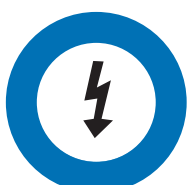




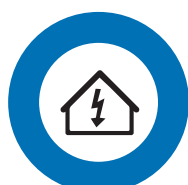
*High Voltage Testing and Engineering Commission
Commission d'étude des questions relatives à la haute tension*

The Swiss association for independent testing and advisory services relating to high-voltage technology and energy transmission

- The FKH is a group of **neutral, independent experts** utilizing its own **test and measurement equipment**.
- The FKH offers **on-site testing services** for quality assurance and condition assessment of medium- and high-voltage equipment, as well as **expert technical reports** pertaining to transmission grids.
- As a nonprofit association, the FKH offers its members (electrical energy utilities, the manufacturing industry and railway sector, as well as academic chairs) a **bridging function** and **platform for knowledge exchange**. In addition, it **helps develop young engineers** through research collaborations and practical training opportunities (internships).
- FKH focuses on overarching technical issues involved in energy transmission and high voltage engineering, participates in international **standardisation and technical committees**, and makes knowledge from universities and specialised institutions available to its members.



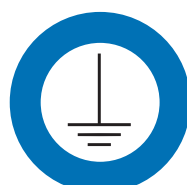
In-situ testing of
HV operational equipment



HV tests in the
Dänikon test facilities



Analyses of
insulating oils



Grounding/earthing,
environmental and grid issues



Engineering



Professional training

Power transformer diagnostics



- Induced and applied voltage tests
- Partial discharge measurements (online or offline)
- Partial discharge localisation using acoustic sensors
- Condition analyses using various measurement methods (winding resistance measurements, dynamic DC resistance measurement to assess on-load tap changers, ratio measurements, measurements of short-circuit and open-circuit impedance, dissipation factor measurements on bushings, SFRA (Sweep Frequency Response Analysis), FDS (Frequency Domain Spectroscopy)/PDC (Polarisation/Depolarisation Current))
- Recordings of inrush current
- Impulse voltage tests
- Oil analyses (dielectric-chemical/gas-in-oil/furan analysis)

Transformers are among the most important grid components. As such, regular, science-based condition diagnostics throughout their service lifetime contributes to their cost-effective operation and reduces the risk of failure.

trafo@fkh.ch

Cable testing



- Voltage tests with series-resonant systems
- Partial discharge measurement using a coupling capacitor, installed partial discharge sensors in joints and terminations, current sensors on cable shielding, and acoustic emission sensors
- Tangent delta measurement to assess cable insulation condition
- Location of PD defects using time-of-flight techniques
- Oil analyses

For high-power cable tests, the FKH uses a series-resonant high-voltage source, developed in-house. Thanks to its modular design, we can test even very long cables, without the need to split them into shorter sections.

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Grounding/earthing measurements



- Verification of both personnel and plant equipment safety, even in the case of ground faults, per Swiss Electrotechnical Association (SEV) rules: "Grounding as a protective measure in electrical power systems"
- Measurement of actual real voltage profiles and touch voltages using ground-fault current injection
- Measurement of potential gradients to determine the grounding system's impedance
- Independent consulting on technical measures to improve the earthing system in case of non-compliance with limit values, supported with grid modelling if required
- Measurement of ground fault current distribution to assess the effectiveness of ground connections and detect possible influencing factors
- Line impedance measurement

The FKH measurement system generates a ground fault current with a measurement frequency that differs from the grid frequency. This allows precise measurements of touch voltages and line impedances, even in case of strong interference due to operating currents.

erdungen@fkh.ch

Oil analyses in our ISO/IEC 17025-accredited laboratory

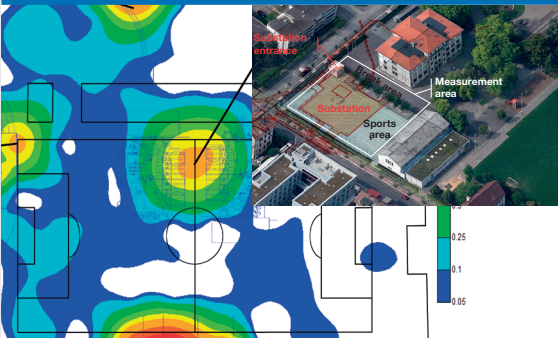


- Dielectric-chemical analysis in accordance with IEC 60422
 - Breakdown voltage and water content to assess the oil's insulation resistance
 - Neutralisation number and interfacial tension to assess the oxidation state of the insulating oil, and as a risk indicator for sludge precipitation
 - Tangent delta measurement to quantify conductive ageing products
 - Colour number and appearance to estimate oil ageing
- Furan analysis to assess thermal ageing and related mechanical stability of the solid insulation
- Analysis of decomposition gases in oil as an indicator of local thermal overload or electrical discharges
- Oxidation stability according to IEC 61125 to simulate accelerated ageing

Risk assessment based on oil analyses is a complex undertaking that requires many years of experience. FKH has access to one of Switzerland's largest databases of analysed transformer oil samples.

oelabor@fkh.ch

Advisory services and expert assessments

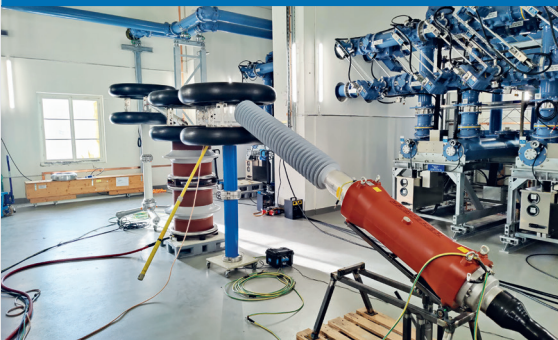


- Assessment of electromagnetic compatibility including effects on surrounding infrastructure and compliance with standard limits for persons
- Assessment of grounding/earthing and environmental issues
- Calculation of transient effects in the grid (ferroresonance, switching overvoltages, fault currents, transformer switching and long lines)
- Structural design of grid components
- Corona noise calculations on high-voltage overhead lines
- Thermal design of cable systems
- Damage and condition analyses
- Dielectric calculations
- An extensive collection of specialist literature, standards and scientific calculation programmes is available

Our team of experienced experts knows how to efficiently analyse complex interdisciplinary issues related to high voltage, while our extensive test and measurement activities provide repeated opportunities to validate our analyses.

studien@fkh.ch

Testing of medium- and high-voltage switchgear

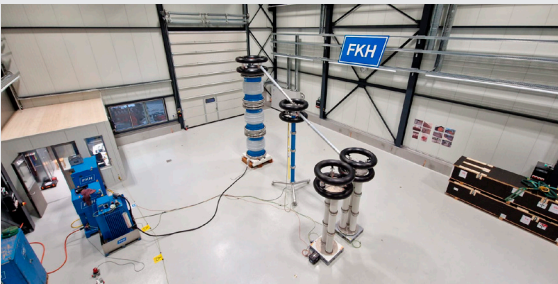


- Integral AC voltage test (including voltage converters) with >70 Hz to verify dielectric strength after installation
- UHF and conventional partial discharge measurement combined with time-of-flight techniques to locate and classify PD defects (even in difficult conditions of high-level background interference, very sensitive PD measurements are possible, thanks to advanced signal-processing techniques such as narrow-band UHF filtering)
- Lightning surge test to minimize risks when using new types of switchgear
- CIGRE sensitivity check to prove that UHF sensors can detect a 5-pC defect of a specified fault type
- Consulting and testing methodology to assess insulation integrity and analyse post-fault damage

According to a CIGRE study, about half of the defects causing faults on GIS (gas-insulated switchgear) systems are already present when they are commissioned; carrying out a highly sensitive on-site partial discharge measurement greatly reduces the number of faults during operation.

gis@fkh.ch

Key data on our infrastructure and testing facilities



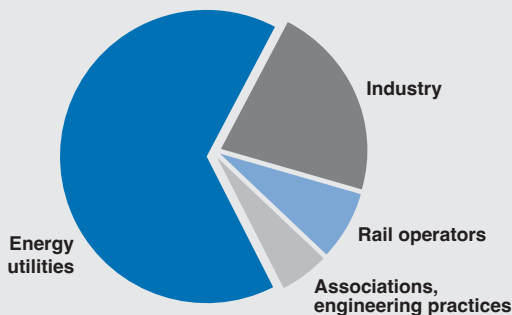
- Large high-voltage laboratory:
 - AC- and BIL-tests up to 245 kV rated voltage level possible
 - High-voltage AC using series-resonant systems up to 600 kV_{eff}
 - BIL using 15-stage modular Haefely impulse generator up to 1350 kV_{peak}
- Small high-voltage laboratory:
 - High-voltage AC tests up to 200 kV_{eff} possible
 - Assorted 50 Hz test transformers available
- Open-air test site:
 - Fixed 1 MV test transformer along with moveable 400 kV test transformer
 - Covered outdoor area for artificial rain-water tests
 - B-field measurements on distribution transformers possible
- Measurement infrastructure:
 - Mobile, modular, PD-free series-resonant sources
 - Mobile impulse generators, grounding measurements trailer, and transformer test-sets
 - Comprehensive measurement capability for insulation diagnosis, transients, and EMI
 - Current injection transformers for temperature-rise testing up to 10 kA

For many years, we've been optimizing our logistics centre and testing equipment to enhance our operational flexibility. This allows us to perform complex, challenging tests at short notice, in Niedergösgen as well as anywhere in Switzerland or abroad.

info@fkh.ch

Membership and benefits for members

Composition of FKH membership



- A members' discount is granted on all services provided by FKH itself (testing services and expert reports)
- FKH promotes the development of specialist knowledge in the field of high-voltage technology and related disciplines
- Specialist information is issued to members
- A comprehensive collection of literature on high-voltage technology is made available
- FKH organises and stages specialist events and courses at discounted prices for employees of corporate members
- FKH develops high-voltage testing methods and undertakes research projects with the results being made available to members
- FKH promotes the younger generation of specialists through collaboration with Switzerland's technical colleges and universities
- FKH develops high-voltage testing methods and undertakes research projects with the results being made available to members

We are certified



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