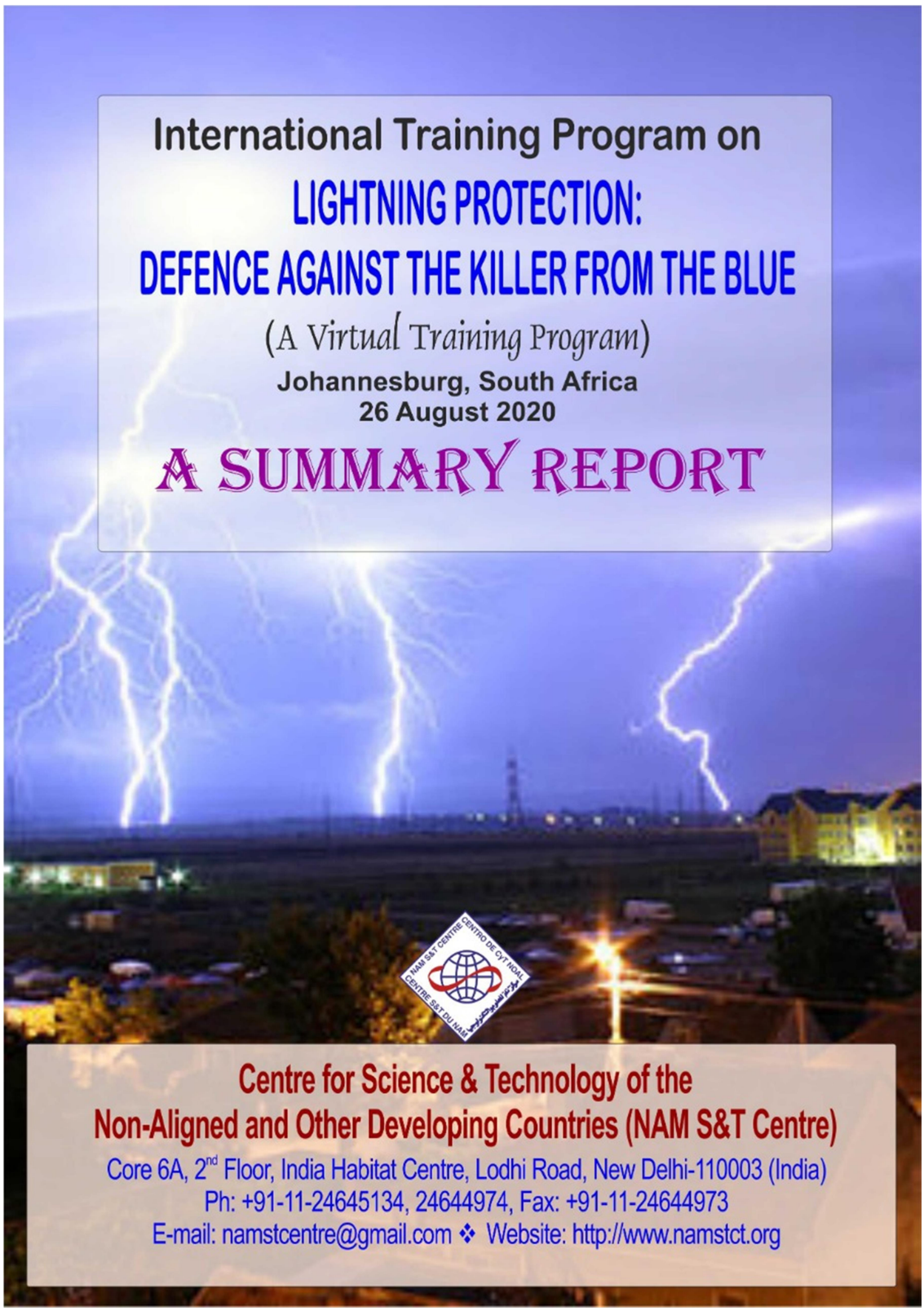

International Training Program on

LIGHTNING PROTECTION: DEFENCE AGAINST THE KILLER FROM THE BLUE

(A Virtual Training Program)

Johannesburg, South Africa
26 August 2020

A SUMMARY REPORT

Centre for Science & Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre)

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INTERNATIONAL VIRTUAL TRAINING PROGRAM

LIGHTNING PROTECTION: DEFENCE AGAINST THE KILLER FROM THE BLUE

26 AUGUST, 2020

BRIEF REPORT

Lightning is a naturally occurring electric discharge caused by electromagnetic field imbalances between clouds and the ground or within the clouds themselves. As a thundercloud (known as Cumulonimbus) matures, colliding particles of rain, ice or snow inside separate charge with opposite polarity. Typically, the positively charged particles reach upper layers of the cloud, and negative charge deposits at the lower layers. As the field strengths exceed certain thresholds, discharge takes place inside the cloud, and a charged channel starts extending towards ground. Usually, such channels carry negative charge. As they approach the ground, the objects on the ground, such as steeples, trees, people, and the soil or water itself, become positively charged. Those objects send positively charged streamers upwards towards the down-coming channel tip. As one of the upward streamers meets the channel from the cloud, a large current flow through the object that sent the successful channel. Then the object is said to be “lightning struck”.

A direct strike described above, accounts for only about 3-5% of deaths in the developed countries. More deaths and injuries are caused by step potential (40-50%), side flash (20-30%), upward streamers (15-20%), or contact injuries (15-20%). Apart from human injuries, lightning leads to property damage, service interruptions, data and signal corruption causing financial losses of many billion USD per year. Sometimes, downtime losses exceed the recovery cost of physical damages. Thus, lightning safety and protection measures may save a fortune for any country that experiences a high density of thunderstorms.

In order to impart technical training on the scientific phenomenon of **‘Lightning’** to the concerned scientists and professionals in various countries, the **Centre for Science & Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre), New Delhi,** jointly with the **Center of Excellence in High Voltage Engineering, University of the Witwatersrand, Johannesburg, South Africa,** organized an International Training Program on "**Lightning Protection: Defence Against the Killer from the Blue**" on **26 August, 2020** through Virtual Mode**.**

The scientific event was hosted by the Centre of Excellence in High Voltage Engineering, University of the Witwatersrand, Johannesburg. It was a very dynamic event that was aimed at providing basic knowledge on the scientific phenomenon of lightning with technical understandings on (i) lightning accidents and level of risks involved; (ii) international and national lightning standards; (iii) basic concepts of structural protection and earthing; (iv) protection of low voltage power-systems; (v) protection of signal and data systems (including shielding and bonding); (vi) lightning safety education; (vii) low-cost solutions for lightning protection focusing the developing countries; and (viii) lightning protection as a small and medium-scale entrepreneurship and development of Lightning Training Centres.

The **Inaugural Session** started with an address by Dr. Amitava Bandopadhyay, Director General, NAM S&T Centre, New Delhi, who welcomed the participants and briefly highlighted the centurial concerns of lightning and thunderstorms to human beings; and the associated dangers of lightning strikes that cause damage to human lives, livestock, property and infrastructure including the destruction of power-lines, electronics and communication systems. He also highlighted the importance of scientific and technological developments that are being made in computational and smart algorithms to process millions of data with real-time feedback loops, thus, making possible even the slightest prediction of lightning and thunderstorms with high accuracy and reliability. Dr. Bandopadhyay in his address also mentioned about the significant contribution made by the NAM S&T Centre for capacity building of the scientists and professionals of its Member Countries on the subject of 'Lightning' and other extreme natural events in partnership with various global S&T institutions and agencies through organisation of various scientific programs on the subject. He further added that these programs of the Centre have also led to the establishment of the African Centre for Lightning and Electromagnetics Network (ACLENet) in Kampala, Uganda, and the Zambian Centre for Lightning Information and Research (ZaCLIR) in Lusaka, Zambia, and the formation of national centres in several other African countries are in-process. The opening remarks were then made by the South African co-organiser and host Prof. Chandima Gomes, Professor of High Voltage Engineering, **School of Electrical and Information Engineering (EIE),** University of the Witwatersrand, Johannesburg. Prof. Gomes in his address welcomed the participants and underlined the importance of the subject with a special focus on the developing countries.

The Online-Training Program was attended by **123** participants from **21** countries, namely Argentina, Australia, Bangladesh, Bhutan, China, Colombia, Egypt, India, Iran, Malaysia, Maldives, Mauritius, Myanmar, Mexico, Nepal, Nigeria, Palestine, Sri Lanka, USA, Zambia and the host country South Africa.

The overall Training Program was conducted in several technical training sessions; facilitated by Dr. Amitava Bandopadhyay, DG, NAM S&T Centre. The salient features of the various Technical Sessions are summarized below.

Technical Session-1: The Program commenced with introduction to the participants on **'The Fundamentals of Lightning'**. Dr. Shriram Sharma, Chairman, South Asian Lightning Network (SALNet) and Senior Lecturer, Tribuvan University, Kathmandu, Nepal was the Resource Person in the session and familiarized the participants with the basic principles of

lightning. Dr. Sharma in his lecture highlighted that lightning flash is basically a transfer of charge between cloud-ground, cloud-cloud, or cloud-air mass. The first type is commonly known as 'Cloud to Ground Lightning Flashes' (CGF) and the second and third types are known as 'Cloud Flashes' (CF). Out of these, CGFs have the highest impact on human beings, animals and man-made structures.

Technical Session-2: Mr. Ron Holle**,** Senior Scientist, Vaisala Inc., Tucson, Arizona, USA imparted training in this technical session on **'Lightning Accidents and Risk Levels'**. Mr. Holle highlighted that lightning safety in the developed countries is in better-state due to reliability on lightning-safe buildings and infrastructure; hence they face less casualties and damage in contrast to the developing countries. He further added that in these vulnerable locations, priority should be given on installing code-compliant lightning protection systems to provide safer locations to people at large. Projects such as ACLENet (African Centres for Lightning and Electromagnetics Network) and SALNet (South Asian Lightning Network) are critical to overcome this gap.

Technical Session-3: In this session, Mr. Alexis Barwise, Chairman, IEC 62305-TC 81 Mirror Committee of South Africa, Pretoria, engaged the participants' interest with his talk on **'Structural Lightning Protection Systems'**. He stated that in order to protect a building and its occupants from possible lightning related damage, a comprehensive structural protection system is required. The purpose of a "Lightning Protection System (LPS)" designed for a structure is to intercept a lightning stepped leader reaching the building and pass the lightning current safely into the ground without creating any potential risks. The lightning protection system should not be considered as a device which prevents or repels lightning. A typical structural protection system consists of both external LPS and internal LPS. An external LPS is intended to: intercept a direct lightning strike on the structure (with an air-termination system); conduct the lightning current safely towards earth (using a down-conductor system); disperse the lightning current into the earth (using an earth-termination system); while an internal LPS prevents dangerous sparking within the structure using either equipotential bonding or a separation distance between the external LPS components and other electrically conducting elements internal to the structure. A consultation with LPS designers and installers, architects and builders is essential in order to achieve the best results at a minimum cost.

Technical Session-4: The South African co-organiser and host, Prof. Chandima Gomes, Professor of High Voltage Engineering, **School of Electrical and Information Engineering (EIE),** University of Witwatersrand, Johannesburg, South Africa, delivered a lecture on the theme of **'Lightning Surge Protection of Low Voltage Systems'**. Prof. Gomes in his presentation explained that the loss due to both lightning and switching transients can be minimized by installing Surge Protective Devices (SPDs) in the power systems and communication and data-line systems. He further emphasized that for a productive and cost-effective surge protection scheme, the following steps should be taken into consideration: (i) system analysis and risk assessment; (ii) strategic location selection for protective devices; (iii) selection of appropriately coordinated protective devices; (iv) proper installation and commissioning; (v) regular maintenance and replacement of faulty devices.

Technical Session-5: Dr. Mary Ann Cooper, Managing Director, African Centers for Lightning and Electromagnetics (ACLENet), Kampala, Uganda & Professor Emerita, University of Illinois, Chicago, USA led the session and imparted further learning to the participants on **'Lightning Safety Education'**. Emphasizing the importance of the phrase 'Knowledge is Power', Dr. Cooper stated that it is important to provide individuals or groups with proper lightning safety education through reliable communication channels and preferably in their local / regional languages to avert or minimize the risk. Several safety education campaigns and emergency management initiatives in developed countries have significantly reduced the lightning related damage to life, property and infrastructure; and it is important to be emulated by the developing countries as well.

Technical Session-6: Prof. Gomes further expanded the understanding of the participants on the subject and spoke on his second session on **'Research, Entrepreneurship and Development of Training Centres**'. In this session, Prof. Gomes highlighted the importance of regional Lightning Centres (LCs) that plays a significant role in Small and Medium-Scale Entrepreneurship (SME) Development. Apart from facilitating entrepreneurship, these Lightning Centres significantly contribute in disseminating awareness about lightning safety among the general public, trainees and technicians, engineers, scientists conducting or facilitating lightning-related research, officials collecting information and developing databases on lightning-related accidents and losses in the affected region, supporting governments and standard institutions in promoting policies, guidelines, recommendations etc.

Technical Session-7: As the Head of the African Centers for Lightning and Electromagnetics (ACLENet) Kampala, Uganda; Dr. Cooper, additionally conducted a short session and briefed the participants on **'ACLENet - Reflections'**.

Technical Session-8: Dr. Sharma led the last session on **'Raising Awareness and Training on Lightning Protection - An Experience from Nepal'.**

This was followed by a Panel Discussion by all the Speakers and a Question-Answer Round for clarifications and consolidation of learning; which was facilitated by Mr. Gopa Kumar, MD, Cape Electric Pvt. Ltd, Chennai, India.

The **Concluding Session** was chaired by Dr. Bandopadhyay, DG, NAM S&T Centre and Prof. Gomes, Professor, University of Witwatersrand. Extensive discussions were held and views were exchanged for understanding the key learnings, experience and takeaways from the program.

The participants expressed gratitude to the organisers and hosts – the NAM S&T Centre and University of Witwatersrand for the excellent organisation and efficient coordination of the Training Program. They appreciated that such scientific programs not only provided opportunities to them to meet, engage, gain and share knowledge on a common platform at the time of a global pandemic, but also facilitate in understanding the rudiments of lightning from a scientific and technological perspective – a collaborative approach essential for lightning protection.

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Dr. Shriram Sharma (Ph.D.) is a Senior Faculty in the Department of Physics, Amrit Campus, Tribhuvan University, Nepal.

He has obtained his Ph.D. through a Sandwich Program between the Uppsala University, Sweden and Colombo University, Sri Lanka in 2007. He was involved in research activities at Ångström Laboratory, Uppsala University, Sweden as a Post-Doctoral Researcher in 2009 and 2014.

Dr. Sharma has supervised over 50 Masters Level Students and PhD graduates under his supervision and has authored and co-authored over a dozens of Research Articles in International Peer Reviewed Journals.

Chairman: Lightning and Atmospheric Research Center (LARC), Nepal

Chairman: South Asian Lightning Network (SALNet) based in Kathmandu, Nepal

He is a Resource Scientist at the Nepal Academy of Science and Technology (NAST) and a Main Facilitator and Trainer at Ministry of Home Affairs and Asian Disaster Preparedness Center (ADPC) with its Head Office at Bangkok.

He has led the Upgradation Team of Electrical Code (incorporating in Building Code) under the Department of Urban Development and Building Construction (DUDBC), Ministry of Urban Development, Government of Nepal.

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Mr. Ron Holle
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Mr. Ron Holle is a Meteorologist in Arizona in the **United States**. He has studied lightning safety policies, and compiled information about lightning deaths and injuries around the world. His particular interest has been with regard to the time of day and year, location, activity, gender, and age of lightning injuries. He has—published extensively on the occurrence of lightning with regard to meteorological factors influencing lightning formation, and the applications of lightning data. Ron is a Senior Scientist with Vaisala, and a Fellow of the American Meteorological Society. He is an active member of the U.S. National Lighting Safety Council and African Centres for Lightning and Electromagnetics Network (ACLENet). He is co-author of the Springer Press book "Reducing Lightning Injuries Worldwide" with Dr. Mary Ann Cooper.

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Mr. Alexis Barwise received his bachelor's degree in Engineering (B.Eng.) in both Electrical and Electronic Engineering from the North-West University in South Africa in 2007.

He has been active in the field of earthing and lightning protection for over 10 years in different parts of the world and in many different industry sectors.

He currently serves as the Chairman of the National Mirror Committee for TC 81 and is an active member on both national and international standards and technical committees.

He has written several technical articles and provided many training courses in lightning and surge protection in several countries around the world.

He is a true Ceraunophile, a father of two boys and a loving husband and huge cricket fan.

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Prof. Chandima Gomes is the Professor of High Voltage Engineering; the Chair, ESKOM Power Plant Engineering Institute-HVAC; and the Director, Centre of Excellence on High Voltage Engineering, University of the Witwatersrand, South Africa. He is a Chartered Engineer registered in UK, a Professional Physicist in South Africa and a Fellow of the South African Institute of Electrical Engineers (SAIEE). He was a Professor of Electrical Engineering and a researcher in high voltage engineering and lightning protection at Universiti Putra Malaysia until October, 2018. Chandima was a founder of the Centre for Electromagnetics and Lightning Protection (CELP), Malaysia and the first Head of the Centre. He has held full-time/adjunct/visiting professorship and lectureship in physics, engineering and meteorology at universities based in Malaysia, Sri Lanka, USA, Australia, Kazakhstan, Pakistan, Zambia, Sweden, Colombia and Japan. He was a Senior Adviser to the National Lightning Safety Institution (NLSI), USA and the Chief Adviser to African Centers for Lightning and Electromagnetics (ACLENet) based in Uganda and adviser/mentor to several other national lightning research/awareness centers in a few countries. He is a Member of the TC81 of IEC 62305 – Protection against lightning, SABS TC 0067/SC 06 –Electricity distribution systems and components: Installation, and WG SANS 10313 - Protection against Lightning - Physical damage to structures and life hazards. Chandima has conducted over 120 training programs in **Lightning Protection and Electrical Safety** in 12 countries so far. He has published over 300 international research papers and several books on his expertise. He obtained a First Class Degree in Physics from the University of Colombo, Sri Lanka in 1993. He has done research for his PhD (1999) and postdoctoral research on lightning protection and high voltage engineering at Uppsala University, Sweden. He is also an expert in power and energy, electromagnetic compatibility, sensing and processing technologies and industrial optimization.

Dr. Mary Ann Cooper,
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Dr. Mary Ann Cooper, MD, an emergency physician by training, is an international expert in lightning injuries and lightning injury prevention. She received her BS and MD from Michigan State University and trained in Emergency Medicine (EM) at the University of Cincinnati.

In addition to awards from both the medical and lightning communities, Dr. Cooper was the first physician to be awarded Fellowship from the American Meteorological Society in 2003. In 2014, she was awarded the International Conference on Lightning Protection Scientific Committee's Award for 'Outstanding Contribution to Lightning Science by Research or Teaching'. She has served as a Board Member of the Lightning and Electrical Shock Survivors International, a support group for lightning survivors over 30 years.

Dr. Cooper was awarded **Professor Emerita** on retirement from the University of Illinois but continues working internationally to mentor young lightning scientists, research and prevent lightning injuries, and educate and raise awareness of lightning safety. Since 2014, she has been the Managing Director of the African Centres for Lightning and Electro-magnetics Network (https://ACLENet.org), a non-profit organisation dedicated to reducing deaths, injuries and property damage from lightning across Africa and is active internationally with many other lightning safety programs around the world.

Mr. Gopa Kumar,
MD
Cape Electric Pvt. Ltd, Chennai, **India**
E-mail: gk@capeindia.net

Mr. S. Gopa Kumar is an Electrical Engineer and Managing Director of Cape Electric, Chennai.

He has more than 25 years' experience in electrical safety, lightning protection, EMI/EMC etc. He is actively participating in various national and international standardising programs specially on electrical safety. He is a Member in IEC.

1. **TC-64** (MT 3, MT 12, MT 41, PT 60364-8-3, WG 43)
2. **TC-81** ahG 19, MT 3, MT 14, MT 21, WG 18
3. SC 37 A (WG3 & WG 5)

He is associated with the Bureau of Indian Standards (BIS) especially with the:

- National Building Code of India-2016 (Electrical Committee),
- ETD 20 & ETD 30 (National Electrical Code, IS732, IS3043…etc)

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