DEVELOPING A LIGHTNING AWARENESS PROGRAM MODEL FOR THIRD WORLD BASED ON AMERICAN-SOUTH ASIAN EXPERIENCE

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***Abstract*-This paper reviews the lightning safety and protection awareness programs conducted in USA at various levels during the last 40 years. The review is focused on the teams that conducted awareness programs, target groups, themes and areas of concern and the outcome. Special attention was given to the knowledge barriers that have been overcome and the commercial-promotion based misconceptions that are being rectified. We also discuss the advantageous and drawbacks of program models that are currently being conducted in USA. In the second part we review the awareness programs on lightning safety and protection conducted in third world countries, paying special attention to Sri Lanka and Bangladesh, during the last two decades. Among the third world countries Sri Lanka is in the forefront of lightning safety education, however, we point out several drawbacks of the programs conducted so far which prevented the achievement of optimum results. In Sri Lanka a large number of plenary lecturers have been conducted at school level. This mode of dissemination of knowledge has been found to be successful as a way of conveying message to the elders. In Bangladesh, many low-cost techniques have been developed to convey the message of safety and protection to both general public and technical communities. The programs for the general public have been conducted with very fundamental techniques such as dramas, folk songs, story telling etc and instead of calling the public to the city, the awareness promotional team has gone to the root level of the country and has conducted the events in an environment familiar to the public. A continuous feedback has been obtained from many of the participants to evaluate the success of the program. We propose this Bangladesh model to be applied to communities with very law level of literacy rate, especially in African and South Asian countries. We analyze the applicability of techniques that have been successfully tested in USA, in the third world countries as well. We also discuss the benefits and drawbacks of obtaining the contribution of the commercial sector in promoting lightning awareness. Consequently we build up several lightning safety and protection awareness models for the third world to educate the public and some specific communities to minimize the lightning related hazards. Finally we recommend institutionalizing the scattered lightning safety and protection awareness events, in each country, to construct a more organized body that enhance the awareness and technical skills of the people, during a relatively short period of time.**

***Index Terms*—Sri Lanka, America, Bangladesh, Lightning Awareness, Safety, Protection, Standards, Injuries**

I. INTRODUCTION

The objective of this paper is to share the experience of education on lightning safety and protection over several decades, with the rest of the scientific community. We analyze the lightning awareness programs and their present situation in one developed country; USA and two developing countries with different literacy levels; Sri Lanka and Bangladesh. The results of this study are summarized to develop a model to promote lightning safety and protection awareness effectively in third world countries.

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II. LIGHTNING SAFETY AWARENESS IN USA

The British lightning code was sourced by the National Fire Protection Association (NFPA) in 1903 to become the first USA lightning protection document, updated and known today as NFPA-780 "Recommended Standard for the Installation of Lightning Protection Systems." Accurate statistics about lightning deaths and injuries, as well as cost of damages to facilities, were not well kept until the 1990's. Research looking back on the subject indicates much science then was devoted to lightning phenomenology including atmospheric physics and general meteorology investigations. Lightning safety issues were neither well publicized nor studied.

Looking back on the early days of lightning safety information, notable is the seminal work edited by R.H. Golde called "Lightning." Published in two volumes by Academic Press in 1977, it received little attention outside the research community. It contained a contributory paper by University of Manchester (UK) Professor W.R. Lee entitled "Lightning Injuries and Deaths."

At the end of the 1980's and the beginning of the 1990's organizations and peer-reviewed technical papers began to appear. Some examples:

Establishment of the "Lightning Strike and Electric Shock Survivors International (LSESSI), a victim support group under the administration of S. Marshburn and with professional medical direction from Dr. M.A. Cooper . More information, see the website: www.lightning-strike.org

Cherington M, Vervalin C, 1990: "Lightning Injuries – Who is at Risk?", Physician and Sports Medicine No. 18:

Holle RL, Lopez R et al., 1992: "Cloud-to-ground lightning related to deaths, injuries and property damage in Central Florida",Internjational Conference on Lightning and Static Electricity, FAA Report No. DOT/FAA/CT-92/20.

Cooper, Cherington, Holle and Lopez became prolific authors and central leadership figures, broadcasting the lightning safety message for some 15 years. In 1992 the Denver Colorado St. Anthony's Hospital Lightning Data Center was formed under the aegis of Dr. M. Cherington, R. Holle, R. Larson and others. That organization survives today and can be accessed via the Home Page Search Engine at: www.stanthonyhosp.org

Books and magazine articles on lightning safety began to emerge quickly. One of the earliest books was "Lightning Protection for People and Property", authored by M. Frydenlund (Van Nostrand Reinhold, NY 1993 ISBN 0-442-01338-8). The information contained in this out-of-print book is still valid today.

Lightning safety issues sometimes were discussed in various journals and papers given at conferences such as the European International Conference on Lightning Protection (ICLP), the International Electrical and Electronic Engineers (IEEE), the International Conference on Lightning and Static Electricity (today known as ICAE) and others. For the most part, however, the subject was confined to academia and similar narrow audiences. The emergence of the National Lightning Safety Institute (NLSI, see www.lightningsafety.com) in 1994 coincided with rapid expansion of the Internet and email correspondence. Suddenly audience interest spread quickly from academia to safety organizations to those groups needing subject matter information. Interested parties from the Boy Scouts, the YMCA, national, state and local recreation organizations, commercial airports, military services, colleges and universities etc. etc. could obtain objective assistance at low cost/no cost with the flash of a keyboard message through cyberspace.

In 1997-1998 B. Bennett, Univ. of Virginia and K. Walsh, Eastern Carolina Univ. advocated lightning safety guidelines for the National Collegiate Athletic Association (NCAA) and the National Athletic Trainers Association (NATA). These agencies require their members to adhere to the safety protocols outlined in their operating manuals. In 1998 the American Meteorological Society *ad hoc* Lightning Safety Committee promoted fundamental recommendations which have gained national recognition.

The US federal government under the Weather Service began sponsoring National Lightning Safety Awareness Week (LSAW) in 2002. Publicity here reached new audiences across the country. Information on the LSAW program can be viewed at: www.lightningsafety.noaa.gov

During the period 1950-present recorded annual USA lightning incidents to people have been reduced by approximately two thirds, from the lower 100's to the middle 30's. In part this is a result of a more urban and less rural population. In part it is due to the stochastic annual distribution of lightning across the USA. And, safety groups like to claim, it is in part due to increased awareness and education of the general population.

While lightning deaths and injuries are descending, costs and losses to the commercial and industrial sectors of the country are increasing. This is due to the rapid installation and use of low voltage semi-conductor silicon-based computers and other instrumentation upon which our culture and economy have become dependent. Present day consequences from lightning are estimated at $5-6 billion/yearly. As with personal safety issues, the key to protecting economic assets also is education about the essentials of risk reduction and protection of assets.

III. LIGHTNING SAFETY AWARENESS IN SRI LANKA

In Sri Lanka, over 50 deaths per year are reported due to lightning (Sri Lanka Meteorology Department). Properties worth more than 2.5 million USD, damaged in the power, communication and industrial sectors and at

domestic level, during the two lightning seasons of the year (Survey done by Colombo University, Lightning Research Group). This amount does not take into account the billions of indirect loses due to the downtime caused by the damaged and malfunctioning equipment and lose of data in the microprocessors. The equipment damage is on the increasing trend for the last few decades, may be, due to the wide spread of the use of electronics and extension of the national power grid into rural areas.

Another concern of Sri Lanka with respect to lightning is the death of domesticated elephants by lightning strikes. Most often these animals are subjected to step potentials or side flashes as they are tied to trees and wooden stubs by iron chains. The cost of a domesticated elephant in Sri Lanka is about 15,000 USD.

Lightning related research has been started in Sri Lanka in the late 70s, at the University of Colombo, therefore the Lightning Physics research group in Sri Lanka is one of the oldest such groups in South Asia. The group has strong research collaboration with Uppsala University, Sweden. However, until about the year 2000, the scopes of the group has been restricted to purely academic work. With the exception of few programs conducted at personal level by the Meteorology Department of Sri Lanka, public awareness programs on lightning safety and technical awareness programs for the engineering community were hardly conducted.

However, by the year 2000, several organizations have understood the urgent requirement of the promotion of lightning safety and protection awareness in the country. As a result a number of programs have been launched to educate the general public, engineering community and scientists. The University of Colombo, National Science and Technology Commission/Sri Lanka, the Meteorology Department of Sri Lanka, IEE Sri Lanka Branch, Institute of Physics/Sri Lanka, University of Moratuwa, Ceylon Electricity Board, Sri Lanka Telecom, Sri Lanka Standard Institution, Sri Lanka Association for Advancement of Science, Postgraduate Institute of Science/Peradeniya University and several other institutions have conducted awareness and training programs on lightning protection in Sri Lanka. The UNESCO New Delhi, USAID under SARI/Energy Program, and several other funding agencies have sponsored these events.

In Sri Lanka, the awareness programs were conducted at school and village/urban administration level, technical level, engineering and management level and research level. The literacy rate of most parts of the country is above 90% in Sri Lanka. Therefore, the message of lightning safety could be easily conveyed to the general public through plenary lecturers, video demonstrations and booklets. As we have found through our feedback surveys, school programs are one of the most powerful tools in sending scientific information to the surrounding in a country such as Sri Lanka where the school network has a very strong basic structure. The following web site provides the details of such school programs conducted in the country: www.pdf.dec.org/pdf_docs/PNADD530.pdf

However, at technical and engineering level it has been found that, despite the commendable general engineering knowledge of the professionals, it is somewhat difficult to make them follow standard practices of lightning protection. This is partly due to the mis-conceptions and sub-standard technologies introduced and promoted by the commercial sector. One other reason is the ignorance and negligence of the professionals in following standards and codes. The feedback surveys that have been done as post-program activities reveal that the knowledge and psychological barriers of the local professionals could be better overcome when programs are conducted by foreign experts.

IV. Lightning Safety Awareness in Bangladesh

The number of deaths and injuries due to lightning in Bangladesh is over 150 per annum as reported in the newspapers [1]. However, this number may be several times higher as information network in the country is mediocre. We also receive regular reports from Bangladesh where a considerable number of people are killed or injured in a single incident. One example is the death of 8 people and injury of 40 people at Chapainawabgonj, on the 12th July 2005 [1]. In another incident took place on the 16th of February 2006 nine people were killed and 23 were injured when lightning struck a temporary hut in northeastern Bangladesh.

The economic losses due to equipment and property damage, downtime etc. are not yet estimated in Bangladesh. As the country is in the verge of rapid development the lightning related damages will soon be a large burden to the country.

Lightning awareness programs in Bangladesh were started in the year 2004. Initially, lightning safety awareness programs were conducted for school teacher. This approach was preferred considering that once school teachers are educated on the topic they can give the awareness information to the students and to the related guardians and local community as well.

However, in Bangladesh, it has been found that the lectures and presentations are not very affective at rural areas due to the very low literacy levelamong the public. Therefore, the Bangladesh Lightning Awareness Centre, the key lightning safety promotional institution in Bangladesh, adopts various alternative methods of disseminating knowledge among the public. At the very lower level the people are educated through folk songs, road-side stage plays, dramas, dances and story telling. A trained a team of experts have been sent to many parts of the country with the message of lightning safety. The

reports from the team leaders show that the response from the people is very encouraging. At the next level the awareness team conducts student-teacher seminars, and distributes brochures, handouts and booklets etc. and also publish newspaper and wallpaper articles. In few occasions billboard displays are also used. At technical and engineering level the awareness centre conducts seminars and technical sessions. At present the support of foreign experts is obtained in many of the programs at this level.

V. Development of a program model

Based on our experience and outcome of the programs conducted so far, we propose the following model for awareness programs in third world countries.

For regions with very low literacy (below about 30%) the awareness programs should be conducted by teams of trained people who are conversant with local languages and customs. The message of the danger of lightning and lightning safety should be conveyed through folk songs, dramas, story-telling etc. at the places of small gatherings. Display of billboards with photos of lightning affected people and lightning safety rules (without lettering) is also recommended.

For communities with higher literacy (above 30%), we recommend public seminars and demonstrations conducted in local languages. Billboards and posters with written safety tips should also be used. In many communities with literacy above 50% school programs conducted for teachers and students are highly recommended. In each school a small team should be trained in giving seminars on the basics of lightning, lightning safety and protection and essential first aid. Through this teacher-student team the information on lightning safety can be conveyed to the public by regular programs and distribution of awareness materials. In many areas we have found that the support of local administration bodies is highly beneficial in disseminating the knowledge to the public. In addition, the involvement of village doctor, school principal, religious leaders and village leaders should also be very advantageous for the success of such educational programs.

In Areas of literacy rate above 90%, the school and public awareness programs can be incorporated with web based information and educational programs. Especially in the urban areas of many third world countries the computer literacy is developing fast, so that information given by websites will be very useful in few years. In such cases the development and operation of websites based on local information will be more helpful to the public than the information given by foreign websites. Therefore, the regional Lightning Awareness Centres should be encouraged to develop their own websites on lightning safety and protection.

The challenges of overcoming the knowledge and psychological barriers of the technical and engineering communities in the region can be done through methodically organized and well planned educational and demonstration programs initially conducted by experts from developed countries. Once they are confident about the standard practices the education part should be smoothly transferred to local experts.

VI. Establishment of Lightning Awareness Centers in Third World Countries

Many of the states in India and other countries such as Sri Lanka, Bangladesh, Bhutan and Nepal are prone to lightning hazards. The situation is even worse in many African and South American countries. Therefore proper dissemination of knowledge on lightning protection and safety measures is expected to minimize the death toll and other hazards to the human beings and live stock and also to minimize the lightning damages to properties, industries and services such as power and communication. Although a notable effort is made by the scientific community during the last several years to educate the public in the prevention of lightning hazards, still the number of deaths, injuries and property damages due to lightning is unacceptably high in many Asian, African and Latin American countries. According to the National Crime Record Bureau, India 1507 persons died in India during 2001 because of lightning, which is about 1% of the natural and unnatural accidental deaths in the country. In Orissa (a state in Eastern India) alone, about 300 persons were struck by lightning and subsequently died in 2004. Further, the equipment damage is also increasing due to the wide spread the use of electronics, extension of the national power grid into rural areas and the mushrooming communication towers all over the region. Though various lightning protection and safety measures are available internationally, many of the engineers involved with lightning protection in many developing countries in general and South Asia in particular have limited knowledge in this unique field although they may be very competent in general electrical engineering. Lightning Protection is a streamlined field that requires high specialization for an electrical engineer to become an expert. New concepts, techniques and products are constantly introduced into the market and most importantly, based on the scientific discoveries, some products, techniques and even entire concepts are rejected from the standards and engineering practice. The engineers in developing countries are at a distinct disadvantage of not getting an opportunity to access such knowledge. Therefore we propose lightning awareness centers to be established in each developing country.

The proposed lightning awareness centers (LACs) should act as a platform for scientist-to-scientist and institution-to-institution contacts on lightning protection information, awareness and research. The LACs will be able to work in close coordination with the other regional and international institutions/individuals with similar expertise or interests. The LAC will train small-scale

entrepreneurs from different states of India to give solutions to lightning protection, EMC and electrical safety issues at industrial and domestic level. Further, LAC will also educate the engineers and technocrats so that they understand the basic concepts of lightning phenomenon, lightning threats in their fields of work, safety measures that should be taken to minimize lightning hazards, essentials of lightning protection, selection of protective equipment and the finer points of implementing, testing and maintaining a proper lightning protection system. The places where Lightning Research units are also established in addition to the Awareness promotion units, investigations will be done on various aspects of lightning physics and engineering. The research will be focused on the topics address national and regional issues. Wherever possible, collaborations will be initiated with research groups with similar interest at international level

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VIII. References

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