

## Overhead Lines

By Dr. Konstantin O. Papailiou, Chairman SCB2.

The main highlight for SC B2 in 2013 has been the Study Committee Meeting in Auckland/NZ in combination with a Symposium (together with SC A3) on "Best Practice in Transmission and Distribution in a Changing Environment". The extremely professional organized venue by the NC of New Zealand has been very well attended by 330 participants from 35 countries. 102 Papers have been presented in 21 sessions and numerous tutorials held.

Other highlights of SC B2 in 2013 are listed below:

- ◆ SC B2 counts 23 WG and 2 JWG with some 300 experts from 41 countries.
- ◆ Two Electra papers linked with Technical Brochures have been published.
- ◆ Six tutorials and one general presentation on SC B2 attracting 800+ participants have been held.
- ◆ The Cigre Reference Book on OHL is scheduled for publication and presentation at the 2014 Paris session.

In the last year there have been no significant changes in the organization which is still organized according to the following three strategic directions:

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

These strategic directions are linked with the following four key technical areas of expertise, which thus determine also the structure of SC B2:

- ◆ Electrical performance,
- ◆ Towers, insulators and foundations
- ◆ Conductors and fittings
- ◆ Asset management

The activities of SC B2 in these key technical areas are described in more detail in the following sections.

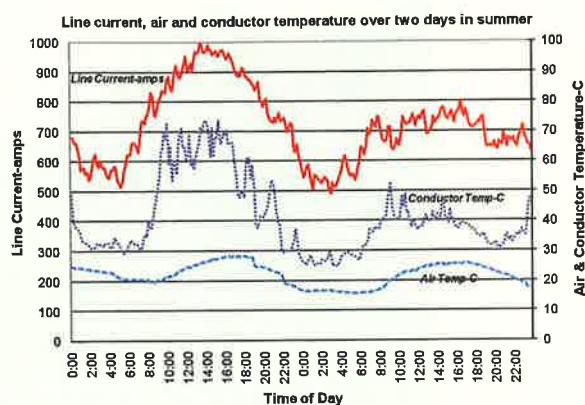
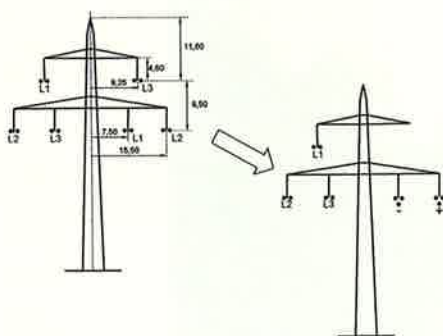
### Electrical Performance

As in previous years, the emphasis in the technical area of Electrical Performance concerns the improved design, analysis and utilization of new and existing overhead transmission lines. The main topics include modifications of existing lines to allow conversion from AC to DC, to raise thermal capacity and to increase surge impedance load limits. We continue to be concerned to improving existing analytical tools such as thermal rating and step potential calculations and to optimize the economic and power flow capabilities with new lines. To accomplish this wide spectrum of activities, a total of seven working groups are in various stages of activity.

**WG B2.38** "Evaluation of High Surge Impedance Load solutions for increased natural capacity of OHL" has completed an Electra article concerning use of expanded bundle spacing and other methods of increasing High Surge Impedance Loading (HSIL) of existing line. The article is to be published in 2014.

**WG B2.41** "Guide to the conversion of existing AC lines to DC operation" has completed their writing of a new technical brochure concerning the technical aspects of converting existing transmission lines from AC to DC. The brochure has been reviewed by the Study Committee and is to be published in 2014 as "Guide to the conversion of existing AC lines to DC operation". It considers the possibility of converting Double Circuit AC to an AC-DC hybrid configuration as shown.

**WG B2.42** "Guide to Operation of Conventional Conductor Systems above 100°C" has completed a draft of its new Guide to Operation of Conventional Conductor Systems above 100 °C intended to provide improved tools for



evaluating creep and annealing when pushing older lines to much higher than original design temperatures without reconductoring. This brochure will be presented to the SC for review in Paris.

**WG B2.43** is developing a “Guide for Thermal Rating Calculations for Overhead Lines with high temperatures and real-time weather & load data” which is a major revision of the existing TB 207 which includes new information on calculation of ac resistance, radial temperature drop and convection at low wind speeds and incorporates a numerical method for performing temperature and thermal rating calculations. As shown in the graph, the newly added numerical calculation method allows one to track the temperature of overhead line conductors during periods of varying weather and line current. This brochure will be presented to the SC for review prior to the Paris meeting.

**WG B2.51** “Methods for optimized design of overhead transmission lines” is studying methods for the optimized design of overhead transmission lines and will incorporate the results of a questionnaire on the topic. The goals of the WG are to study the relationship between structural/mechanical line components and the line’s electrical function for both AC and DC transmission. The resulting document can be used by utilities to optimize the design of lines.

**WG B2.55** “Conductors for the Upgrading of Existing Overhead Lines” is expanding existing technical brochure 244 on Line Upgrading to consider newer types of high temperature conductor, to reference recent Cigre technical brochures on sag-tension, ac resistance, and thermal rating calculations.

**WG B2.56** “Ground Potential Rise at Overhead AC Transmission Line Structures during Faults” is concerned mainly about the safety aspect due to “Ground Potential Rise at Overhead AC Transmission Line Structures during Faults” and is in the early stages of its work.

Tutorials have been presented in Bamberg, Germany in May, 2013 and in Auckland, New Zealand, in September, 2013, in Bamberg on Conversion of AC to DC (WG 41) and on Transmission Line Upgrading based on TB 244 as part of a half-day symposium hosted by three German utilities and in Auckland on High Temperature Conductors at the general meeting of the Cigre Symposium there.

## Towers, insulators and foundations

A new Technical Brochure entitled «Assessment of in-service composite insulators by using diagnostic tools» was issued in 2013. The summary was published in Electra No. 269, August 2013.

Two new brochures are expected to be available by the end of 2014:

- ◆ Dynamic Loading on Foundations by WG B2.23 “Geotechnical and structural design of the foundations of HV & UHV Lines, application to the updating to the refurbishment and upgrading”.
- ◆ Qualification of HV and UHV Overhead Line Supports Under Static and Dynamic Loads by WG B2.24.

One Working Group, WG B2.24 “Qualification of HV and UHV Overhead Line Supports Under Static and ...”



Dynamic Loads”, which aim is to review the performance of transmission line towers to all kind of dynamic loads, is under way, being expected to publish the relevant Technical Brochure by the end of 2014.

Four new TAG-05 Working Groups are under approval and are expected to be formed during 2014:

- ◆ Current Application Knowledge of Composite Insulators.
- ◆ Design of High Voltage OHL Supports using Carbon-Fiber Reinforced Polymer ( CFRP ).
- ◆ Detection, Prevention and Repair of Sub-surface Corrosion in Overhead Line Structures.
- ◆ Foundations Inspection Methods.

One tutorial/course was organized by the Bolivian National Committee of Cigre with the participation of TAG-05. It was held in Cochabamba, Bolivia, on 29th-31st of August 2013. Many SCB2 Technical Brochures recently published were discussed. The tutorial had the participation of about 180 attendees.

## Mechanical Behavior of Conductors and Fittings

This entity covers all aspects related to conductors and their fittings, such as fatigue and endurance capabilities, protection against wind induced vibrations and movement, assessment of new and aged fittings, updating and creation of standards and new equipment and service technologies.

**B2.46** “WG B2.46 Wind induced motion on bundle conductors (excluding ice galloping)” is dealing with the topic of experimental and field data on bundled conductors and comparison with analytical simulations for aeolian vibrations and subspan oscillations. The aim is to assist overhead line engineers to improve line protection by better being able to predict line behaviour with respect to bundle configuration. The WG has nearly completed its work and the results will be published in two separate Electra papers in 2014 that will cover aeolian vibrations and subspan oscillations respectively.

**B2.47** “Remedial actions for aged fittings and repair of conductors” addresses the topic of improving line reliability by reviewing the experience with conductor and conductor fitting systems, the different mode of failure of these systems and the best practice to restore the integrity of damaged conductors. A questionnaire was sent in 2012 and 39 replies have been received. 33% of utilities lack guidance on handling repairs. The WG is preparing a brochure that will be ready for publication at the end of 2014.

**B2.48** “WG B2.48 Experience with the mechanical performance of new conductor types” reviews experience with novel conductors and gathers all available data on the mechanical performance of the conductors not covered by the “Safe Design Tension” guidelines (Including high temperature conductors). This includes data on self-damping, fatigue performance as well as field experience. A technical brochure is in draft form and should be completed in 2015.

**B2.49** “Safe design tension for conductors fitted with elastomer cushioned suspension units” is dealing with the

topic of safe design tension for conductors fitted with elastomer cushioned suspension units with and without helical rods. In the first step literature, field test results and laboratory test results were collected within the WG and presented respectively analyzed. Lack of field data on elastomer suspension with dampers led to removal of this section. A technical brochure is in draft form and should be completed by the end of 2014.

**B2.50** "Safe handling of fittings and conductors" is working on the topic of the correct handling and installation of fittings and conductors, given that many problems experienced in the field are due to poor handling and installation practices. A guideline will be produced with the aim of promoting good practice to minimize handling and installation problems with fittings and conductors. A questionnaire was sent in 2012 and 73 replies have been received. A technical brochure is under preparation and should be completed in 2015.

Two new groups will begin their work in 2014:

*Coordination of transmission line surge arrester (TLSA) and vibration damper installations*

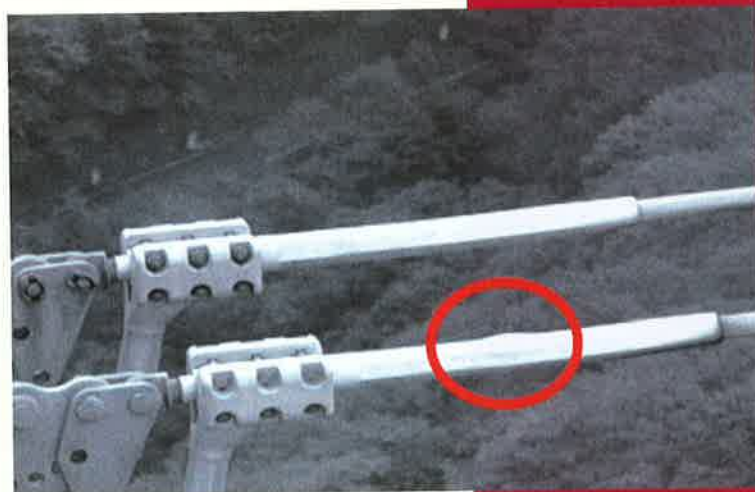
Most transmission line surge arrester (TLSA) installations are fitted after construction to improve lightning performance. Surge arresters are large, heavy and often placed outside vibration damper locations. The objective is to produce a guideline for application of dampers to retain vibration control for normal surge arresters applications.

*Modelling of the vibration behaviour of high-temperature/non-conventional conductors*

In order to perform adequate analytical simulations of aeolian vibrations on non conventional conductors, their characteristics must be known. Moreover, there is a lack of any data regarding the effect of temperature and temperature cycling on conductor self-damping and then on the conductor behavior to Aeolian vibrations for the HTLS conductors, both from conductor manufacturers and in literature. This WG will prepare a state of the art, collect data and preparer recommendations on this aspect.

The following tutorials and workshops have been held in this area in 2013:

- ◆ TF4 Safe design tension, March 2013, 2013 Colloquium of the HQ/RTE, 200 participants.
- ◆ WG49 High temperature conductors, June 2013, The electric energy society of Australia, 40 participants.
- ◆ Cigre International Symposium and Study Committee Meetings, 15-20 September 2013, Auckland, New Zealand
  - Symposium: Tower head design for galloping based on new Cigre criteria,
  - Tutorial: Engineering Guidelines Relating to Fatigue Endurance Capability of Conductor/Clamp Systems



## Asset Management, Reliability, Availability

The Working Groups involved under this technical area of expertise deal with a wide range of engineering topics, from electrical to civil, which impact on the reliability, availability and life cycle of overhead transmission lines.

The following WG's are scheduled to complete their work in 2014 and 2015:

**WG B2.28** "Meteorological data for assessing climatic loads. Update of IEC TR 61774": The theme of WG B2.28 shall be to compile and restructure updated meteorological knowledge for the purpose of application in international standards, paying particular attention wind turbulence in steep terrain, weather models and field observations of ice loads. Publication of the final report was put on a hold after the Paris session 2012 due to a debate about the then wet snow accretion model which appeared to be inconsistent with field data. New text has been produced and discussed based on a new model and this is now included in the WG28 report. The WG is currently working on the final editing as well as the Electra summary.

**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 is progressing via a series of internet based meetings in November to discuss aspects of the TB and the questionnaire response analysis. Further internet based meetings are planned for late February/March and the draft of TB is planned for mid-2014, with completion still planned for August 2014.

**WG B2.44** “Coatings for protecting overhead power network equipment in winter conditions”: This WG is examining techniques to protect transmission lines from ice and snow accretion through the use of active coatings, or passive coatings with superhydrophobic/icephobic properties, which can significantly reduce or even eliminate ice accretion. In addition, some of these coatings can also provide protection against corrosion, while others, characterized by high permittivity or conductivity, can considerably improve the electrical performance of insulators under icing, pollution or combination of both. The final draft of the TB will be discussed at a WG meeting in April 14 in Barcelona with aim of having it ready for review in Paris 2014.

**WG B2.45** “Bushfire characteristics and potential impacts on Overhead Line Performance”: This study group is to review 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.

**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. The WG is reviewing recent developments and will summarise the potential benefits of increased use of robotics by utilities.

**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 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 have received responses from 20 Asset Owners in 12 countries and 18 Service Providers from 6 countries. The WG has met 6 times since its formation including a meeting in Auckland. We plan to meet at least one more time before the Paris Session in 2014. We will ask for reviewers during the 2014 Paris Session and we plan to have the final publication of the TB and Electra report ready by the SC B2 meeting in 2015.

**WG B2.54** “Management of risk associated with severe climatic events and climate change on OHL”: This study group is to review the management of risk resulting from severe meteorological events; provide an overview of risk management techniques for the operation and management of overhead line assets; review the influence of aging and maintenance of overhead lines on reliability and their consequences in managing risk; review climate change impact trends; and review risk modelling techniques to assess the reliability of overhead lines. Contributions from 16 country delegates to our work since the 2012 Paris Session has been disappointingly limited, despite repeated follow-up. However, notwithstanding this, a draft Technical Brochure will be completed by end March 2014 and sent to reviewers appointed at the Auckland meeting in 2013. Following this review it is proposed to have the document available for the wider country delegate review in June/ July. Comments and final contributions to the draft TB would then be reviewed/edited and the TB submitted for approval of SCB2 Chairman around November 2014.

**JWG C3/B2/B1.13** “Environmental issues of high voltage transmission lines for rural and urban areas”: The aim of this Joint Working Group between 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 and to advance the work presented already in previous Cigre Technical Brochures, especially TB 147 and TB 50. Work is on-going and meetings have been held in both Dublin and Arnhem with a further meeting scheduled for London in early June. Overall target is to have a draft TB ready for review by the Paris 2014 meeting.

## Publications

In 2013 SC B2 has published two Technical Brochures and the related Electra papers:

1 - Electra #269, TB #545 - August 2013	Assessment of in-service Composite Insulators by using Diagnostic Tools (WG B2.21)
2 - Electra #271, TB #561 - December 2013	Live Work – A Management Perspective (JWG B2.B3.27)

## Customer Advisory Group (CAG)

A new survey of the Study Committee B2 Target Groups was issued to all Country Representatives on February 2014. The survey is expected to be forwarded to representatives of all target groups, including:

- ◆ Upper management,
- ◆ Designers,
- ◆ Planners,
- ◆ System operators,
- ◆ Maintainers,
- ◆ Consultants,
- ◆ Suppliers, and
- ◆ Sciences and education group members.

Survey responses will be considered in creating new work groups, development of new technical publications and improvement of services to all Target Groups. CAG will analyse responses to the 2014 Target Group Survey and will present the results at the SC B2 Technical Meeting during 2014 Paris Session. Recommendations will be made to:

- Help create new work groups,
- Develop new technical publications, and
- Improve quality of services to all Target Groups.

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

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