Hydro Québec

High-Voltage Testing

765-kV compressed-gas circuit breaker

A major component of Hydro-Québec's research facilities, the high-voltage laboratory ranks as one of North America's leading research and testing centres for high-voltage lines and equipment.

The test facilities, which can reach rated voltages of 2100 kV_{rms} AC or ±1200 kV DC and generate impulse waves of 5.4 MV, are used for research and testing in a number of areas including external insulation without pollution, corona, electric fields, internal insulation (gas, oil or solid) and the contamination of insulators and surge arresters.

Its personnel offers Hydro-Québec, other electric utilities and industry a combination of competence and professionalism in performing the most stringent tests, at the best possible cost. The purpose of these tests is to check whether electrical equipment conforms to standards and specifications (ANSI, IEC, CSA, IEEE, etc.) as well as the specific requirements of manufacturers and electric utilities. The high-voltage laboratory has received ISO/IEC 17025 accreditation and provides apparatus manufacturers with independent testing services, an important factor in the commercialization of equipment.

ISO / CEI 17025

Serving the electrical industry

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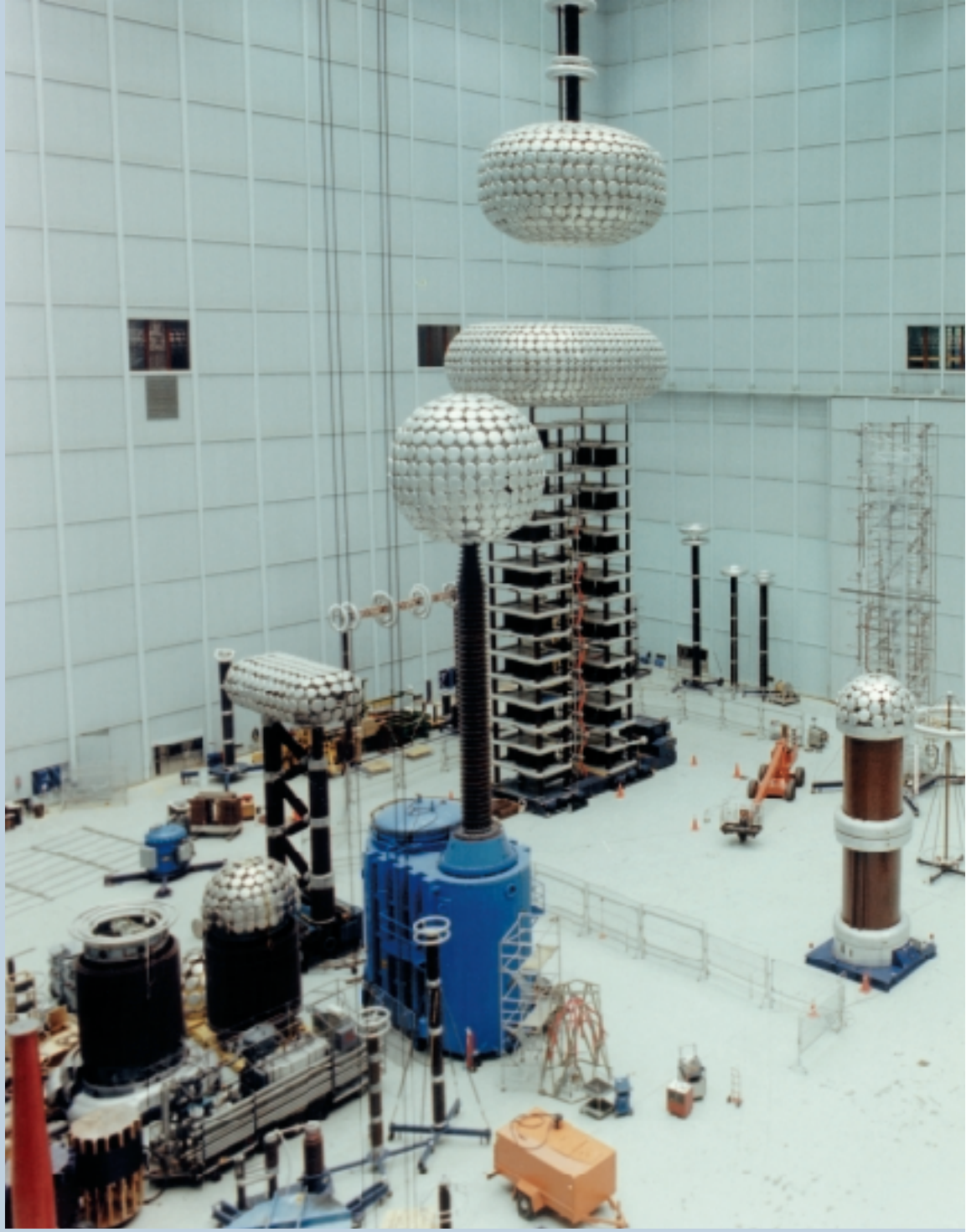
Main Test Hall

The main test hall (82 m x 67 m x 50 m high) is the dominant feature of the high-voltage laboratory. Electrically, it resembles a Faraday cage, ensuring protection from radio interference (50 to 60 dB attenuation at 1 MHz) and acoustic attenuation. It is used for research and extra-high-voltage testing on transmission system apparatus. The main hall can be divided into three separate test areas, each of which can be combined in different configurations or even used as a single test area if the voltage level requires it.

The main test hall's lighting system is designed to allow brightness to be varied to almost total darkness. In addition, all test equipment is mobile, most of which is mounted on air cushions, for optimum use of the facilities. Three radio-controlled cranes are also available, each offering a capacity of 10 t.



Voltage dividers

Type	Capacitive-resistive	Resistive	DWINA
Rated voltage	Up to 5.4 MV, 1.2/50 µs	350 to 2.5 MV	±1.0 MV DC
Response time	Up to 100 ns depending on the coupling configuration	14 to 55 ns	
Main uses	Measurements: AC high-voltage; lightning and switching surges	Measurements: lightning-impulse voltages	Reference element for DC dividers and switching surges
Location	Fixed (suspended from the ceiling) and mobile	Mobile on wheels	Mobile on wheels

Other RC- and RCR-type parallel voltage dividers supplement the range of apparatus available for measuring test voltages at the high-voltage laboratory. A range of capacitors of up to 1.2 MV is also available for measuring capacity, tg δ and partial discharges.

Main hall control room

High-voltage laboratory main test hall

Types of tests

Tests under dry or wet conditions
- High-voltage tests: DC up to 1.2 MV or AC up to 2.1 MV_{rms}
- Lightning or switching impulses superimposed on an AC voltage or combined voltages
- Switching surges (up to 2.7 MV)
- Lightning impulse and chopped wave (up to 5.4 MV)
- Current impulse wave (8/20 µs, 40 kA)

Other tests
- Radio influence voltage tests
- Partial-discharge measurements
- Capacitance and loss angle (tg δ) measurements
- High-voltage measurements in oil or gas
- Temperature-rise tests
- Loss measurements

Equipment tested

- Disconnectors
- Circuit breakers
- Power cables
- Line hardware
- All types of insulators
- Bushings
- Surge arresters
- Air- or steel-core reactors
- Instrument transformers (voltage and current)
- Spark gaps
- Distribution cabinets
- Bundle conductors
- Tower windows
- Connectors
- High-voltage measuring and testing instruments
- Tools and equipment for live-line work

Test equipment

- Two impulse generators (one 6.4 MV, 400 kJ and the other 1.5 MV, 56 kJ)
- Two cascade rectifiers (1.2 MV, 125 mA)
- Six high-voltage transformers, 550 kV_{rms}, 1.25 A, offering various connection possibilities to reach 60-Hz voltages of 2.1 MV_{rms}
- One SF_6 test cell, 1.0 MV
- Two test tanks, one rated 550 kV_{rms}, the other 1500 kV_{rms}
- Rain apparatus, adjustable for precipitations of 1.5, 3 and 5 mm/min, for testing equipment with a system voltage of up to 765 kV
- Rectifiers (150 kV, 17 mA)
- One 1-MVA current transformer for heating cables or current transformers
- Several spark gaps for producing chopped waves

Pollution Chambers

Tests performed on an insulating structure equipped with auxiliary sheds made of rubber

Two pollution chambers have been erected in the high-voltage laboratory for determining the external insulation level of certain equipment (insulators, bushings, insulator columns, and surge arresters, instrument transformers, etc.) and for studying flashover mechanisms under pollution. They are designed for both AC, DC and impulse testing or combinations (e.g. AC-impulse, DC-impulse). These tests are carried out in accordance with International Electrotechnical Commission (IEC) standards and are based on the clean-fog and salt-fog methods.

The clean-fog method consists in applying a layer of pollution on the surface of the test object by various techniques (dipping, spraying or vaporization). The salt-fog method, for its part, consists in subjecting the test object to fog produced from an aqueous solution of sodium chloride sprayed through fine nozzles.

Large chamber

Dimensions: 19.8 m x 17.1 m x 24.4 m high
Doorway: 11 m high x 5.5 m wide
Suspension system: 15.2-m steel beam held by two winches (maximum load: 9 t)

Test voltages
- clean fog: 800 kV_{rms}
- salt fog: 500 kV_{rms}
- 650 kV dc, 5% voltage drop for 3 A
- switching impulse: 1050 kV (250/2500-µs waveforms)

Small chamber

Dimensions: 4.7 m x 4.7 m x 4.7 m
Test voltages:
- 150 kV_{rms}; short-circuit current higher than 12 A_{rms}
- 150 kV dc

Test parameters

The tests in both pollution chambers are monitored from an adjacent control room. The following parameters are measured:

- pressure, temperature and steam rate (for clean-fog tests)
- test voltage and leakage current (on oscilloscope and microprocessor-controlled analyzer)
- ambient temperature and humidity before testing
- deposit density of the pollution (for clean-fog tests)
- temperature and conductivity of the solution (for salt-fog tests)
- water content of the fog (for specific clean-fog tests)
- insulator surface resistivity during testing

Transformer Test Area

Tests performed on power transformers

The hall that serves for testing transformers and reactors measures 73 m x 64.5 m x 27 m high. It comprises two power-frequency test areas, an impulse test area and a control room. The control room contains the data acquisition systems for power-frequency tests, partial-discharge measurements, resistance measurements, impulse and fault-detection tests.

The local rail track runs directly into the building, which makes it easier to receive and ship heavy apparatus. Equipment inside the hall is moved using two 175-t travelling cranes which can be connected by a central coupling beam with a capacity of 325 t.

Test equipment

- one generator, 3 MVA (set frequency of 180 Hz)
- one generator, 3 MVA with a rated frequency of 180 Hz (variable frequency ranging from 90 to 201 Hz)
- one generator, 5 MVA with a rated frequency of 60 Hz (variable frequency ranging from 30 to 67 Hz)
- one single-phase regulator, 5 MVA
- three 5-MVA single-phase regulators which can be connected in parallel or in wye
- one impulse generator, 3.2 MV, 200 kJ
- five step-up transformers rated 50, 110, 122, 175 and 310 MVA, with tertiary windings that can be connected to a 5-Mvar reactor and three 80-Mvar capacitor banks to meet reactive-compensation requirements.

Measuring devices

Parameters	Instrumentation
Impulse currents and voltages	• Coaxial shunts and wire-wound shunts with response-time compensation • Resistive and damped capacitive voltage dividers • Digital data acquisition and processing system for monitoring impulse tests on power transformers
Medium-voltage alternating current and voltage	• Active and passive current transformers • Standard capacitor and voltage transformers for voltage measurements
Power loss at a low power factor	• Electronic wattmeters • Active bridge
Partial discharges	• Broad-band and narrow-band continuous measurements • Automatic partial-discharge measuring systems • Fault detection through partial-discharge measurements • Coupling capacitors up to 1.2 MV_{rms}

Laboratories at the service of the electrical industry

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HV Underground-Cable Test Area

A test area measuring 20,000 m² is available for studying high-voltage underground cables. Demonstration tests are performed to check the components of cable links and to define the long-term behavior of such cables and their accessories under real operating conditions.

The cable test area comprises three cable loops, each about 100 m long, their bushings and related apparatus. The test equipment is designed to operate under the climatic conditions prevailing in the Montréal area. Each device is mounted on a concrete base with busbars providing the connection with the cable bushings. The test area also includes a control building which houses fully automatic measuring and data acquisition equipment. The test area is equipped with an AC voltage source (series resonant source), 1.2 MV_{rms}, 16 MVA, a DC voltage source (1.2 MV, 50 mA) and three current sources (4 kA, 150 V, 60 Hz). An impulse generator (3.6 MV, 360 kJ) is also used for testing purposes.

Types of tests

- DC or AC voltage application and current circulation for cable-aging purposes
- Cycling tests
- Polarity-reversal tests
- Impulse superimposed on AC or DC voltage
- AC voltage superimposed on a DC voltage
- Standard type and routine tests

HV underground-cable test area

ISO / CEI 17025

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