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DEVELOPMENT OF A RISK ANALYSIS COMPUTER PROGRAM ACCORDING TO THE IEC62305-2.

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Abstract: This work presents Brazilian software based on the IEC62305-2/2006 for the risk analysis due to lightning to structures and its contents.

1 INTRODUCTION

After, and even before, the publication the IEC62306-1[1] standard in 2006, several research groups announced computer programs for risk evaluation due to lightning based on this publication or on its draft. In Brasil, the structures protection standards working group will study this part of the IEC standard in 2010. This group has studied part 1 in 2006, started part 3 studies in 2007 and going under revision during 2009 and, after finishing this, the group will study part 4. This way, part 2 will be studied, probably, in 2010.

Despite of not yet supported by a Brazilian standard concerning risk analysis, a research group of the IEE-USP (Institute of Electrotechnics and Energy – University of São Paulo) and students of the EPUSP (Politechnic School) started the development of a computer program based on the IEC62305-2/2006 standard for the lightning associated risks analysis.

2 DEVELOPMENTS

The computer program so far developed only includes the protection and the structures analysis against lightning and doesn't include the services protection module to be developed later. The program was developed using C# programming language because this language is object oriented and uses .net platform, providing a good graphic interface leading to an easy utilization by the final user.

Whenever possible, the program used IEC recommended data and tables and the present version analyses the structures considering it on an integral way and not zones divided. In a future version it will take account the possibility, and also, the services protection. The program was named "Tupã" that means "thunder" in the ancient "tupi" amerindian language.

The program is presented in three screens: In the first one the user inserts structure data; in the second are inserted the surroundings data, the way services in the structure are fed by the power sources and eventual adjacent structures connected to the main studied structure; in the last screen the user may choose types of lightning to be considered in the studies (in the structure, near the structure, in the service, near the service). The user may choose de project name and calculate the risks of Loss of human life, Loss of service to the public, Loss of cultural heritage and Loss of economic value. Results are shown on the same screen on a red bottom in the case of the calculated value is major than the tolerable or on a green bottom for lower than tolerable values. The program, also, allows the creation of a "pdf" format archive with the inserted data and obtained results.

3 PROGRAM DETAILING

The Tupã program when installed and running accesses to three screens: Technical Data, Other Data and Results. Includes, also, a menu bar where is possible to access other two menu: "Projeto" and "Sobre". The "Projeto" menu makes possible to load a previously saved file by the "Carregar" line and, also, to save a file by the line "Salvar". Saved files have the ".zpj" extension. The menu "Sobre" describes the program version the author and corporations where it was developed.

3.1 Technical Data Screen

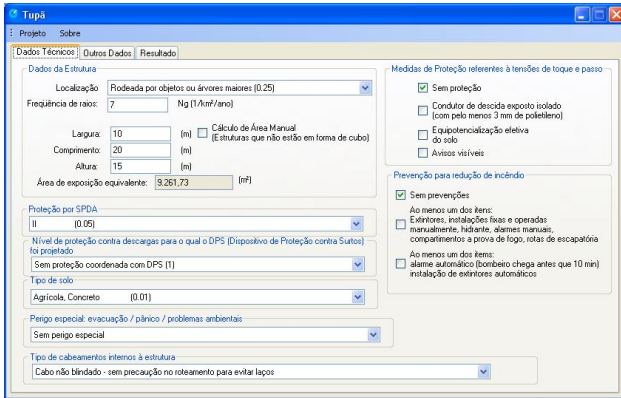


Fig. 1 - “Dados Técnicos” Screen

The “Dados Técnicos” screen (see Figure 1) has the initial group of data concerning the structure, where is possible to select the structure location. In this case the program used the parameters indicated in the IEC62305-2 Table A.2 (Location factor – C_d). Next to be informed is the lightning frequency (N_g) that has to be informed by the user and obtained by best possible form, that is, the estimated values of the lightning detection grid and standardized formulas. The Brazilian standard shows the following formula (1) to obtain this value, and the IEC standard the formula (2).

$$N_g = 0,04 \cdot T_d^{1,25} \quad (1)$$

$$N_g = 0,1 T_d \quad (2)$$

Where, N_g – number of lightning flashes per km^2 per year
 T_d – Thunderstorm days per year

The determination of the collection area (A_d) may be inserted in the program by two manners: For an isolated rectangular structure, just enter the length (L), width (W) and height (H) values. For a complex shaped structure it is needed to enable the “Cálculo de área manual” option and indicate the “ A_d ” value in square meters in the “Área de exposição equivalente” option.

In the “Proteção por SPDA” option, the user has to choose one of these based on the Table B.2 – Values of P_B depending on the protection measures to reduce physical damage. P_B values are those from the IEC62305-2 - Table B.2.

In the “Nível de Proteção contra Descargas para o qual o DPS (Dispositivo de proteção contra Surtos) foi projetado”, data were obtained from the Table B.3 – Value of the probability P_{SPD} as function of LPL for which SPDs are designed.

In the “Tipo de solo” option data were obtained from Table C.2 – Values of reduction factors r_a and r_u as a function of the type of surface of soil or floor.

In the “Perigo especial: Evacuação / Pânico / problemas ambientais” option data were obtained from Table C.5 –

Values of factor h_z increasing the relative amount of loss in presence of a special hazard.

In the “Tipo de cabamentos internos à estrutura” option data were obtained from Table B.5 – Value of factor K_{S3} depending on internal wiring.

In the “Medidas de proteção referentes à tensão de toque e passo” options group, the user may choose “Sem proteção” or one, or two or all the three others options for those the data were obtained from the Table B.1 – Values of probability P_A that a flash to a structure Will cause shock to living beings due to dangerous touch and step voltages”.

In the “Prevenção para redução de incêndio” options group, the user may choose “Sem prevenções” or one two others options. Data were obtained from the Table C.3 – Values of reduction factor r_p as a function of provisions taken to reduce the consequences of fire.

3.2 Screen: Other data.

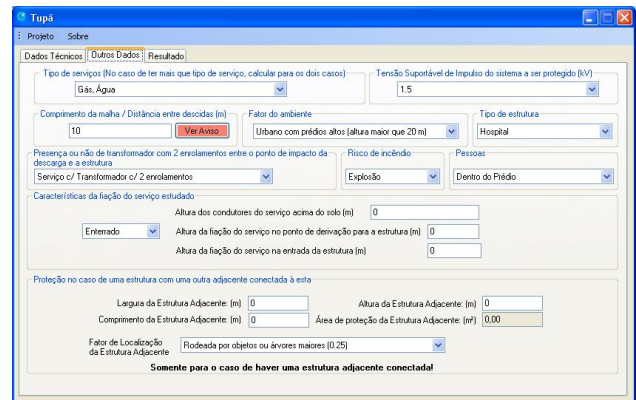


Fig. 2 – “Outros dados” screen

In the “Outros dados” screen (see Fig. 2) the user has to insert several data that were grouped according to the subject. In the option “Tipo de serviços” the user has to choose one of the two options. For structures having two options, calculations have to be performed for both. Data were obtained from IEC Table C.6 – Typical mean values of L_f and L_0 .

In the option “Tensão Suportável de Impulso do sistema a ser protegido (kV)”, data were obtained from IEC Tables B.6 and B.7: Table B.6 – Values of the probability P_{LD} depending on the resistance R_S of the cable screen and the impulse withstand voltage U_W of the equipment and Table B.7 – Values of the probability P_{LI} depending on the resistance R_S of the cable screen and the impulse withstand voltage U_W of the equipment.

For filing the option “Distância da malha/Distância entre descidas”, the user has to enable the option “Ver Aviso” where is defined that in this option it has to insert a distance, in meters, that may be that distance between two down conductors, two metallic columns of the structure, two concrete reinforcing steel used as part of the LPS, the length of the spatial type metallic grid.

In the option “Fator do ambiente” data were obtained from the IEC Table A.5 – Environmental factor C_e .

In the option “Tipo de estrutura”, the user has several options that data are obtained from several IEC tables. User has to choose: Hospital, School, Hotel, Industrial plants, Churches among others.

In the option “Presença ou não de transformador com dois enrolamentos entre o ponto de impacto da descargas e a estrutura”, the user chooses between two options that the data were obtained from IEC Table A.4 – Transformer factor C_t .

In the option “Risco de incêndio”, data were obtained from IEC Table C.4 – Values of reduction factor r_f as a function of risk of fire of structure.

In the option “Pessoas”, the user choosing one of the two options (inside or outside the building) makes the program to use data from more than one table from IEC standard.

In the data group named “Características da fiação do serviço estudado” the user has to choose between buried or aerial and inform three different heights (in meters) of the installation: cabling height above the ground, height of cable splitting point in the structure, height of the service cabling in the incoming service point.

In this screen there is still one data group “Proteção no caso de uma estrutura com uma outra adjacente conectada à esta” that has to be filled in cases where the structure under evaluation is connected to other near structures by means of cabling or metallic pipes. In this case the dimensions of this other structure must be informed (for an isolated rectangular structure) or manually calculated the “área de proteção da estrutura adjacente” for the complex shaped structure case.

3.3 Screen: Results

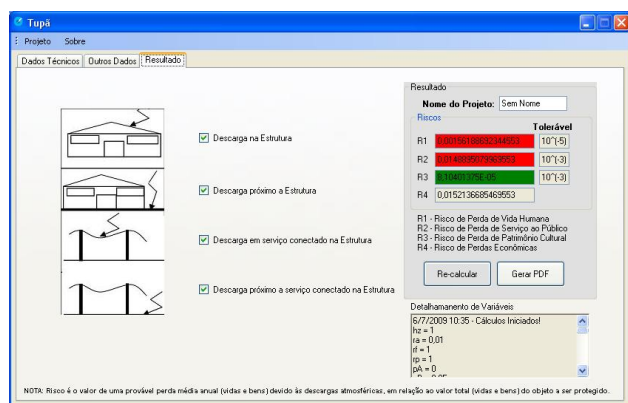


Fig. 3 – Screen “Resultado”

In the screen “Resultado” (see Fig. 3), the user may choose one or more types of lightning to be analyzed: direct lightning to the structure, lightning near to the structure, direct lightning in the service connected to the structure, lightning near to the service connected to the

structure. The drawing shown in this option was adapted from the IEC62305-2.

After choosing an option, or options, the user may name the project filling the window “Nome do projeto”.

Enabling the window “Calcular”, the program performs all the simulation and presents as results the risks: R1 – Risk of loss of human life; R2 – Risk of loss of service to the public; R3 – Risk of loss of cultural heritage and R4 – Risk of loss of economic value. These risks values are shown in red fonts in cases are above the tolerable values, according to the IEC Table 7 – Typical values of tolerable risk R_T . Are shown in green fonts in cases are under the tolerable values. The window “Detalhamento de variáveis” presents the values that were used by the software for all necessary variables for calculations.

The user may change the inserted data at any screen in order to bring the risks results to the tolerable limitations. This way, for instance, if in the window “Proteção por SPDA”, initially, was chosen “Sem SPDA” it may be modified to another option, for instance, “SPDA Tipo II” and recalculate in the screen “Resultado” to check if the risk is under the tolerable value.

Once is the analysis is obtained, in the window “Gerar PDF”, the user may create a “pdf” type file to be saved in a directory chosen by the user.

4 CONCLUSION

This work presents Brazilian software based on the IEC62305-2:2006 for risk analysis concerning structures lightning protection. This software can be easily operated by LPS’s designers and contractors. The software is still under analysis by the Brazilian standard Study Commission in charge of studying the structures LPS and, eventually, will be purchased with the revised standard to be issued. Presently, a testing version may be ordered to one of the authors or via sueta@iee.usp.br.

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