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LABORATORY TESTS AND NORMAL OPERATION REGARDING THE ELECTRIC FIELD INTENSITY

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Abstract

One of the requirements introduced by the utility company for the general hardware components is the operating voltage range. Nevertheless in normal conditions the specific factor is not the voltage but the maximum electric field intensity which initiates the local discharges and determines the disturbances level (i.e. RIV produced by the busbars terminations, the insulators...).

Moreover the relations between the cause and the consequences are highly non linear.

In order to avoid any significant differences between the previous data and the real operation figures, we need to perform laboratory tests with nearly the same electric field intensity than in operation (a well known similar situation is the corona cage which operates at reduced voltages in order to obtain the same electric field intensity around the bundle).

The purpose of the proposed paper is to quantify the effect of the geometry of the test room on the electric field intensity around the tested object. The charge simulation method is used and the results show significant differences in relation with the room geometry.

Keywords

Electric field intensity - Computation - Laboratory tests - Normal operation.

1. Interference caused by equipment

Overhead line-conductors have their elementary sources of interference distributed over very great lengths, a piece of substation equipment can be considered as a localized generator of interference, which permits its level to be measured by means of a laboratory set-up. It is generally assumed that this measurement can be made indoors, which amounts to disregarding atmospheric conditions.

Equipment principally refers to isolators and circuit-breakers, which are the main cause of R.I. recorded in substations. The ends of busbars, lightning-arresters, and spacers can also be sources of interference and are sometimes subjected to laboratory measurements.

For this category of apparatus, noise generation is generally localized on rough edges or sharp angles, where the electric surface gradient reaches the critical value and generates discharges.

From the manufacturer point of view it is possible to meet the requirements either by computation or by experimental tests.

We observe since more than 15 years a great amount of work in the field of voltage gradient intensity computation methods (charge simulation, finite differences, finite elements, surface integrals...).
These tools may help the designer to obtain the best shape of the equipment in order to limit the partial discharges (or corona) consequences.

The geometry of the equipment is the most important factor in this computation.

Nevertheless it is also necessary to test the equipment in normal conditions. In order to avoid any significant differences between the previous date and the real operation figures, we need to perform laboratory tests with the same electric field intensity around the electrode than in operation.

As the relation between the cause and the consequences of partial discharges is highly non linear, the importance to meet a good agreement between laboratory tests and normal operation is considerable.

2. Influence of the electrode shape

By using the classical charge simulation method it is possible to quantify the influence of the geometry of the electrode on the local electric field intensity.

We simulate an end of busbar and we can observe the variation of the local intensity of the electric field.

The figure 1 shows the computation results for three different shapes.

3. Influence of the room sizes

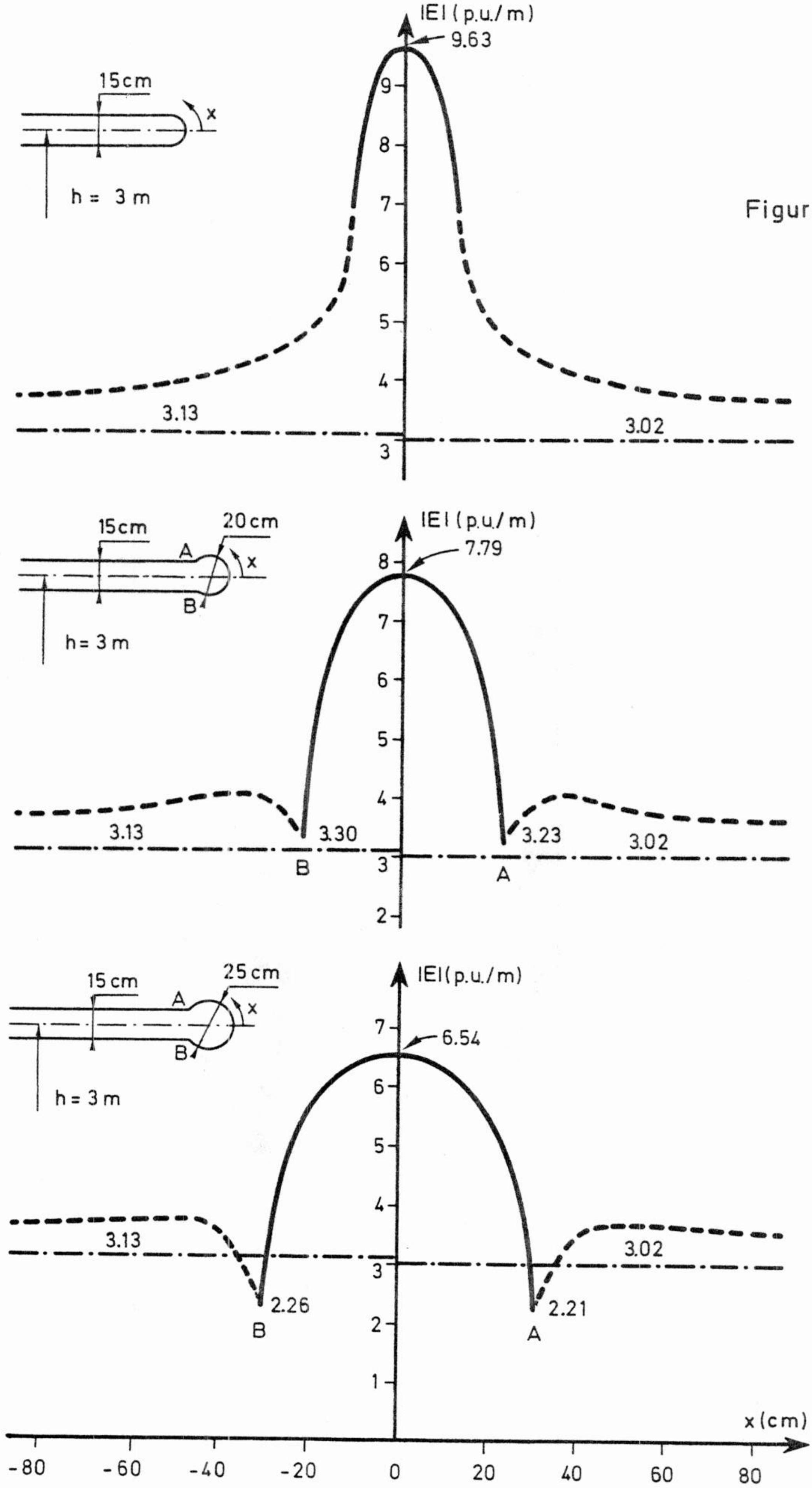
The purpose of the computation is to quantify the influence of the walls location on the electric field intensity. The figure 2 represents the cross section of the studied situations.

The computed values are reproduced (table 1) and the difference between the reference case (cylinder parallel to ground) is always higher than 10%.

4. Conclusions

Before performing tests to verify if the equipment has good requirements, it is necessary to have a sufficient knowledge of the normal operating situation of this equipment (general layout and relative position of the others equipments and ground).

The operating voltage range is not the specific factor but well the maximum electric field intensity which initiates the local dis charges.



|E| (p.u./m)
9.63
15cm
x
h = 3 m
3.13
3.02
|E| (p.u./m)
7.79
15cm
20cm
A
B
x
h= 3 m
3.13
3.30
3.23
3.02
B
A
|E|(p.u./m)
6.54
15 cm
25 cm
A
B
x
h = 3 m
3.13
3.02
2.26
2.21
B
A
x (cm)
-80
-60
-40
-20
0
20
40
60
80

Figure .1

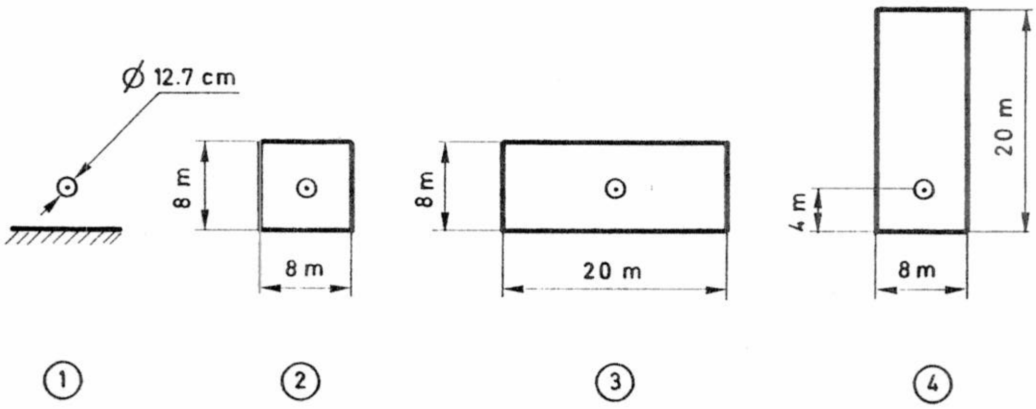


Figure 2

Configuration	1	2	3	4
E max p u(V/m)	3,3080	3,7328	3,5937	3,6793
E min	3,2055	3,7328	3,5922	3,6479
E mean	3,2564	3,7328	3,5930	3,6640
ΔE mean %		+ 14,6	+ 10,3	+ 12,5

Table 1

In order to avoid any significant differences between tests and real operation figures, we need to perform laboratory tests with the same electric field intensity than in operation.

The charge simulation method is a possible tool to quantify the influence of the laboratory room geometry.