A SUCCESSFUL LPC POWERCENTER SWITCHGEAR DEVELOPMENT – 6300A – 100kArms -690V

(by IEC 61439-1&2 plus internal arc test **100kArms** + seismic tests)

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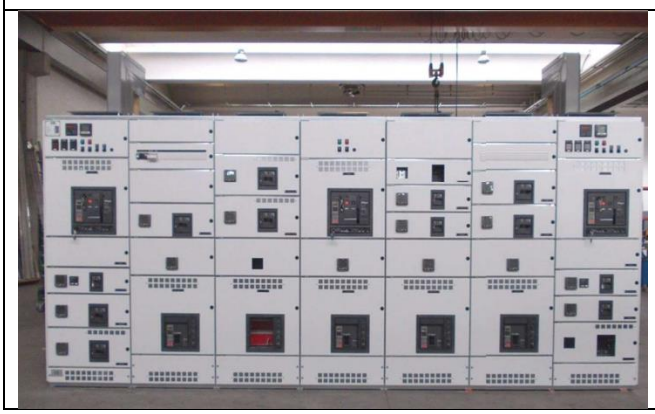
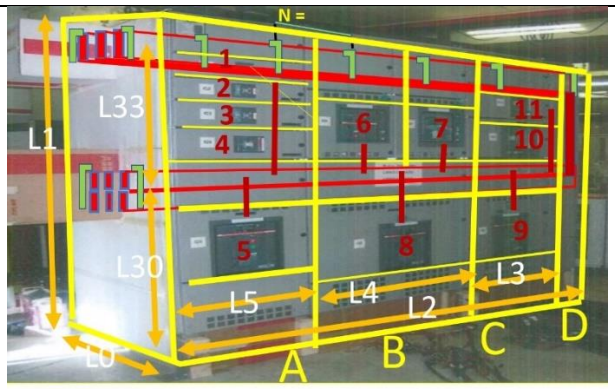




1. ABOUT THE DEVELOPMENT, THE PRODUCT AND THE LIST OF TESTS

To develop a reliable product that pass all the IEC tests and is optimized to be more efficient, using less materials saving Earth resources is a hard task. In this article we do an overview of the process and main tests successfully performed.

ICEL did developments based on the existing copper LPC POWERCENTER SWITCHGEAR with the assistance of the coauthor consultancy to carry out a detailed assessment of the electromechanical design of the equipment already submitted to the tests including “Internal Arc” and “Seismic” tests.

The sequence of the work involved, at first to analyse the ICEL data and drawings in order to elaborate validated simulations models with the software SwitchgearDesign. A set of calculations and recommendations was prepared and written in a “Design Review Report”.

To enable the understanding and discussions of the design details, a training was prepared by Cognitor with the collaboration of ICEL team. Based on the design review report, the testing simulations and the experience of the participants ICEL defined the final details of the design.

Along the discussions it was also performed an analysis of the compatibility of the design with circuit breakers from various manufacturers and even the elaboration of alternative designs with other materials, for future innovative designs.

After this the ICEL LPC was successfully submitted to the final laboratory tests in 3rd part laboratories. The tests were performed according to the IEC 61439 series of standards with focus on:
Part 0 (2022) - Guidance to specifying assemblies.
Part 1 (2020): General rules
Part 2 (2020): Power switchgear and controlgear assemblies
IEC TR 61641:2014 - Enclosed low-voltage switchgear and controlgear assemblies - Guide for testing under conditions of arcing due to internal fault
For the seismic tests the reference standards are:

- IEC 60068-3-3:2019
- IEC 60068-2-57: 2013
- IEC/TS 62271-210
- IEEE-693-2018

The list of tests performed and passed on the LPC switchgear are the following:

Temperature rises test at 6.300 A (10.10) and verification of dielectric properties (10.9)	IEC 61439-2 §10.10, §10.9
Verification of protective circuit (10.5), verification of short circuit withstands strength 100kA 1 sec (10.11) and dielectric properties (10.11)	IEC 61439-2 §10.5, §10.11
Internal arc test 100KA 0,3sec	IEC TR 61641 Ed. 3.0 (2014)
Seismic “Earthquake Tightness Test”	IEC 60068-3-3:2019 IEC 60068-2-57: 2013 IEC/TS 62271-210 IEEE-693-2018
Resistance to corrosion	IEC 61439-1 (§10.2.2.2)
Verification of degree of protection against access to hazardous parts IP3X	IEC 60529 § 12 §13
Verification of degree of protection IPX1	IEC 60529 § 14.2.1
Verification of degree of protection against external mechanical impacts (IK10 code)	IEC 62262

2. INTERNAL ARC TESTS PERFORMANCE

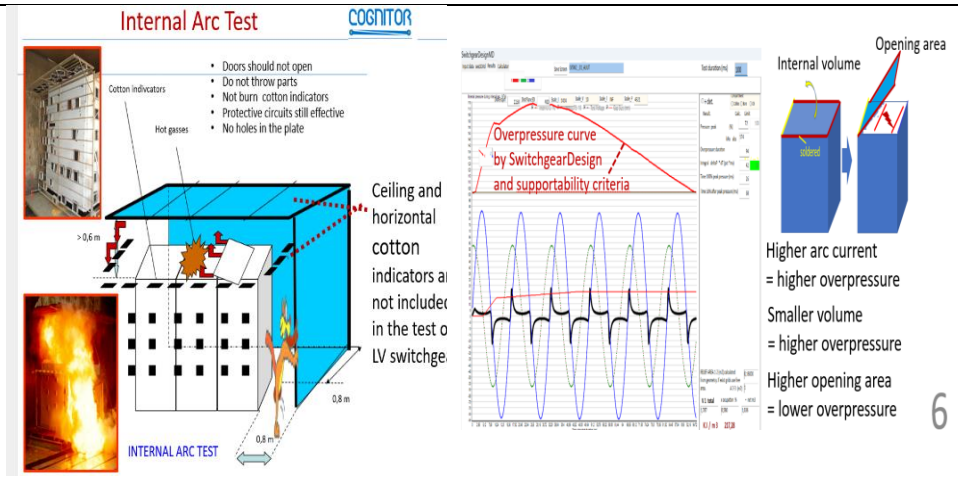
Internal arcs in switchgear above some 15 kArms are extreme events that cause risks to life and installations. Deaths are not rare when an operator is in front of a door that opened by overpressures or an enclosure hole. Look the videos in the article of [Ref .1] to have an idea. In LV systems the voltages are some 1/15 of the MV systems. However, currents higher than 40kArms are each time more frequent. Short circuit levels like 85 to 100kArms are not anymore, an exception. So, the amount of energy involved in LV is not high as in HV systems but is very high.

IEC TR 61641 is a guide for LV switchgear internal arc tests. It aims to assess the ability to limit the risk of personal injury, damages, and suitability for further service. It covers arcing classes related to

(i) personnel protection,
(ii) damage restricted to part of the assembly, and
(iii) suitability for limited service after an internal arc.

For MV/HV, the standard specifies levels of personnel protection and differentiates areas restricted to skilled persons and others accessible to ordinary persons. It covers access from front, back and sides and – very important - requirements for arc ignition protected zone.

The test consists in creating an arc inside the switchgear through very thin wires. When you energize the equipment arcs will be created moving in the direction opposite to the source. They cause a big internal overpressure which will try to open doors and bend the walls. If the arc stop in a bolt of a bad finished busbar may burn-through creating a hole. The cottons represent the skin of an operator outside. Some conditions shall be met during and after the test.



The test was made in 6 applications of current **100 kArms** during 300ms. In all of them the criteria 1 to 5 was fully attended.

3. SEISMIC TESTS PERFORMANCE

The test [Ref.2] consists of fixing the panel to a shaking table that will produce specified lateral and vertical forces, as in an earthquake. The key aspect is “what will be verified after the tests” related to the panel functionalities. The principles of “inspection and functionality tests” after passing by the vibrations in the table are detailed in document IEC TS IEC 62271-210. The observations after a successful seismic test, are verified by visual inspection. They are:

- No permanent deformation, dislocation, breakage, or cracks
- No loosening of components/equipment's from their original mounting and
- Doors to remain in closed position as was before test.
- Mounted equipment's should be in operational state in energized condition.

The functional tests performed during the “Earthquake Tightness Test” carried out September 2023 started with an initial check in which, before starting the test, the functionality of the switches was verified by testing their opening and closing through.
a remote connection. In the initial state, before starting the test, the switches were placed in the CLOSED position (normal operation).
During the seismic test, which duration is 30 seconds for each run, the switches were OPENED, CLOSED, and then REOPENED through remote commands, to test their functionality during the earthquake.
After the seismic test, the perfect functionality of the switches was verified through the same sequence of openings and closures of the switches.
The mechanical integrity of the switchboard and its main components was also checked successfully for the fixing points, bracing elements, vertical uprights of the structure, busbars and relative bus bar supports and bolted connections. In addition, no deformation or alteration of the state of the painting was detected between before and after the test.

4. ABOUT THE PROTECTIVE CIRCUIT, VERIFICATION OF SHORT CIRCUIT WITHSTANDS STRENGTH

If the remaining busbar configurations are of the same construction, then using a single busbar configuration is adequate for this test. Every component meant to be linked to the operational protective conductor, including the enclosure, needs to be linked.

The maximum thermal and dynamic stresses that could arise from short circuit currents up to the rated values must be applied to the circuits during testing. For the given duration, these are the rated short time resist current and the rated peak withstand current. Every kind of circuit must have one examined. The test voltage must then be applied

after the switching device has been closed and maintained closed.

If a neutral conductor is present, it must pass one test to demonstrate its ability to tolerate short circuits in respect to the closest phase conductor. Deformation of the busbars and conductors following the test is allowed as long as the clearances and creepage distances are maintained.

The insulation's characteristics must be maintained in a way that ensures the equipment's mechanical and dielectric qualities meet the standards of the applicable industry. The cable restraint, support, or busbar insulator hasn't broken into two or more pieces.

A single-phase test supply must be connected to both the incoming protective conductor terminal and the one-phase incoming terminal in order to test the protective circuit. Every representative exiting unit must undergo a different test. The frame needs to be insulated from earth. The single-phase value of the rated operational voltage multiplied by 1,05 is the test voltage. During the three-phase test, the test current in the protective conductor must be at least 60% of the phase current.

The protection circuit's continuity and short-circuit withstand strength should not be noticeably compromised following the test. In addition to visual assessment, current measurements are used to confirm this.

5. ABOUT THE DIELECTRIC PROPERTIES TEST

A power-frequency withstand test shall be performed on all circuits in accordance with a duration of 1 s. This test need not be made on auxiliary circuits which are protected by a short-circuit protective device with a rating not exceeding 16 A. Also need not to be made if an electrical function test has been made previously at the rated operational voltage for which the auxiliary circuits are designed.
As an alternative with incoming protection rated up to 250 A, the verification of insulation resistance may be by measurement using an insulation measuring device at a voltage of at least 500 V d.c. In this case, the test is satisfactory if the insulation resistance between circuits and exposed conductive parts is at least 1 000 Ω/V per circuit referred to the supply voltage to earth of these circuits.

6. ABOUT THE TEMPERATURE RISE TEST

The complete assembly shall be verified by temperature rise testing of the most onerous arrangement(s) possible in service. For this test the incoming circuit is loaded to its rated current and each outgoing functional unit to its rated current. This test became very complex in the last revision of IEC61439-1 and several tests were necessary to verify the LPC POWERCENTER switchgear, which was approved in all the tests as stated in the test report.
At the end of the test, the temperature rise shall not exceed the values specified in Table 6 of IEC61439-1 standard. The apparatus shall operate satisfactorily within the voltage limits specified for them at the temperature inside.
On the contrary of the temperature rise tests specified for medium voltage switchgear (IEC62271-1), in the low voltage standard, the values are not objectively specified in a way that the testing laboratory can state that the temperature rise limits of connections were attended. By this reason it is common to find in the market test reports without the “passed” statement.
This is an important aspect of the tests made by ICEL. The test results are very well detailed, and the statement “Passed” is clearly informed.
For readers that want to go deeper in the matter we suggest reading IEC TR 60943 in reference [4]

7 -FINAL COMMENTS

We are really happy with the results of the development and tests. We can state using detailed and transparent test reports that the LPC Power Center is a good and rare alternative for the market.

To have a 6300 A – 690V tested for internal arc 100 kArms and with seismic test is very difficult to achieve.

With these last tests the LPC series Power Centre is now fully type tested in all aspect that characterized a LV Switchgear, from mechanical and electrical point of view.

It is clear the IAC classification is not a mandatory characteristic for an electrical cabinet, linked to the place and way of use; if possible, it is better to avoid such additional feature but from the test done we learn a lot of where an IAC can start in normal use and especially how it run and work inside a switchgear.

Same consideration for the Seismic test which was impressive in term of movement and stress that can be applied on the switchgear during such events.

All these lesson learning, will surely improve our manufacturing system giving always much more care to the details, which can reduce the risk during use by end users.

For more details and news, we suggest to see our web site https://icel.energy/.

In particular, for Seismic and IAC refer to these interesting links:

- IAC internal Arc Type Test (A-FLR 100kA 0,3 sec) on our LPCA Power Centre ACAE – LOVAG Certificate n.IT 24.011 ➔ https://www.linkedin.com/posts/icel-sistemi-elettrici_icel-powercenter-lowvoltage-activity-7123583351076077568-b_Ky?utm_source=share&utm_medium=member_desktop

- Seismic withstand type test on our LPCA Power Centre at EUROCENTRE (by ACCREDIA) ➔ https://icel.energy/il-powercenter-di-icel-ora-certificato-anti-sismico/

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REFERENCES

[1] IEC TR 61641 – Internal arc tests in LV switchgear: some testing labs misinterpret shots. Read IEC explanation & avoid exaggerated tests.
https://www.cognitor.com.br/TR_133_ENG_AnswerIECaboutInternalArc.pdf

[2] Article: HOW TO BE APPROVED in SEISMIC TESTS for SWITCHGEAR, SWITCHBOARDS & BUSWAYS IEC 62271 / IEC 61439 https://www.cognitor.com.br/seismicswitchgear.pdf

[4] IEC TR 60943:1998 - Guidance concerning the permissible temperature rise for parts of electrical equipment, in particular for terminals. Issued by IEC Technical Committee TC 32.

Other reference articles:

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