CIGRE Study Committee C4

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

WG [1]N° C4.73	**Name of Convenor:** Ivo Uglešić (Croatia)
Strategic Directions #[2]: 1, 3, 4	**Sustainable Development Goal #[3]:**
The WG applies to distribution networks: ☐ **Yes /** ☒ **No**	
Potential Benefit of WG work #[4] : 3, 4	
Title of the Group: Insulation Coordination of HVDC Overhead Lines	

Scope, deliverables and proposed time schedule of the WG:

Background:

Insulation coordination of HVDC overhead line is the selection of the dielectric strength of line equipment in relation to the DC voltages and overvoltages which can appear on the line for which the equipment is intended and taking into account the service environment and the characteristics of the available preventing and protective devices.

An HVDC transmission system is environment friendly because improved energy transmission possibilities contribute to a more efficient utilization of existing power plants.

There are only a very few documents covering insulation coordination aspects of HVDC overhead lines. Several questions should be considered regarding the insulation coordination aspects of HVDC lines:

- Representative voltage stresses of HVDC overhead lines in service.
- Origin and classification of voltage stresses.
- Characteristics of overvoltage protective devices.
- Selection of line insulation for the operating voltage in conjunctions with the specific conditions of pollution and wet conditions.
- Coordination of the insulator length with internal clearances and coordination of external clearances to internal clearances.
- Insulation coordination of neutral conductors. Dedicated Metallic Return of OHTL should be considered.
- Special considerations for HVDC overhead lines with various tower configurations.
- Required withstand voltage.

Beside the DC voltage the equipment of HVDC line could be stressed by different kind of overvoltages: temporary, switching, lightning, very-fast-front and combined overvoltages. The protective devices as spark gaps and surge arresters shall be designed and installed to limit the magnitudes of overvoltages against which they protect equipment.

The length of insulating string (vertical spacing) should be selected for normal operating conditions. In polluted conditions, the line design may require long insulators, which means that the shortest gaps could be between the pole conductor and the supporting structure. The line insulation should be determined by considering all internal clearances and not only the insulator length.

Horizontal spacing are determined taking into account the impact of switching surges at designed wind pressure. The gap between the pole wires in the span should be selected taking into account the maximum operating voltage, overhead line design parameters and climatic conditions.

When determining the distance of the wire from the ground in the span the switching overvoltages must be taken into account as well as environmental requirements and the electric field intensity under the line at an operating voltage.

It is also necessary to consider the insulation coordination of the neutral conductors. An important issue is the designing of arcing horns that are used to eliminate the fault.

Lightning protection of bipolar HVDC line is ensured by the rope protection. In most cases, lightning current has negative polarity, so the isolation of the positive pole is more exposed to a lightning strikes than the isolation of the negative pole.

Where the design employs free-swinging insulators, the dielectric strength of air clearances should take into account conductor movement and it is necessary to consider balancing with different wind pressure.

The insulation co-ordination procedure terminates with the determination of the required withstand voltage that should be verified in standard type test conditions and at standard reference atmosphere. It is determined taking into account all factors, which may decrease the insulation in service at the equipment location during the equipment life.

Scope:

State of the art on insulation coordination of HVDC transmission lines. Examples of existing lines should be included.

Reflect on the representativeness of the existing standards and when relevant to suggest potential improvements.

Determination of required insulators lengths and distances between the parts of HVDC line for the safe operation.

Guidelines for the modelling of HVDC lines components for insulation coordination studies including the influence of the line insulation on the incoming surge to the converter station.

A proposal for the calculation and measurement locations of the ground electric field under the HVDC transmission line.

Recommendations to criteria on line faults applications and subsequent events will also be studied.

Note: This WG is based on power system performance and it will be done in cooperation

with B2 and B4.

Remarks:

Deliverables:
☒ Technical Brochure and Executive Summary in Electra
☒ Electra Report
☒ Future Connections
☐ CSE
☒ Tutorial
☐ Webinar
Time Schedule: Start: January 2023 Final Report: January 2026
Approval by Technical Council Chairman:  **Date**: October 18th, 2022

Notes: [1] Working Group (WG) or Joint WG (JWG), [2] See attached Table 1, [3]See attached Table 2 and CIGRE reference Paper: Sustainability – at the heart of CIGRE's work. [4] See attached Table 3
Refer Comments at end of document.

Table 1: Strategic directions of the Technical Council

1	The electrical power system of the future reinforcing the End-to-End nature of CIGRE: respond to speed of changes in the industry by preparing and disseminating state-of-the-art technological advances
2	Making the best use of the existing systems
3	Focus on the environment and sustainability (in case the WG shows a direct contribution to at least one SDG)
4	Preparation of material readable for non-technical audience

Table 2: Environmental requirements and sustainable development goals

	CIGRE selected the 7 SDGs that are the most relevant to CIGRE. In case the WG work refers to other SDGs or do not address any specific SDG, it will be quoted 0.
0	Other SDGs or not applied
7	**SDG 7: Affordable and clean energy** Increase share of renewable energy; e.g. expand infrastructure for supplying sustainable energy services; ensure universal access to affordable, reliable, and modern energy services; energy efficiency; facilitate access to clean energy research and technology
9	**SDG 9: Industry, innovation and infrastructure** Facilitate sustainable infrastructure development; facilitate technological and technical support
11	**SDG 11: Sustainable cities and communities** Increase attention on sustainable and resilient buildings utilizing local (raw) materials, power for electric vehicles, strengthening long-line transmission and distribution systems to import necessary power to cities, developing micro-grids to reinforce the sustainable nature of cities; protect and safeguard the world's cultural and natural heritage; reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and waste management
12	**SDG 12: Responsible consumption and production** E.g. Promote public procurement practices that are sustainable; address reducing use of SF6 and promote alternatives, encourage companies to adopt sustainable practices and to integrate sustainability information into their reporting cycle, address inefficient fossil-fuel subsidies that encourage wasteful consumption
13	**SDG 13: Climate action** E.g. Increase share of renewable or other CO_2-free energy; energy efficiency; expand infrastructure for supplying sustainable energy; strengthen resilience and adaptive capacity to climate-related hazards and natural disasters; integrate climate change measures into national policies, strategies and planning; improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning
14	**SDG 14: Life below water** E.g. Effects of offshore windfarms; effects of submarine cables on sea-life
15	**SDG 15: Life on land** E.g. Attention for vegetation management; bird collisions; integration of substations and lines into the landscape

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.

Comments:

1) CIGRE Official Study Committee Rules re WG Membership:
https://www.cigre.org/GB/about/official-documents
No more than one member per country unless by SC Chair exception.
WG nominees must first be supported by their National Committee (or local SC Member) as an appropriate representative of their country.
Acceptance of the nomination is granted by the SC Chair and advised to the WG Convener

2) CIGRE will provision a dedicated Space for the Working Group in the Knowledge Management System. The WG will use the KMS for drafting collaboration, capture and retention of discussion and meeting records. WG Members will be sent registration instructions by the Convener.
https://www.cigre.org/article/GB/collaborative-tools-2