CIGRE Study Committee C4

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP (1)

<table>
<tr><td>WG* N°C4.33</td><td colspan="2">Name of Convenor : Silverio Visacro (BRAZIL)
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<tr><td colspan="2">Technical Issues # (2): 9</td><td>Strategic Directions # (3): 2</td></tr>
<tr><td colspan="3">The WG applies to distribution networks (4): No</td></tr>
<tr><td colspan="3">Title of the Group: Impact of Soil-Parameter Frequency Dependence on the Response of Grounding Electrodes and on the Lightning Performance of Electrical Systems</td></tr>
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Scope, deliverables and proposed time schedule of the Group :

Background :

The transient response of grounding electrodes is a complex phenomenon that can significantly influence the lightning performance of the electrical power system. Though accurate computational models based on different approaches are currently available to simulate the behavior of electrodes subject to lightning currents, some basic aspects of this behavior still require further clarification, notably those related to the frequency dependence of soil parameters.

Experimental results, such as those by Smith-Rose, Scott, Longmire and Smith, and Visacro, show a significant frequency dependence of soil resistivity and permittivity. However, due to the lack of accurate general formulation to express this effect, it has been neglected and, in a conservative approach, soil resistivity is assumed as that measured at the low frequency range and relative permittivity of soil is assumed to vary from 4 to 81, according to the soil humidity.

In the last years new methodologies have been developed to determine this frequency dependence based on measurement under field conditions. The results provided by their application have demonstrated significant variation of both parameters in the representative frequency range of lightning currents. It has also be shown that the conservative assumption of constant values for soil resistivity and permittivity lead to large errors in the simulated response of electrodes subjected to currents with lightning-patterned waveforms (from 30% to 150%, in terms of measured impulse impedance). Furthermore, the results have suggested that it is feasible to develop general formulations for expressing this frequency dependence for accurate estimates of the lightning response of grounding electrodes.

In addition to the relevance of this effect on the impulse response of electrodes, another important issue to address is how this change in the electrode response impacts the lightning performance of the electrical power system, notably of transmission lines. This is a significant issue with respect to power system technical performance, since the lightning performance of the EHV lines can significantly impact overall system reliability. Therefore, it is very important to provide guidelines to take this frequency dependence of soil into account in calculations of the impulse response of grounding electrodes and of the lightning performance of the electrical power system.

Scope :

1. Demonstrate in a concise manner the frequency dependence of soil parameters within the frequency range of 0 to 4 MHz (where most of the lightning energy typically resides) by providing the fundamental scientific basis for this dependence and by referring to the

relevant literature addressing its significance based on experimental results.
2. Develop critical analysis of the existing experimental methodologies for determining this frequency dependence and corresponding published results. In this respect, it is fundamental to assess whether experimental measurements provide consistent verifiable results and how easily these measurable results can be obtained. Eventually, new feasible methodologies could be proposed.
3. Summarize reliable published results and propose complementing them by means of short term cooperation among participants of different countries.
4. Suggest plausible general expressions for prediction of the frequency dependence of soil parameters.
5. Evaluate the impacts of this dependence on grounding-electrode behavior and on the lightning performance of the electrical power system. In particular, it is of interest to develop equivalent circuits for selected arrangements of electrodes buried in different soils to represent their response to the impression of lightning currents, taking this effect into account. This includes an analysis of substation ground grids.

Deliverables : A Cigre technical brochure with summary in Electra.

Time Schedule : start : March 2013 **Final report** : March 2016

Comments from Chairmen of SCs concerned :

SC B3 - One area that would be useful is to consider the effects of different configurations, type, material and shape of electrodes. Hopefully this can be picked up in Item 5, .e.g. round versus ribbon and hollow stainless steel vs solid copper.

SC B2 - B2 has a working group working on related issues (WG B2.56 Ground Potential Rise at Overhead AC Transmission Line Structures during Faults), please consider the convenor George Watt (george.watt@hydroone.com) as a member.

Approval by Technical Committee Chairman : M. Waldron
Date : 28/02/2013

(1) Joint Working Group (JWG) - (2) See attached table 1 – (3) See attached table 2
(4) Delete as appropriate

Table 1: Technical Issues of the TC project "Network of the Future" (cf. Electra 256 June 2011)

1	Active Distribution Networks resulting in bidirectional flows within distribution level and to the upstream network.
2	The application of advanced metering and resulting massive need for exchange of information.
3	The growth in the application of HVDC and power electronics at all voltage levels and its impact on power quality, system control, and system security, and standardisation.
4	The need for the development and massive installation of energy storage systems, and the impact this can have on the power system development and operation.
5	New concepts for system operation and control to take account of active customer interactions and different generation types.
6	New concepts for protection to respond to the developing grid and different characteristics of generation.
7	New concepts in planning to take into account increasing environmental constraints, and new technology solutions for active and reactive power flow control.
8	New tools for system technical performance assessment, because of new Customer, Generator and Network characteristics.
9	Increase of right of way capacity and use of overhead, underground and subsea infrastructure, and its consequence on the technical performance and reliability of the network.
10	An increasing need for keeping Stakeholders aware of the technical and commercial consequences and keeping them engaged during the development of the network of the future.

Table 2: Strategic directions of the TC (cf. Electra 249 April 2010)

1	The electrical power system of the future
2	Making the best use of the existing system
3	Focus on the environment and sustainability
4	Preparation of material readable for non technical audience