Sessions 8a, 8b: Moderator's Report

Lightning Deleterious Effects

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1. Introduction

The topic is devoted to the problems of kerauno-medicine, lightning hazard to humans and animals, statistics of lightning death, injury and damages, risk evaluation in accordance with its acceptable level and protection of humans and animals.

In this short report, these issues are briefly addressed making reference to the state of the art. Moreover, an overview of the papers presented in this session is presented.

2. Preliminary Remarks on the Problem of lightning Deleterious Effects

Lightning deleterious effects are considered first of all both in terms of hazard for human beings and livestock, as well as in terms of risk of damage for structures and their apparatus, involving sensitive equipment to lightning electromagnetic impulses (LEMP).

As far as the hazard for human beings and livestock is considered, it should be emphasized that the conditions for electric shock or injury due to lightning current are different from those appearing due to the current from electrical systems. The latter (current) may be DC or low frequency AC, whereas the lightning current can consist of several uni-polar and/or bi-polar fast impulses with different peak values and durations. The interaction of a lightning stroke with human and animal bodies is quite different from the usual experience with electric shock derived from electrical systems. This is a reason for which different Technical Reports have been formulated (compare Part 4 with Parts 1,2 and 3 of [1]).

It is well known and formally established [1] that in lightning accidents the pathway often includes the head. This implies a probable inclusion of the brain stem, which includes the respiratory centre, in contrast with pathways of the shock current arising from electrical systems. In particular, it has been pointed out that differences exist between accidents caused by a direct flash compared with those interactions, which are caused by step voltages. Even very short single impulses of lightning can cause cardiopulmonary arrest [3], [5], [6].

Moreover, it can be stated that intense electric interactions with living organisms are very dangerous but, surprisingly in many cases, not always lethal. It is confirmed that 70% or more lightning accidents involving humans are not fatal [2], [4], whereas a corresponding reliable data for livestock is not available. There is a large variation in outcome due to different environments, different activities of people and knowledge of first aid and quality of medical care [2], [3]. In order to standardize the singular effects of lightning strokes, an effort has been made to create a special Technical Report (see [1] Part 4). In [1], the physics of lightning is presented as a basis and the interaction with living bodies is then described, followed by consequences for the life of the victim.

As far as the risk of lightning damages of structures and their equipment is considered, two approaches to the problem should be distinguished:

- the traditional one, which has been known for more than 20 years and which is based on the probabilistic approach involving the Poison's distribution, and,
- a new approach based on the principles of fuzzy logic.

It should be noted that the first approach to the methods of risk assessment is already quite developed and has been described in a large number of different papers (e.g. [7-12]. It is also standardized. The first version of the standard [13], [14] is now under revision and its draft [15] has already been accepted.

The application of fuzzy logic to the lightning risk assessment is just under development and some preliminary studies have been published (see, e.g. [16]). Two new papers (papers 8.5 and 8.6) presented in this session confirm the enhanced use of this technique in lightning risk assessment.

3. Brief Overview of Papers Selected for Session 8

3.1. General

One oral session and one poster session are devoted to the problem of lightning deleterious effects. A total of 12 papers (from Australia, Austria, Brazil, China, Colombia, France, Germany, Hungary, Italy, Japan, Poland, Spain, and Sweden) were selected for presentation at these sessions. For this aim they have been divided into groups according to different aspects of lightning deleterious effects. The following groups have been distinguished:

- Group 1: Lightning accidents and human injuries (Papers 8.2 and 8.3).
- Group 2: Safety measures and protection (Papers 8.1, 8p.1, 8p.2, 8p.3, 8.4, 8p.5)
- Group 3: Risk assessment (Papers 8p.4, 8.5, 8.6 and 8.7).

The papers of the oral session, organised in these 3 groups, are specified in Table 1. Similarly the papers of the poster session, which have been organized in 2 groups only, are specified in Table 2.

It should be noted that 5 papers of the session are the result of international collaborations involving at least two different countries. This is already almost a custom that more and more countries take on the scientific cooperation.

Table 1- Papers of oral session

No	Title and authors	Group
8.2	Lightning caused injuries in humans. **C. Cooray, V. Cooray, Sweden; C. J. and Andrews, Australia;**	**1**
8.3	Examples of severe destruction of trees caused by lightning. **F. Heidler, W. Zischank1, Germany; G. Diendorfer, Austria;**	
8.1	Grounding Procedures to Assure People and Equipment Safety Against Lightning. **C. Portela, Brazil;**	2
8.4	The Resistance Measurement of Living Tree and Model. Experiments for the Shielding Effect of Resistive Object to Distribution Lines. **Y. Goto, Yosio Sato, Kazuhiro Iwanaga, Japan**	
8.5	Acceptability of risk of damage due to lightning using fuzzy logic. **L.E. Gallego, O. Duarte, H. Torres, D. Rondón, Colombia**	3
8.6	Lightning Data Relevance in Risk Assessment. **E. Balog, I. Berta;**	
8.7	Development of a risk assessment calculator based on a simplified form of the IEC 62305-2 Standard on lightning protection. **A.J. Surtees1, USA; A. Gillespie, Australia, A. Kern, Germany; A. Rousseau, France;**	

Table 2- Papers of poster session

No	Title and authors	Group
8p.1	Ground potential rise, step and touch voltages during lightning strokes to GSM base station. **A. Sowa, J. Wiater, Poland**	2
8p.2	Assessment of the electric shock hazard during lightning at the small electric power system. **J. WIATER, Poland**	
8p.3	Analysis of Lightning Accident at Floating Roof Tank System. **A. GUAN Xiangshi, B. DING Haifang, China;**	
8p.5	Use of lightning data services in the industry. **Marc Bonnet, France;**	
8p.4	Meaning of the Discrepancy Between Lightning Strikes and Lightning Flashes for Risk Assessment. **C. Mazzetti, Italy; Z. Flisowski, Poland;**	3

3.2. Papers of Group 1: Lightning Accidents and Human Injuries

In Paper 8.2, the authors discuss mechanisms of interaction of a lightning flash with humans. The paper documents cases of lightning injuries resulting from a lightning strike, namely, injuries to the respiratory and cardiovascular system, injuries to the eye and ear, to the nervous system, skin and finally psychological and blunt injuries.

Paper 8.3 presents examples of severely damaged trees by lightning strikes. The reported cases are correlated the recorded waveforms are correlated with Lightning Location System (LLS) data, and, it is found that the trees were most likely struck by positive cloud-to-ground lightning, characterized by large amplitudes.

3.3. Papers of Group 2: Safety Measures and Protection

Paper 8-1 addresses the issue of grounding procedures to assure human and equipment safety against lightning. A methodology is proposed and examples of application are also presented.

In Paper 8p.1, the authors present a numerical model to compute potential rise and step voltages resulting from a lightning strike to a GSM base station.

The paper 8p.2 presents numerical evaluation of potential rise, step and touch voltages in an electric power system, typically a HV/MV substation.

In Paper 8.4, the authors discuss methods for measuring the resistance of living trees and their impact on lightning strikes to nearby distribution lines.

Paper 8p.3 discusses the performance of metal oil tanks and metal floating roof tanks against lightning. Two fire accidents caused by lightning in Yellow Island and in Shanghai are described and discussed.

In Paper 8p.5, the author presents the use of lightning data services in the industry in general. Present applications and future trends are addressed.

3.4. Papers of Group 3: Risk Assessment

In papers 8.5 and 8.6, fuzzy logic is applied to the problem of lightning risk assessment. It is supported that fuzzy logic handles in a more efficient way some uncertainties and/or inaccuracies in the parameters needed for the risk assessment.

In Paper 8p.4, the authors discuss the issue of lightning risk assessment associated with flashes and with strokes. Discrepancies in the results of risk assessment are investigated and discussed.

Paper 8.7 describes a software tool based on the IEC 62305-2 standard for the calculation of risk assessment associated with lightning.

References

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[13] IEC 61662, 1995: Assessment of risk of damage due to lightning.

[14] IEC 61662/A1, 1996: Assessment of risk of damage due to lightning. Annex C: Structures containing electronic systems.

[15] IEC 62305-2: Protection against lightning – Part 2: Risk management.

[16] Torres H., Duarte O.G., et al.: Fuzzy risk analysis due to lightning in Colombia; 26-ICLP Kraków 2-6. 09. 2002 paper 8b.2.