



**2008 SC B1 PROGRESS REPORT
(INSULATED CABLES)**

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February 2009
Rev March 2010

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1 Overview

The main highlights of 2008 are:

- The disband of two B1 Working Groups (WG) at the foreseen deadline after publishing important technical brochures "Earth potential rises in specially bonded screen systems" and "Remaining life management of existing HV AC underground lines". In addition, a Joint Working Group (JWG) with B3 was also disbanded after publishing a technical brochure on "Application of long high capacity GIL in structures".
- Four new WG were launched in Paris 2008 B1 meeting and 2 *ad hoc* Task Forces whose work is to discuss whether or not to install a full WG to address on this topic.
- 200 experts are participating in B1 work.
- The 42nd CIGRE Session with a SC B1 discussion meeting with around 200 to 270 people attending the meeting. 43 prepared and app 47 spontaneous contributions were presented, referring to 11 questions as proposed by the Special Reporter, Gunnar Evenset (NO). The organisation and the quality of the contributions made it a very active and lively forum of international experts,
- For the first time, SC B1 held a Poster Session during this event. As it was successful, it is planned to repeat it in 2010.
- An important effort was made on the preparation of tutorials. Their quality and number are high.
- An important renewal of the SC Members. 12 Regular Members (out of 24) and two Observer Members (out of 8) were renewed.
- The cooperation with IEC TC20, Jicable and IEEE/ICC continued to be good

2 SC organisation

The activities of CIGRE Study Committee B1 concern all types of AC and DC insulated cable systems for land and submarine power connections and are focused mainly on high voltage applications. Whenever appropriate, however, lower voltage applications are also considered.

Within this field, the scope of work of the Study Committee covers theory, design, applications, manufacture, installation, testing, operation, maintenance and diagnostic techniques.

The main goals of the SC B1 are the following:

- to contribute effectively to the progress in insulated cable systems technology,
- to facilitate the integration of insulated cable systems in electric power networks and in the environment, covering the complete life cycle of cables,
- to maintain its leading position in the field of power cables by providing unbiased and neutral information on all essential cable aspects,
- to be recognised by the Electric Power Industry as a leading and reliable partner with competence in all engineering issues related to insulated cable systems, i.e. technical, economical, ecological and social,
- to monitor and assess current trends in cable technology,
- to promote advancements in cable technology.

The basic operating structures of the SC are its Working Groups. Their effective performances are based on a clear definition of their terms of reference and on work plans with specific time limits (typically three years).

In order to achieve this, it is the normal practice of SC B1 to set up a Task Force (TF) to define the terms of reference of a new WG prior to its establishment. The duration of this type of TF must not exceed one year.

The SC is presently composed by 24 Regular Members, 8 Observer Members, a Secretary and a Chairman, 14 coming from Manufacturers, 12 from Utilities, 3 from Consultants and 5 from Universities/Institutes.

The SC B1 has its web site at the following address: www.cigre-b1.org. The SC Secretary is also the web master.

3 Publications

Published in 2008

WG/TF number	Name of the Publication	Publication date	Electra issue and number of TB
WG B1.26	Earth potential rises in specially bonded screen systems	June 2008	Electra 238 TB 347
WG B1.09	Remaining life management of existing HV AC underground lines	October 2008	Electra 240 TB 358
JWG B3/B1.09	Application of long high capacity GIL in structures	October 2008	Electra 240 TB 351

To come

WG/TF number	Name of the Publication	Publication date	Publication type
WG B1.08	Cable systems in multipurpose or shared structures	2009	Electra TB
WG B1.10	Update of Service experience on underground and submarine cables	2009	Electra TB
WG B1.11	Upgrading and uprating of existing cable systems	2009	Electra TB
WG B1.21	Third party damages on underground and submarine cables	2009	Electra TB

TB : Technical brochure

4 2008 main events

As usual, CIGRE held a Session on August 25 – 29 in Paris. The SC B1 Discussion Group Meeting was held on Wednesday, August 27th, 2008 during which 22 accepted papers were discussed.

Some trends:

- In many ways the development of cable and accessories is incremental, and much of it is related to materials and manufacturing processes. When it comes to submarine three-core AC cables, the development trend is clearly towards higher voltage and longer lengths. There are now three-core XLPE 150 kV cable systems in operation, with cross-sections under 1,000 mm². A cable system that will become operational shortly consists of three-core 240 kV, with cross-sections of 500 mm².
- It is getting more frequent to replace parts of older cable systems (that often are oil cables), with XLPE cable systems. In doing this, reliable transition joints need to be made.

- There are today 320 kV and 500 kV DC cable systems qualified in laboratories, allowing power transmission of some 2,800 MW. The highest rating of extruded DC cable systems installed and in operation, is presently 350 MW at 150 kV.
- Although the experience of PD measurements at site is slowly getting greater, it seems to be the general opinion that there is a need for guidelines, and possibly standardisation of test set-ups.
- EMF mitigation techniques is of increasing interest. Methods to reduce the EMF from power cable links were discussed.

5 2009 main events

The 2009 SC B1 meeting will be hosted for the first time by Poland. It will be held in Poznan on September 22 – 24 and SC B1 will offer a tutorial to polish experts.

SC B1 will also contribute to two CIGRE Colloquia: "Power Frequency Electromagnetic Fields" to be held in Sarajevo (BA) on June 03 – 04 and "Northern European experiences and future needs of HVDC & FACTS applications" to be held in Bergen (NO) on June 10 – 12.

6 2010 main events

The Preferential Subjects that will be discussed during the 2010 CIGRE Session on August 26 are:

PS1 : Technical challenges that have been overcome in newly installed underground and submarine cable systems

- Current state-of-the-art in the design of AC and DC submarine and underground traditional cable systems.
- Current state-of-the-art in cable systems installation techniques.
- Experiences of operation of cable systems.

PS2 : Key factors in current and foreseen development of cable systems

- Environmental impact.
- Balancing capital costs (including costs for Right of Ways) vs operational costs (including costs for operation and maintenance, social costs, losses, dismantling, etc).
- Prospects of UHV cable systems.

PS3 : State-of-the-art and trends for cable system testing

- Qualification, type testing, routine, sample, after installation testing of cable systems.
- Representation of installation and operational stresses in testing of cable systems
- Diagnostic testing of cable systems.

7 Administrative report

7.1 SC Meeting

Four WGs, three preparatory TFs finished their work. Each WG kept an editorial team to finalise its documents to be published as Technical Brochure and Executive summary in Electra. Then, they will be officially disbanded.

- **WG B1.08** "*Cable systems in multipurpose or shared structures*" to be published as a technical brochure ; an executive summary will be inserted in Electra in the second half of 2009,
- **WG B1.10** "*Update of Service experience on underground and submarine cables*" to be published as a technical brochure ; an executive summary will be inserted in Electra by mid 2009
- **WG B1.11** "*Upgrading and uprating of existing cable systems*", finished its work last year but faced difficulties to finalize its final report. It will be published as a technical brochure ; an executive summary will be inserted in Electra during the last 2009 quarter,
- **WG B1.21** "*Third party damages on underground and submarine cables*", to be published as a technical brochure ; an executive summary will be inserted in Electra in the second half of 2009,

- **TF B1.28** "*On-site Partial Discharge Assessment of HV and EHV cable systems*". The work of TF B1.28 launched last year was to consider whether a full working group was desirable on this issue,
- **TF B1.29** "*Guidelines for maintaining the integrity of XLPE transmission cable accessories*". The work of TF B1.29 launched last year was to consider whether a full working group was desirable on this issue,
- **TF B1.30** "*Review of Cable Systems Electrical Characteristics*". The work of TF B1.29 launched last year was to consider whether a full working group was desirable on this issue,

One WG saw its lifetime duration extended for one more year.

- **WG B1.22** "*Cable accessories workmanship*", the final report being now expected in 2009,

In 2008, SC B1 launched four new Working Groups and two preparatory Task Forces:

- **WG B1.28** "*On-site Partial Discharge Assessment of HV and EHV cable systems*" which term of office is 2011,
- **WG B1.29** "*Guidelines for maintaining the integrity of XLPE transmission cable accessories*" which term of office is 2011,
- **WG B1.30** "*Review of Cable Systems Electrical Characteristics*" which term of office is 2011,
- **WG B1.32** "*Recommendations for testing DC extruded cable systems for power transmission at a rated voltage up to 500 kV*" which term of office is 2011,
- **TF B1.31** "*Testing of superconducting cable systems*" which term of office is 2009,
- **JTF B1.33** "*Feasibility of a common, dry type interface for GIS and Power cables of 52 kV and above*" which term of office is 2009,

SC B1 currently has three Advisory Groups, thirteen WGs and two TFs and participates in one JTF with another organization.

7.2 TC Award

Susumu Sakuma (JP) and Gunnar Evenset (NO) were honoured with the CIGRE Technical Committee Award 2008 for their contribution to the work of the Study Committee.

7.3 Web site

The new SC B1 web site is on line since June 15, 2005 (www.cigre-b1.org). It offers an open space to the public and private pages to SC Members. Each Working body has private pages where documents can be exchanged among members.

The number of visits confirms that Internet is a very important tool for internal and external communication.

8 Technical report

8.1 Advisory Groups

8.1.1 Strategic Advisory Group

Convener: Fredrik Rüter (Sweden)

A permanent Strategic Advisory Group (SAG) was set up in 2002, which terms of reference are to assist the Chairman in the definition of the strategic directions that should be followed by SC B1.

The SAG is composed of a limited number of members: the Chairman, who will convene, the SC Secretary, and a few other SC Members or experts, all chosen by the Chairman.

The Conveners of the other SC B1 Advisory Groups are permanent members of the SAG.

The SAG will consider, if needed, the set up of other specialized Advisory Groups and will decide about the use of their outcomes.

The SAG will initiate, whenever appropriate, the set up of new TFs or WGs.

The SAG will meet at least once a year, but will communicate as required.

All the items discussed during the 2008 SAG meeting were covered in the 2008 SC B1 meeting agenda.

8.1.2 Customer Advisory Group

Convener: Eugene Bergin (Ireland)

A permanent Customer Advisory Group was installed in SC B1 with the Scope to implement CIGRE TC's suggestion, that "Study Committees have to ensure that the needs of their Target Groups are fulfilled." The B1-CAG is the working body within SC B1 to co-ordinate all activities in this field. It works in close contact with the SC Chairman and the Strategic Advisory Group B1-SAG and involves all SC B1 members as contacts and interfaces to their national or local customers.

The Terms of Reference (ToR) of the B1-CAG are as follows:

1. Identification of Target Group
 - systematically identify SC B1's Target Groups in different countries
 - listing of respective organizations, persons, social groups, etc.
 - analyzing of organizational levels and hierarchies
 - identifying of most important and influential addressees
2. Communication means with TGs
 - develop systematic and effective concepts for active contacts and communication
 - consider how to implement sustainable communication links to organizations and persons
 - consider how to disseminate most effectively B1's activities and outcomes to TGs
 - propose appropriate presentations (Paris Session, Tutorials, Symposia, etc.) in accordance with the TAG
3. Collection and mapping of TG's needs
 - identify problems and map systematically needs of TGs
 - propose review/revision of current SC B1 activities with regard to needs of TGs
4. Collection and evaluation of feed-back from TGs
 - collect and map the degree of TG's satisfaction
 - evaluate the findings and derive, if necessary, measures for improvements and new actions
 - identify opportunities to increase TG's satisfaction
 - coordinate activities at national level where appropriate

This Advisory Group is a difficult one as there is not a CAG in each SC and each of them does not have the same target groups. Nevertheless, it is important to collect their needs and to feed them back with our reports. The principle for their representation is to have one representative per continent or sub-continent.

It is of evidence that a SC could not communicate directly to all the target groups and should preferentially do it through the CIGRE National Committees.

Since the last SC meeting, CAG produced a flyer to introduce the White Book (list of all SC B1 publications) and a letter towards target groups. CAG prepared a new questionnaire for the 2008 Session and will collate in the future all approved CIGRE documents regarding cables and classify them under headings

8.1.3 Tutorial Advisory Group

Convener: Pierre Argaut (France)

A permanent Tutorial Advisory Group was installed in 2004 in SC B1 with the Scope to implement CIGRE TC's suggestion, that "Study Committees have to deal with education, continuous training, tutorials and publications". The B1-TAG is the working body within SC B1 to co-ordinate all activities in this field. It works in close contact with the EPEE, the SC Chairman, the Strategic Advisory Group B1-SAG and the Customer Advisory Group B1-CAG. It involves all SC B1 Members and Conveners as contacts.

The Terms of Reference (ToR) of the B1-TAG are as follows:

1. Identification of the potential groups interested in education, continuous training, tutorials or technical presentations

- identify SC B1's Tutorial Target Groups in different countries,
 - listing of respective organisations: students, young or older engineers, universities, etc...,
 - identification of the respective expected topics to be taught and training levels,
 - identification of other learned societies, IEE, IEEE,....
2. Identification of the means to disseminate the SC B1 knowledge
 - prepare the structure of appropriate presentations (Paris Session, Tutorials, Symposia, events organised by other learned societies, etc.) in accordance with the CAG
 3. Collection of SC presentations
 - establish an education and training procedure
 - preparation of a standard presentation,
 - each SC working body will prepare a full presentation (up to 30 slides),
 - the TAG will prepare a synthetic presentation (up to 4 slides)
 4. Coordination of activities with EPEE and with other SCs

To compensate the lack of expertise, one solution is to propose technical education and training through tutorials that could be addressed from basic to advanced experts, from students and teachers to managers and public.

The TAG proposed a common tutorial structure that could be easily managed according to the depth needed by the public.

Each current and new WG will have in its terms of reference the production of a tutorial. For the past WGs, some SC B1 experts are preparing the relevant tutorials.

By the end of 2008, the list of validated tutorials is:

- Thermal Environment of Underground Links
- Thermal Monitoring of Underground Cables
- Dynamic Rating of Underground Cables
- Environmental Impact Assessment
- Technical and Environmental Issues regarding the integration of a new cable system in the Network
- Special Bonding of High Voltage Power Cables
- Large Cross-sections design
- Composite Screens design
- Maintenance for HV Cables and Accessories
- Accessories for HV / EHV Extruded Cables
- Earth Potential Rises
- Lightning Impulse Transients on Long Cables
- Up-Dating of Service Experience of HV Underground and Submarine Cable Systems
- Remaining Life Management and Replacement Program for HV Cables

Tutorials can be offered by SC B1 Members or experts on demand.

8.2 Working Groups

8.2.1 WG B1.08 Cables systems in multipurpose or shared structures

Past Convener: Ken Barber (Australia), Present Convener: Ray Awad (Canada)

WG B1.08 was set up in 2004 and was due to present its final report in 2007. After a last year of hard work, the WG presented the final report which received very good feedback from the SC Members.

The terms of reference were the following:

- To establish the appropriate terminology,
- To collect comprehensive information and experience on the use of multipurpose or shared structures for the installation of cable systems. It is anticipated that a comprehensive questionnaire developed by the WG will be necessary. The survey should not be limited to technical aspects such as type of cables, structure design, construction, installation, other infrastructure installed, mutual impacts, maintenance and operational constraints. It should also

consider economical aspects, occupational health and safety aspects, administrative aspects, legal aspects and decision-making aspects,

- To collate, summarise and review the information,
- To identify the issues that need to be considered when installing underground cable systems in multipurpose or shared structures,
- To recommend guidelines for the practical application of for the installation of cables.

The scope of work should cover:

- MV, HV, and EHV cables,
- Solid, fluid and gas insulated cables,
- Multi-purpose tunnels and structures shared with pipe services (water including hot or cooled, oil, gas and sewage) and other utilities (other electricity services and telecommunications), Transport services (Roads, Railways and Subways).

There is a low probability of fault on cables installed in tunnels but when it occurred, the impact is high, justifying such a group.

The change of Convener from Ken Barber (AU) to Ray Awad (CA) occurred in 2008.

A shared structure "Any continuous structure containing one or more utility services which permits the replacement, renewal, maintenance, repair or revision of the service without the necessity of making excavation" implies the structure is traversable by people and in some cases by some sort of technology.

The cable installation and engineering problems are similar whether the structure is shared or not and the compatibility of services important but not critical.

The most difficult point raised was how to manage the security when the legislation and/or the structure owners change.

The report should be published as a Technical brochure in 2009.

8.2.2 WG B1.10 Update of Service Experience of HV cable systems

Convener: Robert Rosevear (United Kingdom)

WG B1.10 was set up in 2004 and was due to present its final report in 2007. Due to late responses to the questionnaires, the Chairman agreed on a one year extension. The final report was presented in 2008.

The SAG identified service experience as a topic which was not addressed since long, as the last figures published by CIGRE regarding underground cables dealt with the experience gained between 1982 and 1986, those regarding accessories for HV cables with extruded insulation dealing with the experience gained up to 1992 and the last figures regarding submarine cables being published in 1986.

The terms of reference are:

To update up to 2003 existing service experience and previously published information studying at least:

- Technology,
- Laying zone (urban, rural, submarine,...),
- Type of current (AC, DC),
- Internal or external faults,
- Type of cable burial, (protection or not)
- Number of faults per year per mileage,
- Fault duration,
- Repair duration.

It was possible to collect information up to the end of 2005.

Scope of work :

- The voltage range will be above 50 kV limited to transmission levels according to the countries.
- AC and DC cables,

- Land and submarine cables.

The WG Convener said that this report was important as the cable community was without service experience figures since 15 years. He considered that the data was collected on a reasonable population of cables leading to representative statistics. Fault rates have been calculated and trends associated with changes in technologies identified.

The Convener said that the registered failure rates were higher in the range 220-500 kV than in the range 60-219 kV. Was it the real life or is it only because the data is better collected ?

The report should be published as a Technical brochure in 2009.

8.2.3 WG B1.11 Upgrading and Upgrading of Underground Cable Systems

Convener: Frederic Lesur (France)

WG B1.11 was set up in 2004 and was due to present its final report in 2007. At that time, some items were missing. Most of them are completed, but the report was not fully finalized at the time of the 2008 meeting. It was asked to speed up to publish the report in 2009.

The difficulties to obtain planning permission for new sites favour the life extension of existing facilities, with the goal of transmitting more power with higher reliability.

The terms of reference are:

- To review the literature on similar subjects (IEC, CIGRE, IEEE publication),
- To establish the appropriate terminology,
- To inventory the possible technical solutions for increasing the transmitted power in an existing cable system, or extending the life duration of the cable system
- To gather available utility experience in such cases,
- To list the technical and environmental issues to be addressed in such cases,
- To propose a step by step approach.

Scope of work :

- AC and DC cables
- Extruded and lapped cables
- Land and submarine cables
- Cooling systems.

The study will be limited to whole cable systems, not considering the components themselves.

The Convener presented the final report which was considered of good value. Some concerns were raised as upgrade may lead to legal problems. A great warning is awaited at the beginning of the report.

The report should be published as a Technical brochure in 2009.

8.2.4 WG B1.21 Third party damages on underground and submarine cables

Convener: Christian Jensen (Denmark)

WG B1.21 was set up in 2005 and presented its final report on schedule in 2008.

Utilities are already suffering for a long time from third party damages, the damages caused to cables from so-called external origins: usually digging activities but also indirect aggression such as overheating, corrosion or change of backfill due to other utilities. Compared with the efforts to solve "internal" damage, issues are usually treated in an off-hand or unmanaged way, although in terms of money it is a very serious problem.

The terms of reference are:

To give guidance to all relevant parties involved (cable owners, utilities dealing with electricity, contractors, authorities, other utilities) as follows:

- To define the right terminology.
- To collect information worldwide about third party damage failure statistics. To collect information about main “damagers”, the most sensitive areas and the most “dangerous” civil works techniques.
- To collect information about existing practices to control/solve the problem in different countries around the world.
- To propose improvements to present methods, after examination and comparison of present methods/practices.
- To propose guidelines on how to effectively control/reduce third party damages of cables.

Scope of work :

- AC and DC cables.
- Land and submarine cables.
- MV (whenever appropriate), HV and EHV.
- Mechanical, thermal damages and, more generally, all damages caused by human activities.

The Convener, Christian Jensen (DK), presented the WG final report.

The replies to the questionnaire were not at the expected level and were only used as an indication as they did not give enough information to know whether it is better to choose ducts or direct burial as the preferential laying technique as third party damages are concerned.

Then, the Convener introduced the methods to limit the third party damages and the "criticality matrix" combining the probability of an aggression with the severity of the effects and the consequence on the network.

The SC members found the report of very good value. Nevertheless, they expressed some comments that will be discussed within the group before the report could be published.

As both WG B1.10 and WG B1.21 will present statistics on service experience, they were asked to coordinate.

The report should be published as a Technical brochure in 2009.

8.2.5 WG B1.22 Cable accessories workmanship

Convener: Kieron Leeburn (South Africa)

WG B1.22 was set up in 2005 and was due to present its final report in 2008. The Convener said that the WG was not able to present the final report as initially requested in the Terms of Reference and asked for a one year extension. Even if the Chairman was not happy with the WG progress, he agreed on the one year extension and strongly required the final report being ready by end of June 2009.

One of the trends in the cable technology is the reduction of the cable insulation thickness and therefore the growing of electrical stress based on a better knowledge of the insulating material and the extrusion process. As the cables are made under well-defined factory conditions, their quality and reliability are usually assured. Accessories, however, are mounted on site, and even if this job is done by skilled and trained jointers, it is realized in more delicate and undefined conditions than in the factory.

In view of safeguarding the cable system's reliability which utilities rely on, it is important to study the electrical stress limits in the different types of joints, to learn about the safety margins between theoretical and practical strength levels, to examine the necessary skills of jointers and relative Quality Assurance and to study the recent service experience of high stressed cables.

The terms of reference are:

- To review the literature on the subject
- To complete the terminology not covered by TB 177 "Accessories for HV cables with extruded insulation"

- To prepare an easy to understand guide that could be useful for non-technical customers aligned to IEC voltage ranges
- To prepare guidelines for jointers training. The objective is to have this document referenced in call for tenders

Scope :

- HV Extruded AC >30kV cable systems only (MV and HTS cables are excluded)
- Land and Submarine cable systems
- Special considerations may be needed for large conductors
- Types of joints and terminations
- Interface preparation (Different methods)

It was agreed during the SC to reword the terms of reference of the WG by changing "type of joints" by "accessory designs".

Moreover, it was considered that the experts' skills were not sufficient to cover the submarine cables. It was agreed to delete these types of cable systems from the ToR and validated by the TC Chairman.

One important point is presently considered whether the necessary skills to prepare an accessory were voltage dependant or section dependant.

8.2.6 WG B1.23 Impact of EMF on current ratings and cable systems

Convener: Harry Orton (Canada)

WG B1.23 was set up in 2006 and is due to present its final report in 2009.

Numerous methods have been devised by electric utilities and various research organizations to manage power frequency magnetic field levels in the vicinity of underground cable systems. Although information will be available (ongoing work TF C4.2.04) concerning considerations for implementing the various methods, their impact on construction, their cost effectiveness, and their impact on cable ratings needs to be evaluated. In particular, there are differing opinions about the derating effects of transmission cables placed in ferromagnetic shielding structures such as pipes and casings. Past work at CIGRE and elsewhere addressed magnetic field calculation procedures (with and without ferromagnetic components), however, they do not address the derating impact of the magnetic field management methods or their practical application to electric utility systems.

Terms of Reference:

- To define the correct terminology for field management techniques.
- To review practical magnetic field management methods that are currently used for underground transmission cable systems.
- To quantify the shielding effectiveness of practical methods.
- To review practical design and construction considerations relating to engineering, standardization of components, scalability, constructability, environmental suitability of component materials, impact by third party damage, reduction of rating due to air inclusions, corrosion, theft of materials, logistics, and worker skill level.
- To review the cost effectiveness of different field management methods.
- To quantify the cable ampacity de-rating aspects of the various field management methods

This working group will neither cover any environmental or biological effects of EMF, nor discuss any specific levels of EMF.

Scope of work :

The work shall focus on single conductor, high voltage, AC land cable systems, excluding pipe type cables with :

- Extruded dielectric insulation
- Lamina dielectric insulation

Health affects will only be covered very briefly as this is not within the Working Group Scope. Since there is no electrical field external to an underground transmission cable, the Working Group will focus on magnetic field mitigation techniques, their effects on cable ratings and their related costs.

De-rating of cables due to magnetic field mitigation must be based upon existing standards and regulations. Reference will not be given to magnetic field absolute values, but only to the shielding factors required to mitigate the field.

Investigation of commercially available software to determine magnetic field levels for specific mitigation designs will be included in the study.

It was confirmed that the pipe type cables will be excluded from the scope of work as the EMF level is low for this cable technique.

The Convener informed that the progress of the WG was satisfactory. The WG should normally be on time even there is still a lot of work to do.

The activities during this last year were mainly about existing and recent shielding cases and all the information collected with these experiences.

8.2.7 WG B1.24 Test procedures for HV transition joints

Convener: Marco Marelli (Italy)

WG B1.24 was set up in 2006 and is due to present its final report in 2009.

Extruded cable is increasingly being used for transmission and distribution circuits in preference to cables with lapped insulation. It is becoming more common for a length of extruded cable to be introduced into a lapped cable circuit, when the latter is repaired or diverted. International cable specifications are generally written to cover a specific insulation technology e.g. IEC 60840 applies to cables with extruded insulation and their accessories. Applications that involve cables with more than one insulation system are not usually considered. The test regimes differ between lapped paper and extruded polymeric insulation ; for example an AC after laying test might be used with extruded cable and a DC test with paper cable.

Terms of Reference:

- To review the range of transition joints currently available
- To review the existing international standards and the extent to which they cover the testing of transition joints
- Align voltage levels to those specified in IEC Standards for extruded cable systems
- To propose test regimes for transition joints and their associated cables. Type, routine, sample and after-laying tests should be considered.

Scope of work :

The WG should take into account AC cables and accessories for rated voltages above 30 kV up to 500 kV. Transition joints in submarine or DC cable systems are not considered. Priority should be given to jointing paper cables with extruded cables, in particular SCFF cables with XLPE cables.

All forms of testing should be considered. Priority shall be given to after-laying and type tests.

The Convener was satisfied with the progress of his group and considered that the report will be delivered in due time.

The SC agreed to consider a transition joint as a joint between two different insulations. Joints connecting cables having the same type of insulation, even if involving different conductor size/material and/or different core dimensions (asymmetric joints) are covered by respective Standards.

The WG considered that transition joints are supposed to have a low-volume market, thus will propose to limit the factory tests to the routine ones and the severity of the test regimes to avoid any constraint on future developments. The type tests will mainly be based on IEC standards for extruded cables, the after laying tests shall be sufficiently severe to prove the integrity of the new (part of the) extruded system, without damaging an existing (old) lapped system.

8.2.8 WG B1.25 Advanced design of laminated metallic coverings

Convener: Pierre Mirebeau (France)

WG B1.25 was set up in 2006 and is due to present its final report in 2009.

WG 21.14 published in 1992 "Guidelines for tests on high voltage cables with extruded insulation and laminated protective coverings". Numerous improvements appeared on laminated coverings since then in parallel with field experience. We now have a feed back relative to their use as a function of the length to be laid, the installation method (ducts, directly buried...), the environment, the design of the metallic screen (aluminium, copper wire screen + aluminium, copper...), the connection and grounding of the screen (single point, cross bonding, double point)...

In parallel, new processes and new installation methods have appeared.

Terms of Reference:

- To review and update the tests on cables with extruded insulation and laminated protective coverings taking into account the system view, i.e. the installation of accessories. Tests on cable, on accessories and on the system itself should be addressed, including the short circuit one
- To issue a Guide to Use for non experts explaining what could be the different cable designs

Scope of work :

- Extruded cable systems only
- AC cable systems only with a focus above 36 kV
- Land cables

The SC confirmed the definition of a laminate covering which consists of several layers of plain (not corrugated) metal and plastic materials bonded together to get a special set of properties: bending ability, radial watertightness. It can be used to carry the capacitive, circulation and short circuit currents, according to the cable system design.

A questionnaire was circulated and received a good response.

When comparing the IEC standards and the work done so far, the WG saw that some tests such as the spike test, the moisture penetration test, the screen contact resistance test and the extended thermal cycles test are not used and could probably be removed. This will be further considered before being proposed.

The Chairman was happy as the WG was on time

8.2.9 WG B1.27 Test recommendations on XLPE AC submarine cables from 170 kV to 500 kV

Convener: Anders Gustafsson (Sweden)

WG B1.27 was set up in 2007 and is due to present its final report in 2010.

For a long time the prevailing highest voltage for XLPE submarine AC cables was 170 kV. A recent submarine installation of single-core XLPE AC cables at 420 kV has moved the technology forward significantly. The existing Recommendations on AC submarine cables are presently limited to 170 kV.

It is considered necessary to prepare test recommendations on XLPE AC submarine cables from 170 kV to 500 kV.

Terms of Reference:

- Examination of relevant IEC standards / CIGRE recommendations and documentation.
- The work should adopt a system approach. Particular attention should be paid to repair joints as part of the sub-marine cable system and the Working Group should consider tests with external water pressure, heat cycling and mechanical handling (during installation of a repair joint).
- The work should propose development and prequalification tests for the EHV submarine cable system and re-qualification in case of minor or major changes and define the range of prequalification and type approval for EHV submarine cable systems.
- The work should propose tests for long submarine cable lengths - both in the factory and after installation and explain clearly the basis for the recommended tests and the range of application.
- The work should include a review of the currently available technologies for sub-marine cable and joint design and consider possible implications for testing
- A Technical Brochure should be prepared for publication

A recommendation should be prepared to Cigré B1 on the revision of "Recommendations for testing of long AC submarine cables with extruded insulation for system voltage above 30 (36) to 150 (170) kV". This review should be performed based on the new edition of IEC 60840.

Two questions were raised to the SC:

- Should transition joints from submarine to land cables be included in the test recommendation?
- Should the recommendation regarding the update of Electra 189 (<170 kV) be included in the TB (or elsewhere)?

To the first question, the answer was positive and regarding the second one, it was decided that the update of Electra 189 should be done separately from the final WG report.

The Convener added that the TB will be organized as the previous document Electra 189, with some additional chapters.

The Chairman was happy with the WG progress.

8.2.10 WG B1.28 On-site Partial Discharge Assessment of HV and EHV cable systems

Convener: Nigel Hampton (USA)

WG B1.28 was set up in 2008 and is due to present its final report in 2011.

Cable Systems undergo various steps in testing, specifically tests after installation. To provide additional information after installation, on-site pd measurements may be undertaken. Such measurements under field conditions may be complicated to perform, and complex to analyse, but can provide valuable data on the quality of the cable installation. There is a significant interest from the owners of using these techniques both for verifying the sound installation, but also for the purpose of diagnostic testing during the life of the cable system. The work of this WG, that has the strong support of IEC TC 20, will fill the need of widely accepted guidelines.

Terms of Reference:

The work should be limited to HV and EHV extruded AC cables, but addressing both commissioning and diagnostic testing,

The WG shall:

- collect experience with PD testing, with respect to methods/equipment and results
- evaluate the added value of the PD testing at site for commissioning and diagnostic testing
- evaluate the applied technology, taking into account what previous CIGRE and ICC WG's have done so far
- recommend the protocol, to validate the on-site measurement results (calibration, sensitivity assessment)
- recommend guidelines for PD test procedures at site (voltage level, measuring time, measuring conditions)
- identify widely acceptable requirements for commissioning and diagnostic testing

8.2.11 WG B1.29 Guidelines for maintaining the integrity of XLPE transmission cable accessories

Convener: Steve Swingler (UK)

The work is motivated by the occurrence of disruptive failures of cable end terminations, with consequent risks for personal and material loss and damage.

Terms of Reference:

The scope shall be limited to land XLPE cable systems at 110 kV and above. Priority shall be given to outdoor and oil-immersed terminations, but also joints (that are not directly buried) shall be considered.

The work shall concentrate on recent incidents, but near misses shall also be included in the analysis.

The WG shall:

- Review recent experience with failures of outdoor and oil-filled terminations
- Review the consequences of termination failures for cables within substations and outside.
- Examine the role of design, assembly and quality control in mitigating the effects of termination failures
- Examine the role of testing (development, type, routine & after-laying) and condition monitoring in minimising the incidence or severity of termination failures
- At the SC B1 meeting in 2010, the WG shall provide recommendations on possible extensions of work into joints (not directly buried), and accessories for oil-filled cable.

8.2.12 WG B1.30 Review of Cable Systems Electrical Characteristics

Convener: Christian Royer (Canada)

It is now well known that underground transmission cables have significantly different electrical characteristics than overhead lines, and that these differences must be taken into account during cable system planning, design, and operation.

For all these topics, reliable input data are necessary and therefore accurate impedance calculations are of the highest importance. This is not always easy to achieve.

In-depth analysis of the topics related to cable integration in network may require sophisticated calculation computer programs and a detailed and reliable knowledge of the components and system characteristics at any time.

Terms of Reference:

- To prepare proper definitions for "Cable Characteristics"
- To list relevant cable systems types: cable construction, configuration of installation, bonding
- To list the information to be collected for each cable system study
- To review relevant formulae existing in literature
- To identify relevant missing formulae when necessary
- To establish if possible these formulae or propose alternate methodology
- If possible, to collect and analyse case studies

Scope of work :

- Paper cable systems (SCFF and HPFF) for land and submarine AC applications
- Extruded cable systems for land and submarine AC applications
- Power frequency
- Voltage range 45 kV and above

8.2.13 WG B1.32 Recommendations for testing HVDC extruded cable systems for power transmission at a rated voltage up to 500 kV

Convener: Bjorn Sanden (Norway)

TB 219, published in 2003, deals with the same subject matter, but is limited to 250 kV. Today cable systems above that voltage are available. An update to 500 kV is needed.

Terms of Reference:

General scope of work :

- To prepare recommendations for testing of HVDC extruded cable systems at rated voltages up to 500 kV

The WG shall work in 2 steps :

- Review existing recommendation in TB 219 to higher voltage levels that may be required for commercial projects in the near future, e.g. 350 kV, and draw conclusions on applicability and modifications
- Develop a recommendation for rated voltages up to 500 kV

The work scope and structure shall to greatest extent possible follow the content and structure of TB 219, i.e.:

- A survey of existing laboratory and operational experience shall be carried out by WG members.
- The recommendation shall cover the voltage range where laboratory and/or operational experience exist. The WG shall, however, assess the impact of extrapolation of the recommendation to 500 kV.
- The recommendation shall consider both submarine and land applications, with due consideration to the aspects related to testing of long lengths of cables.
- The recommendation shall cover electrical, thermal and mechanical aspects.
- Where appropriate standards/recommendations exist, the WG shall recognise and refer to these, with particular attention to the specifics related to the electrical aspects of extruded DC cables. In case the existing standards not being appropriate, the WG shall identify this issue and either propose a resolution or refer the issue to the SC.

The recommendation shall at least cover :

- Prequalification tests, Type tests, Routine tests, Sample tests, and After installation tests
- The WG may consider a range of type approval and, if applicable, tests/verifications that may demonstrate the consistency between the prequalified system and the actual system to be supplied.
- The recommendation shall take actual operational and installation conditions into account (e.g. ambient temperature, polarity reversal, impulse level, etc.), when developing the test conditions and requirements.

8.3 Task Forces

8.3.1 TF B1.31 Testing of superconducting cable systems

Convener: David Lindsay (USA)

The number of installed cable systems with HTSC (High Temperature Superconducting) cable systems is steadily increasing. In response to an initiative from IEC TC90 (superconductivity) and TC20 (cables), the SC B1 SAG proposed to address the testing of superconducting cable systems.

The TF should discuss and conclude in 2009 on whether or not to install a full WG to address the topic.

8.3.2 JTF B1/B3.33 Feasibility of a common, dry type interface for GIS and Power cables of 52 kV and above

Convener: Pierre Argaut (France)

The interface between cable terminations and GIS is ruled by existing IEC standards. The TF is to examine and evaluate the feasibility of a common, dry type interface for GIS and Power cables of 52 kV and above, which may imply the need of changes introduced to the applicable IEC standard.

The TF should discuss and conclude in 2009 on whether or not to install a full WG to address the topic.

8.3.3 JTF SCB1/ICC Interactions between CIGRE SCB1 and IEEE/PES Insulated Conductors Committee

Convener: Willem Boone (The Netherlands)

This JTF was launched in 2000 and the evaluation made in 2005 concluded that the cooperation should continue. A Discussion Group CIGRE/IEC International Organizations E10D, was launched by ICC which purpose is to exchange information about both organizations, to give information from SC progress, to present tutorials prepared by SC B1 WGs. Presently, six B1 WGs exchange information with ICC.

During the ICC meeting held in March 2008, the SC B1 SAG had its annual meeting allowing great exchanges between both organizations. Four presentations were made by SC B1 SAG members. On the Transnational Lunch, chaired by Wim Boone and Pierre Argaut,, our Chairman gave a successful presentation on "Cables for the future, perspectives and discussion".

The future activities will be to launch a joint activity CIGRE B1/ICC (tutorial +panel), but the sudden passing of the ICC Chairman, Shan Nandi, could postpone its set up.

8.3.4 Relations with other CIGRE Study Committees

SC B1 doesn't have at present formal relations to other SCs, however SC B1 has some common issues with other SCs (B2, B3, B4, C1, C3, C4, D1).

SC B1 is involved in several WGs where B1 experts are among the WG members to provide their expertise in the cable systems. These WGs are:

- **WG C4.207** "EMC of communication circuits, low voltage systems and metallic structures in the vicinity of power systems"
- **WG C4.502** "Modelling and analysis of the technical performance of electrical power networks with very long/large number of HV/EHV AC cable lines"
- **WG D1.20** " Water Tree Detection in XLPE insulation"
- **WG D1.23** "Diagnostics and accelerated life endurance testing of polymeric materials for HVDC application"
- **WG D1.24** "Potential of Polymer Nanocomposites as electrical insulation for highly stressed insulation material in AC and DC application"
- **WG D1.26** "Basic principles to determinate methane content of cross-linked solid extruded insulation of MV and HV cables"

8.3.5 AORC

SC B1 is a very good contributor to the AORC (Asia Oceania Regional Committee) as the AORC B1 panel, led by Ken Barber (AU) meets regularly with the experts from the AORC countries. In return, the experts provide subjects of interest for themselves that could be taken into consideration at the SC level.

This AORC B1 panel met in Bangkok (Thailand) in November 2008 and held workshops and a technical tour.

8.3.6 IEC

The close liaison between CIGRE SC B1 and IEC TC 20 is very well established and the IEC TC 20 Chairman is permanently invited to the SC meetings.

IEC TC20 relies on CIGRE SC B1 expertise for the development of particular technical matters that are necessary for the preparation of new standards or for the maintenance and revision of existing standards.

As an example, IEC recommended to SC B1 the launch of a Working Body on High Temperature Superconducting cable systems.

IEC will also take profit from the work produced by SC B1:

- WG B1-06 : Prequalification procedure → present revision of IEC 60840 and 62067
- WG 21-14 : Tests on laminated covering → IEC TR 61901
- WG B1-25 : Advanced design of laminated screens → future revision of IEC TR 61901
- WG B1-03 : Large conductors and screen losses → present revision of IEC 62087
- WG B1-10 : Update of service experience
- WG B1-22 : Workmanship of accessories
- WG B1-24 : Test procedures for HV transition joints