Early Streamer Emission Lightning Protection Systems

Calculations completed for

ALPS Ltd

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By

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Summary

This report provides calculations of the Radius of Protection R_p provided by Early Stream Emission Air Terminal (ESEAT) devices installed to protect against lightning strikes. The calculations were done according to standard NF C 17-102. The results are presented for ALPS' ESEAT device, using data provided by the company. The results are compared with data from other products on the market.

Contents

1 Background

An Early Stream Emission Air Terminal (ESEAT) is a lightning protection device that is designed to provide additional protection over an equivalent Simple Rod Air Terminal (SRAT) of the same size. The ESEAT provides a mechanism to encourage ionisation near its tip, and the theory implies that its lightning capture area is greatly increased. AFNOR, the French national standardization body, issues a standard, NF C 17-102, covering this technology. ALPS Ltd have developed and manufactured an ESEAT device and have commissioned the required tests of the device against this standard.

The current report presents calculations, based on these tests, and according to the standard. The tests are to estimate the efficiency ΔT of the ESEAT, which is roughly equivalent to the reduction in time taken for electric field brake down when compared to the SRAT device as a reference. The value of ΔT must be greater than 10 μs for it to qualify as an ESEAT device. **The maximum value for ΔT, whatever are the test results, is 60 µs.**

The results in this report are presented "as is" following the calculation procedure presented in NF C 17-102, without comment on the accuracy of the theory related to Early Stream Emissions. WMG do not have particular expertise in lightning protection, but are simply following the calculation procedure in the standard. We are not suitably qualified to assess the test procedure and results.

2 Objectives

The objectives of this work are to produce the calculations of the Radius of Protection according to the standard NF C 17-102.

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3 Calculations according to NF C 17-102

From the standard, section 5.2.3.2:

The protection radius R_p of an ESEAT depends on its height h relative to the surface to be protected; to its efficiency and to the selected protection level r

$$R_p(h) = \sqrt{2rh - h^2 + \Delta(2r + h)} \qquad \text{For } h \geq 5m$$

and

$$R_p = h \times R_p(5)/5 \qquad \text{For } 2m \leq h \leq 5m$$

where

$R_p(h)$ is the protection radius at a given height h (metres)

h is the height of the ESEAT tip over the horizontal plane through the furthest point of the object to be protected

r depends on the chosen level of protection:

20m for protection level 1

30m for protection level 2

45m for protection level 3

60m for protection level 4

$\Delta = \Delta T \times 10^6$ is the efficiency, and ΔT is the ESEAT efficiency (in μs) as measured by the ESEAT test

Care must be taken to implement the formula correctly. As an example, if the efficiency $\Delta = 40$, the height $h = 3$ and protection level 2 (so $r = 30$), then

$$R_p = 3 \times \frac{\sqrt{(2\times30\times5) - (5\times5) + 40\times((2\times30)+5)}}{5} = 39.23m$$

as we are applying the formula in the range $2m \leq h \leq 5m$.

The test results for ALPS' ESEAT device are given in accompanying document *TR47233_ALPS.pdf*

The average ΔT efficiency from the 50 tests was found to be $62.7\mu s$. However, the standard (on page 18) states that the **maximum possible value is $60\mu s$**, therefore, in the remainder of this report, all calculations referring to **ALPS' ESEAT device will use the value of $\Delta T = 60\mu s$**.

Table 1 presents all of the results for varying levels of protection and at varying heights for ALPS' ESEAT device:

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		Level 1 r = 20	Level 2 r = 30	Level 3 r = 45	Level 4 r = 60
h(m)	2	31.43	34.58	38.83	42.66
	3	47.15	51.87	58.25	63.99
	4	62.86	69.17	77.67	85.32
	5	78.58	86.46	97.08	106.65
	6	78.77	86.74	97.49	107.16
	8	79.09	87.27	98.26	108.15
	10	79.37	87.75	98.99	109.09

Table 1 - Radius of protection for ALPS ESE device for various heights and protection levels

There are some products on the market that report greater protection values, possibly because the calculations have been performed using a different formula from another standard. The example in Table 2 is from Safe Strike (http://safestrike.co.uk/download/). The values shown in the table are higher than those obtained using $\Delta T = 60\mu s$ and the formula in NF C 17-102. It would help to understand the difference if SafeStrike reported their data for heights greater than 4m and the value of ΔT.

	Level 1			Level 2			Level 3			Level 4		
h (m)	35	40	65	35	40	65	35	40	65	35	40	65
2	41	50	66	45	56	71	52	67	79	58	73	98
3	49	64	80	56	72	88	64	84	99	76	90	112
4	51	66	81	57	73	89	66	85	99	77	92	112

Table 2 - Rp values from SafeStrike for each protection level

To clarify the situation, Figure 1 below shows protection levels for various ΔT values at protection level 1. The plot compares the ALPS' product to other ΔT values over a range of heights h. Also shown is the SafeStrike data, which exceed the values from $\Delta T = 60\mu s$.

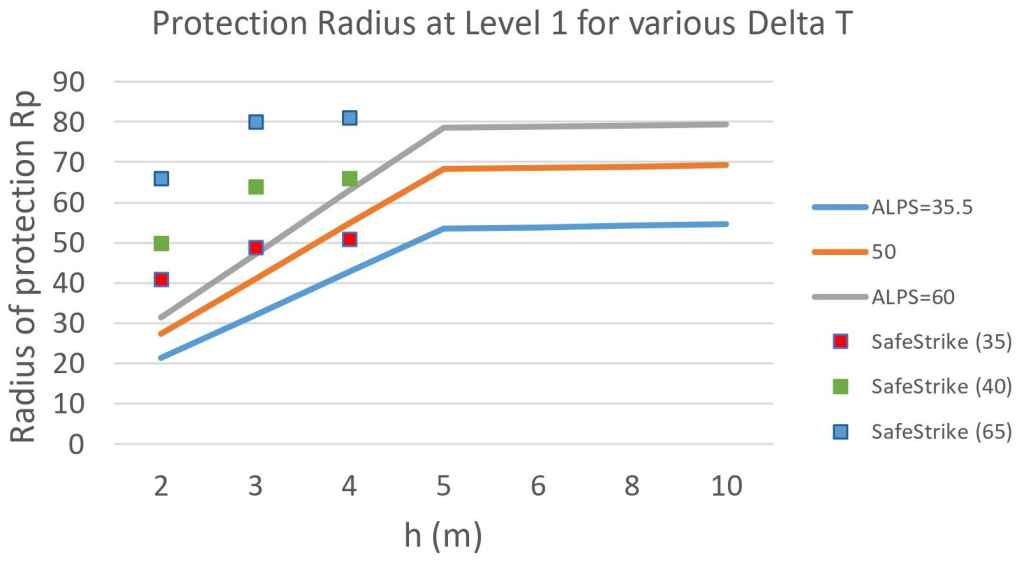

Figure 1 - Protection levels for various DT at protection level 1

Similar results are seen for protection levels 2, 3 and 4.

4 Comments

ALPS Ltd has invested significantly to ensure they comply with the available standards for ESEAT devices. Their device has passed tests to confirm that it is functioning as an ESE device according to NF C 17-102 and has been given an efficiency rating of $\Delta T = 60\mu s$ – the maximum possible value. Competitor products either claim greater ΔT values than this or use calculations producing R_p values that are greater than the values according to NF C 17-102.

Therefore, care must be taken in the ESEAT device and lightning protection market that all products are tested according to the same procedure and standard. Currently there is a standard from the French standards authority; a British standard would support the development of the domestic market. Further consideration could be given to this by experts in lightning protection.