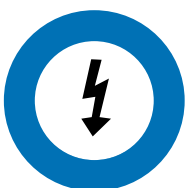




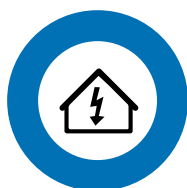
*High Voltage Testing and Engineering Commission
Commission d'étude des questions relatives à la haute tension*

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

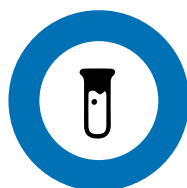
- FKH is a group of **neutral, independent experts** with their own **test and measurement equipment**.
- FKH offers **in-situ testing services** for quality assurance and to assess the condition of medium- and high-voltage components, as well as **expert technical reports** in connection with transmission grids.
- As a nonprofit-oriented association, FKH performs a **bridging function** and provides a **platform for knowledge exchange** among its members – who come from energy utilities, the manufacturing industry and the railway sector – as well as university chairs specialising in high voltage; FKH also **promotes the younger generation of engineers** by offering practice-based services and research alliances.
- FKH focuses on overarching technical issues involved in energy transmission and high voltage; it participates actively in **standardisation and technical committees**, and makes knowledge from specialist bodies, colleges and universities available to its members.



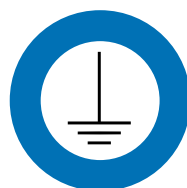
In-situ testing of HV operational equipment



HV tests in the Dänikon test facilities



Analyses of insulating oils



Grounding/earthing, environmental and grid issues



Engineering



Professional training

Power transformer diagnostics

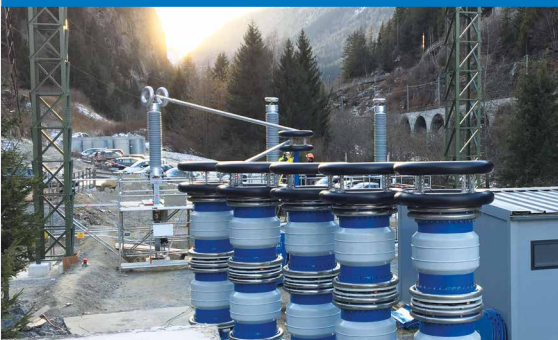


- Induced and applied voltage tests
- Partial discharge measurements (online or offline)
- Partial discharge localisation using acoustic sensors
- Condition analyses using various measurement methods (winding resistance measurements, dynamic DC resistance measurement to assess on-load tap changers, ratio 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 number among the most important grid components. Regular, science-based condition diagnosis throughout the service life of grids contributes to their cost-effective operation and reduces the risk of failures.

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
- Fault localisation using signal time-of-flight based PD location
- Oil analyses

Thanks to the series-resonant method we developed ourselves, FKH has a source that can be used on a modular basis for high-power cable tests. This also gives us the ability to offer tests on very long cable sections that are not subdivided.

kabel@fkh.ch

Grounding/earthing measurements



- Proof of safety for people and plant, even in case of faults, as per Swiss Electrotechnical Association (SEV) rules: "Grounding as a protective measure in electrical heavy-current installations"
- Measurement of real voltage profiles and touch voltages with supplied ground fault current
- Measurement of potential gradients to determine the ground impedance
- Independent advice on technical measures to improve the earthing situation 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 problems
- 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 the ISO/IEC 17025-accredited laboratory

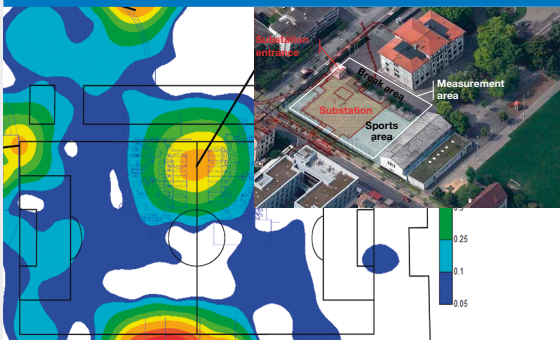


- Dielectric-chemical analysis as per IEC 60422
 - Breakdown voltage and water content to assess the oil's insulation resistance
 - Neutralisation number and interfacial tension to assess the oxidation state of the insulating oil, and as a risk indicator for sludge precipitation
 - Tangent delta measurement 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 as per 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 service and expert reports



- Assessment of electromagnetic compatibility, influence exerted on infrastructure, and compliance with limit values for persons
- Assessment of grounding/earthing and environmental issues
- Calculation of transient processes 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

Our team of experienced experts understands how to efficiently analyse complex interdisciplinary issues related to high voltage. Practical testing activities give us repeated opportunities to validate our forecasts on the basis of measurements.

studien@fkh.ch

Testing of medium- and high-voltage switchgears



- Integral AC voltage test (including voltage converters) with >70 Hz to prove dielectric strength after installation
- UHF and conventional partial discharge measurement combined with signal arrival-time-based PD location to classify and localise faults (thanks to narrow-band UHF filtering, very sensitive measurements are still possible in case of difficult interference conditions)
- 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 determine condition and analyse damage

According to a CIGRE study, an average of half of the causes of faults on GIS (gas-insulated switchgear) systems are already present when the systems are commissioned. This means that an in-situ test with sensitive partial discharge measurement can greatly reduce the number of faults during operation.

gis@fkh.ch

Key data on our infrastructure and testing facilities



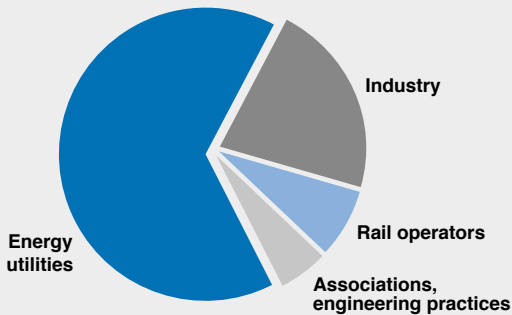
- Däniken logistics centre with depot and mechanical workshop
- Laboratory for insulating oil analyses and special experiments on insulating materials (dielectric-chemical and spectroscopic methods using GC, HPLC and FTIR)
- Däniken test site with 1 MV test transformer, partial discharge measurement facility and rain testing facility
- Mobile modular system of series resonance test rigs with resonance chokes (total 30 units), 4 resonant supply sources
- Accessories for corona-free test setups; tests up to apparent power of 25 MVA and voltages of up to 800 kV
- Test source for excitation and partial discharge measurement of large transformers in situ, with a frequency converter or diesel generator set and various step-up transformers
- Mobile surge unit for lightning surge, switching and oscillatory surges up to peak values of 1,800 kV and charging energy of up to 180 kJ
- Grounding measurement system for measurement currents of up to 200 A
- Measuring van and trailer with towing vehicle
- Equipment for technical measurement equipment for insulation diagnostics, grid transients and EMC measurements
- Temperature rise tests with currents of up to 10 kA
- Collections of specialist literature, standards and scientific calculation programs

For many years, we've been optimizing our logistics centre and testing equipment so we can operate flexibly. This allows us to offer complex and challenging tests even at short notice, not only at Däniken but also elsewhere in Switzerland and in other countries.

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 – the results are made available to members
- FKH promotes the younger generation of specialists through collaboration with Switzerland's technical colleges and universities
- FKH provides a forum where specialists can contact one another and where business contacts can be initiated within the industry

We are certified

FKH

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