Design of IEC62271 & IEC61439 products: (training)

WHY NOT USING OLD TABLES of BUSBARS amperes

https://www.cognitor.com.br/replaceoldtables.pdf

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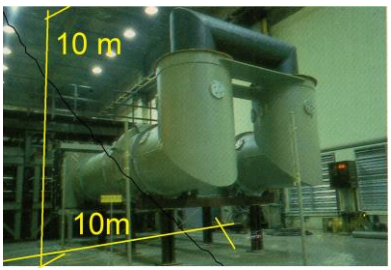
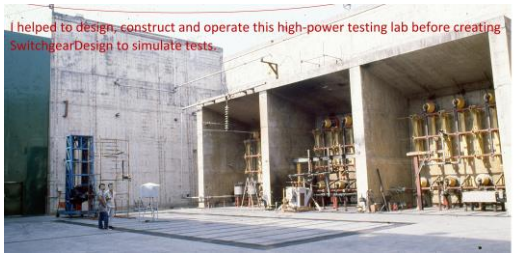
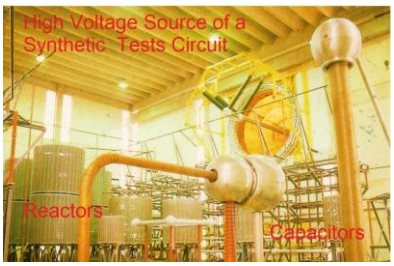
1) INTRODUCTION

Recently a client asked me to update some old tables used in his company for the design of electrical HV / MV / LV switchgear and busbars systems. I remembered my work of 40 years ago when I participated in the design and construction of the large CEPEL's high-power laboratories (short circuit, internal arc, temperature rise, etc...), in Brazil . I was the assistant of the main designer and learned a lot with my friend and mentor Dr. George Zabludowski . Years after, the set of labs received his name. He was a great person and master.





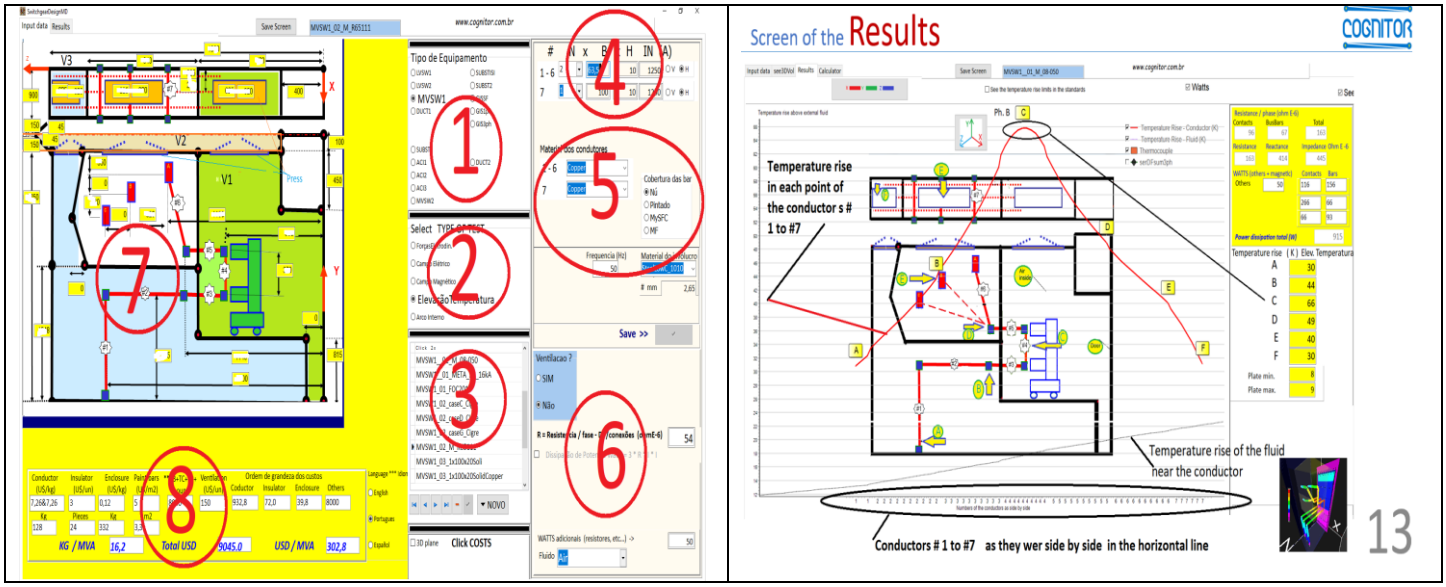


At that time, the practice for designing busbar systems, was to use tables from the excellent handbooks of Siemens, ABB, Schneider, etc... I had small knowledge about concepts for temperature rise design. I worked 25 years in those labs doing tests and managing testing and research teams. It was amazing. When I left the research centre, 22 years ago, I started to act as a consultant for manufacturers who, were going to testing labs to do such expensive tests. I soon realized that the knowledge needed to design power equipment, to pass in the tests, goes far beyond the knowledge of doing tests.

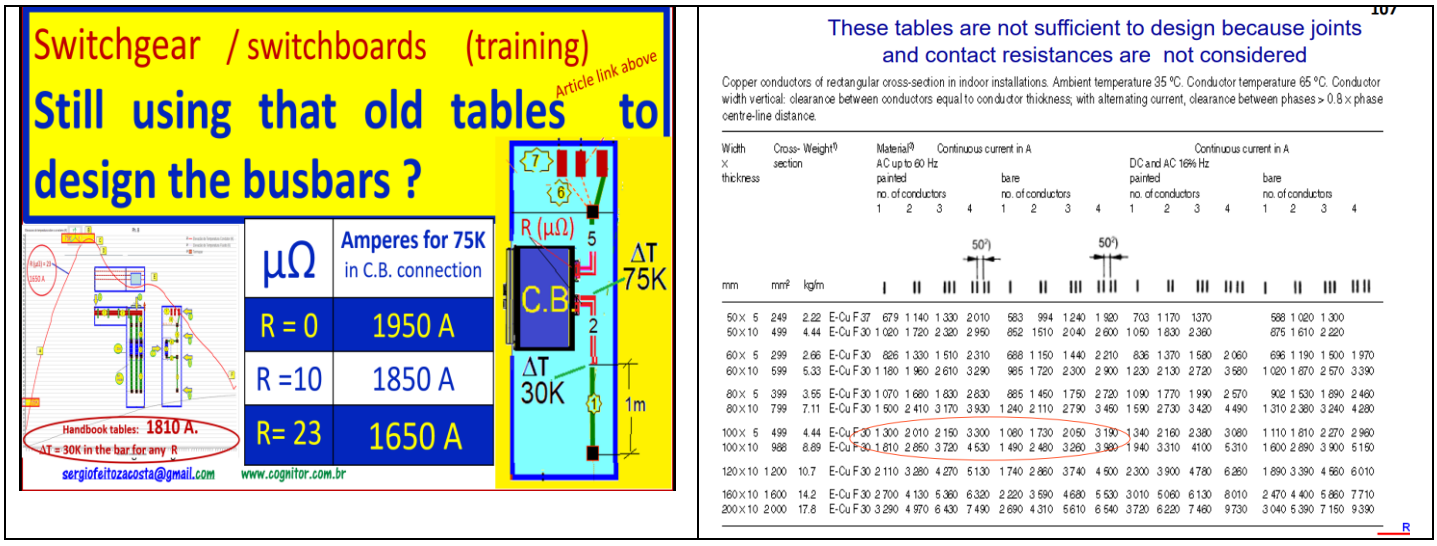
Then I started to develop the software SwitchgearDesign to simulate the tests (+/-5% of the real test results). Along the time, I could validate and improve the calculations by comparing the simulation results with the test results obtained by my clients. The success rate is over 97%. Nowadays a single notebook permits to use the software to do complete simulations in a fast way. Forty years ago the old tables were useful but, nowadays I consider a mistake to use them because the opportunity to optimize projects is lost.

The reason is that those tables only indicate the current that , if you apply in a long conductor with no connections, will produce a temperature rise of 35K. Switchgear and busways are plenty of connections and contacts and these will be the hottest points that will decide whether or not the equipment will be approved in the temperature rise test. IEC 60943 explains the concepts that I show in the training I apply.

Currently there are 2 possibilities of defining the busbars to use in a certain project. The first one, that I recommend, is to use the software SwitchgearDesign to calculate the specific case. You use just one screen to input the data and another to see the temperature rise in each relevant point.



The second one that I suggest not to use, is to write a set of tables with hundreds of combinations taking into account busbar arrangements, currents, resistances, ventilation openings. It would look more or less like the old tables but with columns for the resistances and other data. You may see in the next figure a simplified example.



Width × thickness	Cross-section	Weight[1]	Material[2]	Continuous current in A AC up to 60 Hz painted no. of conductors 1	2	3	4	bare no. of conductors 1	2	3	4	Continuous current in A DC and AC 16⅔ Hz painted no. of conductors 1	2	3	4	bare no. of conductors 1	2	3	4
mm	mm²	kg/m		I	II	III	III[3]	I	II	III	III[3]	I	II	III	III	I	II	III	III
50 × 5	249	2.22	E-Cu F 37	679	1 140	1 330	2 010	583	994	1 240	1 920	703	1 170	1370		568	1 020	1 300	
50 × 10	499	4.44	E-Cu F 30	1 020	1 720	2 320	2 950	852	1510	2 040	2 600	1 050	1 830	2 360		875	1 610	2 220	
60 × 5	299	2.66	E-Cu F 30	826	1 330	1 510	2 310	688	1 150	1 440	2 210	836	1 370	1 580	2 060	696	1 190	1 500	1 970
60 × 10	599	5.33	E-Cu F 30	1 180	1 960	2 610	3 290	985	1 720	2 300	2 900	1 230	2 130	2 720	3 580	1 020	1 870	2 570	3 390
80 × 5	399	3.55	E-Cu F 30	1 070	1 680	1 830	2 830	885	1 450	1 750	2 720	1 090	1 770	1 990	2 570	902	1 530	1 890	2 460
80 × 10	799	7.11	E-Cu F 30	1 500	2 410	3 170	3 930	1 240	2 110	2 790	3 450	1 590	2 730	3 420	4 490	1 310	2 380	3 240	4 280
100 × 5	499	4.44	E-Cu F 30	1 300	2 010	2 150	3 300	1 080	1 730	2 050	3 190	1 340	2 160	2 380	3 080	1 110	1 810	2 270	2 960
100 × 10	988	8.89	E-Cu F 30	1 810	2 850	3 720	4 530	1 490	2 480	3 260	3 980	1 940	3 310	4100	5 310	1 600	2 890	3 900	5 150
120 × 10	1 200	10.7	E-Cu F 30	2 110	3 280	4 270	5 130	1 740	2 860	3740	4 500	2 300	3 900	4780	6 280	1 890	3 390	4 560	6 010
160 × 10	1 600	14.2	E-Cu F 30	2 700	4 130	5 360	6 320	2 220	3 590	4 680	5 530	3 010	5 060	6 130	8 010	2 470	4 400	5 860	7 710
200 × 10	2 000	17.8	E-Cu F 30	3 290	4 970	6 430	7 490	2 690	4 310	5 610	6 540	3720	6 220	7 460	9 730	3 040	5 390	7 150	9 390

In the example above, if you take a copper bar, without connections, in the free air at 35°C and apply 1810 A this will produce a temperature rise of 30K. In the figure you may see the currents which would produce a 75K temperature rise in the same bar with just one connection for different values of resistance. If you do not consider the value of resistance, you cannot know if you are over dimensioning or under dimensioning. Here is key point for optimizations. Most of the products we see in the market are copies of old over dimensioned projects. People go copying and copying without trying to reduce the use of materials. My experience all over the World is that less than some 25% of the manufacturers are updated for the use of the testing simulations for improving designs.

In the article of Reference [1] I present comparisons of effects including the role of ventilation. It is a small size switchgear (Figures 1 and 2) enabling the use of a very small lab to validate the results. It was originally made to compare the use of aluminum and copper to attend a specific project .

Figure 1 – The test case of “small” switchgear

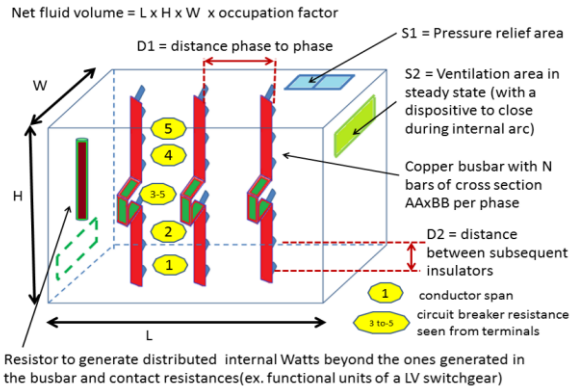
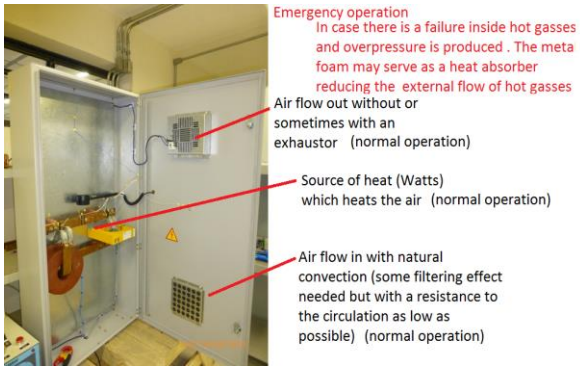


Figure 2 – The enclosure 1400 x 700 x 220 mm



In the next figure you may see some of the types of equipment that can be simulated with SwitchgearDesign.

ANNEX 1 – REFERENCES

[1] Finding the Optimal Switchgear Design: A comparison between aluminum and copper and an idea of new concept. - Coauthors: Sergio Feitoza Costa & Marlon Campos
http://www.cognitor.com.br/DesignOptimization.pdf

[2] Book “Switchgear, Busways, Isolators - Substations & Lines” (available also in Spanish and Portuguese)
http://www.cognitor.com.br/Book_SE_SW_2013_ENG.pdf

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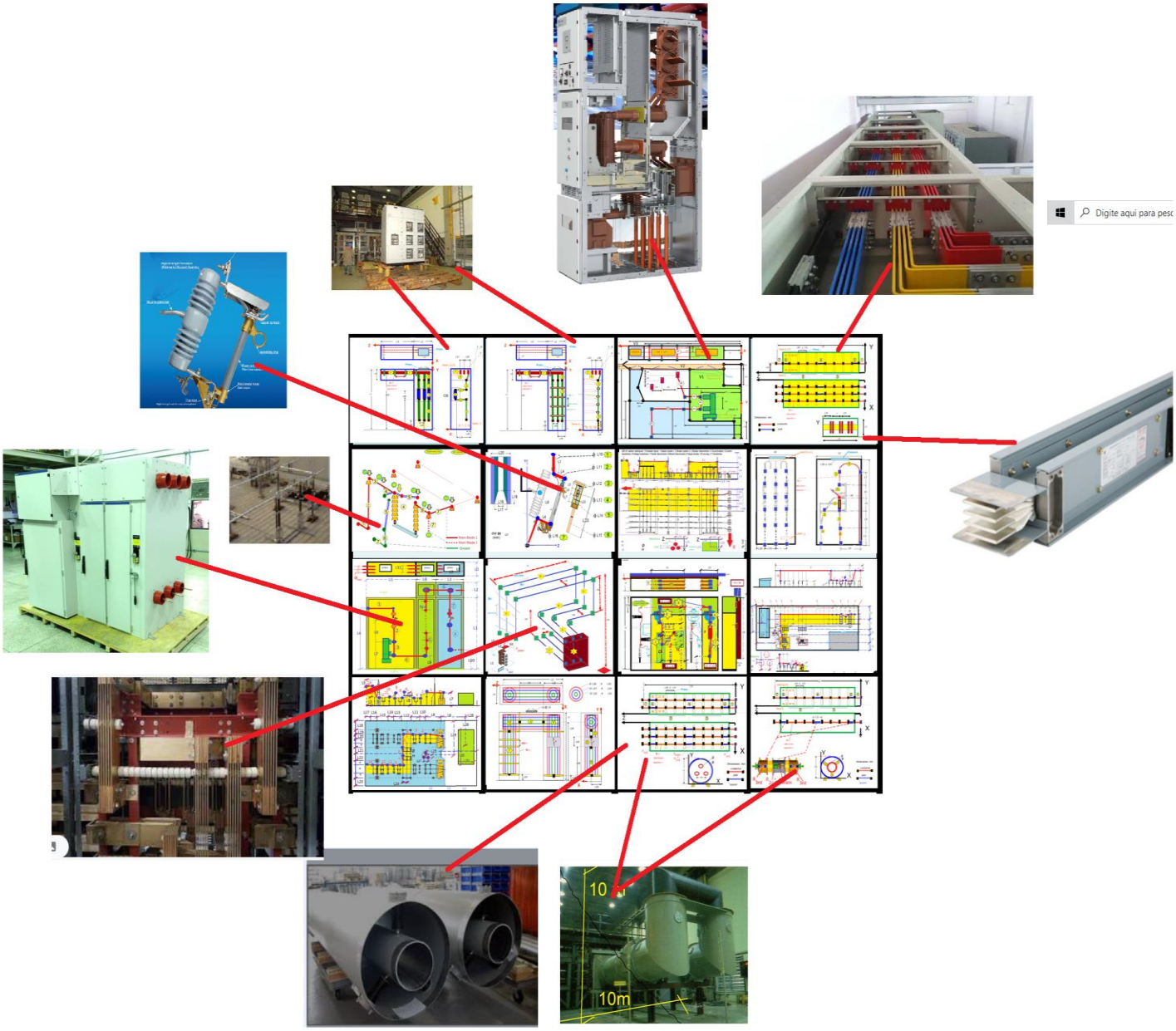
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