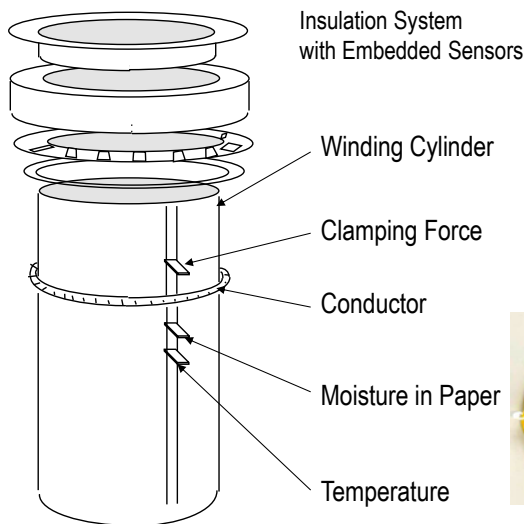
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TMF SMART INSULATION™ – DIRECT MONITORING APPROACH



F-SmartSpacer™



T-SmartSpacer™



M-SmartSpacer™
Sensor

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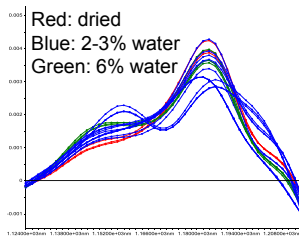
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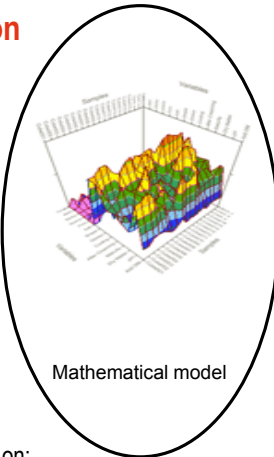
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**Temperature compensated “Mi” sensor – moisture measuring
principle – light absorption**



Light (Infrared) absorption at
different wavelength



Rel. Water
content [%]

Model based on:

- Known water (moisture) content
- Different insulation materials (density, raw material)
- Different insulation liquids



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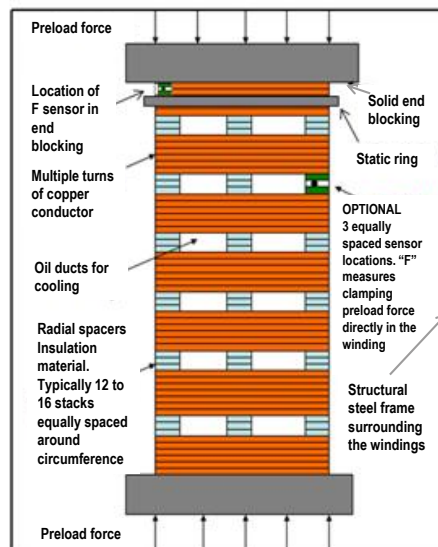
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Temperature compensated “F” sensor



**Fiber optic “F” sensor mounted in winding
insulation structure directly measures factory
preset and operational change in transformer
short-circuit withstand capability**



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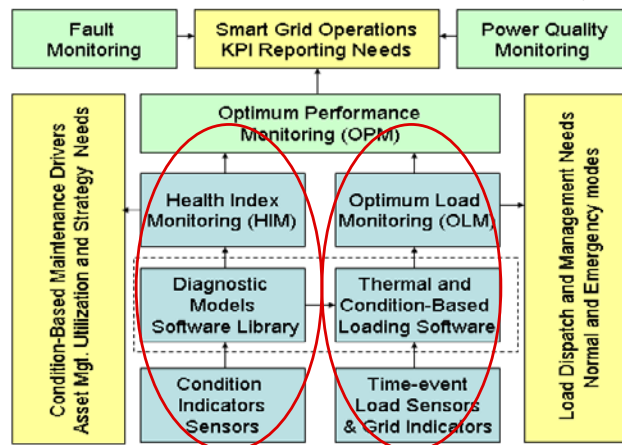
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Optimum Performance Monitoring™ for meeting KPI's

Holistic Asset Management geared toward enhanced reliability, less risk of forced outage and optimized equipment use - ahead or behind asset life cycle



Soon available with **Developed**
TMF sensors

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WEIDMANN monitoring development laboratory, VT, USA



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Conclusions

The effects of all three variables (Temperature, Moisture and Force) are cumulative and can result in shortened life and in some cases in transformer sudden failure.

Monitoring the Moisture and Force (along with Temperature) in the windings provides a valuable tool to assist operators in managing power flow through the grid.

Smart Insulation™ includes winding and core insulation system components integrated with embedded fiber optic sensors for direct monitoring of Temperature, Moisture in insulation and clamping Force.

A Health Index also based on real time data coming from these sensors will be more accurate.

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THANK YOU!

Questions ?



"I would rather have questions that can't be answered than answers that can't be questioned!" R Feynman

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