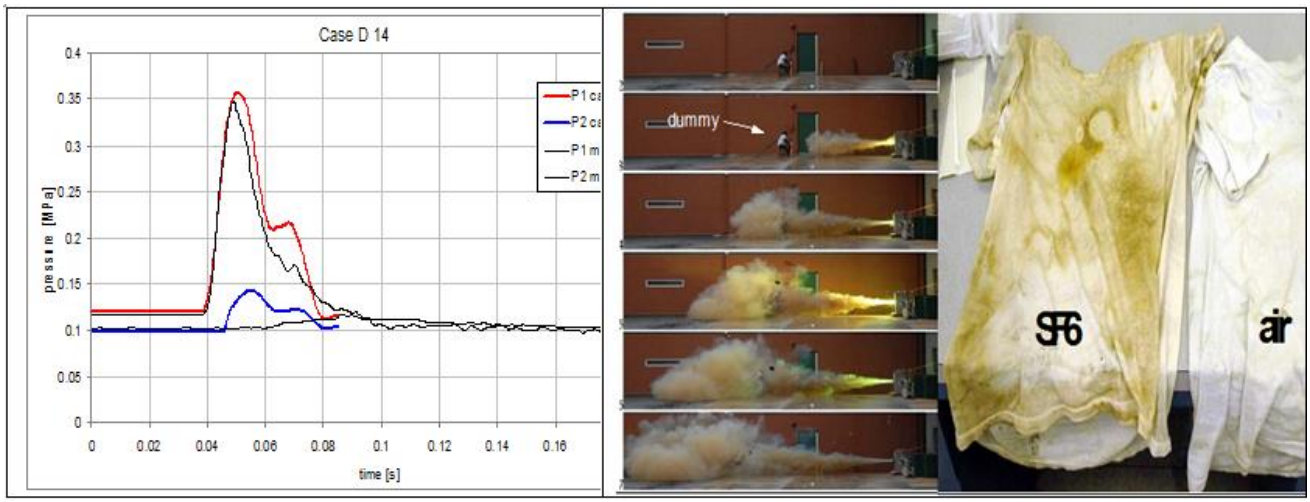
OVERPRESSURE MEASUREMENTS during INTERNAL ARC TESTS: IEC 62271-200 X Cigrè Brochure 602 X new IEC 62271-307

Author name: Affiliation:
Sergio Feitoza Costa COGNITOR – Consultancy, Research and Training Ltd.
Email: sergiofeitoza@cognitor.com.br Site : http://cognitor.com.br/

Keywords: IEC, CIGRÈ Simulations, High Power Tests, Switchgear, Switchboards, Bus-bar, Testing Laboratory, Internal Arcs, Overpressure, Temperature rise, Electrodynamic forces, stresses, Short time currents, EMC, Magnetic fields, Electric Fields, Substations, certification.



Several articles and documents have been published about internal arc in panels and switchgear. Certainly, the most complete document in this theme is the recent brochure CIGRE 602 / 2014 “TOOLS FOR THE SIMULATION OF THE EFFECTS OF THE INTERNAL ARC IN TRANSMISSION AND DISTRIBUTION SWITCHGEAR”. That document cover many aspects as the theoretical fundaments, calculations, simulations and practical aspects of the daily life, for example:

- Calculation of pressure using basic and complex models (with simple and with complex software tools)
- Internal arc testing
- Standardization and test experience
- Effect of internal arc on structures (mechanical stress on switchgear and building walls due to overpressures)
- Burn-through effect
- internal arc simulation review and tools for the simulation of the effects in T&D switchgear
- Comparison of actual and reference switchgear using design parameters
- Equations for pressure rise calculation
- Pressure sensors: types and accuracies
- Cotton indicators: energy absorption and flammability
- How to determine worst case scenarios for simulations.
- Comparisons between effects in air and SF6 equipment

It is a “must” document for designers of switchgear. One of the useful aspects covered in this Cigre brochure are the contributions which may be used for improvements in IEC 62271-200 (medium voltage switchgear) and other related high voltage and low voltage standards. One of these aspects is the importance of measuring the overpressure during internal arc tests. It is almost unbelievable that after so many years of use of these IEC standards and knowing that the overpressure is the most relevant parameter which influence test results, the measurement is not mandatory in IEC 62271-200 nor in IEC 61641. As it is not mandatory, the testing laboratories, for saving time, do not perform it unless it is formally requested by the laboratory client. A lot of useful information is simply lost.

The new IEC 62271-307 (medium voltage switchgear) give guidance for the extension of the validity of test reports made in accordance with IEC 62271-200. However, for practical purposes this is possible only when the overpressure has been measured in the test of the original equipment. If a manufacturer is doing a test in a “first of a series”

equipment and do not request the overpressure measurement to be included in the test report it is throwing away the opportunity to save hundreds of thousands of Euros in the execution of future tests. Simple like this. Cigre brochure 602 present several objective information about the importance and how to the measurements of overpressure.

The information given by this easy measurement can be used for improving designs and solutions and even to clarify doubts that arise during testing in laboratories. An example is when the test conditions become more severe than is specified in the technical standard because extra arcs were produced due to some failure in the (laboratory) cables which feed the test. This is difficult to identify even for experienced designers and testing teams. If the overpressure curve is available, it is easy to identify the causes and to avoid manufacturer expenses with test repetitions.

Internal arc tests on AIS equipment are type tests for medium voltage panels (IEC 62271-200) but are not yet (why?) type tests for low voltage panels (IEC 61439). The buyer market, however, increasingly requires, on a sound basis, that manufacturers of low voltage panels prove that the equipment has been tested and approved in the IEC TR 61641 test.

The work of team preparing the Brochure 602 began reviewing the existing literature (more than 100 papers and technical standards) and collecting test data from many internal arc tests. Test data were collected from more than 80 different cases with enclosure sizes ranging from less than 5 liters to large GIS tanks (1200 liters). Fault currents ranged from 12 kA to 63 kA, with fault durations ranging from 10 ms to 1.2 s.

It included to analyze from simple enclosures to equipment with several compartments insulated by SF6 and air. During the analysis, the three main effects of an internal arc were (a) the overpressure (b) mechanical stresses in the enclosure, installations and walls caused by internal overpressure, and (c) the "burn-through" effect trying to make holes in the enclosure

In section B.4 of the brochure one of the references is the text "Guidelines for the use of simulations and calculations to replace some tests specified in international standards". Cognitor Guide 2010. This Guide propose maximum tolerances for the differences obtained between the simulation methods and the results that would occur in the laboratory test specified in the relevant product standard would be specified.

Type of test	Parameter to compare	Acceptable difference tests X simulation (%)
Temperature rise test	Temperature rise in solid and fluid parts	1% to 5%
Internal arc test	Overpressure in the enclosure (crest value, time to peak and time to 50% of peak)	5% to 10%
Short time current and crest withstand current test	Electrodynamic forces and mechanical stresses	5% to 15%

Per the Guide, the minimum input data to be recorded in laboratory test reports are:

- The circulating electric current,
- Materials used in conductors, insulation parts and fluid inside a compartment.
- The position and spatial geometry of conductors
- The volume of the fluid inside the compartment and the area of the overpressure relief devices.
- The ventilation entrance and exit areas (if exist devices that close them during an internal arc)
- The relative position of the equipment in relation to the walls and ceiling.

The author of this article is Mr. Sergio Feitoza Costa. Sergio is an electrical engineer, M.Sc in Power Systems and director of COGNITOR. Sergio has 25 years of experience in design, operation and management of high power, high voltage and other testing laboratories.
He gives consultancy in the design of new testing laboratories and design of panels, switchboards, busducts.
Sergio has also 16 years of experience in testing simulations in support to manufacturers and certification companies.
Sergio is the author of the simulations software SwitchgearDesign and provide training on this..

Here is a link for parts of the trainings applied by Sergio (in English, Spanish or Portuguese):
https://www.youtube.com/channel/UCyQtdE7dQTvsZPHBw3ostMg/videos?view=0&sort=dd&shelf_id=0