International Journal of Research in Advanced Engineering and Technology
www.allengineeringjournal.in
ISSN: 2455-0876
Received: 28-04-2023, Accepted: 14-05-2023, Published: 29-05-2023
Volume 9, Issue 2, 2023, Page No. 13-16

Investigating the necessity of lightning protection system in abubakar tatari ali polytechnic, bauchi, northern, Nigeria

B D Halilu
Department of Electrical and Electronics Engineering, Abubakar Tatari Ali Polytechnic, Bauchi, Nigeria

Abstract
A lightning strike could bring thousands mega-ampere of current in a blink of an eye. As a result, a failure of grounding the strike may cause serious damage to home and industrial appliances. The function of an external lightning protection system is to intercept, conduct and disperse a lightning strike safely to earth. Without such a system building's structure, electronic systems and the people working around or within it are all at risk. This work seeks to investigate whether or not LPS is a requirement in Abubakar Tatari Ali Polytechnic Bauchi in safeguarding lives and properties. To achieve this risk assessment analysis was carried out for every existing structure within the polytechnic in accordance to standard design procedure with a viewed to determining whether or not LPS is a necessary requirement within the institution. Obtained results shows that 100% of the existing structure required LPS but only less than 1% has a functional and effective LPS installed. It also shows that lightning strike frequency (N_d) increases with increase in equivalent collective area (A_e) of the structures. For all the identified structures, N_d was obtained to be higher than N_c this therefore makes LPS a necessity within the polytechnic environment.

Keywords: Lightning protection system (LPS), risk assessment analysis, lightning strike frequency (N_d) tolerable lightning frequency (N_c)

Introduction

This paper exhumed the need for Lightning Protection System (LPS) in Abubakar Tatari Ali Polytechnic Bauchi which is located in North eastern Nigeria. [3] defined Lightning as an electric discharge in the form of a spark or flash originating from a charged cloud. It causes a lot of communication system failure, loss of lives and properties in addition to economic losses due to down time. He pointed out that Bauchi with thunderstorm days of 125 has 12.9 Lightning Density per km^2 per year as can be seen in the map shown in figure 2. This value shows a high density of Lightning activities within the state hence the need for this investigation as the institution consist of high-rise structures with high concentration of students.

[5] Categorizes the four sources of Lightning as: (1). Strike to a structure, (Direct Strike) (2). Strike near to a structure (Indirect Strike) (3). Strike to a service line (Indirect Strike) and (4). Strike near to a service line (Indirect Strike) as illustrated in figure 1 below:

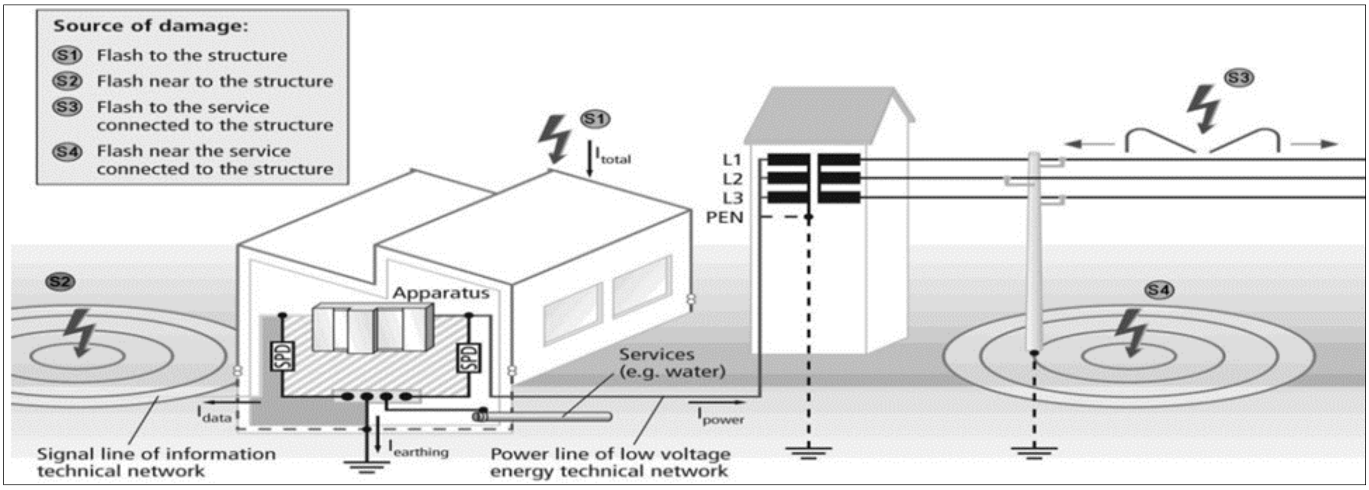

Fig1: Representation of different sources of lightning (IEC 62305-4)

Method

Having gotten the thunderstorm days (T_D) and consequently lightning density per square km per year (F_D) from [3], all the available structures within the institution were identified and risk assessment analysis carried out on each with a view to determining whether or not their tolerable lightning frequency (N_c) is greater than the lightning strike frequency (N_d) which is a determinant for LPS. Risk assessment was carried out in accordance to design procedure as illustrated in figure 2 below for each identified structure within the institution.

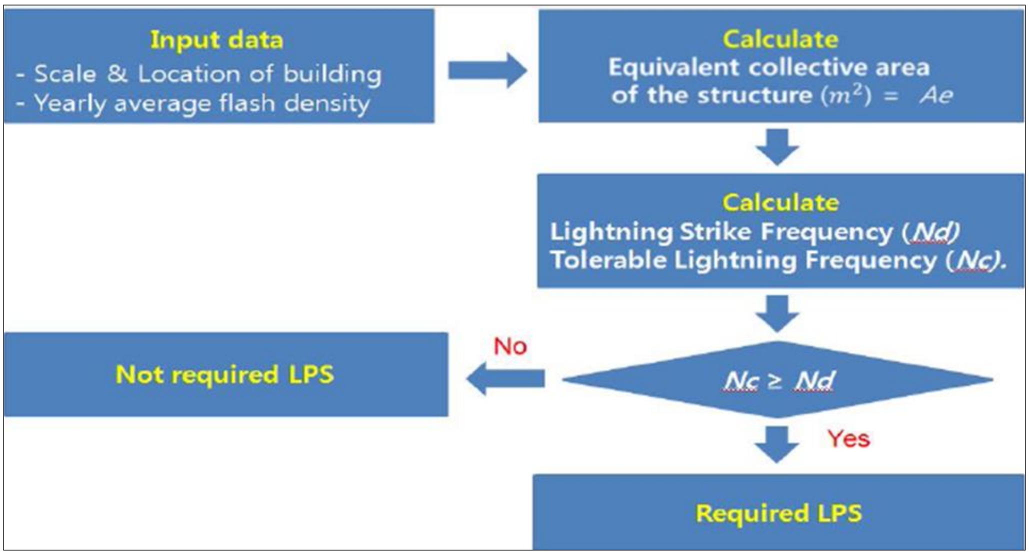

Fig 2: Design procedure for LPS. [6]

A total of seventy-eight (78) structures were identified within the institution and risk assessment analysis carried out on each in accordance to standard design procedure for LPS.

Design Parameter Calculation

Lightning Strike Frequency $(N_d) = (N_g)(Ae)(C_1)(10^{-6})$ (1)

Where
The yearly average flash density in the region where the structure is located
Ae: The equivalent collective area of the structure

$$\text{Ae} = LW + 6H(L+W) + \pi 9H2 \quad (2)$$

C_1: The environmental coefficient

Tolerable Lightning Frequency $(N_c) = \frac{(1.5\times10^{-3})}{C}$ (3)

$$C = (C_2)(C_3)(C_4)(C_5) \quad (4)$$

C_2: The structural coefficient
C_3: The structure contents coefficient
C_4: The structure occupancy coefficient
C_5: The lightning consequence coefficient

N_d can be found through the multiplication of the equivalent area (Ae) of the structure and the yearly average flash density (N_g) in the region. The tolerable lightning frequency (N_c) is calculated through the multiplication of the several coefficients as shown in equation (3) and (4). [6].

Results

As shown in figure 2 above, the design procedure for LPS was carried out for all the existing seventy-eight (78) structures in the institution and the result tabulated, 30 samples of the computed results are shown in table 1 below:

Table 1: computed sample result

S/N	$A_e(km^2)$	N_c	N_d	LPS Requirement
1.	0.01021	0.0015	0.03293	SHOULD BE INSTALLED
2.	0.00652	0.0015	0.02102	SHOULD BE INSTALLED
3.	0.00962	0.0015	0.03103	SHOULD BE INSTALLED
4.	0.00962	0.0015	0.03103	SHOULD BE INSTALLED
5.	0.00962	0.0015	0.03103	SHOULD BE INSTALLED
6.	0.00515	0.0015	0.01659	SHOULD BE INSTALLED
7.	0.00498	0.0015	0.01606	SHOULD BE INSTALLED
8.	0.00814	0.0015	0.02625	SHOULD BE INSTALLED
9.	0.00985	0.0015	0.03175	SHOULD BE INSTALLED
10.	0.00344	0.0015	0.01111	SHOULD BE INSTALLED
11.	0.00239	0.0015	0.00771	SHOULD BE INSTALLED
12.	0.00729	0.0015	0.02352	SHOULD BE INSTALLED
13.	0.00606	0.0015	0.01954	SHOULD BE INSTALLED
14.	0.00606	0.0015	0.01954	SHOULD BE INSTALLED
15.	0.01052	0.0015	0.03393	SHOULD BE INSTALLED
16.	0.00147	0.0015	0.00475	SHOULD BE INSTALLED
17.	0.00904	0.0015	0.02916	SHOULD BE INSTALLED
18.	0.00634	0.0015	0.02045	SHOULD BE INSTALLED
19.	0.00371	0.0005	0.01196	SHOULD BE INSTALLED
20.	0.00909	0.0005	0.02931	SHOULD BE INSTALLED
21.	0.00432	0.003	0.01394	SHOULD BE INSTALLED
22.	0.00192	0.003	0.00620	SHOULD BE INSTALLED
23.	0.00307	0.0015	0.00991	SHOULD BE INSTALLED
24.	0.00459	0.0015	0.01481	SHOULD BE INSTALLED
25	0.00614	0.0015	0.01980	SHOULD BE INSTALLED
26.	0.00500	0.0015	0.01614	SHOULD BE INSTALLED
27.	0.00221	0.0015	0.00713	SHOULD BE INSTALLED
28.	0.00192	0.0015	0.00620	SHOULD BE INSTALLED
29.	0.00509	0.0015	0.01640	SHOULD BE INSTALLED
30.	0.00480	0.0015	0.01549	SHOULD BE INSTALLED

Plots of the obtained results from table 1 above as can be seen in figure 4 below indicates the relationship between the Equivalent collective area (Ae), Lightning strike frequency (N_d) and the tolerable lightning strike frequency (N_c). The result shows that lightning strike frequency (N_d) increases with increase in equivalent collective area (Ae). This shows that structures occupying larger areas not necessary high-rise buildings within the polytechnic are more exposed to lightning strikes.

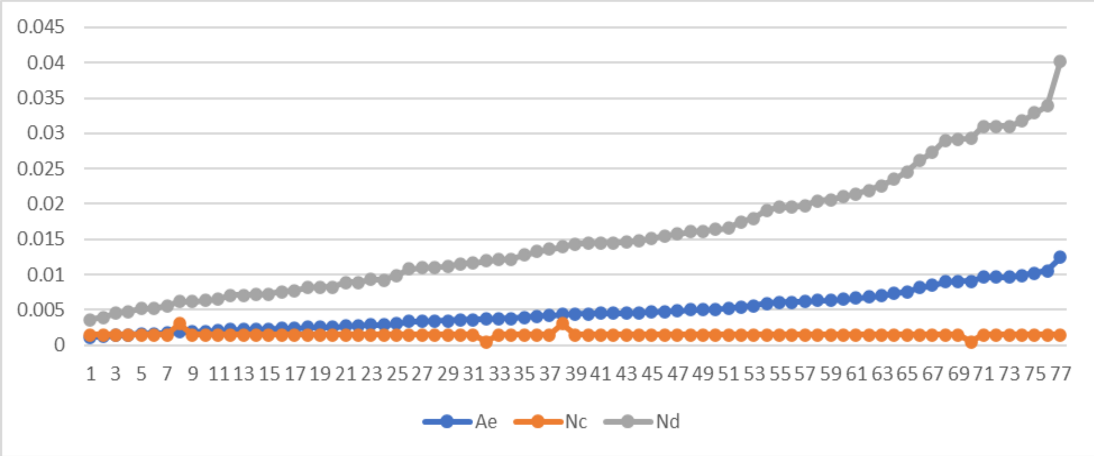

Fig 4: Equivalent Collective Area (Ae) N_c and N_d Relationship

Figure 5 below shows that N_c is not affected by the size of the structure but by the content and usage.

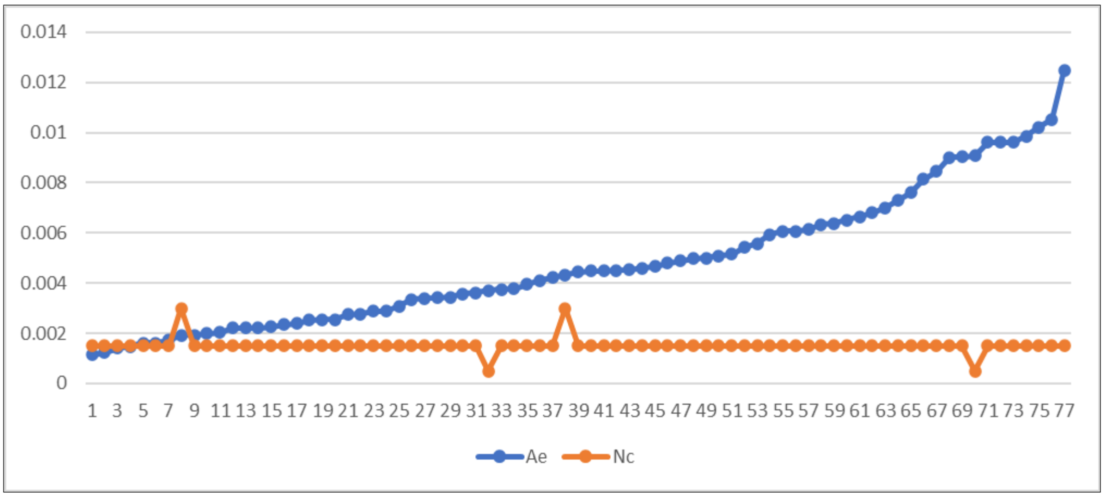

Fig 5: below shows that N_c is not affected by the size of the structure but by the content and usage.

Figure 6 below indicate the variation of the lightning strike frequency with equivalent collective area per structure.

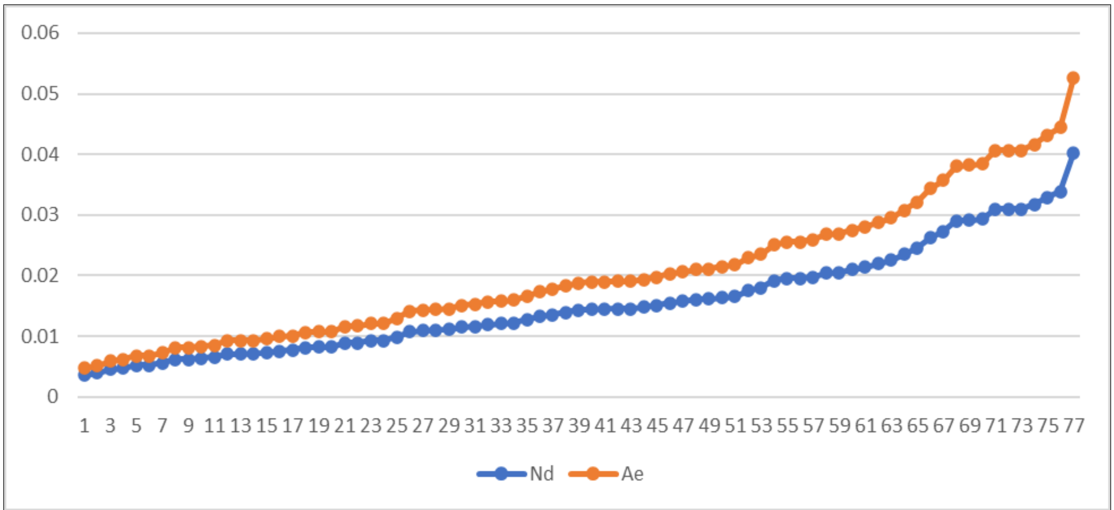

Fig 6: Equivalent Collective Area (Ae) and N_d Relationship

Conclusion

The result from this study shows that for all the identified structures within the polytechnic, their tolerable lightning frequency (N_c) is less than the lightning strike frequency (N_d) that the structures are exposed to, as a result all the identified structures requires the installation of a functional and effective lightning protection system in order to safeguard life and properties Thus making LPS a necessity within the polytechnic environment.

References

1. Abidin HZ, Ibrahim R. "Thunderstorm Day and Ground Flash Density in Malaysia", National Power and Energy Conference Proceedings, Bangi, Malaysia, 2003.
2. Electrical Research Association (ERA), Great Britain report No 87-0328 Lightning Protection Seminar Proceedings, Technology, 1988.
3. Adegboyega GA, Odeyemi KO. Assessment of Areas That Are Prone to Thunderstorm Activities in The Northeast Zone of Nigeria. Journal of Academic and Applied Studies (JAAS),2012:2(1):1-7. Available online @ www.academians.org.
4. Standard of BS EN/IEC 62305-4:2006: Protection against Lightning
5. Donald W Zipse. Lightning Protection Systems: Advantages and Disadvantages. IEEE Transactions on Industry Application,1994:30(5):1351-1361.
6. Seung-Wook. L and Myoung-Sub R: Application of Early Streamer Emission (ESE) Air terminal in Lightning Systems of NPP. Transactions of the Korean Nuclear Society Autumn Meeting Gyeongju, Korea, 2013, 24-25.