29th International Conference on Lightning Protection

23rd – 26th June 2008 – Uppsala, Sweden

PRACTICAL APPROACH FOR ECONOMIC LOSSES LIGHTNING RISK EVALUATION

Alain Rousseau
SEFTIM
alain.rousseau@seftim.fr

Pierre GRUET
INERIS
pierre.gruet@ineris.fr

49 rue de la bienfaisance 94300 Vincennes France

Abstract - Lightning risk evaluation for human life (named R1 in IEC 62305-2 standard) is the most popular for evaluation of the need for lightning protection for structures. However, the most frequent losses due to lightning are the economic ones as hopefully in most of the cases the human beings are not injured in a structure in case of damage caused by lightning. The aim of this paper is to show the results obtained with the economic losses lightning risk evaluation (named R4 in IEC 62305-2 standard) for real cases. Practical examples and results obtained for two structures with different activities are presented. Difficulties are mainly located in the evaluation of the cost of the structure and its content as well as the evaluation of the cost of protection measures. In particular, when various protection solutions are investigated it may be difficult to recalculate the pricing for each solution especially as the company which is making the study is not a specialist of lightning protection products and installation. For this purpose, the software Jupiter is presented and is very helpful as it offers easy calculation based on a rich data base.

1 INTRODUCTION

We can calculate up to four different lightning risks for a structure. Risk R1 for human life, risk R2 for service to the public, R3 for national heritage buildings and R4 for economic losses. Basically on an industrial site only risk R1 and R4 are relevant. R1 is the general one, integrating both human life and environment protection. However, it may be tempting to also perform risk R4 which will determine if the protection means are economically justified or not. In most of the cases the risk to human life or to the environment is such that economical calculation has no real meaning except to determine the cheapest of the possible protection solutions. However, the economic calculation is of interest for the site manager which will be able to compare the damage to his structure and content to the price of the protection solution. In that case, it would be useful to be able to integrate the production loss and this is not really integrated in the standard method. This is why some entities have extended the risk R2 to a broader use than only service to the public as this risk structure is really appropriate for industrial sites. We performed the calculation risk R4 to industrial sites and we faced many difficulties for evaluation of the structural and content cost as well as for the protection solution cost. Purpose of this paper is to present these difficulties.

2 PRESENTATION OF REAL CASES STUDIED

INERIS has recently built new buildings to extend its site and we decided to study one of them to illustrate our paper. In addition, we will describe a typical building belonging to a chemical plant. The two buildings that we have decided to present in that paper are named: “reception” for the Ineris building and “laboratory” for the other one.

The “reception” building, located near Paris, is mainly the place where all visitors should register before entering the site. This building also includes a 300 people ball room. The security people are also located in that building and the various alarms are then connected to that place including video cameras all around the site. A telecom switch is also present in that place. This building will be numbered A in our study. This building is built under the HQE scheme which means “high quality for environment” which is a label characterizing the buildings which have been built in such a way that there is very limited impact on the environment both during its lifetime and after it is dismantled. This scheme is very similar to other equivalent systems in various countries: LEED in USA, HK-BSE in Hong-Kong, BREEAM in UK, CASBEE in Japan, MINERGIE in Switzerland, PASSIVHAUS in Germany or TOTAL QUALITY in Austria. This building is thus important for the image of INERIS and as such need a special care.

Fig. 1 – Building A

The “laboratory” building, located near Lyon, is inside the industrial site fences. Its main activity is to deal with chemicals measurements for the plant. There is a small explosive area located at the first floor of that building. This will be numbered B in our study.

Fig. 2 – Building B

The building main characteristics are given in Table 1.

Table 1: Dimensions and characteristics of buildings

	A	B
Length	30	48
Width	8	15
Height	7	7
Type of roof	Metal	Concrete
Type of framework	Wood	Concrete
Type of walls	Wood + glass	Concrete + glass
Type of ground surface	Ceramic	Concrete
Surroundings	Lawn	Asphalt
Number of connected lines	4	3
Ng	1,5	3,1

3 CALCULATION OF R1 AND R4 ACCORDING TO IEC/EN 62305-2

We have been using the English version of the software JUPITER (release 2.1) for the calculations.

A. Calculation of R1 for reception building

The calculation results are shown in Figure 3.

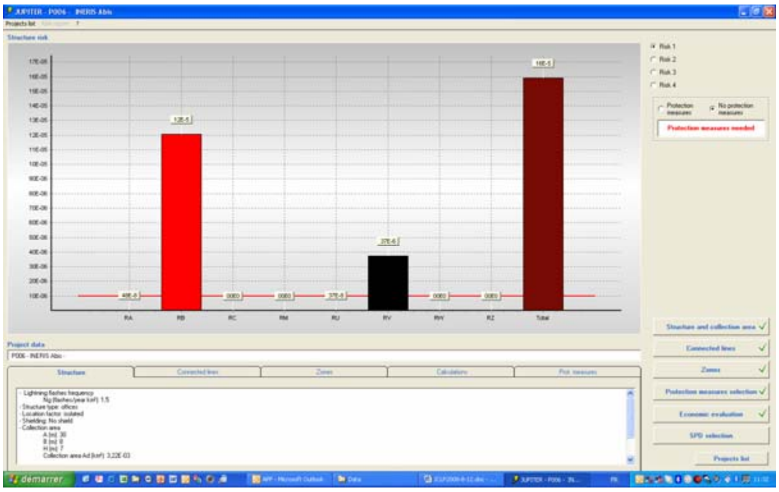


Fig. 3 – Calculation of risk R1 for building A – no protection measures provided

As can be seen on the figure, the total risk (column on the left) 16 10^{-5} is 16 times higher than the tolerable risk (horizontal line). This means that a protection is needed for that building. In fact component Rb is the main contributor to the total risk and this is mainly due to the high risk of fire for that building. The main reason for that is the wooden structure. The component Rv is the second significant contributor of the total risk and the calculation is showing that the reason is mainly due to the telecom switch.

A protection is then needed. To protect the building, we need to implement a lightning protection level 2 according to IEC/EN 62305-3. This means of course that equipotential bonding SPDs need to be installed at the entrance of all the lines. When such protection measures are provided the risk decreases below the tolerable risk reaching the value of 0,77 10^{-5}, as can be seen on Figure 4.

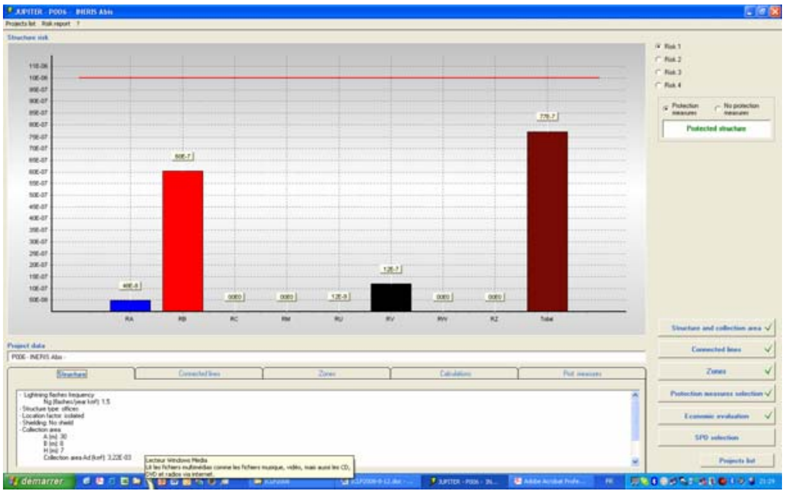


Fig. 4 – Calculation of risk R1 for building A – level 2 protection measures provided

B. Calculation of R1 for laboratory building

The calculation results are shown in Figure 5.

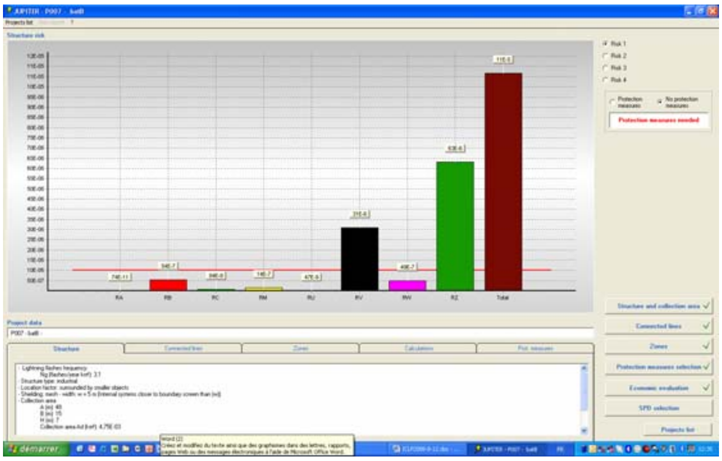


Fig. 5 – Calculation of risk R1 for building A – no protection measures provided

As can be seen on the figure, the total risk (column on the left) 11 10^{-5} is 11 times higher than the tolerable risk (horizontal line). This means that a protection is needed for that building. For that case, component Rb is not the main contributor to the total risk. The main contributors are Rz and to a lower extent Rv related respectively to induced surges on the connected lines (this occurs mainly in one of the zones which has an explosive atmosphere content and where is connected an analyzer and a sensor) and to direct strikes on the lines (mainly for the security system).

A protection is then needed. To protect the building, we don't need to implement a lightning protection system but equipotential bonding SPDs are needed at the entrance of all the lines as well as coordinated SPD on the line entering the explosive zone. When such protection measures are provided the risk decreases below the tolerable risk reaching the value of 0,87 10^{-5}, as can be seen on Figure 6.

Fig. 6 – Calculation of risk R1 for building A – level 2 protection measures provided

C. Calculation of R4 for reception building

The calculation principles of risk R4 are as following:

- first you calculate the economic losses due to lightning
- then you calculate the residual economic losses that are still existing in the property in spite of the lightning protection means implemented (see above)

- the third step is to calculate the annual cost of the lightning protection means
- the final step is to calculate the potential savings calculated as the economic losses less the residual economic losses and less the annual cots of protection. This may be, of course, positive, which means that lightning protection means generate savings or negative which means that it is not economically appropriate to implement lightning protection means.

The annual cost of the lightning protection measure is based on the total cost of the protection means and on financial data: interest rate, amortization rate and maintenance rate.

For case A, the calculation results are shown in Figure 7.

Fig. 7 – Calculation of risk R4 for building A

- economic losses due to lightning (blue in Figure 7) : 812 €
- residual economic losses (yellow in Figure 7): 215 €
- annual cost of the lightning protection means (red in Figure 7): 2 700 €
- potential savings (green in Figure 7): - 2 103 €.

It is not appropriate to implement lightning protection means. Of course, due to the importance of the building, lightning protection may still be implemented.

D. Calculation of R4 for laboratory building

The calculation results are shown in Figure 8.

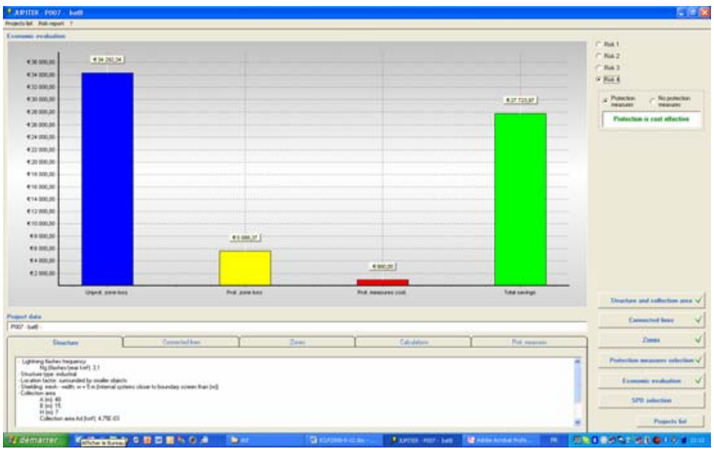


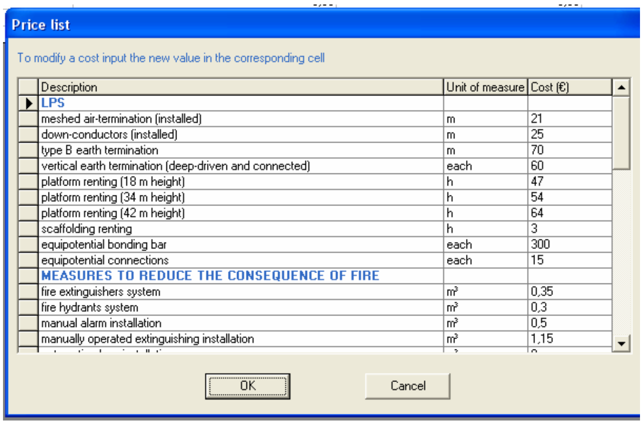
Fig. 8 – Calculation of risk R4 for building B

- economic losses due to lightning (blue in Figure 8) : 34 292 €
- residual economic losses (yellow in Figure 8): 5 588 €
- annual cost of the lightning protection means (red in Figure 8): 980 €
- potential savings (green in Figure 8): 27 724 €.

It is appropriate to implement lightning protection means for that structure.

4 CONSIDERATIONS ON DIFFICULTIES REGARDING CALCULATION OF R4

To calculate R4 there are many difficulties. The most important is to obtain the economics data regarding the building. The people involved in lightning protection in an industrial site are very often related to environment, maintenance, safety or other related topics and they have not having easy access to the economics data. In many cases, it has been difficult to obtain these data even with the cooperation of insurance companies. Other difficulties are coming from the calculation of lightning protection cost. Lightning protection products pricing is not easy to access for the engineer who is making the risk calculation. There are of course some price lists for the products but first of all there are very different from one lightning protection company to another and the lightning protection specialist does not know at this stage the company which will be selected for implementing the lightning protection. In addition, the total price is depending on the raw material price. At the present time, the copper price, for example, is changing each day and the copper part represents a big part of the total price. Furthermore, the product part of the price of the total project is very often lower than the sum of the published price of all he products, due to a discount applied for the total project. The price of the installation of the lightning protection is much more difficult still to assess for the lightning specialist. This is largely depending on the contractor who will install the lightning protection and there is no price list available for such activity. A lightning contractor will systematically go to the site for making an evaluation of his cost and then of his price. It appears that it is rather difficult to make a correct evaluation of the lightning protection means. The only way is to have a large experience of various situations and products and even in that case, the best way is to establish a price including enough margins to cope with the approximations. This procedure of evaluation of protection means price becomes a burden when various solutions have to be estimated.


Price list

To modify a cost input the new value in the corresponding cell

Description	Unit of measure	Cost (€)
LPS		
meshed air-termination (installed)	m	21
down-conductors (installed)	m	25
type B earth termination	m	70
vertical earth termination (deep-driven and connected)	each	60
platform renting (18 m height)	h	47
platform renting (34 m height)	h	54
platform renting (42 m height)	h	64
scaffolding renting	h	3
equipotential bonding bar	each	300
equipotential connections	each	15
MEASURES TO REDUCE THE CONSEQUENCE OF FIRE		
fire extinguishers system	m^3	0,35
fire hydrants system	m^3	0,3
manual alarm installation	m^3	0,5
manually operated extinguishing installation	m^3	1,15

OK Cancel

Fig. 9 – Economic evaluation: price data base

The software we have be using for these studies named Jupiter is incorporating a guided mode for the economical evaluation of the lightning protection measures cost. This is based on a data base of prices that can be updated by the user as can be seen on Figure 9. Based on the dimensions of the building and on the protection measures which have been selected the software is using the price data base to evaluate the protection cost for SPD at the entrance of the lines and for the LPS. Then, following the description of the zones and mainly their size, the particular protection means for the zone such as spatial shielding or coordinated SPDs are evaluated by the software as well. On Figure 10, the price of "general" protection means is circled in red when the price for the dedicated zone protection is circled in green. When multiple protection solutions are possible on the structure, the software also helps to find the most economical one.

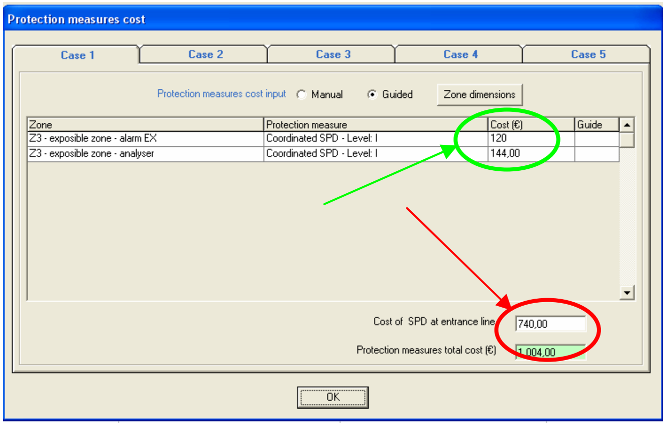


Fig. 10 – Economic evaluation protection measures cost

5 CONCLUSIONS

The main difficulty in calculating risk R4 (economic calculation) is to obtain the data from the user/owner of the building. Very often these data are not easily available and to get them the task of the lightning protection engineer is often more complex than to make the calculation. In practice, these data are seen as confidential to some extent. Even if the calculation is seen as profitable by the user/owner of the building, the fact of making the data available to the lightning protection engineer and to some extent to the public area is making the process rather difficult. In addition, generally more than one lightning protection scenario is established by the lightning protection engineer and this means that not only getting the raw data for the building but also calculating the price of the lightning protection means is a burden. In addition, what is interesting is not the price of the lightning protection component but mainly the price of the set-up of the system. This may be very tricky if the engineer has no experience in that field. Hopefully, the risk software that we used is designed in such a way that it has an economic data base and that this data base can be updated by the designer in order to make the calculating process smoother.

6 REFERENCES

[1] "Protection against lightning Part 2 Risk management", IEC/EN standard 62305-2, 2006.