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Developed Simplification of the Risk Assessment

Norbert Szedenik
Department of Power Engineering
Budapest University of Technology and Economics
Budapest, Hungary
szedenik.norbert@vet.bme.hu

Tamás Bodócs
Department of Power Engineering
Budapest University of Technology and Economics
Budapest, Hungary
bodocstomi@gmail.com

István Kiss
Department of Power Engineering
Budapest University of Technology and Economics
Budapest, Hungary
kiss.istvan@vet.bme.hu

István Berta
Department of Power Engineering
Budapest University of Technology and Economics
Budapest, Hungary
berta.istvan@vet.bme.hu

***Abstract*— The IEC 62305, which was published 10 years ago, has fundamentally changed the structure of planning lightning protection [1]. The method determined in the standard – which requires a detailed risk assessment for each and every structure – has made the standard user's task more difficult due to the vast amount of parameters. Meantime many criticism, application examples and explanations of the risk assessment were published [2], [3], [4], [5]. We have elaborated a developed simplified risk assessment process based on the standard, which substantially facilitates the determination of the needed level of protection in most cases.**

Keywords- standardization; risk assessment; simplification

I. Introduction

The substance of the simplified risk assessment process is that compared to the detailed risk assessment process, it is able to determine the needed level of protection based on much less input data, by simply reading it out from a table [6]. This simplification could be used in case of family and apartment houses. In order to broaden the usability of the simplified process, we have created the core tables for further structures. Naturally the proposed simplified process cannot be used in case of all types of building since there are special buildings which do not comply with the conditions of this simplified process. In these cases the detailed risk assessment should be carried out according to the relevant standard. However in most of the cases these conditions are met, and therefore the proposed simplified process can significantly reduce the lightning designer's daily tasks. In most cases this process can simplify the determination of the needed lightning protection level (LPL), which allows to design the lightning protection system (both the primary and secondary protection) according to the 3rd part of the standard. However we needed to take into consideration that some of the parameter weights changes for different building types. To overcome this problem, the formerly used sensitivity analysis helped us [7]. After examining the variables we have found out, that the previously interpreted table needs to be improved by adding only one extra coefficient – the special hazard coefficient h_z.

II. Application Criteria

The following simplified process can be used instead of the risk assessment described in IEC 62305-2 chapter 6 of this standard, if all the following conditions are met:

- only the risk of loss of human life is considered (R1);
- the specific fire load of the structure is less than 800 MJ/m^2 (risk of fire is low or ordinary);
- the structure is not explosive;
- the structure is not a hospital;
- the failure of internal systems does not endanger human life.

If all the points listed above apply to the structure, it is not necessary to calculate the risk R1. Instead of the risk assessment detailed in chapter 6 of this standard the needed level of protection can be read out from the appropriate table (Table 1, 2, 3 or 4) directly.

The following data are needed for the simplified process:

- type of the building;
- h_z: special hazard (if exists, e.g.: evacuation difficulties);
- r_f: risk of fire (low or ordinary);
- N_G: lightning ground flash density;
- height of the structure.

III. APPLICATION OF THE SIMPLIFIED METHOD.

First the type of the structure should be identified. This simplified process can be used only for the following types of structures according to Table C.2 of IEC 62305-2:

- others;
- industrial, commercial;
- public entertainment, church, museum;
- hotel, school, civic building.

In case of each structure the appropriate table (Table 1, 2, 3 or 4) should be used.

After choosing the appropriate table, the presence of special hazard (evacuation difficulties, level of panic etc.) shall be determined according to Table C.6 of IEC 62305-2 and the related value of h_z (1, 2, 5 or 10) shall be taken into account.

Depending on the risk of fire (rf, see Table C.5 of IEC 62305-2) the left (specific fire load is lower than 400 MJ/m^2), or the right (specific fire load is between 400 MJ/m^2 and 800 MJ/m^2) column shall be used.

The value of lightning ground flash density determines the appropriate row.

After having these parameters identified, a protection level and a height value can be found in the cell. As long as the height of the structure is lower than the value indicated in the cell, the protection level indicated in the cell should be used for the given structure. If the height of the structure is higher than the value in the cell, but it is not higher of its 1,4 times value, then a one stricter level of protection shall be chosen than in the cell. If the height of the structure is higher than the 1,4 times value in the cell, then the simplified process cannot be used.

The steps of the simplified process can be seen in the Figure 1.

TABLE 1: THE NECESSARY LPL. STRUCTURE TYPE: OTHERS

h_z	1		2		5		10	
r_f / N_G	**0,001**	**0,01**	**0,001**	**0,01**	**0,001**	**0,01**	**0,001**	**0,01**
≤ 4	No LPL (40 m)	LPL IV (35 m)	No LPL (19 m)	LPL IV (21 m)	LPL IV (54 m)	LPL II (28 m)	LPL IV (35 m)	LPL I (32 m)
$4 < N_G \leq 7$	No LPL (16 m)	LPL IV (23 m)	LPL IV (67 m)	LPL III (19 m)	LPL IV (38 m)	LPL II (17 m)	LPL IV (23 m)	LPL I (19 m)
$7 < N_G \leq 14$	LPL IV (65 m)	LPL III (19 m)	LPL IV (43 m)	LPL II (21 m)	LPL IV (23 m)	LPL I (19 m)	LPL III (19 m)	LPL I+ (19 m)
$14 < N_G \leq 30$	LPL IV (40 m)	LPL II (19 m)	LPL IV (25 m)	LPL I (22 m)	LPL III (16 m)	LPL I+ (18 m)	LPL II (19 m)	LPL I++ (60 m)
$30 < N_G \leq 70$	LPL IV (19 m)	LPL I (19 m)	LPL III (15 m)	LPL I+ (19 m)	LPL II (15 m)	LPL I++ (54 m)	LPL I (19 m)	LPL I++ (30 m)

TABLE 2: THE NECESSARY LPL. STRUCTURE TYPES: INDUSTRIAL, COMMERCIAL

h_z	1		2		5		10	
r_f / N_G	**0,001**	**0,01**	**0,001**	**0,01**	**0,001**	**0,01**	**0,001**	**0,01**
≤ 4	No LPL (18 m)	LPL IV (21 m)	LPL IV (62 m)	LPL III (16 m)	LPL IV (35 m)	LPL I (32 m)	LPL IV (21 m)	LPL I (17 m)
$4 < N_G \leq 7$	LPL IV (67 m)	LPL III (19 m)	LPL IV (44 m)	LPL II (21 m)	LPL IV (23 m)	LPL I (19 m)	LPL III (19 m)	LPL I+ (19 m)
$7 < N_G \leq 14$	LPL IV (45 m)	LPL II (21 m)	LPL IV (27 m)	LPL I (24 m)	LPL III (19 m)	LPL I+ (19 m)	LPL II (21 m)	LPL I++ (63 m)
$14 < N_G \leq 30$	LPL IV (25 m)	LPL I (22 m)	LPL III (21 m)	LPL I+ (23 m)	LPL II (19 m)	LPL I++ (60 m)	LPL I (23 m)	LPL I++ (35 m)
$30 < N_G \leq 70$	LPL III (15 m)	LPL I+ (19 m)	LPL II (19 m)	LPL I++ (62 m)	LPL I (19 m)	LPL I++ (30 m)	LPL I+ (19 m)	LPL I++ (9 m)

TABLE 3: THE NECESSARY LPL. STRUCTURE TYPES: PUBLIC ENTERTAINMENT, CHURCH, MUSEUM

h_z	1		2		5		10	
r_f / N_G	**0,001**	**0,01**	**0,001**	**0,01**	**0,001**	**0,01**	**0,001**	**0,01**
≤ 4	LPL IV (54 m)	LPL II (28 m)	LPL IV (35 m)	LPL I (33 m)	LPL III (27 m)	LPL I+ (27 m)	LPL II (28 m)	LPL I++ (78 m)
4 < N_G ≤ 7	LPL IV (38 m)	LPL II (16 m)	LPL IV (23 m)	LPL I (20 m)	LPL II (31 m)	LPL I+ (15 m)	LPL II (17 m)	LPL I++ (54 m)
7 < N_G ≤ 14	LPL IV (23 m)	LPL I (19 m)	LPL III (19 m)	LPL I+ (20 m)	LPL I (36 m)	LPL I++ (54 m)	LPL I (19 m)	LPL I++ (30 m)
14 < N_G ≤ 30	LPL III (16 m)	LPL I+ (18 m)	LPL II (19 m)	LPL I++ (60 m)	LPL I (18 m)	LPL I++ (28 m)	LPL I+ (18 m)	LPL I++ (6 m)
30 < N_G ≤ 70	LPL II (15 m)	LPL I++ (54 m)	LPL I (19 m)	LPL I++ (30 m)	LPL I+ (15 m)	LPL I++ (-)	LPL I++ (54 m)	LPL I++ (-)

TABLE 4: THE NECESSARY LPL. STRUCTURE TYPES: HOTEL, SCHOOL, CIVIC BUILDING

h_z	1		2		5		10	
r_f / N_G	**0,001**	**0,01**	**0,001**	**0,01**	**0,001**	**0,01**	**0,001**	**0,01**
≤ 4	LPL IV (35 m)	LPL I (32 m)	LPL IV (21 m)	LPL I (17 m)	LPL III (12 m)	LPL I+ (12 m)	LPL I (32 m)	LPL I++ (49 m)
4 < N_G ≤ 7	LPL IV (23 m)	LPL I (19 m)	LPL III (19 m)	LPL I+ (19 m)	LPL II (17 m)	LPL I++ (54 m)	LPL I (19 m)	LPL I++ (30 m)
7 < N_G ≤ 14	LPL III (19 m)	LPL I+ (19 m)	LPL II (21 m)	LPL I++ (63 m)	LPL I (19 m)	LPL I++ (30 m)	LPL I+ (19 m)	LPL I++ (9 m)
14 < N_G ≤ 30	LPL II (19 m)	LPL I++ (60 m)	LPL I (22 m)	LPL I++ (35 m)	LPL I+ (18 m)	LPL I++ (7 m)	LPL I++ (60 m)	LPL I+ (-)
30 < N_G ≤ 70	LPL I (19 m)	LPL I++ (30 m)	LPL I+ (19 m)	LPL I++ (9 m)	LPL I+ (10 m)	LPL I++ (-)	LPL I++ (30 m)	LPL I++ (-)

Certain cells in the table have the following markings: LPL+, LPL++. These markings cannot be found in this standard, but they are defined here according to the Table B.2 of IEC 62305-2:2010:

LPL+: "Structure with an air-termination system conforming to LPL I and a continuous metal or reinforced concrete framework acting as a natural down-conductor system."

LPL++: "Structure with a metal roof and an air-termination system, possibly including natural components, with complete protection of any roof installations against direct lightning strikes and a continuous metal or reinforced concrete framework acting as a natural down-conductor system."

IV. EXAMPLES

The application of the simplified method is illustrated by the following two examples.

A. *Example 1: Family house*

The family house is classified as "Others" (apartment block is also classified here). The data of the structure:

- risk of fire is low (0,001);
- lightning ground flash density: 4 (1/km^2/year);
- height: 6 meters;
- special hazard: none.

Since there is no special hazard the two columns related to h_z=1 column should be considered in Table 1. As the risk of fire is low, and the lightning ground flash density value is 4, thus the column related to 0,001 and the row related to ⩽4 shall be taken into consideration. The height of the structure is lower than the value found in the cell, hence the protection level in the cell is valid, and state that it is not necessary to supply with lightning protection system. The result of the risk assessment according to IEC 62305-2 is R1 = 2,53 x 10^{-6}, which is smaller than the tolerable risk $R_T = 10^{-5}$, i.e. there is no need protection too.

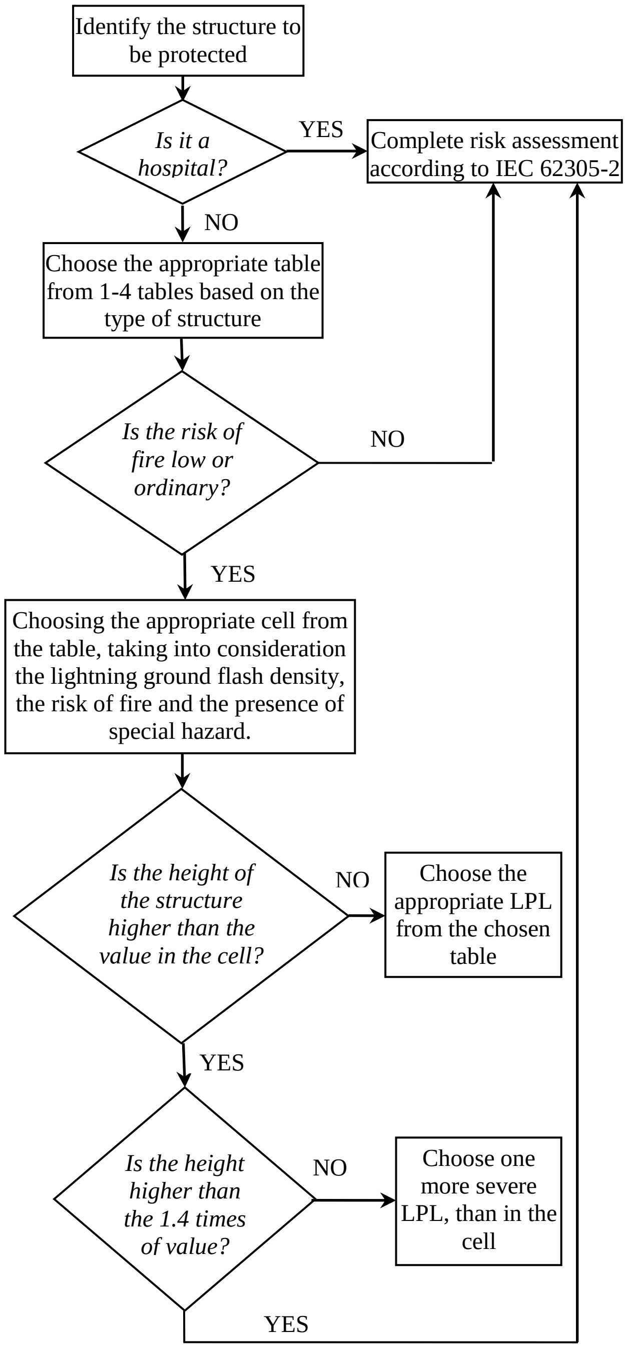

Figure 1. Flowchart of the simplified procedure

B. Example 2: Primary school

Assume, that this primary school can accommodate 400 people. Based on the type of the structure, Table 4 shall be used. Data related to this primary school:

- risk of fire: ordinary (0,01);
- lightning ground flash density: 1,8 ($1/km^2$/year);
- height: 16 meters;
- special hazard: evacuation difficulties (400 people)

Based on the holding capacity of the structure, column h_z = 5 shall be taken into account. According to the lightning ground flash density and the risk of fire, the first cell of the right column is chosen. The value in the cell is higher than the height of the structure, however it is not higher than the 1,4 times, therefore the level of the needed protection is LPL II, which is a one more severe level than the LPL III in the table. The result of the risk assessment according to IEC 62305-2 is R1 = $3{,}017 \times 10^{-4}$. Choosing LPL II, the risk will be under the RT, the value of R1 is $8{,}055 \times 10^{-6}$, which is also in a good agreement with the simplified method.

V. Conclusions

The draft of the future 3rd edition of the IEC 62305 aims to simplify the calculations. Some coefficients will be contracted, re-grouped or new variables will be introduced. Since these changes will be new to the users, they can be considered as complicated, hence they do not reach their goal: to simplify the risk assessment process. The method shown above is however able to simplify the lightning risk assessment process in great majority of the cases. Furthermore a great advantage of the simplification process is that it is completely based on the IEC 62305 regulation, therefore the used variables are well-known to the users of the regulation.

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