

Overhead Lines

Study Committee B2 can look back to a long, successful history being one of the oldest and largest Study Committees of CIGRE. The strong focus on renewable energy sources in recent years has increased the focus of the experts but also of the public to overhead transmission lines. The wide range of technical disciplines encountered in overhead lines (electrical, mechanical, materials, environmental, etc.) can only be adequately covered by the active participation of some 300 experts from utilities, manufacturers, academic institutions and consultants from more than forty countries.

Activities of Study Committee B2 cover the design, construction and operation of overhead lines (OHL), including the mechanical and electrical design of line components (conductors, ground wires, insulators, accessories, supports and their foundations), validation tests, study of in-service performance, assessment of the state of line components, maintenance, refurbishment and life extension as well as upgrading and uprating of overhead lines.

For the management of the Study Committee, the current and planned works are conducted according to the following three strategic directions, which aim to increase:

1. Acceptability of new OHL
2. Capacity of existing OHL
3. Reliability and availability of all OHL

and are grouped in four key technical areas:

1. Electrical performance,
2. Towers, insulators and foundations
3. Conductors and fittings
4. Asset management

Additionally and in line with the fourth strategic direction of CIGRE, i.e. to enhance communication also with non-technical audiences, particular emphasis has been given to the organising of events (symposia, colloquia, tutorials) and to the publication of documents (Technical Brochures, Electra papers) for a wider use.

Last but not least Study Committee B2 has always fostered a strategy to encourage young engineers to participate in their work.

Electrical performance

Here the focus remains on the increased utilization of existing lines, on the conversion of existing lines from AC to DC, and on the optimal design of new lines.



Expanded bundle in a HSIL test line in Brazil

WG B2.36 “Dynamic and enhanced line rating systems” has completed its TB “Guide for application of direct real time monitoring systems on overhead transmission lines” in 2012.

WG B2.38 is studying the use of High Surge Impedance Loading (HSIL) Lines to HVDC operation and has scheduled a TB to be finished in 2012.

WG B2.41 is studying the upgrading of existing AC lines to HVDC operation and has scheduled a TB: ” Guide to the conversion of existing AC lines to DC operation” in 2013.

WG B2.42 is developing a Guide to Operation of Conventional Conductor Systems above 100oC to help transmission line engineers to increase the thermal capacity of existing lines without reconductoring.

WG B2.43 is developing a “Guide for Thermal Rating Calculations for Overhead Lines with high temperatures and real-time weather & load data” to be completed in 2013. This includes revising the existing TB 207 to include new information on ac resistance, radial temperature drop and convection at low wind speeds.

WG B2.51 is studying methods for the optimized design of overhead transmission lines and has scheduled a completion date of 2014.

WG B2.55 is studying the alternative transmission with DC Lines and has scheduled a TB: ” Guide to the conversion of existing AC lines to DC operation” in 2013.

Others aspects of electrical theme have been studied by the SC over a number of years and several Technical Brochures are already published. The more recent are:

“Increase capacity of OHL, needs and solutions” (JWG B2 C1.19-TB 425, August 2010). ●●●

“A guide to evaluating and accepting new types of conductors” (WG B2.26-TB 426, August 2010)

Towers, foundations and insulators

After many years of investigation and lots of CIGRE publications, the “strength factor of such components”, is still an issue for research in SC B2, especially when related to the supports. After all, according to IEC 60826, the “suspension towers” should be designed as the weakest link of the whole system. Methods and techniques for assessing the real condition of the line components, as well as, and their in-service performance, continue to be essential topics to be covered, e.g.:

On the Assessment of composite insulators after service, a Technical Brochure has just been published (TB 481, December 2011).



Inclined plane test with a specimen cut from an insulator housing

Evaluation of advanced tools for composite insulators, diagnostic in service, is also presently under study on WG B2.21.

For better understanding on the absorbing mechanisms of the so called dynamic loads by the supports, a new group has been launched. WG B2.24 has as main targets, to review historic performance of transmission line towers to dynamic loads, investigations on the dynamic analysis software available in the world, and recommending their utilization accordingly.

As far as the OHL tower foundations are concerned, the following studies are under way on the scope of the WG B2.23:

- Static and dynamic loading on foundations,
- Geotechnical consequences of the support location in respect of foundation design,
- Foundations refurbishment and upgrading.

Mechanical behavior of conductors and fittings

This thematic entity includes all aspects related to conductors and their fittings, such as fatigue and endurance capability, protection against wind induced vibrations and movement, assessment of new and aged fittings, updating of old and preparation of new international standards and new equipment and service technologies.

WG B2.25 has prepared proposals for the new standards IEC 62567 “Method for self-damping characteristics of stranded conductors” and IEC 62568 “Method for fatigue testing of conductors for OHL”. For the self-damping method additionally an ELECTRA Technical Brochure (TB 482) has been published in December 2011.

Further proposals for the revision of the existing IEC standards 61284 “Overhead Lines- Requirements and tests for fittings”, IEC 61854 “Overhead Lines-Requirements and tests for spacers” and IEC 61897 “Overhead Lines- Requirements and tests for Stockbridge type aeolian vibration dampers” has been finalized by the end of 2011.

WG B2.31 has published a paper for the subject of “Aeolian vibration of single conductor strung at relatively high tensile load, application to HV and UHV lines” (ELECTRA No. 256).

WG B2.32 has studied the “Assessment of performance of aging and end of life of fittings with respect to the testing, acceptance criteria and recommendations for HV and UHV lines” and has issued in October 2011 Technical Brochure No. 477 on « Evaluation of aged fittings”. This TB will be the basis in developing sustainable asset management strategies for aged fittings.

Interval between Inspections: Years	Ground Inspection	Helicopter Inspection	Climbing Inspection
0-1	51%	41%	3%
>1-2	8%	11%	2%
>2-5	11%	14%	22%
>5-10	6%	2%	23 %
>10	0	3%	12%
Never/rarely	6%	6%	10%
No reply	16.0	17%	18%
Decision based on inspection results	2%	6%	9%

Results of questionnaire – Frequency of inspection of OHL



B2.33 has studied and identified the factors that affect the safety for cable carts as well the factors which consider the condition of the conductor and earth wire.

This study includes the constructor features, line design features and the environmental and history features. The complete study has been published as Technical Brochure TB 471 in August 2011.

In 2011 five new WG's have been inaugurated covering the following topics:

- B2.46 "Wind induced motion on bundled conductors"
- B2.47 "Remedial actions for aged fittings & repair of conductors"
- B2.48 "New conductor types"
- B2.49 "Safe design tensions for conductor fitted with elastomer cushioned suspension units"
- B2.50 "Safe handling of fittings and conductors"

Asset Management, Reliability, Availability

Since the last SC B2 annual report (Electra 252 – October 2010), two TB's have been issued in this field:

TB 438 – WG B2.29 – December 2010: "Systems for Prediction and Monitoring of Ice Shedding, Anti-Icing and De-Icing (AI/DI) for Overhead Power Line Conductors and Ground Wires". This TB informs on the mechanical and thermodynamic aspects of ice accretion. It also highlights the role of modern meteorological forecasting models for reliable use of AI/DI techniques.

TB 485 – WG B2.39 – February 2012: "Overhead Line Design Guidelines for Mitigation of Severe Wind Storm Damage". TB 256 (2004) already described the characteristics and frequency of localized High Intensity Winds (HIW) that have caused significant damage to Overhead Transmission Lines (OHTL). TB 350 (2008) provides a further review of literature and reports on suggested simplified load cases to account for the impact of thunderstorm downdrafts and tornadoes on OHTL. This new TB 485 focuses on the latest detailed methodologies that may be adopted to minimise the potential extent of damages from the various forms of severe HIW storm events.

The following WG's have scheduled the completion of their work in 2012:

WG B2.22 – "Mechanical Security of Overhead Lines Containing Cascading Failures and Mitigating their Effects". This TB will outline various cascade mitigation strategies that have been proven successful by increasing the mechanical robustness against cascade failures. TB 344 already summarized the lessons learnt from big storm events.

WG B2/B3.27 – "Live line maintenance – A management perspective" of OHTL and substations.

WG B2.28 – "Meteorological data for assessing climatic loads" for updating existing Standards. The TB will also deal with ice loads considered by TB's 179, 291 and 438.

WG B2.34 – “The impact of line configuration on electromagnetic fields, radio interference and audible noise for 800 and 1100 kV OHTL”. This TB will be an extension of TB 278 that was limited to 400 kV.

WG B2.40 – “Calculation of the electrical distances between live parts and obstacles for OHTL”. This TB will be a complement to TB 248 which deals only with the internal clearances determining the tower top geometry, while the new TB will consider the external clearances that guarantee the safety of the general public.

Between September 2010 and May 2011 six new WG's have been created :

- B2.44 Coatings for protecting overhead power network equipment in winter conditions;
- B2.45 Bushfire characteristics and the potential impacts on OHTL performance;
- B2.51 Methods for the optimized design of OHTL;
- B2.52 The use of robotics in assessment and maintenance of OHTL;
- B2.53 Management guidelines for outsourcing OHTL technical expertise;
- B2.54 Management of risk associated with severe climatic events and climate change on OHTL.

Meetings

In 2011 SC B2 has organized or participated amongst others in the following events:

Symposia and colloquia

In March 2011 a colloquium on ELF-EMF took place in Paris. It has been organized by the CIGRE French National Committee and SCB2 (headed by SC B2 past Chairman Bernard Dalle), SC B1, SC B3, SC B4, SC C3 and SC C4. ●●●



Failed tower due to the severe 1998 ice storm in Canada

The Iceland National Committee of CIGRE organized in July 2011 in Reykjavik together with the SC B2 annual meeting, a colloquium on “Natural Hazards and Visual Aspects”, while SC B2 has presented the following tutorials:

- Upgrade of OHL
- Innovative solution for towers
- Ice melting methods for OHL
- Aged fittings
- Current trends in OHL design
- Impact of climate change on OHL

In September 2011, a CIGRE symposium on “The Electric Power System of the Future” was held in Bologna with strong participation of SC B2 officials.

Additionally SC B2 has organized together with the CIGRE NC of India in October 2010 in New Delhi an international colloquium on “Best Practices in Design and Maintenance Techniques for EHV lines” chaired by SC B2 Chairman Konstantin O. Papailiou.

Tutorials and workshops

SC B2 has delivered in 2011 a number of tutorials and workshops in a range of areas including conductor vibrations, new conductors, towers, foundations, composite insulators, fittings and methods for improving line capacity, reliability and maintainability of overhead lines. This capability is continuously developing in line with the activities of the SC.

More details (full list of Working Groups, Terms of Reference, Strategic Plan of B2, list of publications etc.) are available under www.cigre-b2.org and www.cigre.org. ■