

Overhead lines

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The main highlight of the year for SC B2 was the Study Committee meeting in Cape Town, in connection with the very successful CIGRE-IEC International Symposium entitled “Development of Electricity Infrastructures on Sub-Saharan Africa”. SC B2 comprises members from 22 countries plus observers from 15 countries. Seven Advisory Groups help to coordinate 21 working groups and two joint working groups (B1.B2.C3.13 Environmental issues and D2.B2.39 Optical fibres), with a total 534 members from 41 countries.

Four Technical Brochures and two papers for the CIGRE Science & Engineering Journal (CSE) were published in 2015:

- ◆ TB 631: Coatings for protecting overhead power network equipment in winter conditions
- ◆ TB 638: Guide to overall line design
- ◆ TB 643: Guide to the operation of conventional conductor systems above 100°C
- ◆ TB 645: Meteorological data for assessing climatic loads on overhead lines
- ◆ “Evaluation of 500kV High Surge Impedance Loading (HSIL) transmission lines solutions concerning electric fields and line parameters”, CSE, issue No. 2, June 2015
- ◆ “Wind induced motion on bundle conductors (excluding galloping), CSE, issue No. 2, June 2015

SC B2 is structured according to the following three strategic directions:

- ◆ Acceptability of new OHL
- ◆ Capacity of existing OHL
- ◆ Reliability and availability of all OHL

which are linked with the following four key technical areas of expertise:

- ◆ Electrical performance
- ◆ Towers, insulators and foundations
- ◆ Mechanical behavior of conductors and fittings
- ◆ Asset management, reliability, availability.

SC B2’s activities in these four key technical areas are described in more detail in the following sections.

Electrical performance

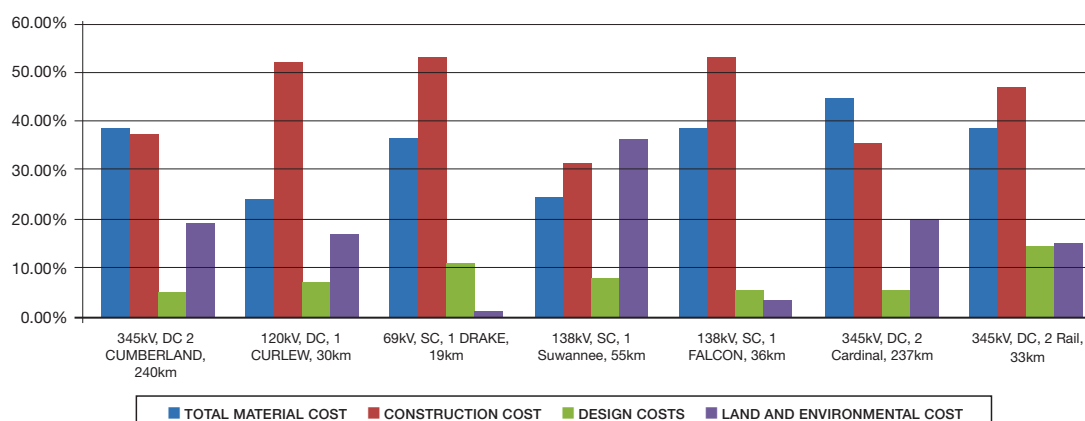
In 2015, as in previous years, the emphasis in technical advisory group TAG4 was on the Electrical Performance aspects of designing, analyzing and utilizing new materials and techniques in the design of new lines and increasing the utilization and reliability of existing overhead transmission lines. The main topics include modifications of existing lines to raise thermal capacity and to increase electrical limits related to voltage drop and surge impedance loading. We continue to be concerned with improving existing analytical tools to maintain electrical clearances at high temperature, optimizing the design of new lines, and ensuring electrical safety through analysis of step potential calculations. To accomplish this wide spectrum of activities, a total of seven approved working groups were active in 2015, while the work of two recently disbanded groups was published, yielding an article for CSE and a new technical brochure.

WG B2.38 completed a paper - “**Evaluation of 500kV High Surge Impedance Loading (HSIL) transmission lines solutions concerning electric fields and line parameters**” - which was published in CSE in June 2015. The monopole tower shown in the photograph uses guyed supports with a single lattice pole and structural parts between phases. To achieve a natural capacity (SIL) of 1200 MW, a combination of “light” compaction and “semi-expanded” bundles were used.

WG B2.42 completed its “Guide to operation of conventional conductor systems above 100°C” which was published in 2016. It is intended to provide improved tools for evaluating creep and annealing when pushing older lines to much higher than original design temperatures without reconductoring. Issues such as high temperature aluminum creep elongation and annealing are quantified.

WG B2.51 was studying methods for the **Optimized design of overhead transmission lines** including the results of its questionnaire in the newly published technical brochure TB 638. Their work was completed in 2015. The bar chart compares line cost breakdown by component for 7 different designs in North America.

% Breakdown of line costs for North American projects



WG B2.55 is expanding and refining the existing technical brochure TB 244 on “**Conductors for line uprating**” to consider newer types of high temperature conductor and to incorporate references to recent CIGRE B2 technical brochures on sag-tension, ac resistance, and thermal rating calculations. This working group should complete their work in 2016.

WG B2.56 is concerned mainly with the safety aspects of “**Ground potential rise at overhead AC transmission line structures during faults**”. The group has met on five occasions since its founding in 2013 and is scheduled to complete its work in 2016.

WG B2.59 held its first meeting in Paris in 2014. It is concerned with the prediction of variable overhead line thermal ratings and requires the involvement of line design, system operations, and meteorologists. It is unique in that it cooperates with a parallel task force of IEEE Subcommittee 15.11 on Overhead Lines.

Two new working groups in this technical area met for the first time in 2015, **WG B2.62** on the design and analysis of compact HVDC lines and **WG B2.63** on the design and analysis of compact HVAC lines.

Towers, insulators and foundations

Two new Working Groups were approved and had their first meetings in 2015:

WG B2.61 “Transmission line structures with fibre reinforced polymer (FRP) composites” – and:

WG B2.65 “Detection, prevention and repair of sub-surface corrosion in overhead line supports, anchors and foundations”

Two technical brochures are in the final stage of preparation and are expected to be published in 2016:

WG B2.23 “Dynamic loading on foundations” and

WG B2.24 “Qualification of Overhead line supports under static and dynamic loads”

WG B2.57 “Survey of operational composite insulators - experience & applications.” The main objective of this Group is precisely to review the application of Composite Insulators and their performance in service.

WG.B2.61 “Transmission line structures with fibre reinforced polymer (FRP) composites”. Traditional materials have been working well for a long time in transmission line projects. However, emerging new fibre reinforced polymer (FRP) materials show great benefits for the electrical industry, addressing many of the challenges utilities currently face. •••

Some of these new materials have considerable durability, environmental friendliness, timely structure delivery and good quality material availability. The aim of this new group is to collect the experiences of utilities around the world with the use of such materials.



Full FRP H-frame

FRP lattice structure

WG.B2.65 - “Detection, prevention and repair of sub-surface corrosion in overhead line Supports, anchors and foundations”.

Metallic grillage type foundations and stay anchors involving direct steel to soil contact have been used successfully by many utilities in different regions. There are, however, a number of instances where the severity of subsurface corrosion has resulted in catastrophic failures (figure 4), and/or expensive restoration programs in affected lines. The aim of this Working Group is to prepare a report on the causes of subsurface corrosion, and to study the failure mechanisms, detection, prevention and repair techniques of affected line structures and/or foundations.

The “Customer Advisory Group” (CAG) addressed new topics for TAG5 as a result of a recent survey carried out. After appreciation and discussion among TAG5 members, two “Terms of Reference” (TOR) for new groups are under preparation:

- ◆ “Assessment and testing of wood poles”
- ◆ “Foundations for difficult soil and geological conditions”

Mechanical behavior of conductors and fittings

TAG 06 covers the mechanical behaviour of conductors and fittings and, in particular, aspects of designing, analysing and utilizing new materials and techniques in the design of lines, and increasing the utilization and reliability of existing overhead transmission lines. Recently, TAG6 has been working on conductor fatigue and repair, vibration mitigation when there are surge arresters and has looked at the performance of non-conventional conductors. It is also working on the installation and handling of fittings.

WG B2.46 completed its activities in 2015 and a paper on “**Modelling of conductor vibrations**” was published in CSE, covering the work done on aeolian vibrations and sub-span oscillations of bundled conductors, plus the work done previously on modelling of a single conductor, single conductors plus damper, and single conductors strung at relatively high tensile load.

WG B2.47 completed a final draft of the “**Guide on remedial actions for repair of conductors**”. The draft will be sent to reviewers and the brochure is expected to be completed in 2016.



Fatigue failure at suspension clamp

Damage from loose AWM

WG B2.48 also completed a draft on “**Experience with the mechanical performance of non-conventional conductors**” which was reviewed in 2015 and sent to SC members and observers for comments at the end of 2015. The brochure is expected to be completed early in 2016.

WG B2.49 completed a brochure on “**Safe design tensions for single conductors fitted with elastomer cushioned suspension units**” in 2015. The brochure should be published at the beginning of 2016.

WG B2.50 is working on the preparation of a TB on “**Correct handling and installation of fittings and conductors**”. Completion of the work is expected in 2017.

The focus of WG B2.58 is on the “**Self-damping characterization of High Temperature Low Sag conductors**”. This WG is particularly interesting since it generates and makes available new data on the subject. It is expected to complete its work in 2018.

Task Force B2.06.7 is examining the “**Interaction of vibration dampers with surge arresters**”. It is about to complete a paper on the subject at the beginning of 2016, which will be published in CSE journal. ***

Flexible disconnect lead and arrester
as originally installedFlexible disconnect lead failed after
seven years in service

Two WGs and one TF are expected to complete their work in 2016. A new Working Group was proposed in 2015 on “Safe handling of HTLS conductors”, which are increasingly common on the market. Approval should be obtained in early 2016. Another proposal is under preparation on “Conductor sustainability”, since many lines throughout the world have now exceeded their expected life. Other topics are also being evaluated for a third WG.

Asset management, reliability, availability

Technical Advisory Group (TAG) 07 deals with a wide range of engineering topics, from electrical to civil, with an impact on the reliability, availability and life cycle of overhead transmission lines.

Technical Brochures Published in 2015

Since the last Study Committee B2 annual report, two Technical Brochures have been published, whilst several others are in the process of submission for final approval for publishing by the Technical Committee:

Technical Brochure 645 - Meteorological data for assessing climatic loads on overhead lines

The theme of TB 645 is to compile and restructure updated meteorological knowledge for the purpose of application in international standards, paying particular attention to wind turbulence in steep terrain, weather models and field observations of ice loads. Atmospheric icing is already described in detail in Cigré TB 291 (2006) “Guidelines for meteorological icing models, statistical methods and topographical effects”. This new brochure updates some information concerning ice load measurements and modelling, especially of wet snow accretion, and the application of numerical weather prediction models for analyses of wet snow and rime ice accretions on electric overhead line conductors. This TB was published earlier this year and is available via the e-cigre website.



Technical Brochure 631 - Coatings for protecting overhead power network equipment in winter conditions

This TB presents techniques for protecting transmission lines from ice and snow accretion through the use of active coatings, or passive coatings with self-cleaning and super-hydrophobic/icephobic properties, these being particularly attractive for application on insulators in contaminated environments. The ice-repelling qualities of coatings (i.e. ice-phobicity) may reduce the risk of insulator flashovers. Ice-phobic coatings are also of interest for application to conductors and supporting structures in order to reduce mechanical loads due to ice accretion in winter periods. The application of super-

hydrophobic coatings to conductors may also have the potential to reduce audible noise, radio interference and corona loss on high voltage transmission lines. Before applying this new breed of coatings, utilities need to be confident in their performance and life expectancy. It is therefore vital to identify suitable test methods, which can be included in a functional specification, to qualify advanced coatings as part of the procurement process. Furthermore it is also important to consider all aspects of applying and maintaining the coating to ensure that its benefits outweigh the total life cycle costs and that the performance of the power system is not in any way placed at risk.

Working Group Activity in 2015 – Development of Technical Brochures

WG B2.40 Calculations of the electrical distances between live parts and obstacles for OHL: Preparatory studies for revision of IEC standard (IEC61865 –IEC60826 –EN50341)

WG 40 is reviewing the approach to electrical and mechanical loading combinations in the calculation of electric distances between live parts. Work on the final technical brochure progressed via a series of internet-based meetings in November, to discuss aspects of the TB and the questionnaire response analysis. Work is progressing well and it is hoped the final document can be submitted for review later in 2016.

WG B2.45 Bushfire characteristics and potential impacts on Overhead Line Performance

This study group reviews the characteristics of wild fires in varying vegetation types, terrain, and associated climatic influences, and the criteria for flashover to occur during fires in close proximity to overhead lines. The work of the group is largely complete and the draft document will be submitted to reviewers by mid 2016.

WG B2.52 The use of robotics in assessment and maintenance of OHL

In order to maintain or increase the reliability of aging OHLs, new robotic technologies are becoming available to assess and diagnose the condition of various OHL components. This WG is reviewing recent developments and will summarise the potential benefits of the increased use of robotics by utilities. It is anticipated that a draft document will be reviewed shortly which will allow final publication in 2016.

WG B2.53 Management guidelines for outsourcing OHTL technical expertise

This study will present guidelines on how to achieve the right balance between outsourcing vs. maintaining in-house technical expertise. In addition, the study will present some best practices for transferring in-house expertise to, and retention of, new engineers and field personnel that do not have an overhead transmission line background. The WG distributed a survey in May 2013. We received responses from 20 Asset Owners in 12 countries and 18 Service Providers in 6 countries. The WG is currently aiming to have the final publication of the TB and Electra report ready by the SC B2 meeting in Paris in 2016.

JWG C3/B2/B1.13 Environmental issues of high voltage transmission lines for rural and urban areas

The aim of this Joint Working Group of B2 and C3 is to create a reference document to enable transmission companies and others to understand how these issues are dealt with in other countries. The aim is to advance the work already done in previous CIGRE Technical Brochures, especially TB 147 and TB 50. Work is on-going and the overall aim is to have a draft TB ready for review by the Paris 2016 meeting.

Customer Advisory Group (CAG)

In the course of 2015, the CAG reviewed the following six new work proposals:

“Transmission line structures with fibre reinforced (FRP) composites”: new WG B2.61 formed

- ◆ “Design of compact HVDC Lines”: new WG B2.62 formed
- ◆ “Compact AC transmission lines”: new WG B2.63 formed
- ◆ “Inspection and testing of equipment and training for live-line work on overhead lines”: a new WG B2.64 formed
- ◆ “Detection, prevention and repair of sub-surface corrosion in overhead line structures”: new WG B2.65 formed
- ◆ “Safe handling and installation guide for HTLS conductors”: in development

Responses from the 2014 CAG survey continue to be analysed and new work proposals are being formulated based on the needs of the SC B2 target groups. CAG will issue notifications to all the survey responders informing them what is being done within SC B2 to address their needs.

Tutorials and conferences in 2015

In Krakow, three tutorials were presented: (1) Rating, uprating & reconductoring existing overhead lines; (2) Real-time monitoring & rating of overhead lines (TB498) and; (3) Optimal design of new transmission lines (WG51).

In Capetown, tutorials were presented on “Thermal rating and real time monitoring of overhead lines”, “Evaluation of 500kV High Surge Impedance Loading (HSIL) Transmission Lines Solutions concerning electric fields and line parameters”, “Dynamic effects on overhead transmission lines - impact on supports and foundations”, “Wind induced motion on bundle conductors (excluding galloping)”, “Remedial actions for repair of conductors and on “Safe design tensions for conductors fitted with elastomer cushioned suspension units.”

In addition, a general tutorial on “Overhead conductor motion phenomena and control methods” was presented at CIGRE Canada in Winnipeg, Manitoba, Canada and TB598, on “Guidelines for the management of risks associated with severe events and climate change on overhead lines” in Bucharest, Romania.

SC B2 was also active in 2015, through the following events:

- ◆ International Conference on Overhead Lines, 8–9 April, New Delhi, India (Conference Chair and tutorial)
- ◆ AORC-CIGRE Technical Meeting 2015, 16-21 August, Kota Kinabalu, Sabah, Malaysia (Keynote and two tutorials)
- ◆ DEMSEE 2015; 10th Jubilee International Conference on Deregulated Electricity Market Issues in South Eastern Europe, 24-25 September, Budapest, Hungary (Keynote)

More details (full list of Working Groups, terms of reference, strategic plan, list of publications, etc.) are available from <http://b2.cigre.org/> and www.cigre.org. ■