LIGHTNING PROTECTION TECHNIQUES AND APPLIED CODES & STANDARDS

MOHIE .M . ALI , HASSAN SHAABAN , SAMIR LAMEY
Atomic Energy Authority , Alex Egypt , P.O.B 183 , Sidi Gaber

ABSTRACT

Lightning is the only natural disaster that protection against it is highly effective.Thus for the safety of critical installation, specifically nuclear, an effective lightning protection system (LPs) is required . The design and installation of LPS's have been addressed by many national codes and standards in many countries .

In this paper the various LPS's have been discussed and compared , including radioactive air terminals , ionizing air terminals and terminals equipped with electrical trigging devices . Also the so - called dissipation array systems are discussed and compared . Moreover , The available codes and standards related to lightning protection systems are presented. Codes and standards issued from different authorities such as National Fire Protection Association (NFPA) 780[1], lightning protection Institute (LPI)[2], underwriters laboratories (UL)[3] (USA) and also those given by both the British Standards (BS 6651)[4] and the German Standards (DIN 57, 185 part1 / VDE 0185 part 1.2)[5] are reviewed .

Finally , the possibility of developing an Egyptian National Standard is discussed .

INTRODUCTION

In the last few years Egypt suffered from the effect of some natural disasters such as flows, earthquakes and lightning . Since lightning is one of these disasters where protection systems could be made , therefore many industrial sectors whose activities are sensitive and need high degree of safety began to think in establishing lightning protection system (LPS). Such sectors include petroleum , chemical and military industries. Since LPS are not familiar in Egyptian industries and there is no Egyptian standard for lightning protection (LP) . This paper has been prepared in order to present and discuss the different LPS codes and standards and methods taking into consideration to facilitate to specialists their duty in preparing LPS specifications while bearing in mind a final goal , that is, to develop an Egyptian code .

DATA NEEDED FOR LPS DESIGN

In many Cases , it is obvious that some form of protection is required. High risk structures as nuclear systems (e.g nuclear power stations , laboratory, ... etc.) ,oil refineries ,explosives factories , ... etc. will require lightning protection system . In other cases the need for protection is not evident .

The codes provide a simple mathematical overall risk factor analysis for assessing whether a structure needs protection . All the Codes Suggest that an acceptable lightning strike risk factor is 10^{-5} per year i.e one in 100,000 per year , therefore, having applied the mathematical analysis to a practical set of parameters,the scheme designer will achieve a numerical solution .These parameters which should be considered for determining an overall risk factor can be summarised as follows :

1) The geographical location of the structure which means , the average lightning flash density or the number of flashes striking an area of one

square kilometer per year .,

2) The effective Collection area of a structure i.e the plan area projected in all directions taking account of the structure's height .,
3) The intended use of the structure (i-e factory, hospital , ...etc.) .,
4) The type of construction (metallic , concrete , timber .... etc).,
5) What is housed within the structure ? (degree of hazardous).,
6) The Location of the structure , Is it located in a large town or forest or on an isolated hillside ?
7) The Topography of the Country .

LIGHTNING PREVENTION DEVICES

Franklin Rod

Nearly two and a half centuries ago , Benjamin Franklin speculated that sharply pointed lightning rods would " draw off the electric fire " from storm clouds and prevent lightning from striking to earth, It was not long , however, that scientists modified his opinion, suggesting that if lightning rods failed to forestall a lightning strike ,they would at least take the electric fire into themselves and thus save a targeted building . While history is vague about Franklin's later conclusions , it seems likely that he eventually discarded the lightning prevention theory altogether in favor of the lightning capture and grounding functions that he had presumed and then observed .

Radioactive Lightning Rods

Radioactivity is a natural process by which atoms emit atomic particles and rays of high energy. These devices continuously produce upward moving emission currents as the radioactive isotopes decay . the rate of decay varies according to the type of radioactive material employed. Decay time periods range from seconds to hundreds of years depending up on the nature's of the used isotopes

Lightning Dissipation Arrays

These systems consist of hundreds of sharp metal points . " dissipation arrays " have recently been proposed as being effective in preventing lightning from striking a structure equipped with a multiplicity of sharp points .

Pulsing Lightning Rods

These devices apply a pulsed high voltage to an air terminals tip which give positive ground currents going upward meeting descending negative leader strokes .

SYSTEM DESIGN

It is logic to assume that a lightning strike terminates on the ground (or on structures) at the point where the upward streamer was originally launched. These streamers are launched at points of greatest electric field intensity and can move in any direction towards the approaching downward leader .

The position of the greatest field intensity on the ground and on the structures will be at those points nearest to the end of the downward leader prior to the last step .The distance of the last step is termed the striking distance .This striking distance can be represented by a sphere with a radious equal to 50 meters, approxmatly (150 feet) .
The principle components of a lightning protection system should comprise the following :

1. **Air terminals network**
   The codes introduce the concept of air termination network on the roof of buildings to act as receiving point .,

2. **Down conductors**
   The function of a down conductor is to provide a low impedance path from the air termination network to the earth termination network to low the lightning current to be safely conducted to earth .,
3. **Earth termination network .,**
4. **Bonding to prevent side flashing .**

THE NEED FOR CODES

The scope of the codes are mainly to cover the requirements needed for the components and installation of lightning protection systems . These requirements are essential to determine the characteristics of components and materials to avoid the risk of fire , electric shock or injury to person . In general , the materials of the components of lightning protection system shall be made of materials that are resistant to corrosion or shall be acceptably protected against corrosion (e.g copper,copper alloy & aluminum) . All components must be certified by an approved testing authority as Under Writers laboratory (UL) , Factory Mlitual (FM) from united state or BASEEFA from United kingdom , ... etc.

COMPARISON OF CODES

The purpose of the codes in general is the practical safeguarding of persons and property from hazards arising from exposure to lightning . All the components shall be used for lightning protection must be approved by the authority having jurisdiction . The codes specify the faraday cage (FC) technique which depends on the ordinary air terminals , down-conductors and earthing .

Now, Many manufacturers produces other kinds of air terminals such as air terminals with radioactive materials which is called ESE (Early Streamer Emission) . Many studies concerning the effectiveness of the ESE System

have been published .,) Such studies include the NIST study, New Mexico IMT Institute study and GIGRE study , These studies concluded that ESE system is not more effective than the normal FC . But the paper which is recommended and approved by the IEEE and published in May 27, 1988 and titled " An Experimental study of Ionizing Air Terminal Performance ") conclude that the area protected by the ionizing air terminal is appreciably larger than that of the non- ionizing terminals and more effective protection especially that terminals using Radium sources rather than other sources because of higher specific activity .

There are other kinds of preventors which are manufactured and used in many places, were not specified in the above mentioned codes .The codes give the installation requirements for LP systems, the maintenance and testing procedures[6] .

There are only minor differences between the codes such as applying the theory of cone- protection only or with the other theory of protection which is called the rolling sphere protection .

Development Of The An Egyptian Code

As the lightning phenomena in Egypt became detrimental due to industrial activities gross and its spreading all over the Egyptian territories, there is an urgent need nowadays for an Egyptian code to regulate the supply , erection and testing of such a systems . In the authors opinion the Egyptian code articles may be based on already approved national codes of other countries taking into consideration the developed technologies appearing all around the world.

Also a certifying well equipped governamental authority such as the Egyptian Atomic Energy Authority may be given the role . of refree for materials supply , testing , and certification .

CONCLUSION

Due to many kinds of preventors used now for lightning protection therefore we must have regulation to determine our needs . from the above disscusion it is obvious that no big difference between the American, British & German standards . We can in Egypt develop our standards taking into consideration the new technology of lightning protection systems .

The main points for the requirments needed in standards or regulations to be considered in a lightning protection system must be :

1 - Material specification is of vital importance to design and install a reliable lightning protection system . The choice of materials and the installation method should ensure a satisfactory life span of at least 30 years .

2 - All the components of lightning protection system must be adopted to specified code or standards and approved by authorised establishment .

3 - The lightning protection system should provide a low electrical resistance path to earth and have the ability to carry high currents repeatdly over the life time of the installation .

4 - Secure and robust fixings are essential .

5 - The requirements for inspecting the lightning protection system, the testing required and detailed records that should be maintained during the service life of the system must be regarded as obligatory .

6- All metal work on or around a stucture must be bonded to the lightning protection system to avoid side flashes .

REFERENCES

(1) ANSI / NFPA - 780 (NFPA - 780 Lightening Protection Code , 1992 Edition) , An American National Standard , National Fire Protection Association 1 Batterynerch Part , P.O. Box 9101,

(2) Lightening Protection Institute , Standard of Portico LPI-175 (1987)

(3) Underwriters Laboratories Standards for safety No UL-96A " Installation Requirements for Lightening protection System "
(4) British Standard No BS-6651, 1992 " Code of Practice for : Protection of Structures against Lightening "
(5) German Standard , DIN 57185 part 1 , VDE 0185 part 1/11 . 82 (Engl.) , (1993)
(6) G.F. Fink , and H.W. Beaty ; Standard Handbook For Electrical Engineers , MCGRAW - HILL BOOK COMPANY , Eleventh Edition, 1978 .