UNDERSTANDING WHY SAVING COPPER, ALUMINUM & INSULATORS MITIGATES CLIMATE CHANGE
IEC, IEEE & LARGE BUYERS OF ELECTRIC PRODUCTS CAN PROFIT FROM THIS. COP_30 2025: some WG could discuss

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English http://www.cognitor.com.br/certificate.pdf   Português http://www.cognitor.com.br/certificado.pdf

ABSTRACT

Saving materials like copper, aluminium & insulators is beneficial for mitigating climate change because minimize the need for new raw materials. These savings reduce greenhouse gas emissions. The best moment for savings and innovations is the design phase. Designs that use less materials are a great opportunity for small and medium-sized manufacturers, since "old designs" predominate in the global sales of large international manufacturers. The big players do not focus on improvements that take them out of their comfort zone of decades of consolidated sales. As they coordinate the preparation of IEC/IEEE standards, they will not include in the texts phrases that encourage more efficient projects that use less materials. Do you think that those who say they are thinking about invading another country to get their rare metals are concerned about saving the Earth?

Producing materials and manufacturing goods require significant energy and resources resulting in more greenhouse gas emissions. Saving materials helps conserve natural resources like minerals, water and timber, reducing the need from extraction to processing, which also contributes to emissions. Retrofitting existing products, e.g. electric panels switchgears require less energy than creating new ones, further reducing emissions. Where materials are kept in use for a longer time you reduce environmental impacts of materials consumption. Big users of electric power equipment like oil and mining companies, and power utilities could use their purchasing power to profit and improve their environmental image, using strategies to encourage the purchase of products that use less materials.

Using Brazil as an example, imagine **if** big companies like PETROBRAS (oil & gas), VALE (mining), ITAÚ & Banco do Brasil (banks / financing), AMBEV (beverage), WEG, ABB, Schneider, Hitachi, Siemens, Eaton and Brazilian standards ABNT, banded together to improve their image as guardians of the environment. They could, in the 1st moment, hold an event to disseminate ideas and concepts that could cut the amount of materials used in the electric industry and boost energy efficiency by lowering power losses. The goal should be to develop more effective substitutes for the designs in the market. It is missing an indicator to demonstrate that a design is better than others. The proper indicator is the kg/MVA transmitted. It is unbelievable that IEC / IEEE standards, at no time, encourage or mention that using fewer materials is good for the Planet.

In this article, I present a strategy to start an innovative process to reduce materials use in the electrical industry. It includes a suggestion for a technical standard with rules for the indicator kg/MVA. These indicator & standard are basis of "Environmental Certificate for Electrical Products" COP_30 in November 2025 in Pará – Brazil would be a good stage to disseminate this Brazilian idea.

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1. SAVING EARTH RESOURCES VIA ELECTRIC POWER INDUSTRY ACTORS

Using, as examples, low voltage (LV) and high voltage (HV) electric panels / switchgear (IEC62271 / IEC61439 series). They are a very visible and profitable part of the world-wide industry. They consume a huge amount of materials such as copper, aluminium, insulating materials and steel. Their design involve technically well-prepared specialists who, however, are rarely concerned with producing designs with fewer materials. The main reason is that commercialized products must meet the test requirements of technical standards that, at no time, encourage or mention that using fewer materials is preferable. Such standards are managed by experts from large global manufacturers, practically without the presence of users.

Companies like ABB, Siemens, Eaton, GE, Hitachi and Schneider were the catalysts of the evolution of the electric industry from some 60 years ago. They invested in knowledge, people education & training, R&D centres and large testing laboratories. It was mainly due to their merits that the electrical industry grew. The solutions that were proper for that old times need to evolve to be more efficient using less materials. Their beautiful environmental speech are stagnant in the comfort zone of commercializing old projects to developing countries. Those designs are worst than the ones used in the G7 countries and use more materials than would be possible today.

It is this thinking and perception that needs to change, creating a new focus in which they can continue making their money and sharing the market, but acting at a higher level of environmental awareness.

It is in this context that the idea of an "Environmental Efficiency Certificate for Electrical Products" comes into play. A catalyst could be an IEC technical standard emphasizing the benefits of saving materials and how to promote it. The best forum to discuss and promote this idea is IEC and its National Committees because that's where these companies sit regularly together to talk about technical things.

National Committees like the Brazilian ABNT could even create a standard like this, even without having an IEC standard as reference, but since some 30 years ago, it has preferred not to create anything and spend 2 to 3 years translating already published IEC standards. When the translation is released, it is already late, since a new revision of the translated IEC is already coming out. Nowadays automatic translators are so good that do everything in minutes.

In the current scenario of irresponsible wars and insane political speeches, the electrical industry can help to create a counterpoint to the enormous loss of credibility on the efforts to mitigate Climate Change. How can the common citizen believe that the efforts to save the Planet are serious when rich countries make billions of dollars selling weapons of destruction? Not to mention crazy irresponsible people who encourage the production of more oil and gas just to gain some votes.

2. kg. / MVA: AN INDICATOR TO COMPARE DESIGNS WHICH ARE BETTER TO CLIMATE CHANGE

Most manufacturers know how to produce more efficient designs. Nowadays even individuals like me can easily create designs with much lower weight (less kg/MVA). IEC standards are followed all over the world. If they include statements telling that saving materials (lower kg/MVA) is good, everyone will follow.

As the large manufacturers are who dictate what will be included in the IEC standards, it would be easy and quick for them to put statements in IEC standards encouraging the use of fewer materials. It would be like done in the 80s in relation to Electromagnetic Compatibility (EMC) when all IEC product standards should include a statement about EMC.

I saw this happen up close because at that time I chaired IEC's Technical Committee 32.

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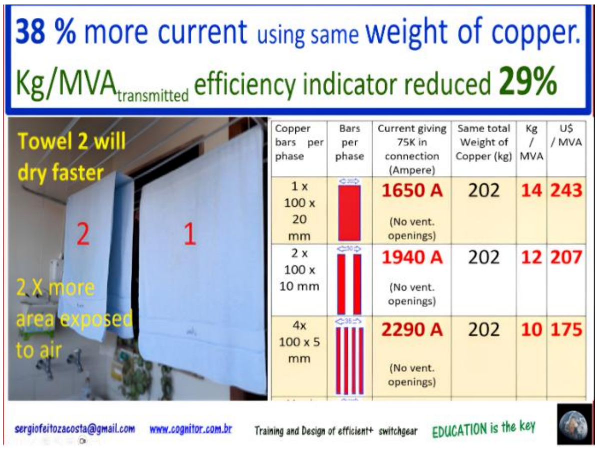
Figure 1 shows an example of how outdated designs might be modified to use less copper. Consider an outdated project that, with a 1x100x20 mm copper bar, can conduct 1650A and pass the temperature rise test. By switching to a 2x100x10mm design, you may conduct 1940 A being approved in the same test. It is even better, if you utilize 4x100x5 mm as you pass the same test even though your weight remains the same at 2290 A. Implies a 39% greater current.

The efficiency indicator kg /MVA transmitted is good to estimate the saving of materials with different designs, as in the table. Can be used to demonstrate, for marketing purposes, that a product is more "ESG" than others. ISO could use it.

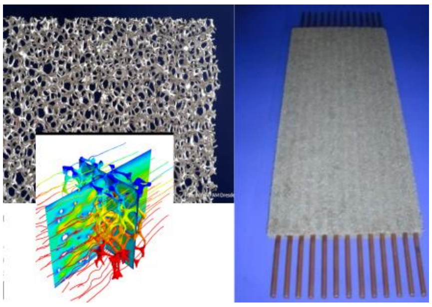


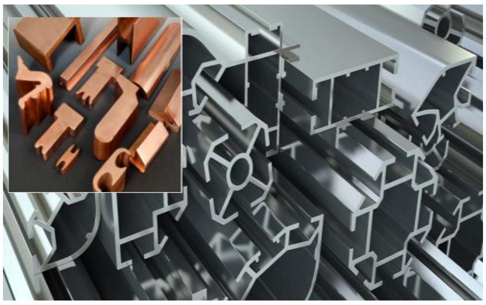
Copper bars per phase	Bars per phase	Current giving 75K in connection (Ampere)	Same total Weight of Copper (kg)	Kg / MVA	U$ / MVA
1 x 100 x 20 mm		1650 A (No vent. openings)	202	14	243
2 x 100 x 10 mm		1940 A (No vent. openings)	202	12	207
4x 100 x 5 mm		2290 A (No vent. openings)	202	10	175

Other technology examples:

(a) the use of metal foams in ceilings of enclosures and even in busbar electric conductor (higher heat dissipation)

(b) the use of extruded profiles in busbar electric conductors .





3. HOW TO PROMOTE THE CONCEPT THAT SAVING MATERIALS FROM THE DESIGN PHASE IS GOOD?

The simplest idea, for a 1st moment action is organize a kind of world-wide technical competition ("Prize"). The Prize would be used to disseminate the idea of a new IEC technical standard having in the background the creation of a certificate to be used in the market, to differentiate products which uses les materials. In the ANNEX 2, I include the basic steps for the organization of the "Prize". A good moment to expose and disseminate the idea is the coming COP30 in November 2025 in Pará – Brazil.

This ***"Environmental Efficiency Certificate for Electrical Products"*** would signalize how higher efficiency, using less materials, a product is. The fundament is that a lower kg/MVA is better to Climate Change. The rules to get the certificate should be clear enough to facilitate products buyers to select suppliers committed with the "saving materials" concept. As said, products IEC standards mandatory statements about the positive impact of a lower kg/MVA would accelerate the process.

> The Certificate would attest that the product was designed and constructed to meet the requirements of the tests prescribed in the product standard but, much beyond this, was designed for the minimum necessary use of copper, aluminum, insulating supports, materials etc.

4. DRAFT OF A TECHNICAL STANDARD to be used a basis for the "ENVIRONMENTAL EFFICIENCY CERTIFICATE FOR ELECTRICAL PRODUCTS".

The draft text for the technical standard is presented in ANNEX 1. The Certificate, based on this standard, is aimed at creating a difference between certified products with lower kg/MVA. The way to speed up the implementation of the certificate and its use in marketing strategies would be to include a mandatory statement in all IEC product standards indicating that using less copper, aluminium, and insulators is good for reducing Climate Change effects and that IEC standards encourage this. The "mandatory statement" is more or less like:

> Products covered by this IEC standard use significant amounts of copper, aluminum, insulators, and metals. Materials savings are desirable for reducing Climate Change and to facilitate Energy Transition initiatives. Products with designs that passes on the type tests and achieve lower values of weight by transmitted power (kg/MVA) are encouraged and considered environmentally better.

The implementation of the statement should be like it was implemented by IEC in the 80's to promote the importance of EMC (electromagnetic compatibility). It became mandatory that IEC products standards should have a clause talking about the susceptibility or not of that product with EMC. Behind that idea were concerns about future cyber-attacks and things of the same nature. Implementation was immediate.

Regarding the Certificate's commercial application, it is expected that it will range from straightforward marketing applications to more intricate uses like "credits of higher environmental efficiency", similar to the idea of carbon credits. A typical marketing strategy is manufacturing products with lower kG/MVA and making the market know this. Big buyers that need to take care of the environmental image, would prefer to buy products with lower kG/MVA values. Possibly, the first ones to obtain the Certificate would do campaigns to disclose who buys and who does not buy more efficient products.

THE CONCEPT

This Certificate attests that the product was designed and constructed to meet the requirements of the tests prescribed in the product standard but, *much beyond this*, was designed for the minimum necessary use of copper, aluminum, insulation supports and other materials etc. This is a measurable objective using indicators like the weight per transmitted power (KG/MVA). Weight per power can be associated with production cost divided by the transmitted power ($/MVA) . Looking at the example presented in Figure 1, the weight of copper is the same in the 3 cases but from the point of view of efficiency , the last line design of the table is much better.

The Certificate shall be issued by third parties and based in an international technical standard explaining the concepts and rules (ANNEX 1). The results shall be transparent, auditable, reproducible, and easy to understand by the common public. It shall demonstrate that the minimum material usage requirements have been met or tried. This is not difficult to do and to verify using the design rules in the tables of the IEC TR 62271-307.

The assessment results to support the Certificate may be obtained by real tests or testing simulations plus the concepts of IEC TR 62271-307. The verification methods should enable us to compare the KG/MVA of different design alternatives. After a certain time and experience, the world values of these indicators will become well-known by users and manufacturers. It will become more evident that designs can become more efficient with simple existing techniques. The test reports issued by the qualified bodies to issue the Certificates must explicitly indicate whether the equipment has passed the tests and to write and demonstrate the KG/MVA indicators.

5. FINAL COMMENTS

The electric industry is one of the main drivers of human activity. Regardless of region, almost all populations can access and benefit from electricity. In contrast to the political insanities, we witness on TV in 2025, the electricity sector offers an excellent platform and counterpoint for the dissemination of new concepts useful for minimizing climate change and the destruction of the Earth.

For example, if the consequences of climate change continue to devastate Earth, innovations such as quantum computers — which will be accessible only to the very rich — will never be deployed on a large scale. We have not yet learned how to end hunger and war.

Saving materials like copper, aluminium & insulators is beneficial for mitigating climate change because minimize the need for new raw materials. Producing new materials require significant energy and resources resulting in more greenhouse gas emissions. These savings reduce greenhouse gas emissions.

Designs that use less materials are a great profitable opportunity for manufacturers, since "old designs" predominate in the global sales of large international manufacturers. The big world-wide manufacturers could lead a process of improvements.

It is unbelievable that, in 2025, seeing the impacts of Climate Change, IEC and IEEE standards, at no time, encourage or mention that using fewer materials is good for the Planet.

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As the big world-wide manufacturers coordinate the preparation of such technical standards, they could promote a change of focus in the electric industry just forcing the implementation of something like the "Environmental Efficiency Certificate for Electrical Products". The main action would be to create and disseminate an IEC technical standard about the benefits of saving materials and how to promote it.

To compare designs, from the point of view of using less materials, it is missing an indicator to demonstrate that a design is better than others. The proper indicator is the kg/MVA transmitted.

A draft text of a technical standard to serve as a base to achieve these objectives is in Annex 1..

About the author

CV Sergio Feitoza Costa https://www.cognitor.com.br/Curriculum.html

Things Sergio helped to do http://www.cognitor.com.br/HelpedToDo.pdf

Follow the ANNEX 1:
"Guidelines for the use of the "ENVIRONMENTAL EFFICIENCY CERTIFICATE OF ELECTRIC PRODUCTS"

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ANNEX 1: BASE TEXT IN THE FORMAT OF ISO / IEC for

GUIDE (Edition 1.0):

Guidelines for the use of the "ENVIRONMENTAL EFFICIENCY CERTIFICATE OF ELECTRIC PRODUCTS"

CONTENTS

FOREWORD

This "Environmental Efficiency Certificate for Electrical Products" aims to induce the electric industry to produce products that goes beyond the quality assured by prescribed type tests . The focus is on highlighting designs and construction actions on electrical power products that lead to lower weight per transmitted power (KG/MVA). This is directly associated with saving Earth materials and climate change. The indicator (KG/MVA) aims to characterize higher efficiency and lower use of materials. It can be used to improve the environmental image.

To obtain the Certificate, it is necessary to pass design verifications that are specified to meet specific requirements and tests. To evaluate these characteristics, real tests, calculations, and simulations may be used.

Laboratory type testing, as specified in product standards, is the most used way to verify if a certain product attends the specifications. However, it is necessary to recognize that tests are expensive and a barrier for new developments. Nowadays there are lower cost alternatives of design verification like testing simulations.

Using the design parameters showed in the tables of IEC TR 62271-307 for Extension of Validity of Test Reports make easier to verify the higher efficiency of designs. Testing simulation techniques can predict results of most type tests. They enable to compare – at a low cost - different designs to see which one is more efficient (lower kG/MVA).

Let's use as an example a simple reference electrical busbar made of copper busbar 1x100x10 mm. The connection between bars is bare. Suppose you do a testing simulation increasing the value of electric current up to the level that the temperature rise of the hot spot is equal to the temperature rise limit prescribed in the technical standard (60K for bare connections). Then you will now do the same simulation for another electrical busbar equal but having 2x100x5mm busbars. The weight of both is the same but the second simulation will show that it is more to pass more current than the first test , reaching the same 60K. This means that the second design has the same weight but a lower kG/MVA than the first one. So, it is more efficient to save materials.

The main concern related to the use of testing simulations instead of real type tests is to be sure that their results are equal to the results of a real laboratory, within an acceptable tolerance. This Guide exemplify tolerances values and give guidelines to validate the methods. Temperature rise tests are the main test to define the weight of equipment busbars. The validation of the simulation method is simple because you just compare the temperature rise measured in the test with the simulation results.

The key aspect for analyzing if a certain design is more efficient than others, is to define an indicator reference values for the comparisons. To define initial reference values, world-wide queries can be made, initially only, for switchgear , switchboards, and busways (IEC 62271 and IEC 61439 series). You need only to know the weight of the equipment and the transmitted power of a product in the limit of passing in the test. So, you have the kg/MVA of that design. This Guide presents some initial reference values of KG / MVA for typical commercial products.

GUIDELINES FOR THE IMPLEMENTATION OF THE "ENVIRONMENTAL EFFICIENCY CERTIFICATE OF ELECTRIC PRODUCTS

1 Scope

This Guide presents guidelines for the systematization of the use of the environmental efficiency Certificate of electric products. The use of this "Certificate" is an action to motivate the electric industry to design and manufacture more efficient electric power products with lower kG/MVA. The concept is that , as the Certificate become known in the world market, companies, especially the ones that need to take care of the environmental image, will prefer to buy products with use less materials that is to have a lower KG / MVA.

The Certificate attests that the project was made to meet the requirements of the tests prescribed in the product standard but, much beyond this, was designed to a lower use of copper, aluminum, insulating supports, materials etc. This is a measurable objective using an indicator like the weight per transmitted power (KG/MVA) of the product .

To facilitate understanding let's consider switchgear produces according to IEC61439 or IEC62271 series. A simple example is that with a single copper bar 100x10 mm you may transmit a certain value of electric current attending a specified temperature rise limit. However, if you use 2x100x5mm (same weight) , for the same temperature rise value, you can transmit quite more current. Higher current means higher MVA and so the indicator KG/MVA is lower in the second case.

A key aspect is that this kind of verification, as in the example above, can be done using real laboratory tests or, faster and cheaper, using validated test simulations. By this reason this Guide give orientation on how to validate test simulations.

The main aspect behind the Certificate is that the product has passed all relevant type tests. The temperature rise test is of particular importance because the weight of busbar conductors is directly associated with the temperature rise limits specified in technical standards. Equipment is composed by conductors; busbar supports and enclosures. Usually, the biggest influence in the kG/MVA of a product is the weight of the busbars.

The Certificate shall be issued by third parties under the concepts in these Guidelines. The verifications and results that lead to the kG/MVA indicator shall be transparent, auditable, and reproducible. The design parameters presented in the tables of IEC TR 62271-307 shall be used.

The data to support the Certificate can be obtained from test reports or from validated testing simulations, considering the design parameters of the tables and concepts IEC TR 62271-307. This IEC document allows, if certain rules are met, to extend the validity of test reports of tests carried out on a certain product representative of a family, to demonstrates that if the tested one passed the tests, other similar non-tested ones would also pass. It is based on sound technical principles.

The extension of the validity of test reports seeks to avoid unnecessary repetition of tests of IEC 62271-200/201 standards. It can be used to extend type tests performed on one sample with a defined set of ratings for another product of the same family with a different set of ratings or different arrangements.

A relevant aspect in IEC62271-307 is the explicit mention to the use of testing simulations used in a comparative sense. If the testing simulations done in the tested equipment give the same results as the real test, they can predict what will be the performance of other non-tested samples.

In other words, suppose you test a product and simulate that test getting the same results. Suppose you now have another design of the same nature as the tested one, but with some differences. If you simulate the tests of the new equipment, using the same tool and a qualified method, there is no reason to question that the new simulation represents what would happen in a real test.

It is expected that, after some time of application of this Guide, the world values of the kG/MVA indicator become well known, unlike today. The consequence will be creating a higher step of design efficiencies with less use of materials and lower weight.

The verification reports issued by the qualified certifiers shall indicate in clear words that the equipment has passed the tests and demonstrate KG/MVA indicators. It is particularly relevant the performance in temperature rise tests (weight of conductors), short circuit tests (higher electrodynamic forces means higher amount and weight of supports) and internal arc tests (weight of enclosures).

Some verifications are possible only when certain specific measurements are presented in the laboratory test report. So, the test reports shall include measurements and photographic registers that make the test to be reproducible .

It is not an objective of this Guide to present calculation methods. It is considered that a model or method is acceptable when it produces validated results within acceptable tolerances if compared with the real test results and this can be demonstrated in a transparent way.

2 Normative references

The following referenced documents may be used for the application of this Guide, where relevant. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

a) ISO/IEC Directives, Part 2:2004, Rules for the structure and drafting of International Standards
b) IEC TR 62271-307:2015 : High-voltage switchgear and controlgear - Part 307: Guidance for the extension of validity of type tests of AC metal and solid-insulation enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV
c) IEC TR 60943: Guidance concerning the permissible temperature rise for parts of electrical equipment, in particular for terminals.
d) IEC TR 60890: A Method of Temperature-rise Verification Assessment by Extrapolation for Partially Type-Tested Assemblies (PTTA) of Low-Voltage Switchgear and Controlgear Assemblies by calculation.
e) IEC 61117: Method for assessing the short-circuit withstand strength of partially type-tested assemblies (PTTA)
f) IEC 60865-1: Short-circuit currents – calculation of effects – Part 1: Definitions and calculation
g) IEC 60865-2: Short-circuit currents – calculation of effects – Part 2: Examples of calculation
h) IEC 60112: Method for the determination of the proof and the comparative tracking indices of solid insulating materials
i) IEC 60071 1: 2010 Insulation co-ordination - Part 1: Definitions, principles and rules
j) Brochure CIGRE 602 / 2014 Tools for the Simulation of The Effects of the Internal Arc in T&D Switchgear
k) Brochure CIGRE 740 (2018) Contemporary Solutions for Low-Cost Substations.
l) Brochure CIGRE 830 (2021):Application and Benchmark of Multiphysics Simulation Tools for Temperature Rise Calculations

3 Definitions

For the purposes of this Guide, the following definitions apply.

3.1 – kG/MVA (weight divided by transmitted power) of an electric product

The aim of the Certificate is to attest that the product was made to meet the requirements of the tests prescribed in the product standard but, much beyond this, was designed with the minimum necessary use of copper, aluminum, insulating supports, materials etc. To measure this objective the indicator to be used is the weight per transmitted power (KG/MVA) . For example, a single copper bar 100x10 mm can transmit 20% less current than using 2x100x5mm (same weight) , for the same temperature rise. So, the indicator KG/MVA is lower in the second case. Less materials were used, and a higher efficiency was obtained. This is better for the Planet resources.

3.2 - Simulation or calculation to replace a test and acceptable tolerances

A calculation method used to predict, within a certain specified tolerance, the results which would occur in a laboratory test as specified in the relevant product standard. Here are typical values of acceptable tolerances of the results to be obtained in the simulations if compared to the real laboratory test results:

Table 1

Type of test	Parameter to compare	Typical values of acceptable tolerance
Temperature rise test	Temperature rise in solid and fluid parts	1% to 5%
Internal arc test	Overpressure in the enclosure above the atmospheric pressure (crest value and integral of the pressure curve)	5% to 10%
Short time withstand current, and peak withstand current tests	Electrodynamical forces and mechanical stresses	5% to 15%
Other applicable tests	The ones listed in IEC 62271-307.	(*)

(*): Values of tolerances to be defined.

3.3 - Product publication

Publication covering a specific product or group of related products

34 - Reproducibility of a simulation or calculation method

The capability of to obtain, for a specified set of input data the same test results or the same simulation results in two or more different occasions or two different test laboratories.

3.5 - Validation of a simulation or calculation method comparing to laboratory test results

A method of comparison between the results showed in a well-documented test report issued at a test laboratory and the results of a simulation method. A simulation method is generally acceptable, from the point of view of users, when it is reproducible and gives a difference between simulation and laboratory results not higher than a certain acceptable tolerance.

3.6 - Minimum input data to be registered in a temperature rise laboratory test report.

Temperature rise is the main parameter which defines the kG/MVA of a product. Equipment is approved during a test if the final measured temperature rises of the parts do not go beyond certain limits dictated by the properties of the insulating and conductive parts. These limits are showed in the relevant product standard. IEC TR 60943 and IEC 60890 explain the concepts involved.

The data affecting the results are the ones explained in the relevant table of IEC 62271-307 . The main ones are:

- the circulating electric current,
- the total power dissipation inside the fluid compartment
- the materials used in the conductor and insulating parts
- the contact resistances and its coatings (total per phase and also the ones of the individual parts like circuit breakers, fuses , isolators)
- the ambient gas or liquid fluid temperature (for example at the bottom , the top and at 50% of the height of the enclosure),
- the fluid velocity
- the geometry and spatial position of the conductors
- the volume of fluid inside the compartments
- The input and output areas for ventilation
- The number of horizontal partitions inside the enclosure if applicable
- The relative position of the equipment in relation to walls, ceiling, and neighbor equipment (as in IEC 60890)

For the sake of reproducibility, the measurement of the total per phase and partial electrical contacts resistances, before and after the test, shall be registered in laboratory test report. The values of the data mentioned above shall be clearly registered in the test report trough drawings and photos,

3.7 - Minimum input data to be registered in internal arc tests laboratory test reports

Equipment is approved during a test if the effects of the overpressures arising during the arc do not cause potential risks to persons in the neighborhood of the equipment. The relevant aspects to consider are showed in the relevant product standard. IEC 62271-200 and IEC TR 61641 explain the concepts involved.

The curve overpressure x time is the main parameter to predict a good or bad test result. The data affecting the test and the simulations results are the ones explained in the relevant table of IEC 62271-307 . They are explained in the reference Brochure CIGRE 602 / 2014. The main ones are.

- the circulating electric current,
- the materials used in the conductor and insulating parts
- the geometry and spatial position of the conductors
- the volume of fluid inside the compartments
- The input and output areas for ventilation and devices to close it during the arc
- The areas for pressure relief after the arc
- The relative position of the equipment in relation to walls and ceiling

For the sake of reproducibility, the measurement of the internal overpressure along the test shall be registered in the laboratory test report. The values of the data mentioned above shall be clearly registered in the test report trough drawings and photos,

3.8 - Minimum input data to be registered in short-time withstand current and peak withstand current test report

The objective of the test is to verify the supportability to the effects of electrodynamical forces on insulators and conductors occurring during a short circuit without arc. The verification is done by visual inspection and measurement of the resistances per phase.

The data affecting the test and the simulations results are the ones explained in the relevant table of IEC 62271-307 . They are explained in references IEC 61117, IEC 60865-1 and IEC 60865-2. The main ones are:

- The circulating electric current,
- The materials used in the conductor and insulating parts.
- The mechanical resistances of the insulators to compression, traction and flexion
- The geometry and spatial position of the conductors

For the sake of reproducibility, the measurement of the total per phase and partial electrical contacts resistances, before and after the test, shall be registered in laboratory test report. The values of the data mentioned above shall be clearly registered in the test report trough drawings and photos,

If visible permanent deformations are identified after the test, they shall be registered by photos and an estimate of the maximum permanent sag after the test.

4 Working procedures

4.1 General

When dealing with subjects relating to the use of simulations or calculations to replace real laboratory tests, in product standards, committees shall follow the provisions of this Guide, which is to be used in conjunction with the ISO/IEC Directives.

The status of the simulation or calculation methods, as well as the acceptable values of tolerances, shall be re-evaluated during the maintenance process.

4.2 Product publications

Committees developing product publications, involving subjects covered by this Guide, shall incorporate this Guide into their own publication by reference. If necessary, they may specify, in their own publications, additional details relevant to their product area

5 QUALIFYING FOR CERTIFICATES

5.1 Steps of the assessment

The usual sequence to obtain the certificate is:

- Test a head of family product using the related product technical standard. Define the electric current (I) that will imply in reaching the permitted temperature rise limit in the hot spot. Register the total weight of the equipment The kG/MVA will be equal to the weight divided by 1.732 x I x rated voltage of the equipment. Simple like this.
- Search for a certification company able to analyze the data and to verify the correctness of the KG/MVA calculated values.
- This entity will issue the CERTIFICATE explaining the details transparently and making statements based on the values of kG/MVA currently practiced in the market.

The initial procedure is to collect data and test reports results of an already (approved) tested design. If testing simulations are used, they should use transparent and validated verifiable tools and methods.

The relevant design parameters to be considered in the tests or test simulations are the ones described in the relevant table of IEC TR 62271-307 . In addition to those parameters, data related to the weight of conductor materials, insulating materials and enclosures will be registered. The final objective is to calculate the indicator KG/MVA as defined in section 3.1.

The Certificate shall inform if the untested sample would be expected to be approved in the type tests and also the KG/MVA indicator. The relevant data shall be presented in a single figure like in the example in Section 5.2.

5.2 An example of a typical assessment

Text to be prepared, based on data below.

Table 2 – Input data for the simulation of temperature rise test, internal arc tests and short time current peak withstand tests.

Rating	Value
Rated voltage (U_r) and number of phases	15,0 kV - 3Φ
Rated frequency (f_r)	60 Hz
Rated normal current (I_r)	(*) A rms
Rated short-time withstand current (I_k) and duration (s)	31,5 or 40,0 kA $_{rms}$ – 1s
Rated peak withstand current (I_p)	79 or 100 kA $_{cr}$
IAC (Internal Arc Classification)	IAC AFLR - 31,5 or 40,0 kA - 1,0s
Busbar dimensions and material	XX copper bars (*) x (*) mm per phase
Circuit breaker contacts resistance	<=45 Ohms E-6
Total resistance per phase	<= 112 Ohms E-6
Inlet and outlet free ventilation area (cm2)	(*) cm2 x (*) cm2
Forced ventilation rated if any (m3/h)	No
Pressure relief free area (cm2)	(*) cm2
Absorbers or parts like grids working as absorbers	Yes with a free area (*) cm2
Weight of conductor materials (Kg)	
Weight of insulating materials (Kg)	
Weight of enclosure and others (Kg)	

Table 3 – Temperature rise test and simulation results (K).

Point of the measurement	Test result (K)	Simulation result (K)
Connection at conductor # 1 (short circuit point)	47	42
Connection at the end of conductor # 3 (circuit breaker - low)	57	54
Connection at the end of conductor # 4 (circuit breaker-low)	64	66
Connection at the end of conductor # 5 (circuit breaker-high)	64	65
Connection at the end of conductor # 6 (circuit breaker-high)	52	53
Connection at end of conductor # 7 (top horizontal)	32	28
Enclosure door circuit breaker	5	
Fluid 50% height - cables compartment	not measured	13
Fluid 50% height - circuit breaker compartment	not measured	9

Fluid 50% height – bus-bars compartment	15	15

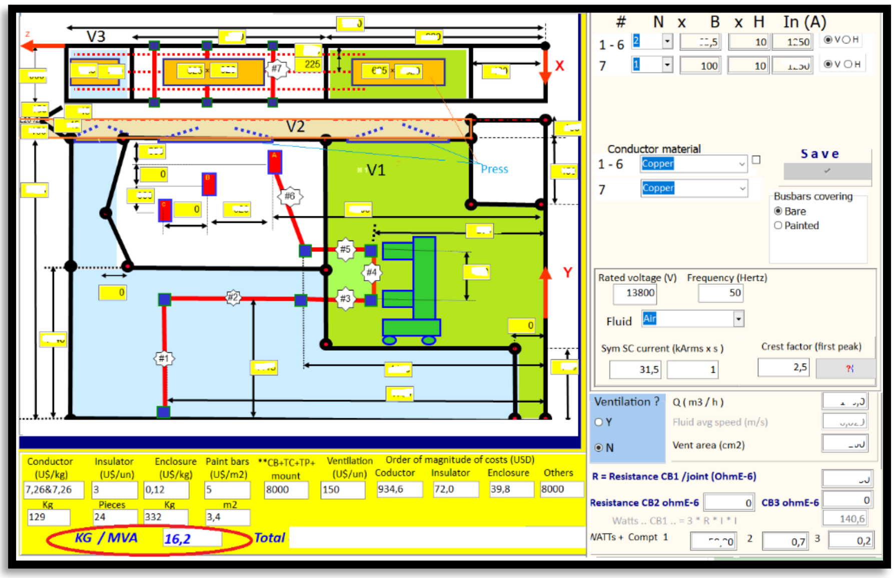
Table 4 – Internal arc test and simulation results (K).

Parameters	Test result	Simulation result
Symmetric or Asymmetric current	Asymmetric	
Arc voltage (V rms)	530	567
Maximum overpressure above 1 bar ΔP (%)	52	52
Overpressure duration (ms)	42	45
Integral Pressure curve along the time (bar*s*1000)	(*)	13
Time to 100% of overpressure peak ΔP (ms)	18	21
Time to 50% of overpressure peak ΔP (ms)	24~26	36

Table 5 – Short-time withstand current, and peak withstand current test and simulation results

	Test result	Simulation result
Max. Mechanical stress σ_H (N/mm2)	Not measured	94
Max. Mechanical stress σ_T (N/mm2)	(*)	18
Max. mechanical stress $\sigma_H + \sigma_T$ (N/mm2)	(*)	111
Max. Force on the insulator in compression or tension (N)	(*)	8918
Max. Force on the insulator in flexion (N)	(*)	5711

Figure 2 – Input data to be used in the assessment of designs according to the parameters in the Tables of IEC 62271-307. The numbers of the conductors are the same used in Tables 2 to 5



4 Recommended statements in IEC products standards.

IEC STANDARDS STATEMENT about SAVING MATERIALS (as was done with EMC in 1980s):

Reduced use of copper, aluminium & insulators is beneficial for the environment. All product standards should add this clause: "PRODUCTS COVERED BY THIS STANDARD use significant amounts of copper, aluminium, insulators, and metals. Material savings are desirable for the Climate Change and Energy Transition initiatives. IEC promotes designs and methods that lower the kg/MVA" design

REFERENCES

[1] 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.

[2] CIGRÈ BROCHURE 830 (2021) – "SIMULATIONS FOR TEMPERATURE RISE CALCULATION".

[3] Cigrè Brochure 740 (2018) Contemporary design of low-cost substations in developing countries.

[4]_CIGRÈ BROCHURE 602 (2014) Tools for Simulation of The Effects of the Internal Arc in T&D Switchgear,

[5] IEC62271-307 (2015) - High-voltage switchgear and controlgear - Part 307: Guidance for the extension of validity of type tests of AC metal and solid-insulation enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV.

END OF THE DRAFT STANDARD

ANNEX 2 – HOW TO ORGANIZE THE PRIZE EVENT

AS A SUGGESTION, THE ORGANIZATION OF THE PRIZE MAY FOLLOW THESE PREMISSES.

a) WHAT IS "THE PRIZE"

The PRIZE is a worldwide competition within the theme of "PATENTS & INNOVATIONS IN POWER T&D PRODUCTS for saving Planet resources". Each candidate project eligible to the PRIZE shall follow the SUBMISSION rules"). The prizes to be awarded are:

- 1st Prize of US$ 35 000,00 (Thirty-Five Thousand United States Dollars);
- 2nd Prize of US$ 20 000,00 (Twenty Thousand United States Dollars); and
- 3rd Prize of US$ 10 000,00 (Ten Thousand United States Dollars).

b) ELIGIBILITY OF PROJECTS AND COMPARISON PERFORMANCE INDICATOR

Each project shall auto-declare the phase of development like one of these alternatives:
** Registered Patent (stage from non-developed to near commercialization)
** Designed project in R&D phase needing to test a prototype
** Designed project with a prototype ready for tests
** Commercialized product trying to reach the market

The candidate project should have, from the technical point of view (but not necessarily from the economical point of view) an expected performance better than the commonly commercialized products in the market. The term "better" here means having a lower weight per transmitted power (kG/MVA). Transmitted power, for example for an electric panel, is the product of the rated voltage by the rated normal current (multiplied by √3 if 3-phase). In the description of the project the candidate shall be skilled enough to give and order of magnitude of the kG/MVA of the proposed project and the kG/MVA products in the market). In other words, the candidate shall understand what is being improved.

There is no fee to register a candidate project for the PRIZE. Project authors may register either individually or as a group of co-authors. On registration, the contact author shall be clearly identified (individuals, institution or company, public e-mail, and clear contact information). The author will be the person with whom the organizers shall communicate in respect of all matters concerning the PRIZE. A 10 lines CV shall be included.

Authors and participating institutions may be from any country in the world and submit more than one project. All authors or co-authors must be living individuals and 18 years of age or older. Each winning submission shall receive only one award regardless of the number of co-authors.

c) HOW TO SUBMIT AND DESCRIBE A CANDIDATE PROJECT

The submission shall be made according to the instructions of the organizers presented in the link below. The project description is free and shall have no more than 4 pages, including figures photos. Being able to do a proper description is part of the aspects to consider in the project analysis. So, the description shall have focus on measurable results, advantages, and disadvantages. Avoid using formulas and descriptions not easily understandable by non-technical people.

As above, a candidate project shall have, from the technical point of view (but not necessarily from the economical point of view) an expected performance better than the commonly commercialized products in the market under the focus kG/MVA. Test reports and test simulation results may be used to demonstrate results. A key information is to include a comparison of the kG/MVA of the proposed project and the kG/MVA products in the market.

d) JUDGING AND AWARD CERIMONY

Submissions complying with the above rules will be reviewed by the PRIZE Advisory Council. More information about the methods are in the link at the end. The judges' decisions will be communicated directly to the winners and during the award ceremony as informed in the link below.

ANNEX 3 - REFERENCES

[1] FREE BOOK "TEMPERATURE RISE LIMITS used in I E C / IEEE TECHNICAL STANDARDS
https://www.cognitor.com.br/TemperatureRiseLimits.pdf

[2] Article "METAL FOAM in SWITCHGEAR, switchboards & bus ducts
http://www.cognitor.com.br/switchgearmetalfoam.pdf

[3] Free book by Sergio "RENEWABLE ENERGY + ENVIRONMENTAL EDUCATION TO TRY TO SAVE THE PLANET"
https://www.cognitor.com.br/educationfortheplanet.pdf

[4] Free book by Sergio "SWITCHGEAR, BUSWAYS & ISOLATORS & SUBSTATIONS & LINES EQUIPMENT"
https://www.cognitor.com.br/Book_SE_SW_2013_ENG.pdf

[5] Free book by Sergio" PROJECT SAVE RIO IN 10 YEARS:
https://www.cognitor.com.br/saverioENG.pdf

[6] URBAN OVERHEAD NETWORKS X "DANGEROUS DISTANCES BETWEEN PEOPLE, CABLES,& TRANSFORMERS.".
https://www.cognitor.com.br/FusesInTheWindows.pdf

[7] Other reference articles free downloads
https://www.cognitor.com.br/Downloads1.html

About the author

CV Sergio Feitoza Costa https://www.cognitor.com.br/Curriculum.html

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