SULTAN QABOOS UNIVERSITY
COLLEGE OF ENGINEERING
DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING
HIGH VOLTAGE LABORATORY

The **High Voltage Laboratory** at College of Engineering, Sultan Qaboos University was established in 1988 just one year after the university was founded. But the actual work in the laboratory has started since 1991. The total cost of the laboratory's equipment, installation and infrastructures was about **OMR 400,000.** In 2002, all laboratory's equipment were tested and calibrated by the supplier "**Haefely**".

TEST FACILITIES

Impulse voltage generator.

Capacitive divider.

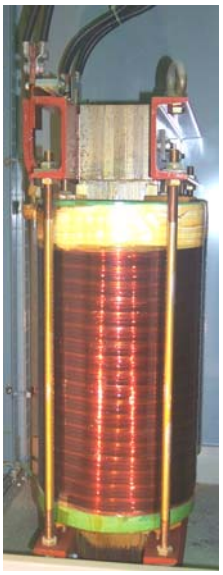
A Haefely 10-stage **impulse voltage generator** rated 1000 kV, 30 kJ with a 0.6 µF stage capacitors rated for 100 kV. The generator is able to produce the standard lightning (1.2/50µs) and switching (250/2500µs) impulse waveforms with a sequence of two impulses per minutes. A Haefely CS1000 damped **capacitive divider** is used to measure high impulse voltages up to 1200 kV and alternating voltages (50 Hz) up to 250 kV (RMS). An impulse peak voltmeter is used to measure and store the peak value of impulse voltage.

Sphere gap.

DC test set.

A Haefely standard vertical sphere-gap (sphere diameter = 250 mm) is used for measuring all types of high voltages. Also, it is equipped with a chopping system controlled by an electronic triggering device (trigarton) and allowing wave-chopping with a maximum dispersion of ~ 0.1 µs. A Haefely DC (direct current) test set can generate direct-current voltages up to 400 kV, 12 mA using two-stage voltage doubler circuits.

Testing transformer.



Compensating reactor.

A Haefely 50 Hz, 200 kVA, 380 V/400 kV **testing transformer with compensating reactors** rated 30, 60, 120 and 240 kVA, i.e. reactors' rating ranges from 30 kVA to 450 kVA. The high voltage is measured using a precision AC peak voltmeter.

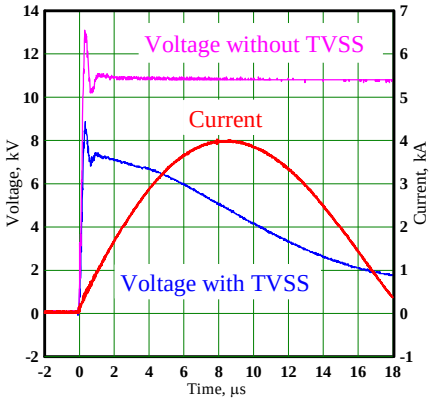
Coupling capacitor.

Standard capacitor.

A Haefely **partial discharge detector and calibrator** are used to detect partial discharges (PD) in equipment. The transferred electrical charge in pC expresses the magnitude of the insulation defect. This system is able to detect PD in the frequency range 70 kHz – 400 kHz with a measurement display ranges from 0 to 100 nC. A **coupling capacitor** rated 400 kV, 1000 pF is used to separate the high frequency PD signal from the 50 Hz test voltage in the range of few kV up to 500 kV. A Haefely **capacitance and tan delta (C and tan δ) bridge** is used to determine the capacitance and the dielectric dissipation factor of insulating materials and high-voltage equipment using either the nominal or a higher test voltage. A **standard capacitor** rated 400 kV, 50 pF is used to limit the test voltage to be lower than the bridge rating. Also, sophisticated digital storage oscilloscopes and impulse current shunts (99.84, 503.8 & 963 mΩ) are available.

SQU salt-fog chamber.

Flashover test of line post-insulator



Testing of ESP's PDO 1.5-kV Transient Voltage Surge Suppressors (TVSS).

PDO financially supported SQU to purchase a salt-fog chamber made of aluminum and having dimensions of 2m×2.5m×2m. This chamber costs about OMR 32,000 and it was installed and commissioned at SQU High-Voltage Lab in March 2005. This chamber is designed for:

- Standard tests on isolators according to different standards, e.g. IEC 61109 and IEC 61462.
- Simultaneous tests under high-voltage and salt mist.
- Evaluation of erosion and creeping current strength.
- Withstand high-voltage tests.
- Ageing tests.

INDUSTRIAL SERVICES AVAILABLE

I) TESTS & EXPERIMENTS

a) **Surge/Lightning Arresters and Transient Voltage Surge Suppressors (TVSS)**
- Power-frequency sparkover test.
- Pollution test.
- Residual voltage test.
- Direct current reference test.
- High current impulse test: short and long duration impulse current test.

b) **Power Cables**
- Dielectric power factor test.
- Partial discharge test.
- Power-frequency withstand test.
- Impulse withstand voltage test.

c) **Transformers and Rotating Machines**
- Induced overvoltage test.
- Partial discharge test.
- Impulse voltage test.

d) **High-Voltage Insulators**
- Power-frequency test:
  (i) dry and wet flashover test, and
  (ii) wet and dry withstand tests (one minute).
- Impulse tests:
  (i) impulse withstand voltage test,
  (ii) impulse flashover test, and
  (iii) pollution test.

e) **Bushings**
- Power factor voltage test.
- Internal or partial discharge test.
- One-minute wet withstand test at power frequency.
- Visible discharge test at power frequency.
- Impulse voltage tests.

f) **Isolators and Circuit Breakers**
- Impulse voltage dry withstand test.
- One-minute power-frequency voltage dry withstand test.
- One-minute power-frequency voltage wet withstand test.

g) Measuring of the **Earth Resistivity** and the **Earthing/Grounding System Resistance**.

h) **Testing of Dielectric Liquids** (Transformers', Switchgears' and Capacitors' Oils)

i) **Power Quality:** Power Systems Harmonic Measurements and Analysis.

II) THEORETICAL SIMULATIONS

a) **Electrostatic & Electromagnetic Modeling**
Electrostatic modeling of insulators, bushings, surge arresters and any electrode system can be done using the **Charge Simulation Method, SLIM and VectorFields packages**.

b) **Transient Overvoltages**
Evaluation and mitigation of transient overvoltages in any power system can be achieved using **PSCAD** and **EDSA** packages. Also, the optimum location of overvoltage protectors (surge arresters) can be simulated.

c) **Electromagnetic Field Calculation**
- Electromagnetic fields under overhead power lines in two and three dimensions (2D and 3D) can be calculated using the CONCEPT software to solve the whole Maxwell's equations.
- Electromagnetic coupling between overhead lines and nearby objects, e.g. pipelines, buildings, using the CDEGS software.

d) **Design of the Earthing/Grounding Systems**
Design of the earthing/grounding system for station, substations, buildings, and utilities can be also done using the **CDEGS** software.

CONTACT INFORMATION

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