SUGGESTIONS TO THE MANAGEMENT OF KEY IEC STANDARDS

About overpressure measurements in IEC 62271-200, temperature rise limits and internal arc in iec61439, aging test in IEC 60282-2 , a new T.R. on testing simulations, standards in more languages & new T.R. on design of LV to HV products. http://www.cognitor.com.br/improvementsiec.pdf

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1. ABOUT IEC STANDARDS PREPARATION AND THEIR REVISIONS

I am an admirer of the competence and quality of the work done at IEC since the time I had the honour to chair the Technical Committee 32 and working group of SC32A (WG) by the end of the 90's. After that I participated in the WG that created IEC62271-307 (2015). In this article I present 7 suggestions related to some IEC documents:

IEC 62271-200:	Measurement of overpressures during internal arc tests of switchgear
IEC 61439 –	Temperature rises limits for temperature rise tests. Include a table like in IEC 62271-1
IEC 61439:	Internal arc test of IEC 61641. include as a type test of IEC 61439.
IEC 60282-2 –	Include an aging test for high voltage expulsion type fuses.
IEC TR XXXXX –	Create a TR for testing simulations.
IEC TR XXXXX –	Create a TR "Guidelines for the design of (lower cost) LV to HV products (lower cost and more rational use of materials and resources (**) for example a unique temperature rise table for all IEC product standards.
IEC XXXXXX -	Implementation of IEC standards in additional languages

IEC technical standards go evolving throughout their use and revisions even though they will never be "perfect" documents. In some standards we percept that old concepts took root in such a way that the will to change them was lost. Maybe this is because, the big international manufacturers are mostly the members of the working groups (WGs). They invest in participating and it is natural that they are averse to changes that can impact their business worldwide. The way IEC organize the preparation is much more efficient than the National Standardization Bodies. The last ones prepare translations that are published 2 to 3 years after the original.

Several developed countries have an active actuation in the IEC WGs. Their geographic location permit to go at lower cost to the WG meetings. For experts living in South America the Mena countries or Asia the geographic distance is a barrier to the participation because there are significant expenses with air ticket, hotels, and time to go two or three times per year to the meetings. I suppose this is improving along the pandemics, due to the use of web meetings.

Each IEC document represents the compromise, which is possible to achieve between WG members interests. I learned this when I was chairing the IEC Technical Committee 32 and collaborating in WGs which did the 1989 revision of IEC 60282-2 and, more recently, created IEC 62271-307 (2015).

Sometimes a WG member proposes something new and useful, but if there is no broad consensus, this is not included in the standard. I experienced this when I proposed – among others - an aging test for high voltage expulsion fuses, and it was not accepted although successfully included in Brazilian standards since the late 1980s. This test has drastically reduced the number of "circuit disconnections without reason". The standard does not adequately consider the relation between the temperature limits of the materials and accelerated aging. IEC 60943, prepared by TC32, explains this in detail as well as the concepts about electrical connections and their materials.

We can demonstrate with numbers that Brazil had important improvements in the SAIDI (System Average Interruption Duration Index) and SAIFI (System Average Interruption Frequency Index)

In the last 10 years, I have been writing suggestions for improvements in IEC standards. Some of them are in next sections.

2. IEC 62271-200 : MANDATORY MEASUREMENT OF OVERPRESSURES DURING INTERNAL ARC TESTS of H.V. SWITCHGEAR.

CIGRÈ Brochure 602 (2014) explains that the occurrence of internal arc in enclosed switchgear is an impacting event. It is the more complete publication about this theme. It is named “Tools for The Simulation of the Effects of the Internal Arc in T&D Switchgear”. It covers the calculation of the overpressure using computation models and equations, simulations review, tools, validation. Also cover effects of internal arc on structures (mechanical stress on switchgear and building walls) and “ Burn-through” effect. I am one of the coauthors of this publication and assure that it is very useful for designers. Suggestions for improvements in IEC 62271-200 related to the importance of measuring the overpressure during internal arc tests. Maybe this influenced the fact that. At least, the measurements are mentioned although optional.

The overpressure is the most relevant parameter which influence test results but the measurement, although easy to do, is not mandatory in IEC 62271-200 nor in IEC 61641. It was an advance to become optional in the 2021 version of IEC62271-200. This is good but we need a step ahead. As it is not mandatory, testing laboratories do not perform it unless it is requested by the lab client. A lot of useful design information is lost without this measurement. The IEC 62271-307 (2015) gives guidance for the extension of the validity of test reports made in accordance with IEC 62271-200. It is easy to avoid tests if the overpressure has been measured in the test of the original equipment. You may base the analysis only in the test simulations, but it is better and easier having the measurement.

If a manufacturer tests a “first of a series” equipment and do not request the (optional) overpressure measurement to be included in the test report it is throwing away the opportunity to save hundreds of thousands of Euros in future tests. The information given by this easy measurement can be used for improving designs and solutions and even to clarify doubts or lab errors that arise during testing in laboratories.

One of the references of the brochure is the text "Guidelines for the use of simulations and calculations to replace some tests specified in international standards". Cognitor Guide 2010 (see section 5 below).

> So, the suggestion is that TC 17/SC 17C maintenance team include the measurement of the overpressure as part of the test specifications and not as optional . While this does not occur manufacturers shall not forget to request to the testing laboratory to do the overpressure measurements if they have the vision to use the openings of IEC 62271-307. Most testing laboratories will not alert them about this aspect before the test because is not their role.

3. IEC 61439 – TEMPERATURE RISES LIMITS of TEMPERATURE RISE TESTS. ADD TABLE FROM IEC 62271-1

In the article “IEC 61439: The Mystery of the Temperature Rise Limits” (link below) , circulated all over the World, I did some questions like (a) Was your low voltage switchgear approved in the temperature rise test? (b) Is this written in the test report ? – if not you have a weak point in your “quality system” (c) Why IEC 61439 series do not have a table, exactly equal to the table in IEC 62271-1, to permit a testing lab to state if the equipment passed or not in the temperature rise test?

I did an alert to buyers of LV switchboards and highlighted the market issue caused by not having clear temperature rise limits defined in IEC 61439. IEC technical standards are powerful documents giving guidance to specifications, tests, and types of equipment which will be commercialized in the Worldwide market. What is written there is seen as unquestionable and most buyers, manufacturers and testing labs follow it fully.

The temperature rises limits define most of the design, use of materials and its cost. Not specifying limits in critical points like the connection of busbars to the circuit breaker, creates unfair competition in the market. This is because LV manufacturers aiming, correctly, to follow Table 1 of IEC 62271-1 may have a design of higher cost, by using more copper / aluminum. The table in IEC series 61439 do not show the relevant values for the hotspots. By this reason, testing labs, in most of the cases, do not write in test reports if the equipment passed or not. The strange deficiency in IEC 61439 standard is detailed in the article. Read with attention the table 1 below.

Table 1 – Values extracted from Table 14 of IEC 62271-1 (2017)) for temperature rise limits of MV switchgear

Note by Sergio Feitoza: The limits of IEC 61439 series should be exactly as these ones because there are no differences between the materials and functions used in both.

Nature of the part, of the material and of the dielectric	Maximum value	
	Temperature °C	Temperature rise at ambient not exceeding 40°C K
Contacts		
Bare-copper or bare-copper alloy		
- in OG	75	35
- in NOG	115	75
- in Oil	80	40
Silver-coated or nickel-coated		
- in OG	115	75
- in NOG	15	75
- in Oil	90	50
Tin-coated		
- in OG	90	50
- in NOG	90	50
- in Oil	90	50
Connections, bolted or the equivalent		
Bare-copper or bare-copper alloy or bare-aluminium alloy		
- in OG	100	60
- in NOG	115	75
- in Oil	100	60
Silver-coated or nickel-coated		
- in OG (like in the air)	115	**75**
- in NOG (like in SF6)	115	**75**
- in Oil	100	60
Tin-coated		
- in OG	105	65
- in NOG	105	65
- in Oil	100	60
Terminals for the connection to external conductors by screws or bolts (refer to points 8 and 14)		
- bare	100	60
- silver or nickel coated	115	75
- tin-coated	105	65
Accessible surfaces		
Surfaces of manual control components to be touched in normal operation:		
- Uncoated metal	55	15
- Coated metal	55	15
- Non metal	65	25

4. IEC 61439 series – INCLUDE THE INTERNAL ARC TEST OF IEC 61641 AS A TYPE TEST OF IEC 61439

If you watch a video of an internal arc test of a medium voltage panel (IEC62271-200) and another video of test on low voltage (IEC61439 + IEC 61641) you will notice that there is a difference in the effects of overpressure relief, but that in both cases, the consequences for a person who is near the switchgear are severe and can even kill.

In IEC 62271-200 the IAC classification corresponds to a type test but in IEC 61439 it does not and consists of a separate TR. The test methods are very similar and there is a difference in the firing indicators. The suggestion here is very simple. Bring the contents of IEC 61641 to an attachment of IEC 61439 and make it a type test.

5. IEC 60282-2:2008 - High-voltage fuses - Part 2: Expulsion Fuses (INCLUSION OF A TEST FOR AGING)

This standard provides requirements for high-voltage expulsion fuses for use outdoors or indoors. It is a well-known fact that the main cause of undue operation of such fuses are the mechanical effects and aging caused by the variation of the values of the currents. Along the day, the currents vary from normal currents to overloads as well as in the distribution transformers that they are protecting. If transformers have a special treatment with overloads capability, we should expect something like this for the fuses electrically in series. Thermal cycling is the basis for aging tests included in some IEC standards.

The Brazilian standards for expulsion fuses are possibly the most advanced in the world, related to the aspects of undue failures. They were published around 1991 and based in hundreds of laboratory tests in a R&D work done by the Brazilian electrical sector. The objective was to reduce the taxes of failures and outages in distribution power utilities. I participated in this work in the testing lab. Just after I coordinated the preparation of the new Brazilian standards. We recently sent suggestions for revisions based on the Brazilian standard NBR 7282 that is now, in 2022 under revision. The suggestions include from aging tests to the adoption of the concepts of “Extension of the validity of test reports”

6. NEW IEC TECHNICAL REPORT (TR) ABOUT THE USE OF TEST SIMULATIONS TO REPLACE SOME TESTS

In 2010, I proposed to IEC and to the Brazilian National Standardization Body the preparation of a TR giving guidance to the use of testing simulations to replace some tests. For IEC, new work proposals are considered only if sent by an associate National Standardization Body. However, the Brazilian Body, at that moment, was not interested in the matter. The proposal was sent by me, with the support of 20 companies that intended to participate in the meetings of a WG. This set included 15 equipment manufacturers, mostly high and low voltage switchgear, testing laboratories, certification bodies, power utilities, and users. The article: "IEC guide for the use of calculations and simulation of laboratory tests” explain the details; It has inside a complete base text of the proposed standard https://www.cognitor.com.br/Article_Competitivity_Eng_04102011.pdf

Year after that proposal became referred in the books / brochures:

- CIGRE Brochure 602 (2014) -Tools for The Simulation of Internal Arc In T&D Switchgear
- CIGRE Brochure 740 (2018) - Contemporary Design of Low-Cost Substations in Developing Countries)
- Not referred by but related to some concepts in the tables of IEC TR 62271-307 (2015)

So, the proposal to IEC is to create a working group to prepare this technical report . The full text proposal can be read in http://www.cognitor.com.br/GUIDE_Simulations_v0_October2010.pdf . The text presents Guidelines for the systematization of the use of simulations and calculations which may be used to replace some laboratory tests in situations where the common sense shows it is reasonable to use it. The most frequent case of such use of simulations is in the extrapolation of real test results done in a certain equipment to predict the results of a test in untested equipment with characteristics close to the tested one. It is something linked to the objectives of IEC 62271-307, for the extension of the validity of test reports, but with a wider reach.

7. IMPLEMENTATION OF IEC STANDARDS AS A NATIONAL STANDARD IN OTHER LANGUAGES

For countries, participating effectively in the preparation of a new IEC publication its implementation as a national standard is almost immediate. Having participated in the preparation, they already know the details and, important, the standard is in a language that most of them they can read easily.

The language, in a technical standard, is much more relevant than most of the people using English as the language of everyday life assume. Important aspects may be not clear between the commas and double meaning words. For the standard average user, the time necessary to correctly understand the intention of the standards makers usually reach some three years. I remember difficulties I had in the past when coordinating IEC WG meetings. Sometimes was difficult to understand sentences and I needed to ask to the experts to explain me the correct interpretation.

IEC publications are bilingual in English and French. There are some publications translated into Spanish. The basic activity of the NSCs is translating the IEC standards from English to the language of their country. They usually start to do it two years after the publication of the original IEC standard. It takes two to three years to do the translation and to approve it as a "National Standard. Therefore, 4 or 5 years after the "new" national standard is finally available. At this moment, a new revision of the IEC is already under publication making that translation old in the origin.

This creates a "technical knowledge gap". IEC as a reliable worldwide opinion leader can give to the World a good example helping to reduce it through actions like, providing the main IEC original standards published in languages as Portuguese, Chinese and some others, independent of the action of NSCs. Most of the buyers of standards in these countries will prefer to buy directly from IEC them to buy a delayed translation of a previous version.

> So, the suggestion is to act to provide the main IEC original standards published also in languages as Portuguese, Chinese, Arabic and others, independently of the action of SNCs.

8. NEW IEC TECHNICAL REPORT (TR) " GUIDELINES FOR THE DESIGN OF (lower cost) LV to HV ELECTRICAL PRODUCTS (with rational use of materials and resources)

Since I participate in IEC work, I notice a lack of overall vision, about the interconnection between product standards for "Low Voltage" and "High Voltage" documents. For example, an IEC62271-200 (high voltage) switchgear has the same fundaments of IEC 61439 (low voltage). Both have the same functions and use the same materials. Why not having a single document to cover the common aspects of both?

An example is for the tables of temperature rise limits in all the products IEC standards. All electrical equipment of any voltage or current are basically the same thing. Electrical conductors conduct currents and heat up. Hot parts touch each other at connections and contacts and touch insulating parts that support the conductors. If the limit temperatures of the materials exceed certain values, the part ages faster or is destroyed. Instead of having for each product a copy – paste, for example, of the excellent table of IEC62271-1 or IEC 60943 table IEC could have this in just one document. All other product standards would not permit to copy-paste. They should just refer the unique table. Tables copy-pastes always introduce unnecessary errors and make the standards increasingly confusing.

It is worth to mention that along decades, committees such as SC 17 A, SC 17 B, SC 17 C, SC32A, SC42B, SC 32C were created subdividing the tasks. Each of them produces excellent standards and TRs but without trying to avoid repeating in "low voltage" what is already written in the "high voltage" documents and vice versa. Orientation should come from the high direction.

My suggestion is to start a kind of "prototype of the concept" like this. IEC has many very high-level and useful documents that are practically unknown to users. Some have even been canceled, possibly because few people bought. The suggestion / idea is to create a document that contributes to a more rational use of Earth's materials and resources, in the manufacturing of electrical products. The design oversizing could be greatly reduced if there is an IEC document with "GUIDELINES FOR THE DESIGN OF (Lower Cost) LV to HV ELECTRICAL PRODUCTS".

This document (TR) would explain how to develop projects to optimally meet the 3 most onerous requirements which are temperature rise, short-circuit electrodynamic forces and internal arc. The text would be based on IEC documents listed below.

It would be possible to write a basic text and discuss it in about 4 working group meetings in a maximum of about 12 months. The reference documents to include are referenced in IEC 62271-307 and CIGRÈ Brochure 740. I was in the WGs that prepared them.

- IEC/TR 60943: Guidance concerning the permissible temperature rise for parts of electrical equipment
- IEC/TR 60890, A method of temperature-rise verification of low-voltage switchgear and controlgear assemblies by calculation
- IEC 61117, Method for assessing the short-circuit withstand strength of partially type-tested assemblies (PTTA)
- IEC 60865-1 Short-circuit currents – Calculation of effects – Part 1: Definitions and calculation methods.
- IEC TR 60865-2, Short-circuit currents – Calculation of effects – Part 2: Examples of calculation
- IEC/TR 62271-307 (2015): High-Voltage Switchgear & Controlgear - Part 307: Guidance For The Extension Of Validity Of Type Tests Of AC Enclosed Switchgear & Controlgear for Rated Voltages .. 1 KV to…52 KV
- CIGRÈ Brochure 740 (2018) - Contemporary Design Of Low Cost Substations In Developing Countries.

I hope the article is useful to you all !!!.

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