The International Project on Electromagnetic Radiation from Lightning to Tall Structures

W. Janischewskyj\textsuperscript{1}, F. Rachidi\textsuperscript{2}, and V. Shostak\textsuperscript{3}

\textsuperscript{1}University of Toronto, Canada
\textsuperscript{2}Swiss Federal Inst. of Technology (EPFL), Switzerland
\textsuperscript{3}National Technical University of Ukraine (KPI), Ukraine

Abstract—A brief report on activity related to International Project on Electromagnetic Radiation from Lightning to Tall Structures (IPLT) is presented.

Keywords—Electromagnetic field, lightning, modeling, measurement, tall structures

I. THE PROJECT

The International Project on EM Radiation from Lightning to Tall Structures (IPLT) was initiated as the outcome of an International Workshop held at the University of Toronto from August 20th to 22nd, 2001. Both, the Workshop and the International Project responded to the need felt by researchers throughout the world for a concerted effort on tackling this specialized question. Electromagnetic radiation from a tall structure hit by lightning is a novel area of studies, and the resolution of associated questions will have an impact upon many lightning-related applications such as lightning protection.

The main objectives of the International Project are:

1. To initiate and pursue collaboration among participating organizations in order to achieve further developments on measurement of lightning parameters, on analysis of acquired data, and on theoretical modeling and numerical simulation in the area of electromagnetic radiation surrounding tall structures when stricken by lightning.

2. To update instrumentation for lightning observations at tall structures used by participating organizations in order to provide novel and upgraded information on parameters required for lightning protection of electric power systems and for electromagnetic compatibility of sensitive contemporary electronic devices in presence of lightning disturbances.

3. To promote collaboration among participating organizations on the acquisition of equipment and its possible inter-loan.

II. PROJECT ORGANIZATION

A. Executive Board and Steering Committee

An Executive board and a Steering Committee were established at the 2001 Workshop with the task of coordinating and guiding the International Project. The board is formed by the Chair, the Vice-Chair and the Secretary. W. Janischewskyj (University of Toronto, Canada), F. Rachidi (EPFL, Switzerland) and V. Shostak (National University of Ukraine “Kyiv Polytechnic Institute”) were serving respectively as the Chair, Vice-Chair and Secretary until September 2009. From October 2009, Marcos Rubinstein (HEIG-VD, Switzerland), Gerhard Diendorfer (ALDIS OVE, Austria) and Carlos Mata (NASA, USA) are the new members of the Executive Board serving respectively as Chair, Vice-Chair and Secretary.

The Steering Committee is presently formed by 12 members from Austria, Canada, Germany, Italy, Japan, Poland, Sweden, Switzerland, Ukraine and USA.

The Executive Board and the Steering Committee are in regular contact, and meet in person at least once a year, in conjunction of international meetings.

B. Project Participants (Partners)

Presently, the project counts 26 institutions as partners from 14 countries. Participants in the International Project apply to individual national or international funding agencies for support of the portions of the International Project to be undertaken by each specific organization. While in touch with the Steering Committee, each participating organization implements the elements of the International Project by its own approach to modeling and by collecting lightning data using enhanced instrumentation. Developed theoretical models are tested, validated and assessed on the basis of observational results, so that improved recommendations could be formulated for application in national and international lightning protection practices.

C. Project Web Site

The International Project has a web site (http://emcwww.epfl.ch/iplt) hosted at the Swiss Federal Institute of Technology, Lausanne, Switzerland, which contains all relevant information and documents and is being regularly updated.
III. EXPERIMENTAL FACILITIES AND DATA

Within the project, several lightning characteristics and parameters are being observed and measured by various partners. Data include directly measured lightning discharge currents and associated electric and magnetic fields at different distances from the lightning channel. Other observations were also performed, namely lightning occurrence characteristics, video and high speed recording of lightning channel development and optical features, leader and return stroke propagation speeds. The obtained results are arranged in databases, exchanged by partners, reported to community, and published.

Direct current measurements on instrumented towers and of associated electromagnetic (EM) fields were made by project’s partners in Canada [1], Germany [2], Brazil [3], Japan [4], and Austria [5]. In addition, lightning currents and associated EM fields were also measured in USA using the rocket-triggered lightning technique [6]. Lightning currents and electric charge associated with the continuing-type current, as well optical features of lightning channel, were studied in Japan using instrumented wind turbines [13, 14].

A new project initiated within IPLT on the instrumentation of a new tower in Switzerland is undergoing [7]. In Germany, the work is continued on upgrading of the lightning parameters recording system at the Peissenberg tower near Munich [15]. In Japan, the preparations on studies of lightning parameters on a new tall telecommunication tower under construction in Tokyo are also in progress [16].

IV. EXPERIMENTAL FINDINGS AND MODELING ACTIVITIES

Significant experimental and theoretical findings related to studies associated with the Project were obtained (see e.g. [8-10]). Most of them are reported at international conferences, published in workshop proceedings and in refereed journals. Interesting results include detailed analysis of lightning current during different phases of lightning discharge and of associated electric and magnetic fields. Electromagnetic environment associated with lightning to tall objects were analyzed and it was shown for instance that the radiated fields from lightning to tall towers could experience significant enhancement. Tall, structures and rocket-triggered lightning were also used as a means to calibrate Lightning Detection Networks (LDN) and their ability to indirectly evaluate lightning currents.

The modeling of the interaction of lightning with tall strike-objects has also been considered in the International Project. References [8] and [9] present a review of recent progress in lightning return-stroke modeling including the presence of a tall structure and the effect of such a structure on the current and radiated electromagnetic fields.

V. INTERNATIONAL WORKSHOP

International Workshops have been organized on a regular basis to provide an opportunity to present latest studies and findings related to the project, and for the exchange of experiences among experts working on instrumented towers and those involved in rocket-triggered lightning. Four International Workshops have been organized in 2001, 2003, 2006 and 2009.

The First International Workshop was organized in Toronto, Canada, August 20<sup>th</sup>-22<sup>nd</sup>, 2001. It was hosted by the University of Toronto (Prof. W. Janischewskyj, Dr. V. Shostak). A total of 16 contributions were presented by participants from 8 countries.

The Second International Workshop was held in Bologna, Italy, June 26<sup>th</sup>-27<sup>th</sup>, 2003, in association with the IEEE PowerTech International Conference. It was hosted by the University of Bologna (Profs. C. A. Nucci, A. Borghetti and M. Paolone). 8 contributions were presented by participants from 8 countries.

The Third International Workshop took place in Vienna, Austria, April 3<sup>rd</sup>-4<sup>th</sup>, 2006, in association with the First International Symposium on Lightning Physics and Effects, with the support of the European COST Action P18. It was hosted by ALDIS OVE, Austria (Dr. G. Diendorfer, Dr. W. Schulz). 26 contributions were presented by participants from 19 countries.

The Fourth International Workshop took place in Montreal, Canada, July 29<sup>th</sup>, 2009, and was hosted by HydroQuebec Canada (Dr. Hubert Mercure and Mr. Jean-Pierre Tardif). A total of 17 contributions were presented by participants from 12 countries.

Contributions to mentioned Workshops were published in the Book of Summaries, available on the IPLT web site.

In 2010, IPLT is sponsoring a Special Session on Lightning to Tall Structures and Wind Turbines at the 30th International Conference on Lightning Protection (ICLP), to be held in Cagliari, Italy, in September 2010.

VI. FUTURE ACTIVITIES

A. Lightning Current Statistics

Distributions of lightning parameters presently adopted in international standards are essentially based on measurements by K. Berger and co-workers in Switzerland [11]. More recent measurements have been obtained using instrumented towers in Austria, Germany, Russia, Canada, and Brazil, as well as using triggered lightning. Further, modern lightning detection networks, which are now widely used, report peak currents estimates from remotely-measured field peaks. There is a need to evaluate these new experimental data to determine the limits of their applicability to various engineering applications [12].
B. Lightning Protection of Wind Turbines

Wind energy is one of the fastest growing electric power generation technologies. Wind turbines are vulnerable to lightning which can cause important damages to wind turbine component. A considerable number of wind turbines are damaged by lightning every year. Modern wind power generation units are, however, characterized by ever taller turbines. As a result, it is expected that modern turbines will be more exposed to lightning strikes in the future and their protection will present a number of new challenges [17]. Thus, it is important to develop studies on characteristics of lightning to wind turbines and on means of their protection [13, 14].

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REFERENCES


