Focus on the new range of tests for the Early Streamer Emission air-terminal technology

Michael TROUBAT
Research Department
FRANCE PARATONNERRES
Limoges, FRANCE
m.troubat@france-paratonnerres.com

Abstract—This paper deals with the Early Streamer Emission air-terminal technology. It aims to give the latest progress of the technology and of the standard in order to validate and to reinforce the efficiency of the technology.

Keywords—component; formatting; style; styling; insert (key words)

I. INTRODUCTION

Since many years, the Early Streamer Emission Technology has been the target of an important lobbying in favor of the said conventional lightning protection system. The critics use to be the same:

• The critics on the first version of the standard tests use to be the same. It was said that they are too large in their definition

In order to answer those critics, the French committee has work on a new version of the NFC 17-102 standard. This latest edition has been published in 2011 [1]

II. THE LABORATORY TESTS SEQUENCE

The last edition of the NFC 17-102 standard proposes a more complete sequence of tests.

Indeed, the 1995 edition only proposed the advanced time test. The new procedure includes the five sections of tests below:

• Marking tests
• Mechanical inspections
• Environmental treatment
• Electrical shocks
• Efficiency test

The five sections of tests shall be carried out on a sample according to the table below:

<table>
<thead>
<tr>
<th>TESTS</th>
<th>NFC 17-102 Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1995 sequence</td>
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<tr>
<td>General</td>
<td>Documentary</td>
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<tr>
<td>Marking</td>
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<td>Mechanical</td>
<td>Dimensions</td>
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<td>Environmental treatment</td>
<td>Salt mist</td>
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<td>Humid sulphurous</td>
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<td>Electrical</td>
<td>High current</td>
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<td>Early Streamer Emission</td>
<td>Assembly</td>
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<td></td>
<td>Climatic parameter</td>
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<tr>
<td>Efficiency</td>
<td></td>
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</tbody>
</table>

A. General Test

This test aims to be sure that an ESE air-terminal can be easily identified after several years of installation on a roof.

• Name, logo and mark
• Serial Number

The marking must be indelible after been rubbing by hand.

B. Mechanical Test

The mechanical test aims to check the dimensions of the parts through which the lightning current impacts and transits.

The ESE should respect the two conditions below:
• Section compliant to EN50164-2
• Striking point with a section of 200mm²

If such conditions are achieved, it assures a good behavior and flow of the current through the ESE

C. Environmental Test

The environmental test aims to confront the ESE air-terminal to natural pollution. The ESE is installed in a Steam room with two different treatments.
• Salt Mist treatment (EN 60068-2-52) [3]
• Humid Sulphurous atmosphere treatment (EN ISO 6988) [4]

It is written in the NFC 17-102 standard that “after environmental pre-conditioning and without the sample being cleaned”, the sample has to go to the next step of test.

D. Electrical Test

The electrical test aims to confront the ESE air-terminal to a high current waveform (10/350µs) of 100kA.

The current waveform has to be applied on the ESE. This configuration enables to confront the ESE to a real impact in energy.

The ESE should still be in work after the sequence of 3 shots.

This test helps to check the robustness of ESEs with internal spark gap and the safe flowing of the current of ESEs with electrical continuity.

E. Efficiency Test

The efficiency (or advance time) test gives the advance time of an ESE.

In comparison with the 1995 procedure, some adjustments have been done to reach more severe requirements in order to be more pertinent
• Experimental assembly more precise
The experimental assembly should be rigorously the same (±1mm). All ESEs have to be compared with the same reference simple rod.
• Recording of the climatic parameters
The climatic parameters that can influence the streamer propagation shouldn’t vary too much
• Measure of the advanced time
The advanced time is averaged on the first 50 impacts with standing time of 2 minutes.

The ESE standard deviation is also compared to the simple rod one. There is a maximum permissible value for this ratio.

III. POSSIBLE IMPROVEMENTS

In order to reinforce in a greater way the ESE technology, the NFC 17-102 procedure of tests can be more precise and also more severe regarding some particulars points.

A. Number of Samples tested

Globally, it is usual for products standard to carry the test on 3 samples. Indeed, the fact to multiply the number of samples tested; avoid the preparation of a specific and optimized product.

As the NFC 17-102 only proposes to realize the test on one sample, an improvement can be to use three samples.

Moreover, a chosen sample can be elected as the witness and will be confront to the whole sequence of test. The table II recapitulates the need of samples:

<table>
<thead>
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<th>TABLE II. NEED OF SAMPLES</th>
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Finally 5 samples will be necessary to achieve the whole tests sequence.

B. Improvement on the Environmental Test

It appears that it is insufficient that no criterion of decision is required at the end of test.

The Test Endorsement can be the point below:
• Well-functioning of the ESE according to the manufacturer procedure
• No pollution or deterioration of the product after the treatments.

C. Improvement on the Electrical Test

The procedure of the Electrical test is not enough clear and detailed.

Indeed, it is asked that the sample shall be subjected to the high current waveform. No more information is given.
This test shall be carried out without direct connection between the ESE and the discharge element of the generator.

Indeed, in order to be more realistic and more pertinent, the discharge point of the generator and the impact point of the ESE should be distant.

For example, the ESE is installed below a spherical electrode of 50mm of diameter in order to create the spark attachment on the ESE point (with an approximate distance of 20mm).

![Fig. 1. Proposal of typical sketch](image)

Moreover, the test endorsement can be reinforced with the validation of the well-functioning of the ESE according to the manufacturer procedure.

D. Improvement on the Efficiency Test

The efficiency test has been very well reinforced with the new evolutions. Nevertheless, it can be still improved.

For example, instead of taking into account a range of variation for the climatic parameters, the use of the correction factor $K$ in order to adjust the input voltage ($U_d$) on the Marx Generator can avoid non applicable test done during a day when the weather isn’t stable.

The real voltage to apply $U_r$ is given by

$$ U_r = U_d \times K \quad \text{with} \quad K = \delta \cdot k $$

and

$$ \delta = \frac{P}{P_0} \cdot \frac{T_0}{T} $$

(density) and

$$ : k = 1 + \left[ 0,002 \left( \frac{H_{abs}}{\delta} - 8,5 \right) \right] $$

(humidity)

where $P$ is the atmospheric pressure [kPa], and $T$ is the temperature [K]; and $H_{abs}$ is the absolute humidity [g/m3]

| TABLE III. RELATIVE CLIMATIC PARAMETERS |
|-----------------|-----|-----|
| To              | 293 | K   |
| Po              | 101.3 | kPa |

E. Insulation Test in rain conditions

Usually a lightning strike is accompanied by rain. So it seems that testing ESE in rain conditions is very pertinent must be required by the NFC 17-102 standard.

The functioning of an ESE shouldn’t be disturbed by the rain and the humidity generated. So a test that will enable to validate the insulation of the ESE must be realized.

The IEC 60060-1 procedure of test can be taken in reference in order to realize this test: The impulse switching high voltage must be a $215\mu s/2500\mu s$ waveform.

First the 50% electrical breakdown voltage ($V_{1d}$) and the withstand voltage ($V_{2d}$) are define for the dry conditions

Then the 50% electrical breakdown voltage ($V_{1b}$) and the withstand voltage ($V_{2b}$) are define for the rain conditions

Finally the insulation $I_1$ and $I_2$ in % are obtained for the $50\% \left( I_1 = \frac{V_{1r}}{V_{1d}} \right)$ and the withstand voltage ($ I_2 = \frac{V_{2r}}{V_{2d}}$).

If the value is close from 100%, the insulation of the ESE is validated. A minimum value may be defined in the standard.

IV. CONCLUSION

The new NFC 17-102 standard proposes a procedure of tests more severe than the precedent edition.

The ESE tested according to this new standard are confront to sequence of equivalent natural perturbations. The fact that the tested ESEs are still working after the sequence of tests confirm the liability of the technology used.

The ESE technology is the only one with a such important sequence of laboratory tests. Others technologies should improve the validation of their product at the same level of requirement.

However, the test requirements can be more severe in order to face all contradictory speeches. This is why we propose some evolutions and improvements of the NFC 17-102 Standard

REFERENCES

[1] Protection par paratonnerres à dispositif d’amorçage, NFC 17-102, September 2011