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UMIST

TEST REPORT
No 43427

Report on: The results of tests of ESE & Franklin terminals.

Submitted by: W J Furse & Co Ltd, Nottingham.
(Companies order no C027861)

On the following sheets are presented the results of tests carried out to assess the relative efficiency of three ESE terminals and a Franklin terminal for protection against lightning strokes. These tests were carried out in the High Voltage Laboratory at UMIST with test arrangements and test parameters generally in accordance with the French Standard NFC 17-102.

The results indicate that under identical electrical and geometrical conditions flashover to either the ESE terminals or the Franklin terminal are random and that the ESE terminals have no apparent advantage over the Franklin terminal.

The results obtained and recorded were independently carried out by Strathclyde University, Glasgow, in collaboration with UMIST personnel.

Tests carried out by:

Supervisor

Head of Department of
Electrical Engineering and Electronics

Background

Standard proprietary Early Streamer Emission terminals were purchased from the market place so that their relative performances could be compared to that of a standard passive Franklin rod terminal under identical High Voltage laboratory conditions. The specific ESE terminals tested were:

- Dynasphere (System 3000) manufactured by Global Lightning Technologies Pty Ltd, Hobart, Australia.
- Pulsar 60 (IMH.6012) manufactured by Helita, France.
- Prevectron S6 manufactured by Indelec, France.

Definitions

Early Streamer Emission (ESE) terminal:
An air terminal or finial located on the upper part of a structure to be protected with claims that it gives off an early upward streamer to meet the downward leader of a lightning discharge.

Franklin terminal:
A simple terminal or finial manufactured from copper, aluminium or steel, which forms part of an air termination system and from which an upward streamer is produced by natural field effects.
Typically it can be solid copper 15mm diameter, 1m long.

High Voltage plane:
An aluminium plate 3m x 3m, with a 250mm diameter tubular periphery supported by insulators from an overhead crane. This plane was used to simulate the thundercloud.

Withstand:
The instance when the gap between the terminal tip and the High Voltage plane did not break down under the application of the impulse voltage.

Object

The prime reason for the tests was to compare the relative achievements of ESE terminals to that of a standard Franklin terminal when tested using the procedure outlined in the French Standard NFC17-102[1]. The tests reported form part of an ongoing major study designed to investigate in a scientific way, the efficacy of early streamer devices. The findings of this study will be reported in due course.

Specifically, the laboratory tests used the electrical and geometrical parameters as laid down in Appendix C of the French Standard.

In addition to the above, comparative discharges (or strikes) were recorded when an ESE terminal and a Franklin terminal were equi-positioned under the High Voltage plane. This report embodies those results.

Preparation

The UMIST High Voltage laboratory was set out as per the layout drawing shown in Figure 6.

The relevant ESE terminal was spaced 1m away from a standard Franklin terminal. Both terminal tips were placed under and equi-distanced from the centre of the 3m x 3m High Voltage plane. Both terminals were mounted on individual plastic base arrangements which in turn were resting on a 3m x 3m earth plate, located directly under the 3m x 3m High Voltage plane.

The base of the terminals were earthed to the laboratory earth.

Appendix C of the French Standard lays down certain electrical and geometrical parameters for testing ESE devices in the laboratory, but does not specify earthing arrangements.

The following parameters are specified to produce;

(a) A ground field simulation which creates the electric field in and around the area of the ground prior to a lightning discharge. This was simulated in the laboratory by an applied DC negative voltage bias.
(b) An impulse field simulation which creates the actual lightning discharge. This was simulated by an impulse voltage produced via a 2MV Marx Generator.
(c) A dimensional requirement of laboratory earth plane to High Voltage plane (H) and a ratio of height of terminal under test (h) to height of High Voltage plane (H) which ensures the correct field simulations referred to in (a) and (b).

Testing of Early Streamer Emission and Frankl

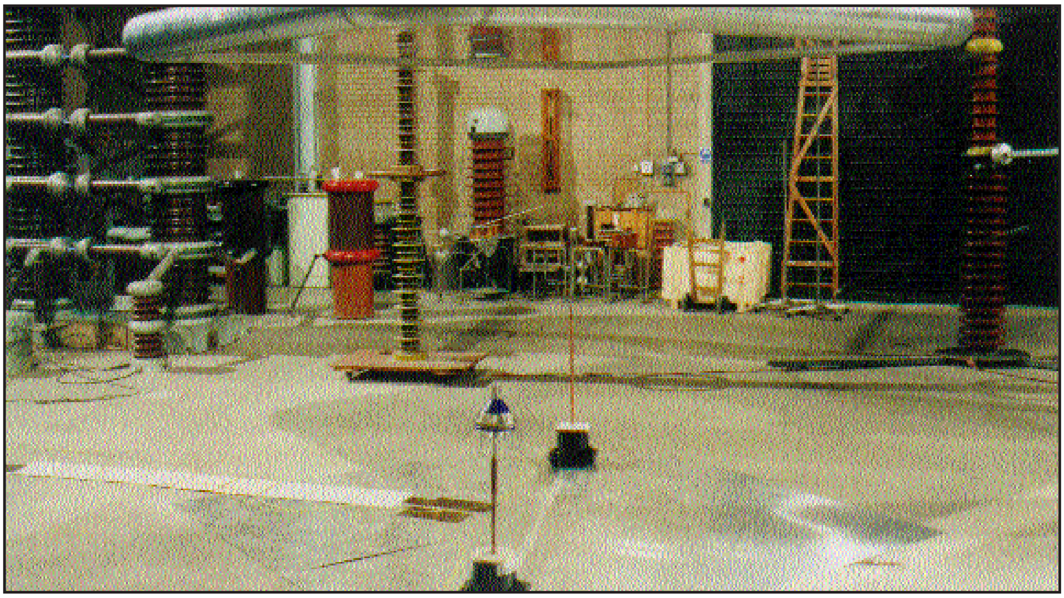
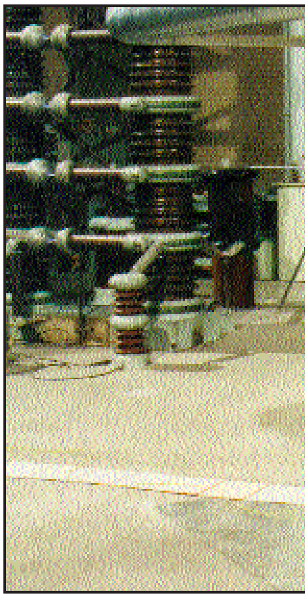


Figure 1 - Testing arrangement showing high voltage plane above equally spaced terminals.



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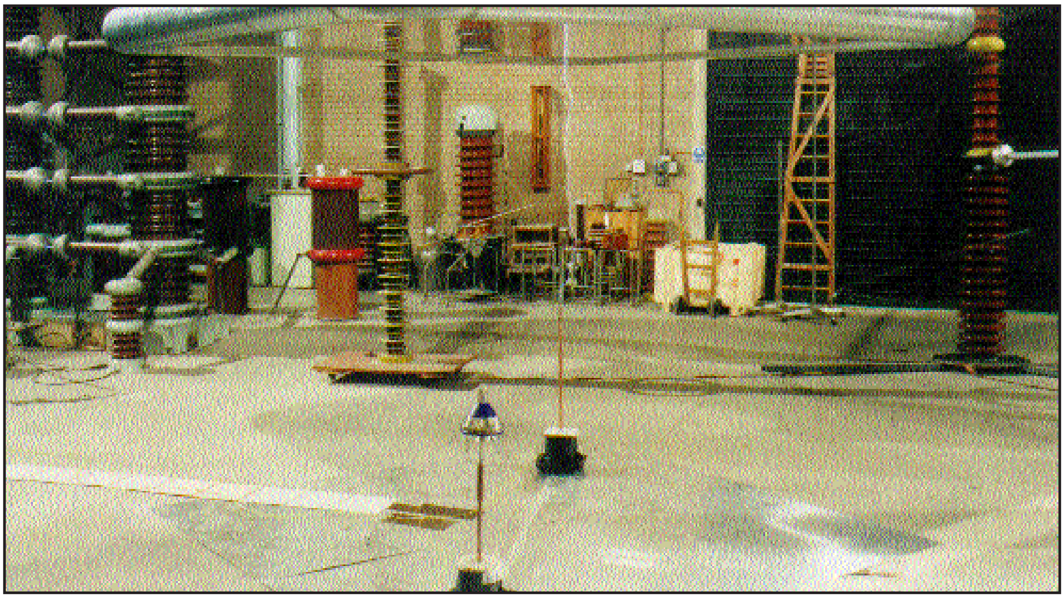
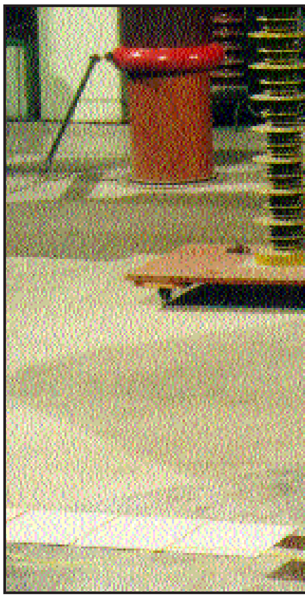


Figure 2(a) - Strike to Franklin terminal at rear - test 1



Figure

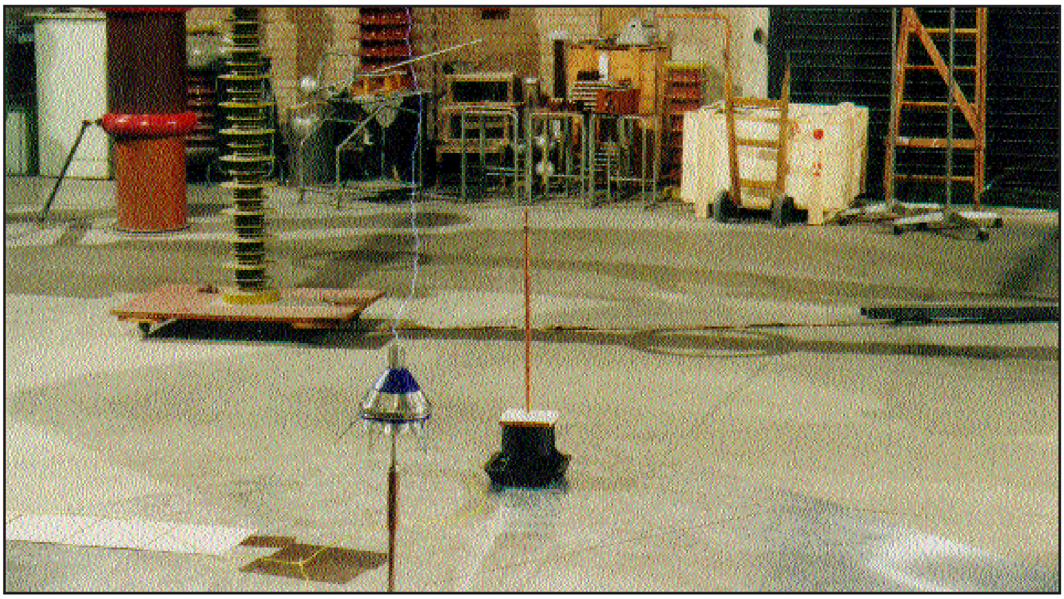
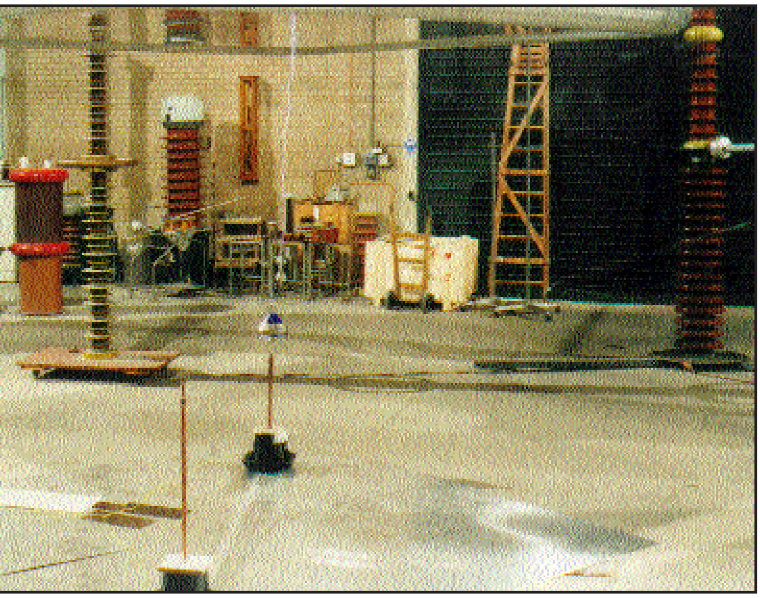


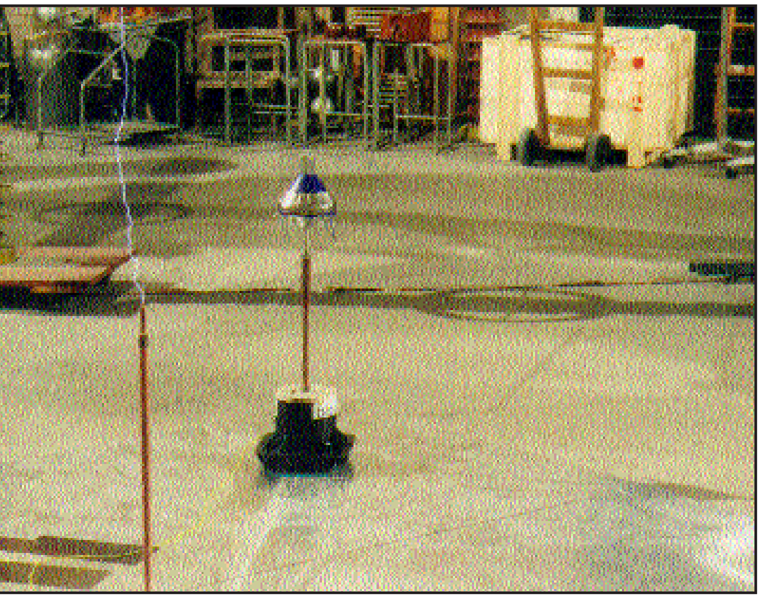
Figure 2(b) - Strike to Indelec terminal at front - test 1

Figur

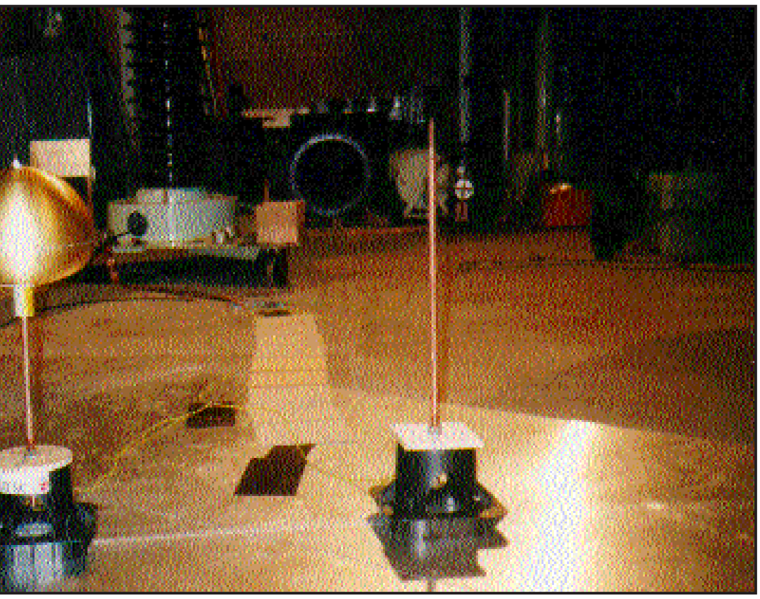
in terminals at UMIST High Voltage Laboratory



e 3(a) - Strike to Indelec terminal at rear - test 2



e 3(b) - Strike to Franklin terminal at front - test 2



e 4 - Dynasphere and Franklin terminals - test 4

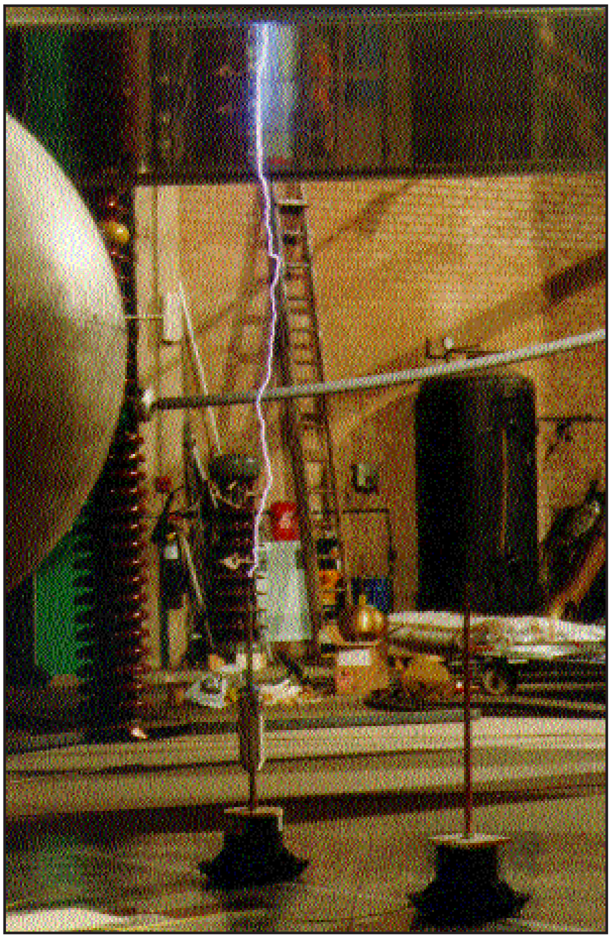


Figure 5(a) - Strike to Helita terminal at rear - test 6

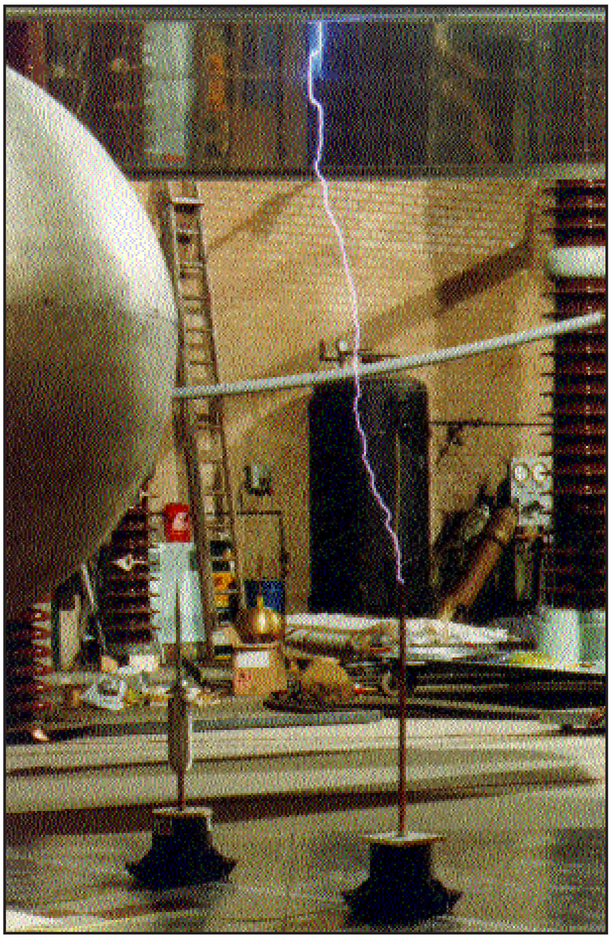


Figure 5(b) - Strike to Franklin terminal at front - test 6

Parameters of test

DC voltage: 45kV negative polarity (3m clearance @ 15kV/m)
Impulse voltage: 840kV negative polarity (Marx Generator 140kV per stage x 10 stages)
Height of High Voltage plane to laboratory earth (H): 2.5m
Height of terminal (ESE & Franklin) (h): 1m
Ratio of h/H: 0.4

Procedure

The ESE and Franklin terminals were placed under the High Voltage plane, as per the arrangement shown in Figure 1.

The precise location of both the ESE and Franklin terminals were accurately measured to ensure that both terminals were equi-spaced from the centre of the High Voltage plane.

The terminals were then subjected to 35 'shots' or discharges from the impulse generator, and the location of each 'strike' was recorded.

The position of the ESE/Franklin terminals were then reversed, to compensate any positional advantage that there may have been, and the discharge procedure repeated. The test was then repeated with the other ESE terminals.

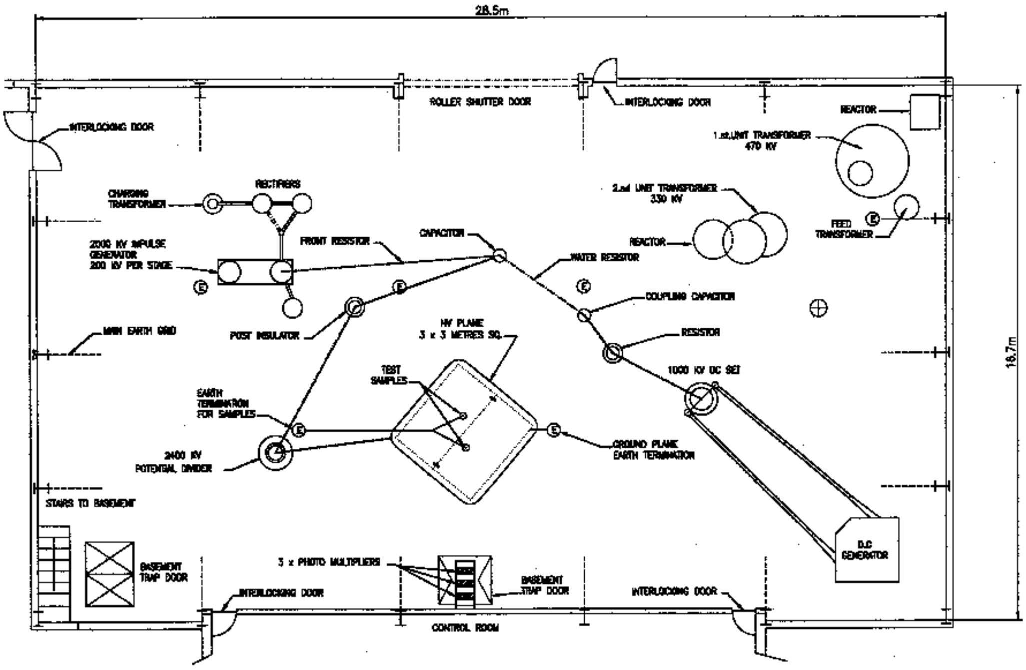


Figure 6 - Layout of UMIST High Voltage laboratory

Summary of results

The summary of the results of these tests are given in the table overleaf.

The findings are in groups of two: eg, Test 1 and 2 relate to the ESE (Indelec) compared with the Franklin terminal.

Test 1 had the Franklin furthest away from the test room (rear) and the Indelec terminal nearest the test room (front).

Test 2 was identical but with the terminals reversed.

Discussion

During the course of the test the magnitude of the DC voltage was changed to see if this had any bearing on the results.

With no DC applied there were times when the gap between the terminal tip and High Voltage plane did not break down.

With 45kV DC bias applied the breakdown occurred every time to one or other of the two terminals.

Tests 9 and 10 were with the terminals 1.75m apart. All the remainder were at 1m apart.

Configuration

Test No	Terminal Type	Total No of shots	Flashover Front	Flashover Rear	Withstand	Impulse Volt (kV_p) negative polarity	DC Voltage (kV) negative polarity	Comments
1	Franklin Indelec	35	7	17	11	840	-	
2	Indelec Franklin	35	10	15	10	840	-	
Total 1 & 2	**Indelec** **Franklin**	**70**	**22** **27**		**21**			
3	Dynasphere Franklin	35	13	6	16	840	-	
4	Franklin Dynasphere	35	8	17	10	840	-	
Total 3 & 4	**Dynasphere** **Franklin**	**70**	**14** **30**		**26**			
5	Franklin Helita	35	14	21	NIL	840	45	
6	Helita Franklin	35	14	21	NIL	840	45	
Total 5 & 6	**Helita** **Franklin**	**70**	**35** **35**		**NIL**			
7	Dynasphere Franklin	35	15	20	NIL	840	45	
8	Franklin Dynasphere	35	8	27	NIL	840	45	
Total 7 & 8	**Dynasphere** **Franklin**	**70**	**28** **42**		**NIL**			
9	Franklin Helita	35	12	23	NIL	840	45	1.75m centres
10	Helita Franklin	35	5	30	NIL	840	45	1.75m centres
Total 9 & 10	**Helita** **Franklin**	**70**	**42** **28**		**NIL**			
11	Franklin Helita	35	10	23	2	570	300	
12	Helita Franklin	35	15	14	6	570	300	
Total 11 & 12	**Helita** **Franklin**	**70**	**24** **38**		**8**			

NOTE: Unless specified the centres between finials during testing is 1.0m.

Conclusion

Of the 12 sets of tests conducted there was a total of 420 discharges.

- 200 discharges hit the Franklin terminal (47.6%).
- 165 discharges hit the ESE terminals (39.3%).
- 55 discharges did not break down the gap ie Withstand (13.1%).

The results produced from this test show a complete random nature of discharges to the Franklin and ESE terminals under identical electrical and geometrical conditions.
They did not substantiate claims of enhanced properties from the ESE terminals.

References

1 NFC17-102 July 1995. Protection of Structures and Open Areas Against Lightning Using Early Streamer Emission Terminals.