CIGRE Study Committees B2/C4

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

JWG N° B2/C4.76	**Name of Convenor:** William A. Chisholm (CA) **E-mail address**: w.a.chisholm@sympatico.ca
Technical Issues #: 7, 8, 9	**Strategic Directions #:** 2
The WG applies to distribution networks: Yes	
Potential Benefit of WG work #: 5, 6, 7	
Title of the Group: Lightning & Grounding Considerations for Overhead Line Rebuilding and Refurbishing Projects, AC and DC	

Scope, deliverables and proposed time schedule of the WG:

Background:

As defined in TB 541 "Asset Management Decision Making using different Risk Assessment Methodologies", line refurbishment options include replacement or refurbishment of the key components of the overhead line (OHL), namely structures, foundations, insulators including fittings, conductors and overhead ground wires (OHGW), and grounding. All five of these components affect the lightning performance, if altered. For examples:

- A change from lattice or guyed structures to monopoles will double or triple the tower surge impedance while improving the visual aspect of a line;
- Corresponding changes to foundations and anchors can have positive or negative influence on ground potential rise under lightning or power system fault conditions;
- Improved insulation strength, integrating transmission line surge arresters (TLSA) and arcing horns as coordinated systems, can be achieved with insulating crossarm options;
- The lightning protection system (LPS) designed to dissipate lightning discharge currents into the ground/earth without causing damage or disruption may not protect persons in the vicinity of the structures from power-system ground potential rise exposure;
- It may not be feasible or economic to re-install grounding when rebuilding a line, based on environmental disturbance or on the superior effectiveness of modern TLSA in regions of high resistivity.

The lightning performance of overhead transmission and distribution lines can significantly affect overall reliability of supply. Technical studies and literature have addressed individual subjects, such as, lightning parameters, remedial measures, line lightning performance, etc. for many decades. The general issue of lightning performance of OHLs is addressed CIGRE C4, and lightning performance of all OHLs is the specific mandate of C4.23.

There is a need for a coordinated approach to grounding design, considering both lightning and power system fault management. Traditional CIGRE resources such as TBs 63, 72, 118, 172, 275, 287, 348, 353, 376, 440, 441, 541, 542, 543, 544, 549, 550, 561, 633 and 704 as well as the CIGRE Green Book "Overhead Lines", do not address this aspect. Grounding for managing power system fault potentials around transmission structures is a topic developed by B2 in TB694 and this quantitative risk analysis received additional development in B3 TB749.

Scope:

The objective of the work will be to add value to transmission and distribution line replacement / reconductor / refurbishment projects by modifications in the redesign process. This JWG will exploit the OHL expertise in the B2 group to identify problems in proposed lightning remediation options and to suggest solutions. Where the C4 groups such as C4.39 have worked to ensure the electrical success of transmission line surge arrester applications, it remains the role of B2 to comment on the mechanical integrity of installations. This includes placement of the TLSA near vibration dampers, support of TLSA on davit arms and integration of TLSA into insulated crossarm systems.

The scope of this working group includes tasks to:

- Review sources of lightning discharge current, its characteristics and distribution.
- Describe conductive or transfer impedance and induced overvoltage effects associated with the discharge current and potential effects in the vicinity of OHL structure during lightning fault and current discharge.
- Discuss observed effects of lightning discharges on electrical facilities and installations bonded to or in close vicinity of the line.
- Review relevant design considerations for line replacement, uprating and selection of mitigation solutions.
- Examine line design requirements, such as structure footing resistance, overhead ground wire / shield wire, cross-bonding, insulation coordination, line surge arrester, etc., that will affect line performance under lightning and associated fault conditions.
- Focus on refitting tower heads that stabilize lateral conductor motion.
- Place the three main methods for mitigating line lightning performance mentioned in TB638 into a quantitative context, leading to a matrix of appropriate design choices based on local conditions such as ice and wind loading levels, ground flash density and median soil resistivity.
- Promote a coordinated approach to grounding among civil and electrical engineers, including power frequency, lightning protection and corrosion aspects and sharing of geotechnical data.
- Describe tower-to-tower variation of soil resistivity as a statistical parameter in lightning and grounding calculations.
- Develop case studies based on utility experiences with MV, HV, EHV and UHV OHL including both AC and DC systems, including AC/DC conversion schemes involving metallic earth return or under-built optical fibre ground wires.
- Evaluate the possibility of leaving off OHGW after icing damage or degradation, relying instead on successful TLSA protection of unshielded lines, reducing the number of power system fault exposures but increasing the magnitude of ground potential rise at the remaining fault location.
- Identify new IEC and EN standards and IEEE guides dealing with certain aspects of the topic.

Close coordination with ongoing CIGRE activity in C4, such as C4.23, C4.33 and new work in C4/A3.35, C4.45, C4.48 and C4.50 will be achieved through shared leadership (B2 convenor, C4 secretary) and joint membership. Coordination with B2.73 (Guide for Prevention

of Vegetation Fires Caused by OHL Systems), B2.65 (Detection, Prevention and Repair of Sub-surface Corrosion in OHL Supports, Anchors and Foundations), B3.54 (earthing system test methods) and other stakeholders will be arranged.

Deliverables:

☒ Technical Brochure and Executive Summary in Electra

☐ Electra Report

☒ Tutorial[6]

☒ Webinar[6]

Time Schedule: start: September 2019 **Final Report**: September 2022

Approval by Technical Council Chairman:

Date: August 19, 2019

Notes: [1] Working Group (WG) or Joint WG (JWG), [2] See attached Table 1, [3]See attached Table 2, [4] Delete as appropriate, [5] See attached Table 3,
[6] Presentation of the work done by the WG

Table 1: Technical Issues for creation of a new WG

1	Active Distribution Networks resulting in bidirectional power and data flows within distribution levels up to higher voltage networks
2	Digitalization of the Electric Power Units (EPU): Real-time data acquisition includes advanced metering, processing large data sets (Big Data), emerging technologies such as Internet of Things (IoT), 3D, virtual and augmented reality, secure and efficient telecommunication network
3	The growth of direct current (DC) and power electronics (PE) at all voltage levels and its impact on power quality, system control, system operation, system security, and standardisation
4	The need for the development and significant installation of energy storage systems, and electric transportation, considering the impact they can have on the power system development, operation and performance
5	New concepts for system operation, control and planning to take account of active customer interactions, and different generation types, and new technology solutions for active and reactive power flow control
6	New concepts for protection to respond to the developing grid and different generation characteristics
7	New concepts in all aspects of power systems to take into account increasing environmental constraints and to address relevant sustainable development goals.
8	New tools for system technical performance assessment, because of new Customer, Generator and Network characteristics
9	Increase of right of way capacity through the use of overhead, underground and submarine infrastructure, and its consequence on the technical performance and reliability of the network
10	An increasing need for keeping Stakeholders and Regulators aware of the technical and commercial consequences and keeping them engaged during the development of their future network

Table 2: Strategic directions of the Technical Council

1	The electrical power system of the future: respond to speed of changes in the industry
2	Making the best use of the existing systems
3	Focus on the environment and sustainability
4	Preparation of material readable for non-technical audience

Table 3: Potential benefit of work

1	Commercial, business, social and economic benefits for industry or the community can be identified as a direct result of this work
2	Existing or future high interest in the work from a wide range of stakeholders
3	Work is likely to contribute to new or revised industry standards or with other long term interest for the Electric Power Industry
4	State-of-the-art or innovative solutions or new technical directions
5	Guide or survey related to existing techniques; or an update on past work or previous Technical Brochures
6	Work likely to contribute to improved safety.
7	Work addressing environmental requirements and sustainable development goals.