CIGRE Study Committee C4

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

WG* N° C4.26	**Name of Convenor :** Jinliang He (CHINA) **E-mail address**: hejl@tsinghua.edu.cn
Technical Issues # (2): 8	**Strategic Directions # (3): 2**

Title of the Group: Evaluation of Lightning Shielding Analysis Methods for EHV and UHV DC and AC Overhead Transmission Lines

Background :

1000-kV ac UHV transmission lines have been built in some countries (Russia, Japan and Italy – limited to experimental installations) and achieved commercial operation in China starting in 2009. On the other hand, two ±800-kV dc UHV transmission lines have been put into operation in 2010 in China, and now a ±1000-kV dc UHV transmission line is being designed for commercial operation in about 2 years. A UHV core network will be built in the near future in China. Now, ±800-kV dc UHV transmission-line is being built in India, too. UHV transmission lines will be good solution for long distance power transmission, which will allow saving some significant occupation of land.

The UHV transmission towers are higher than 100 m, with bundled conductors and large separation from overhead groundwires compared to HV lines. Shielding failures caused by lightning penetration are serious threats to UHV transmission line reliability. From operational experience, lightning currents with high peak amplitude striking the phase conductors were observed in Russia. The large amplitude cannot be explained by the classical electrogeometric model (EGM). In addition, both in Japan and Russia, the observed shielding failure rates of UHV transmission lines have been larger than the rates estimated with the conventional EGM model. In China, the statistical results show the recorded lightning failure rates are much higher than those estimated by EGM. The main reason for this disagreement needs to be investigated and is in part the motivation for this new WG. Now, whether the EGM is suitable to analyze the lightning shielding failure of ultra-high voltage transmission lines is a debatable issue. Secondly, the operation voltages of ultra-high voltage transmission lines are very high, and phase conductor bundle radius is large, and these factors should also considered for their influence on the lightning leader development.

The Working Group objective is to produce a guide on the lightning shielding analysis of EHV/ UHV dc and ac transmission lines in the form of a CIGRE Technical Brochure. During the 1960's, important experiments on long gap discharge have been performed, and for example the link between switching surge flashover strength and the present EGM is rather strong. These kinds of experiments also led to improved understanding of lightning leader development process. From the beginning of 1990's, more physically plausible numerical analysis models, called as leader inception / propagation / development models, have been proposed to analyze the shielding failure of transmission lines. Adaptation of these models to the topic of UHV transmission line shielding is timely and technically relevant. Now is the time to undertake a comprehensive evaluation of these improved shielding analysis models. This WG aims at studying the application of leader models to the shielding failure analysis of EHV/UHV lines and possibly providing an alternative to EGM, to realize sensitivity analysis of transmission lines to lightning flashes and to promote any necessary actions in development of improved standards that will provide suitable procedure for shielding failure analysis of both standard-height and UHV/EHV transmission lines.

This WG will carry out its work starting from what previously carried out by WG C4.405 "Lightning Interception", and will closely cooperate with other WGs of C4, such as WG C407 "Lightning Parameters for Engineering Applications", to exchange information of lightning parameters, and WGC4.410 "Lightning Striking Characteristics for Very High Structures", to exchange observed data related to the striking characteristics of lightning strokes to tall transmission lines and physical characteristics of upward leaders from earthed objects, if necessary.

Scope : The scope of the working group is to:

1. Critically assess the existing analysis methods, including EGM and leader models, for shielding failure of UHV/ EHV transmission lines by means of data from the operation experiences of UHV/EHV transmission lines.

2. Determine the main parameters of leader propagation-type models to make this analysis model solid, and to provide a sensitivity analysis of transmission lines to lightning strikes.
3. Provide the suitable procedure for shielding failure analysis of UHV/ EHV transmission lines, especially, discuss the influence of the operation voltages on the lightning leader propagation process and shielding failure of UHV/EHV DC and AC transmission lines.
4. Apply the proposed procedures in lightning shielding failure analysis of 1000-kV ac ultra-high voltage transmission-line and ±800-kV dc ultra-high voltage transmission-line and validate the findings.
5. To collect experimental data from existing installations in order to compare these results with that of analytical models.

Deliverables : CIGRE Technical Brochure with a summary may be published in the Electra.

Time Schedule : start : Nov. 2011 **Final report** : 2014

Comments from Chairmen of SCs concerned : SC B2 will participate

Approval by Technical Committee Chairman : Klaus Fröhlich
Date :25/01/2012

(1) Joint Working Group (JWG) - (2) See attached table 1 – (3) See attached table 2

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	Interactive communication with the public and with political decision maker