ABB SACE Division
Test laboratory
The ABB S.p.A - ABB SACE Division Laboratory develops, certifies and performs production follow-up tasks for the electrical devices designed and manufactured in different ABB plants. The Laboratory provides a wide range of equipment and experience in electrical, mechanical, climatic and functional tests for low and medium voltage operating, control, safety and measuring equipment. The Laboratory is accredited by ACCREDIA and, thanks to acknowledgements from important international certification bodies such as ACAE/LOVAG, ANCE, ASTA, ETL SEMKO, UL, CSA and Shipping Registers, offers ABB and its customers a qualified certification test service for low and medium voltage electrical devices and equipment, in accordance with the respective product standards.

Our skills
Performing tests and taking measurements correctly is a profession: a group of specialists ensures that the laboratory can provide valid support for its customers thanks to years of experience in many different fields. Uncommon experimental equipment plus use of advanced measuring and testing techniques allow us to simulate the toughest installation conditions and meet the requirements of domestic and international standards.

The systems
The laboratory covers an area of over 3,500m². The plants are constantly serviced and upgraded thanks to yearly investments, the purpose being to boost their capacity for testing as well as their compliance with the laws in force and the market’s more challenging demands. Thanks to sophisticated techniques, accuracy, and traceability of the measuring methods we can study, investigate and assess the behaviour of the equipment subjected to development and certification tests.
We deal with lightning, fire outbreaks and explosions every day. The atmosphere at altitudes exceeding 4,000 meters alternates with the depth of mines and temperatures that jump from -40 to over 70 degrees. We feel the ocean breeze and salty sea air. Time passes either very fast or very slowly.

Every day, we put our circuit-breakers to the test because they'll be put to test by the world.

The main tests

- **Short-circuit**
  The task of the "Power tests" laboratory is to assess the performance of low and medium voltage apparatus in the presence of high current and voltage values. It is equipped with three alternators, one of which is able to supply up to 2800 MVA.

- **Experimental tests**
  The "Experimental tests" laboratory has equipment for testing mechanical and electrical life, plus duration in overload conditions. It has power suppliers for assessing overtemperature and the characteristics of thermal magnetic and electronic releases in the presence of strong current values.

- **Materials**
  The "Material testing" laboratory researches, analyzes and pinpoints new plastic and metal materials able to comply with the continual need for technological innovation that is now a "must" in the electrotechnical field.

- **Electronic devices**
  The "Electronic test" laboratory assesses the electronic devices in the circuit-breakers and all the accessories that form the circuit-breaker system (dialog, signalling, monitoring devices, etc.).

- **Environmental reliability testing**
  The purpose of environmental tests is to study the behaviour of the apparatus when subjected to accelerated life conditions, such as: corrosive environments, thermal ageing, thermal shock and vibrations or a combination of thermal cycles and vibrations at high level environmental stress levels (HALT).
What happens to your electrical system when it operates in extreme conditions? We do everything to find out. And to limit the consequences.
Short-circuit tests

Short-circuit tests are performed to assess the behaviour of low and medium voltage circuit-breakers and switchgears in extreme operating conditions, such as those resulting from faults caused by lightning or negligent maintenance, or the conditions in electric power stations, industrial installations, chemical plants, off-shore oil rigs or in mines. The results of these tests enable us to improve the characteristics of the apparatus itself, as well as the safety conditions for both people and the actual installations. The laboratory equipment also allows us to simulate particular conditions, such as those in installations at high altitudes (with a corresponding drop in atmospheric pressure) or use with wind generators at variable frequencies and direct current photovoltaic systems.
The electric current intensity of lightning typically varies from 10 to 200 kiloamperes. The voltage of the line that supplies a neighbourhood is between 10 and 36 kV.

<table>
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CEI EN 60947-2           | IEC 60947-2     | 150kA for 1s
90kA for 3s | 380V 200kA
600V 200kA
726V 100kA
1100V 80kA | 250V 100kA
500V 100kA
1000V 100kA
1500V 30kA | up to 1100V
15kA | – |
| Low voltage switch-disconnectors | IEC 60947-3
CEI EN 60947-3           | IEC 60947-3     | 150kA for 1s
90kA for 3s | 380V 200kA
600V 200kA
726V 100kA
1100V 80kA | 250V 100kA
500V 100kA
1000V 100kA
1500V 30kA | up to 1100V
15kA | – |
| Low voltage contactors and starters | IEC 60947-4-1
CEI EN 60947-4-1         | IEC 60947-4-1   | –          | 380V 200kA
600V 200kA
726V 100kA
1100V 80kA | 250V 100kA
500V 100kA
1000V 100kA
1500V 30kA | up to 1100V
15kA | – |
| Low voltage switchgears and busbar ducts | IEC 61439-1
CEI EN 61439-1           | IEC 61439-1     | 150kA for 1s
90kA for 3s | 380V 200kA
600V 200kA
726V 100kA
1100V 80kA | 250V 100kA
500V 100kA
1000V 100kA
1500V 30kA | – | – |
|                                | IEC 61439-2
CEI EN 61439-2           | IEC 61439-2     | –          | –          | – | – |
|                                | IEC 61439-6
CEI EN 61439-6           | IEC 61439-6     | –          | –          | – | – |
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CEI 17-86                | IEC 6141        | –          | –          | – | – |

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</thead>
</table>
| High voltage switchgears       | IEC 62271-200
CEI EN 62271-200        | IEC 62271-200   | 150kA for 1s
90kA for 3s | – | – | – | 12kV 31.5kA for 1s
24kV 25kA for 1s |
| High voltage circuit-breakers  | IEC 62271-100
CEI EN 62271-100        | IEC 62271-100   | 150kA for 1s
90kA for 3s | 12kV 60kA
24kV 22kA
36kV 20kA | – | – | – |
| High voltage switch-disconnectors | IEC 62271-103
CEI EN 62271-103       | IEC 62271-103   | 150kA for 1s
90kA for 3s | 12kV 60kA
24kV 32kA
36kV 20kA | – | 24kV 630A
36kV 400A | – |
| High voltage earthing switches and disconnectors | IEC 62271-102
CEI EN 62271-102       | IEC 62271-102   | 150kA for 1s
90kA for 3s | 12kV 60kA
24kV 32kA
36kV 20kA | – | – | – |
| High voltage contactors (also coordinated with fuses) | IEC 62271-106        | IEC 62271-106  | 150kA for 1s
90kA for 3s | 12kV 60kA
24kV 32kA
36kV 20kA | up to 12kV 8kA | – | – |
The climate in our laboratory is just right for testing an entire life-cycle at ultra-high temperatures. Obviously we’re talking about electrical apparatus.
Experimental tests

The "Experimental test" laboratory can perform all sorts of tests essential in the development of robust, reliable and precise low voltage electrical devices. Besides the type-tests required by the standards, circuit-breakers, switchgear and contactors must operate correctly in extreme environmental conditions and with high levels of electrical, mechanical and environmental stress. Due to continuous technological innovation these conditions are more and more frequent.

In order to stress the products beyond their operating conditions and to assess their reliability over the years these kind of tests are performed: mechanical tests in the presence of vibrations and shocks, or with static and dynamic inclination, electrical life and overload tests, extreme thermal cycles in climatic rooms (-40° +100°C, 98% RH) or in corrosive atmospheres.

Strong vibrations, polar climates or wide temperature ranges, humidity and corrosive atmospheres can be reproduced with the test technologies used in the "Experimental tests" Laboratory.
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<td>5kV</td>
<td>50Hz</td>
<td>In=6300A</td>
<td>Vn=1500V</td>
<td>IP40</td>
<td>6kA continuous</td>
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<td></td>
<td>9kA per 120s</td>
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<td>40kA per 0.5s</td>
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<td></td>
<td></td>
<td>1.5 mm² - 185 mm²</td>
</tr>
<tr>
<td>Low voltage switch-disconnectors</td>
<td>IEC 60947-3, CEI EN 60947-3</td>
<td>5kV</td>
<td>50Hz</td>
<td>In=6300A</td>
<td>Vn=1500V</td>
<td>IP40</td>
<td>6kA continuous</td>
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<td>9kA per 120s</td>
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<td>1.5 mm² - 185 mm²</td>
</tr>
<tr>
<td>Low voltage contactors and starters</td>
<td>IEC 60947-4-1, CEI EN 60947-4-1</td>
<td>5kV</td>
<td>50Hz</td>
<td>In=6300A</td>
<td>Vn=1500V</td>
<td>IP40</td>
<td>6kA continuous</td>
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<td></td>
<td></td>
<td>1.5 mm² - 185 mm²</td>
</tr>
<tr>
<td>Low voltage switchgear and and busbar ducts</td>
<td>IEC 61439-1, CEI EN 61439-1</td>
<td>5kV</td>
<td>50Hz</td>
<td>In=6300A</td>
<td>Vn=1500V</td>
<td>IP40</td>
<td>6kA continuous</td>
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<td>9kA per 120s</td>
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<td>1.5 mm² - 185 mm²</td>
</tr>
</tbody>
</table>

6300 A Is the current required to supply 2,510 homes in maximum load conditions. 58 °C Highest temperature recorded on Earth. El Azizia, Libya, September 13, 1922.
Life in power generation systems is difficult even for circuit-breakers. This is why we put all our materials to the test.
Material tests

The "Material testing" Laboratory meets the need for information and measurements imposed by the continual technological innovation featured by today's metal and plastic materials industry. The vast array of tests the laboratory is able to perform include tensile, compressive and flexural strength tests, comparative tracking index tests (CTI), fire resistance and electrical resistance tests and tests to assess the melting and glass-liquid transition temperature of the insulating plastic materials used. In addition, the laboratory is equipped with a metallurgical microscope, FT-IR and ED-XRF spectrometers, salt mist corrosion test chambers and instruments for assessing the contact plates and their interaction with the electric arc.
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<td>IEC 61006 - CEI EN 61006</td>
<td>temperature range: -65 to +650°C</td>
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<td>Melting temperature and heat</td>
<td>IEC 61074 - CEI EN 61074</td>
<td>measuring range: ±350mW</td>
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<tr>
<td>Crystallinity</td>
<td>–</td>
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<tr>
<td><strong>Mechanical tests</strong></td>
<td></td>
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<tr>
<td>Tensile, flexural, compressive strength</td>
<td>Miscellaneous</td>
<td>load: 0.01 to 50kN</td>
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<td>Hardness/Microhardness</td>
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<td><strong>Physical tests</strong></td>
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<td>ISO 1183</td>
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<td>Ash content</td>
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<td>Water absorption</td>
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<tr>
<td>Metal coatings (XRF)</td>
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<td>elements from titanium to uranium</td>
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<td>ASTM E 1421</td>
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<td>Viscosity of thermoplastic melts (MFI)</td>
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<tr>
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<tr>
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<td>–</td>
<td>1.10 -7 R&lt;1.10 6 Ohm</td>
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<tr>
<td>Comparative Tracking Index (CTI)</td>
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<td>up to 600V</td>
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<td>Flame</td>
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<td>With stereomicroscope</td>
<td>–</td>
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<tr>
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</tr>
<tr>
<td><strong>Microscope</strong></td>
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</tbody>
</table>

**Corrosion rate of steel in aggressive environments.** 1000 μm/year

**Hydrogen sulphide concentration in environments where geothermal energy is used, 10 times higher than normal values.** >5 mg/m³
Working in complete isolation is sometimes an advantage. Especially if the environment is hostile and the work challenging.
Tests on electronic devices

The "Electronic test" Laboratory can simulate any type of current and voltage to be found in the World, from the direct current of galvanic systems, solar parks or for powering submarines, to the 1000 Hz ratings of robotized assembly line installations. We can generate harmonics and disturbance of up to 20 KHz, well over the disturbance that the inverters of wind power installations are able to create.

The electronic section can subject all the electronic components to electromagnetic interference that’s way beyond the 5kV Surge value (lightning simulation), the 6kV Burst value (ultra-high power Radio transmitter) and 20kV of electrostatic discharge (ESD).

The electronic section was only created in 2001 but, thanks to continual investments, it has been equipped in little more than 10 years with the best instruments to be found on the market, both as to precision and test automation. At the present time, this section of the Laboratory can count on ultra-high accuracy (0.1%) voltage and current generators, high resolution recorders, multi-channel calibrators able to simulate any type of load that may occur in an installation, climatic chambers that re-create real conditions of use (from -70°C to 350°C) and water in the circuits, Halt Hass chambers to stress even large components with mechanical and temperature shocks, spectrum analyzers and generators that comply with the most stringent electromagnetic compatibility standards.
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<td>Electronic devices on board circuit-breakers</td>
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<td>IEC 60947-2, CEI EN 60947-2</td>
<td>IEC 60947-2, CEI EN 60947-2, Product specifications</td>
<td>–</td>
<td>IEC 61000-4-2, IEC 61000-4-4, IEC 61000-4-5, IEC 61000-4-11, IEC 61000-4-29</td>
</tr>
<tr>
<td>Range</td>
<td>Precision currents: 1mA to 2000A</td>
<td>–</td>
<td>–</td>
<td>Programming possible up to the 40th harmonic</td>
<td>Voltage values up to 6kV dip with 1ms step</td>
</tr>
<tr>
<td></td>
<td>Precision voltages: 1V to 2000V</td>
<td>–</td>
<td>–</td>
<td>Current and voltage with 0 to 3000Hz frequency</td>
<td>Up to 20kHz interference currents</td>
</tr>
</tbody>
</table>

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6 billion Mobile phones in the world that emit electromagnetic interference.

6 kHz Frequency generated by the inverters in wind power installations.

Tests laboratory
The life of an electrical device can be full of pitfalls. We speed it up to make it longer. And safer.
Environmental reliability tests

Every day, our circuit-breakers are used in the farthest corners of the World. They are subjected to extreme temperatures and must withstand the heaviest duty mechanical stress.
To make sure they are able to stand up to this rough treatment, we test all the components at Arctic temperatures (-40°C) through to the hottest temperatures of the most scorching desert.

That’s not all. To make sure that they are sturdily built, we apply thermal shocks that bring our circuit breakers from -40°C to 150°C with a very high humidity rate (98% RH).

We check the behaviour of the hardware and software of the more critical components during 17°C/minute thermal shocks while applying 30 g vibrations (much more than the acceleration that occurs on a Caterpillar).
The lowest temperature recorded in Oymyakon, Russia, January 26, 1926. 

98% humidity rate and 45°C are the environmental conditions of the Amazon rain forest.

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<tr>
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<td>Chamber with controlled temperatures and humidity.</td>
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<td>IEC 60947-1</td>
<td>IEC 60947-1</td>
<td>IEC 60947-1</td>
<td>IEC 61947-1</td>
</tr>
<tr>
<td>Operating range</td>
<td>Test temperature: t.a. to 55°C Test volume: 600dm3</td>
<td>Temperature: -40 to +180°C Humidity: 10 ÷ 98%</td>
<td>Temperature: -80°C to 180°C (15°C/min) Vibration: up to 40g rms (power spectral density 0 to 20 kHz)</td>
<td>5Hz ± 2000 Hz Max acceleration: 95g da +20 a +70°C da -40 a +180°C e UR 98%</td>
<td>da +20 a +70°C da -40 a +180°C e UR 98%</td>
<td>&lt;30g T &lt;20ms</td>
</tr>
</tbody>
</table>

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Tests laboratory
ACCREDIA (Italian Accreditation System)
ACCREDIA is a non-profit body whose purpose is the accreditation of test laboratories. By means of periodic inspection visits, ACCREDIA accredits the laboratory, for each single test, only after having ascertained the existence of precise technical and organizational requirements, so as to guarantee the metrological references, the reliability and repeatability of implemented procedures, the use of suitable instruments, the personnel’s skills, the neutrality of personnel assigned to the tests, according to the provisions of standard UNI CEI EN ISO/IEC 17025 and its prescriptions.
The results contained in the test reports concern exclusively the tested object. The test reports do not entail the product certification.
ACCREDIA is a member of EA (European co-operation for Accreditation) and ILAC (International Laboratory Accreditation Cooperation).
For the list of accredited tests, please visit the website www.acciedia.it.

ACAE (Association for the Certification of Electrical Equipment)
ACAE is an independent product certification body whose members include independent bodies operating in the certification sector, electrical equipment users and manufacturers, research institutions and test laboratories. It is accredited by ACCREDIA for the certification of low and high voltage electric equipment in accordance with standard EN 45011 (“General criteria for product certification bodies”) and it is founding member of the LOVAG (Low Voltage Agreement Group) for the mutual acknowledgement of certifications within the EU. It promotes the mutual acknowledgement of certificates of conformity issued by itself and by other Italian, EU and foreign certification bodies.
ETL SEMKO
ETL SEMKO is a world-wide body specialized in product testing, inspection and certification. ETL SEMKO verifies and certifies full compliance of the products to electromagnetic compatibility standards and to performance tests, offering manufacturers a chance to distribute their products throughout the world.

UL
Underwriters Laboratories Inc. (UL) has been a leading independent body since 1894 in safety tests and product certification; UL is the most well-known trademark in the United States, and it has become one of the most widely recognized product conformity suppliers in the world.

ASTA
ASTA was founded in 1938 as the Association of Short-Circuit Authorities. Intertek’s ASTA Services team delivers leading services for the electrical industry. Their services include schemes truly recognized internationally approvals for low, medium and high voltage certification. The ASTA marks and/or type test certificates clearly indicate that the product has been independently tested to comply with the relevant clauses of the applicable standards. ASTA Certificates/Reports have International recognition, including a very high profile in Asia and the Middle East, often ‘specified’ by major end-users.

ANCE
The Asociación de Normalización y Certificación A.C. (ANCE) is the Mexican body that comprises all standardization and conformity assessment services. It is the body accredited throughout Mexico for product certification.

CSA
The Canadian Standards Association (CSA) is a not-for-profit organization whose declared mission is to develop standards for use in various different fields of specialization. CSA is formed by representatives from the government, from industry and consumer associations. CSA began in 1919 at federal level as Canadian Engineering Standards Association (CESA) for the purpose of creating standards. Now, CSA is accredited by the Standards Council of Canada as an organization that develops standards and as a certification body.
Laboratory timeline

since 1956
The laboratory for short-circuit tests was established at the plant in via Baioni and was equipped with:
- a 150 MVA, f = 50 Hz alternator;
- a 60 MVA transformer with 140 V to 34.6 kV secondary voltage values;
- two test cells, used alternatively, with one single data recording system and timer.

Design engineering of new apparatus marked a process of upgrading for low voltage products: the turning point was moulded-case circuit-breaker Z150, tested in the company’s outfitted test rooms.

Research into air circuit-breakers was also stepped up and led to the creation of the first Otomax prototype, which replaced the previous series of FRM circuit-breakers.

since 1970
The short-circuit laboratory moved to its present headquarters in via Pescaria and the following machines were purchased:
- two 300 MVA alternators with f = 50 Hz;
- a 200 MVA transformer with 160 V to 1100 V secondary voltage values;
- a 600 MVA transformer with 2 kV to 41.5 kV secondary voltage values;
- two test cells, used alternatively, with one single data recording system and a synchronizable timer.

The Material Test Room was also created as a Quality Control Laboratory and was used to perform the following tests:
- metallography tests plus analysis of the hardness and density of the electrical contacts and metal components;
- tensile and compressive strength tests up to 50 kN;
- fire resistance tests on plastic materials;
- ball pressure tests.

since 1976
The Experimental Tests section acquired a Brentford generator for continuative tests up to 6 kA and overload tests up to 40 kA.

since 1976
The first version of the digital recording system for test results became a reality and the first high speed video footage was taken.

The Experimental Tests section purchased test benches for performing relay tripping and heating tests on the entire range of direct and alternating current circuit-breakers.
since 1990
A new 2800 MVA alternator increased the power available for the short-circuit tests. The following equipment was also purchased:
- a 200 MVA transformer with 160 V to 1100 V secondary voltage values;
- two 900 MVA transformers with 2 kV to 41.5 kV secondary voltage values;

The Material Test Room began to support the project engineering tasks for low voltage circuit-breakers. New measuring instruments enabled both plastic and metal components to be subjected to a new range of tests. These tests included:
- infrared spectroscopy (FT-IR)
- differential thermal analyses (DSC);
- glow wire resistance tests.

since 1996
Digital equipment took over from the analog recording systems. The direct current short-circuit values were also increased thanks to a new rectifier bridge.

since 2000
A second station for low voltage tests was installed, with current values of up to 70 kA and voltage values between 140 V and 1000 V.

since 2001
A new laboratory section dedicated to Electronic devices was created.

since 2005
All the laboratory sections were unified in the present building in via Pescaria.

since 2006
The laboratory dedicated to electromagnetic compatibility (EMC) was created for the purpose of pre-compliance tests.

since 2007
The Laboratory began to perform the first Halt/Hass tests with -70 °C to 200 °C stress capacities at 30 g acceleration. Additions were made to the Experimental Tests section with single-phase and three-phase static feeders for tests with 16 Hz to 400 Hz frequency values and current values of up to 10 kA in continuous duty and 18 kA in overload conditions.

since 2009
A new shaker allows vibration and impact tests to be performed.

since 2012
The new ICP-OES equipment (atomic emission spectroscopy) was purchased for the chemical analysis section of the Material Test Room, thereby allowing the elements in different types of materials to be analyzed.

since 2013
The low voltage performance of the short-circuit laboratory was increased to a further extent: up to 440 kA peaks, 150 kA for 1 second and 15 Hz to 60 Hz variable frequency tests.

The electric life system was boosted for direct current tests of up to 2000 A with up to 2000 V voltage values.