



**2010 SC B1 PROGRESS REPORT  
(INSULATED CABLES)**

*by Y. MAUGAIN, Secretary of the Study Committee*

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## TABLE OF CONTENTS

<b>1</b>	<b>OVERVIEW .....</b>	<b>3</b>
<b>2</b>	<b>SC ORGANISATION .....</b>	<b>3</b>
<b>3</b>	<b>PUBLICATIONS.....</b>	<b>4</b>
<b>4</b>	<b>2010 MAIN EVENTS .....</b>	<b>4</b>
<b>5</b>	<b>2011 MAIN EVENTS .....</b>	<b>5</b>
<b>6</b>	<b>2012 MAIN EVENTS .....</b>	<b>5</b>
6.1	DISCUSSION GROUP MEETING.....	5
6.2	SYMPOSIUM ON HVDC .....	5
<b>7</b>	<b>ADMINISTRATIVE REPORT.....</b>	<b>6</b>
7.1	SC MEETING .....	6
7.2	TC AWARD .....	6
7.3	WEB SITE.....	6
<b>8</b>	<b>TECHNICAL REPORT .....</b>	<b>7</b>
8.1	ADVISORY GROUPS.....	7
8.1.1	<i>Strategic Advisory Group</i> .....	7
8.1.2	<i>Customer Advisory Group</i> .....	7
8.1.3	<i>Tutorial Advisory Group</i> .....	8
8.2	WORKING GROUPS.....	9
8.2.1	<i>WG B1.08 Cables systems in multipurpose or shared structures</i> .....	9
8.2.2	<i>WG B1.11 Upgrading and Uprating of Underground Cable Systems</i> .....	10
8.2.3	<i>WG B1.22 Cable accessories workmanship</i> .....	10
8.2.4	<i>WG B1.23 Impact of EMF on current ratings and cable systems</i> .....	11
8.2.5	<i>WG B1.24 Test procedures for HV transition joints</i> .....	12
8.2.6	<i>WG B1.25 Advanced design of laminated metallic coverings</i> .....	12
8.2.7	<i>WG B1.27 Test recommendations on XLPE AC submarine cables from 170 kV to 500 kV</i> .....	13
8.2.8	<i>WG B1.28 On-site Partial Discharge Assessment of HV and EHV cable systems</i> .....	13
8.2.9	<i>WG B1.29 Guidelines for maintaining the integrity of XLPE transmission cable accessories</i> .....	14
8.2.10	<i>WG B1.30 Review of Cable Systems Electrical Characteristics</i> .....	14
8.2.11	<i>WG B1.31 Testing of superconducting cable systems</i> .....	15
8.2.12	<i>WG B1.32 Recommendations for testing HVDC extruded cable systems for power transmission at a rated voltage up to 500 kV</i> .....	16
8.2.13	<i>JWG B1/B3.33 Feasibility of a common, dry type interface for GIS and Power cables of 52 kV and above</i> .....	17
8.2.14	<i>WG B1.34 Mechanical forces in large cross section cable systems</i> .....	18
8.2.15	<i>WG B1.35 Cable rating</i> .....	18
8.2.16	<i>WG B1.37 Guide operation of fluid filled cable systems</i> .....	18
8.3	TASK FORCES.....	19
8.3.1	<i>TF B1.36 Life cycle assessment and environmental impact of underground cable systems</i> .....	19
8.3.2	<i>TF B1.38 After laying tests on AC and DC cable systems with new techniques</i> .....	19
8.3.3	<i>TF B1.39 Generation cable connections to the grid</i> .....	20
8.3.4	<i>TF B1.40 Cable connections to offshore generation</i> .....	20
8.3.5	<i>JTF SCB1/ICC Interactions between CIGRE SCB1 and IEEE/PES Insulated Conductors Committee</i> 20	20
8.4	RELATIONS WITH OTHER CIGRE STUDY COMMITTEES.....	20
8.5	B1 AORC .....	21
8.6	IEC.....	21

## 1 Overview

The main highlights of 2010 are:

- Our Chairman, Fredrik Rüter (SE) reached his term of office. He was replaced by Pierre Argaut (FR). With the change of Chairman, the 3 existing AGs (Strategic, Customer and Tutorial) were disbanded. It is anticipated that new AGs will be launched by the incoming Chairman, to deal with the 4 Technical Directions defined by the Technical Committee (See Electra 249 - April 2010)
- 11 SC Members changed in 2010, with 2 new countries who become Observer Members for the first time, Algeria and Slovenia.
- The cooperation with IEC TC 20 and IEEE/ICC continues to be very good.
- SC B1 launched 3 Working Groups and 3 Task Forces. 2 Working Groups and 3 Task Forces were disbanded.
- More than 200 different experts are working in B1 leading to more than 280 contributions in the various working bodies including SC membership.
- Very good progress was made on tutorials and several of them were delivered.
- New WGs had some difficulties to start and it is difficult to find Conveners. Some Conveners, mainly from utilities, mainly from North America have experienced big difficulties in obtaining permission to travel from their companies.
- The 2010 discussion group meeting and the poster session with more than 300 attendants were a great success. Three invited contributions allowed to widen the view of the attendance (D1/C4)
- Two B1 Working Groups (WG) were disbanded after publishing important technical brochures "Cable systems in multipurpose or shared structures" and "Test procedures for HV transition joints". Moreover, other WGs finished their work that will be published in 2011,

## 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.

By the end of 2010, the SC is composed of 24 Regular Members, 10 Observer Members, a Secretary and a Chairman (36), 15 coming from Manufacturers, 13 from Utilities, 2 from Consultants, 2 from Institutes and 4 from Universities.

The SC B1 has its web site at the following address: [www.cigre-b1.org](http://www.cigre-b1.org). The current SC Secretary is also the web master.

### 3 Publications

Published in 2010

WG number	Name of the Publication	Publication date	Electra issue and number of TB (*)
WG B1.08	Cable systems in multipurpose or shared structures	February 2010	Electra 248 TB 403
WG B1.24	Test procedures for HV transition joints	June 2010	Electra 250 TB 415
WG B1.32	Recommendations for testing HVDC extruded cable systems for power transmission at a rated voltage up to 500 kV (Intermediate report)	June 2010	Electra 250

To come

WG number	Name of the Publication	Publication date	Publication type
WG B1.25	Advanced design of laminated metallic coverings	February 2011	Electra 254 TB 446
WG B1.22	Cable accessories workmanship	2011	
WG B1.11	Upgrading and uprating of existing cable systems	2011	
WG B1.23	Impact of EMF on current ratings and cable systems	2011	

(\*) TB : Technical brochure

### 4 2010 main events

As usual, CIGRE held a Session on August 23 – 27 in Paris. The SC B1 Discussion Group Meeting was held on Thursday, August 26<sup>th</sup>, 2010 during which 27 published papers were discussed.

This event was well attended with more than 300 experts and proposed a fruitful discussion with 49 prepared contributions, 61 spontaneous ones. Moreover SC B1 invited 3 long presentations from other SCs (C4 and D1) to show the interaction of insulated cables with the present development in the networks.

The Poster Session was also a great success.

Some trends:

- DC extruded and Mass Impregnated underground and submarine cables are now competing at higher and higher voltages
- New areas are now opened to HV AC transmission over distances around 100 km and for powers ranging from tens to hundreds of MW
- Upgrading part of an existing cable system to increase voltage, ampacity or service life is often studied as well as replacement with new technologies
- All major recent design evolutions have led to a reduction of the impacts on Global Warming and on Water
- It is time to investigate Ultra Low Frequency after laying testing as a way to test HV cables
- It was confirmed that the recommendations published in TB 303 to introduce the concept of Extension of Qualification and to confirm the ranges of approval of Prequalification Test and Type Test were approved by the cable community allowing to avoid in some contracts costly tests, most probably without added value, which are not requested in CIGRE recommendations.

SC B1 also offered tutorials all along the year:

- A one-day tutorial on cable system design and installation during the 2010 GCC conference.
- One half-day tutorial in Algiers.
- Others were delivered during the ICC meetings in the US and during the AORC meeting in Korea.

## 5 2011 main events

The 2011 SC B1 meeting will be hosted for the first time ever by China. It will be held in Shanghai (China) on September 22 – 24 prior to the B1 AORC meeting to allow experts from this region to attend the public part of this meeting and to exchange views with other cable experts.

SC B1 will also significantly contribute to Jicable where CIGRE is one of the organizers. This event will take place in Versailles (France) on June 19-23.

## 6 2012 main events

In 2012, SC B1 will hold its Discussion Group Meeting during the Cigre Session and will organize jointly with other SCs a Symposium on HVDC Transmission.

### 6.1 Discussion Group Meeting

The Preferential Subjects that will be discussed during the 2012 CIGRE Session on August 30 are:

#### PS1 : Newly installed or upgraded cable systems

- Design, installation techniques, operation
- Issues associated with long cables

#### PS2 : State-of-the-art and trends for cable system rating, testing and monitoring

- Static and dynamic cable rating calculations
- Qualification, type, routine, sample and after installation testing
- Applications of diagnostics to cable systems
- Trends in on line monitoring of cables and accessories

#### PS3 : Cables in the Network of the Future

- Future voltage levels for AC and DC cables
- Conversion of AC cable circuits to HVDC operation
- New functionalities expected from cable systems

### 6.2 Symposium on HVDC

Jointly with SC B4, SC B1 will organize and participate in a Symposium on HVDC transmission to be held in San Francisco in March 2012.

## 7 Administrative report

### 7.1 SC Meeting

Following a TC decision, all Advisory Groups were disbanded as the Chairman reached his term of office. It is anticipated that the incoming Chairman will launch new ones to help him in the SC management, but they were not known at the end of 2010.

One WG and three preparatory TFs finished their work. The WG kept an editorial team to finalise its documents to be published as Technical Brochure and Executive summary in Electra. The TFs were disbanded during the SC meeting and the WG will be disbanded as well after their report is officially sent to the central office.

- **WG B1.23** "*Impact of EMF on current ratings and cable systems*"

and

- **TF B1.34** "*Mechanical forces in large cross section cable systems*"
- **TF B1.35** "*Cable rating*"
- **TF B1.37** "*Guide operation of fluid filled cable systems*"

One WG finished its work on time but saw its lifetime duration extended for one more year in order to have only one homogeneous document from 36 to 500 kV

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

One TF saw its lifetime duration extended for one more year to allow a better definition of the terms of reference:

- **TF B1.36** "*Life cycle assessment and environmental impact of underground cable systems*" which term of office is now 2011,

SC B1 launched three new Working Groups and three preparatory Task Forces:

- **WG B1.34** *Mechanical forces in large cross section cable systems* which term of office is 2013
- **WG B1.35** *Guide for rating calculations* which term of office is 2013
- **WG B1.37** *Guide operation of fluid filled cable systems* which term of office is 2013

and

- **TF B1.38** "*After laying tests on AC and DC cable systems with new technologies*" which term of office is 2011,
- **TF B1.39** "*Generation cable connections to the grid*" which term of office is 2011,
- **TF B1.40** "*Cable connections to offshore generation*" which term of office is 2011,

By the end of 2010, SC B1 currently has no Advisory Groups, twelve WGs, one JWG and four TFs and participates in several WGs or JWGs led by other SCs and in one JTF with another organization.

### 7.2 TC Award

Marco Marelli (Italy) was honoured with the CIGRE Technical Committee Award 2010 for his 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](http://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 increasing number of visits, over 800 per month, confirms that Internet is a very important tool for internal and external communication.

## 8 Technical report

### 8.1 Advisory Groups

The TC Chairman decided to disband all the advisory groups when the SC Chairman finished his term of office to allow the incoming one to launch the advisory groups he considers useful for the SC management. The terms of reference will be redefined according to his views.

The three Advisory Groups were disbanded during the 2010 SC meeting.

#### 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 2010 SAG meeting were covered in the 2010 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.

The CAG collated the documents published by B1 and former 21 since 1968 and filed them by topics.

They also :

- Prepared the 2010 Questionnaire and collated SC Members' Annual Reports
- Discussed the above bullet with SAG regarding future plans and inputs to existing WGs
- Fed inputs to WGs
- Ensured CAG is representative of continents and customers
- Completed collation of SCB1 published documents (including Session Papers, Technical Brochure and Electra articles) and publish it
- Participated and advised SC of TG's concerns !!!

### 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 2010, 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
- Statistics of AC underground cables in power networks
- Up-Dating of Service Experience of HV Underground and Submarine Cable Systems
- Remaining Life Management and Replacement Program for HV Cables
- Test procedures for HV transition joints
- Third Party Damage

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

The next targets are:

- DC cables
- Submarine cables. This tutorial will not deal with critical points which could be part of manufacturers Know How
- History of cable industry
- Synthetic short slide-shows for each tutorial to post them on our web site

The TAG delivered tutorials during the past year (Poznan during the 2009 SC meeting, Scottsdale during the 2009 ICC Fall meeting, Symposium on Power cables in Denmark in June 2010), Algiers in early 2010, AORC meeting in June 2010, GCC regional meeting in Qatar (October 2010), and will do the same in the future Jicable 2011 next June and Xian in China (in relation with the 2011 SC meeting).

## **8.2 Working Groups**

The progress in the different WGs was not identical as the economic crisis and the ash cloud from the islander volcano postponed some WG meetings.

For the first time, the experts involved in WGs from other Study Committees presented the progress of the work.

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

*Convener: Ray Awad (Canada)*

After publication in February 2010 (Electra 248 and TB 403), the WG was officially disbanded.

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).

### **8.2.2 WG B1.11 Upgrading and Uprating 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.

In 2007, 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.

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.

Due to personal problems, the Convener was not able to dedicate enough time to deliver the final report at the expected delivery time. He will do his best to finalize the report quickly.

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.

### **8.2.3 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.

The final report was presented during the 2009 SC meeting and was well received. An editorial team took into account the final comments. After the Chairman's approval, the report will be sent to the central office for publication.

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 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.

## **8.2.4 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 was due to present its final report in 2009.

The Convener informed that due to late start (delay in the Convener's nomination), the WG was unable to deliver the final report on time and asked for a one year extension. This was agreed by the Chairman who required a final report ready for May 2010.

The Convener, Harry Orton (CA) informed that the WG final report was on good tracks by Spring but the WG was not able to meet due to the volcano eruption ash clouds. The final meeting needed before submitting the report was postponed. He said that the final report will be ready soon and circulated among the SC Members for validation. The report will be published in 2011.

**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
- Laminar 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.

### **8.2.5 WG B1.24 Test procedures for HV transition joints**

*Convener:* Marco Marelli (Italy)

WG B1.24 was set up in 2006 and was due to present its final report in 2009. After publication in June 2010, (Electra 250 - TB 415) the WG was officially disbanded.

#### **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.

### **8.2.6 WG B1.25 Advanced design of laminated metallic coverings**

*Convener:* Pierre Mirebeau (France)

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

The Convener, Pierre Mirebeau (FR), received comments from the SC Members. They were analyzed and the report was corrected accordingly. The Chairman approved this final version. As soon as the executive summary is validated, the documents will be sent to the central office for publication.

After publication in February 2011 (Electra 254 and TB 446), the WG was officially disbanded.

#### **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

### **8.2.7 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 was due to present its final report in 2010.

During the SC B1 meeting, the Chairman expressed that he was very happy as the Convener, Anders Gustafsson (SE) delivered the final report at the expected delivery time and the work produced was very fine.

The Convener expressed in his presentation the good contribution of the experts involved. The final report was prepared from the previous one (Electra 189) dealing with the voltage levels from 36 to 170 kV, but was significantly changed with additions, updates, explanations and clarifications. This introduced a great step between both documents and the Convener proposed to update the old Electra accordingly in order to have only one homogeneous document from 36 to 500 kV.

The Convener said that the tests proposed in the report were mainly derived from existing IEC standards but in some cases, this raised some questions. For example, the IEC 62067 definition of a cable length is the one that will be delivered on site. With submarine cables, this length could be very long and could lead in some cases to physical problems as the test facilities could not be used (capacitance, transportation, ...).

The report was well received by the SC Members. There was a fruitful discussion after the presentation of the report.

To the question on when the mechanical tests should be performed, the Convener, replied that the prequalification test qualifies the internal part of the cable and the type test the cable that will be delivered during a contract. It was completed by saying that mechanical and electrical tests are connected.

The Chairman agreed to extend the term of office for one more year to allow the WG to finalize the report with all HV voltages and to prepare terms of reference for a new WG on mechanical tests.

The report is expected in June 2011.

#### **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

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

*Past Convener:* Nigel Hampton (USA)

*New Convener :* Mark Fenger (Canada)

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

As the Convener, Nigel Hampton (US) was prevented from dedicating time to this WG, there was not so much progress. The Chairman informed that he had a discussion with him. For the success of this

important WG, it was commonly decided to move to a more available Convener. In any case, Nigel Hampton will stay as expert in the WG.

The incoming Chairman nominated Mark Fenger (CA) as the new Convener. The Chairman wished all the best to this group in its new configuration. The report is expected in June 2011.

**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

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

*Convener:* Eugene Bergin (Ireland)

This WG was relaunched last year. The Convener, Eugene Bergin (IE) introduced the report by saying that the starting period was long. The progress is now good and he expects to keep the deadline as he succeeded in getting all the WG members working.

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

**8.2.10 WG B1.30 Review of Cable Systems Electrical Characteristics**

*Convener:* Christian Royer (Canada)

WG B1.30 was set up in 2008 and is due to present its final report in 2011.

The Convener, Christian Royer (CA), was prevented from coming due to internal problems within his company. The report was presented by Eric Dorison (FR). He was satisfied with the cooperation with WG C4.502 which is helpful and effective.

Then, he told that there are different needs regarding electrical characteristics which apply for different answers. The first steps were to identify :

- the most common cable designs and configurations of cable systems (cable laying, bonding),
- the existing formulae and their limitations. Power frequency issues are more or less available, sequence impedances may be derived, but some issues have to be dealt with short-circuit current return path and mutual influences between several parallel circuits.
- the measurement techniques

For transient analysis, some issues have to be dealt with semi-conductive layers and screen wires and armours.

One expert asked whether the cable circuit impedances once laid are compared with the studies. Eric Dorison replied that some countries do, but the earth connections and soil humidity may influence the results.

The Chairman decided that Eric Dorison will act as substitute as long as Christian Royer faces availability problems.

**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

### **8.2.11 WG B1.31 Testing of superconducting cable systems**

*Convener:* David Lindsay (United States)

IEC TC20 and TC90 has requested B1 to provide testing recommendations for HTSC cable systems, as the technology has made notable progress during the last years.

SC B1 launched a WG related to this topic, the report of which being expected in 2012.

The WG did not have any face to face meetings but several conference calls and e-mail exchanges.

According to the Convener, the progress is satisfactory.

He would appreciate the nomination of experts from China and Russia. The Chairman supported this proposal.

The Convener reported that the upper voltage limit was 150 kV in the ToR and the WG experts were unanimous to extend this value to 170 kV to cope with the IEC standards.

The Chairman agreed and asked to update the Working Body form accordingly and send it to the SC Chairman for approval by the TC Chairman.

**Terms of Reference:**

- Scope of the WG should be limited to AC High Temperature Superconductors (HTS) only and exclude those materials considered Low Temperature Superconductors (LTS). Voltage range: 10 to 145 kV
- Cryogenic cooling hardware is outside the scope. However, Performance specification, reliability, functional requirements should be addressed
- The WG shall collect detailed experience from existing HTS cable projects.
- The WG shall address HTS cable systems operating under normal and short circuit conditions – including cable, joints and terminations.
- The guideline shall include considerations for all known cable design options including single-core, three-core and three concentric phases.

- The guideline shall address those test requirements associated with design and operation of a pressurized piping and pressure-vessel system as applicable to HTS cable systems.
- The WG shall recommend testing requirements and guidelines for HTS cable system in the following areas:
  - Type / Qualification tests
  - Factory Tests
  - After Laying Tests
- The WG shall discuss and document the prospective of technology up scaling to 275 kV

### **8.2.12 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)

WG B1.32 was set up in 2008 and is due to present its final report in 2011.

The WG Convener, reported that he had a good experience with a "net" meeting.

He confirmed that the TB under preparation is of interest as new contracts are awarded at voltages over 250 kV, which was the limit of the past report on this topic.

He also confirmed that the WG was on tracks with a good attendance of experts. That made the Chairman happy.

The WG published an intermediate report in June 2010 issue of Electra.

The main principles adopted in TB 219 will be extended in the new recommendation with:

- System approach
- The inverse power law will be used as basis for determination of voltage test factors. The WG will make a conservative choice of life exponent 'n' and it is anticipated to have the same voltage test factors as in TB 219.
- The principles for establishing duration of test cycles for Type test and PQ test will be extended. Available data on resistivity of insulation materials have been reviewed and are found to be in-line with the assumptions in TB 219.

It asked what are the connections between this WG and WG D1.23 on "Diagnostics and accelerated life endurance testing of polymeric materials for HVDC application" ?

The Convener replied there were none at the moment, but will contact them.

#### **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.

### **8.2.13 JWG B1/B3.33 Feasibility of a common, dry type interface for GIS and Power cables of 52 kV and above**

*Convener:* Pierre Argaut (France)

*Future Convener:* Pierre Mirebeau (FR)

JWG B1/B3.33 was set up in 2009 and is due to present its final report in 2012.

The interface between cable terminations and GIS is ruled by existing IEC standards.

The WG is to, using a step-by-step approach, examine and evaluate the technical issues of a common, dry type interface for GIS and Power cables of 52 kV and above.

Pierre Argaut (FR), the WG Convener reported that there was no progress at all as he waited for the B3 nominations for a very long time. He will meet the SC B3 Chairman in September to clarify the ToRs. Members from utilities are missing.

The ToRs will be "fine tuned" during the first WG meeting, but an idea could be to limit the voltage range as well as the cross section one.

Due to his new position, Pierre Argaut will convene the first two meetings and then hand over to Pierre Mirebeau (FR).

#### **Draft terms of Reference:**

The scope shall be limited to GIS connections for extruded cable systems for AC of 52 kV and above

The JWG shall:

- examine the conditions around the switchgear and the installations issues (also called site issues)
- consider the testing procedures for GIS/ T and cables (overlapping or missing items).
- propose measures to reduce the potential consequences of the GIS insulation failure.
- propose measures to reduce the potential consequences of the cable termination insulation failure
- review the existing standards ruling the qualifications and extension of qualification procedures applicable to GIS terminations.
- define the relevant qualification procedures needed if any.
- estimate the overall feasibility of the project and the cost involved.
- consider the impact of large cross sections
- consider safety during works
- identify the limit of suppliers' responsibility to be considered
- question the market based on the result of the above estimation
- recommend or not to go to a second step with the launching of a new WG B1.XX to go in detail in the design of the standard components (shape, dimensions, properties ..)
- develop recommendations to IEC SC 17C for requirements to be covered by the standard

The terms of reference will be fine tuned at the first JWG meeting with SC B3 before being submitted to the TC Chairman for approval.

### **8.2.14 WG B1.34 Mechanical forces in large cross section cable systems**

*Convener:* Johannes Kaumanns (Germany)

WG B1.34 was set up in 2010 and is due to present its final report in 2013.

There are no special “bad” experiences with “large conductors”, but the trend is going to larger and larger cross sections. It was identified through our target groups that a technical guide can reduce risk of poor design and installation.

#### **Terms of Reference:**

The WG should identify the forces that interact with the cable system, the internal design of the cable or the accessories being out of the scope. The interaction with all types of joints should be addressed, including transition joints.

The work will be limited to polymeric cables, but should study all types of sheaths and the different installation arrangement such as rigid, flexible, transition from ducts to rigid installations, installation in tunnels, ...

The WG should address:

- short circuit forces ,
- those derived from temperature
- cables in vertical laying

### **8.2.15 WG B1.35 Cable rating**

*Convener:* Frank De Wild (Netherlands)

WG B1.35 was set up in 2010 and is due to present its final report in 2013.

Cable ratings are generally determined by using IEC standards such as IEC 60287 and IEC 60853, but these documents do not cover all situations. As examples, HVDC cables, deep burial, horizontal drilling, multiple circuits are presently not included in these standards though these situations are more and more faced. Then, it is clear that in accordance with IEC TC 20, CIGRE SC B1 should address missing calculations and send the results to IEC for further consideration.

#### **Terms of Reference:**

- To collect experiences and information from different countries
- To assess and interpret the results from the inquiries and to make conclusions and recommendations on how to make a cable rating study
- To set up a general framework to guide the user to calculate the current rating of a cable circuit in any situation
- To report potential difficulties and problems with the methods, as well as to report recent developments in the methods

#### **Scope:**

All AC and DC cables with emphasis on HV and EHV cables, when possible extended to MV as well.

The WG will also take into account :

- the crossings between cables and other heat sources
- the temporary ratings

### **8.2.16 WG B1.37 Guide operation of fluid filled cable systems**

*Convener:* Colin Peacock (Australia)

WG B1.37 was set up in 2010 and is due to present its final report in 2013.

The paper cables are very reliable and should continue their service as long as possible. The present risk is to see the cable suppliers leaving the field, without anybody able to repair the existing cable circuits.

#### **Scope of work :**

The scope will exclude pipe type cables. It will cover AC and DC land and submarine cables which have in principle the same problems. The voltage range is from EHV to distribution levels.

#### **Terms of Reference:**

- To establish the appropriate terminology
- To collect information and experience on the operation of fluid filled cable systems, using a questionnaire developed by the WG. The WG should consider refurbishment strategies for the continued operation of self contained fluid filled cable systems.
- To collate, summarise and review the information
- To produce a working group report as a brochure recommending guidelines on the best practices for the continued operation of self contained fluid filled cable systems. The WG will address the technical aspects on the continued operation of these cables such as: recommended maintenance, testing (routine and after repair), refurbishment and modifications for improved performance, operational availability and constraints, fault repairs, oil system capacity reviews, fluid monitoring and analysis, leak location techniques and a cable and accessories suppliers list.

If time permits the following could also be studied: extension of service life, extension strategies including use of transition joints, cable cooling systems

### **8.3 Task Forces**

The TFs are launched by the Study Committee 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. Task Forces do not publish any report in Electra.

#### **8.3.1 TF B1.36 Life cycle assessment and environmental impact of underground cable systems**

*Convener:* Ray Awad (Canada)

Cable systems are more and more designed in a "green" way.

The TF was due to discuss and conclude in 2010 on whether or not to install a full WG to address this topic.

As the proposal was not mature enough, the Chairman decided to extend the TF for one more year with Ray Awad (CA) as Convener and to add new members to the existing ones. The conclusion is expected in 2011.

#### **8.3.2 TF B1.38 After laying tests on AC and DC cable systems with new techniques**

*Convener:* John Densley (Canada)

After laying tests are used during the commissioning period and as maintenance tools to check the quality of a cable system.

New tests such as low frequency systems or damped AC voltage test are now available.

It is necessary to identify:

- the range of use of these tests,
- the range of use for DC and AC cable systems,
- their efficiency according to the application duration, the cable length and voltage level, ...

The TF was due to discuss and conclude in 2011 on whether or not to install a full WG to address this topic.

### 8.3.3 TF B1.39 Generation cable connections to the grid

*Convener:* Yves Maugain (France)

New generation plants are more and more often connected through cable systems. It is of evidence for offshore wind farms, but it is also the case for land generation plants whatever their power. Several problems are raised:

- the cable rating, especially when very high power is generated,
- the reliability,
- the thermo-mechanical forces, ...

The TF was due to discuss and conclude in 2011 on whether or not to install a full WG to address this topic.

In a first stage, the TF should identify whether the existing standards cover these connections correctly or not by exploring them and finding the eventual gaps.

### 8.3.4 TF B1.40 Cable connections to offshore generation

*Convener:* Christian Jensen (Denmark)

Several off shore wind farms have already been built and more will come. Design of export cable is important. but also the cables between the wind mills.

The TF was due to discuss and conclude in 2011 on whether or not to install a full WG to address the topic.

The Terms of reference should not be limited to offshore wind farms connections. It was asked to add wave generation and flexible connections.

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

*Past Convener:* Willem Boone (The Netherlands)

*New Convener :* Walter Zenger (US)

The CIGRE/ICC JTF was launched in 2000 and the evaluation made in 2005 concluded that the cooperation should continue. A new evaluation was done in 2010.

The cooperation made great progress with the implementation within ICC of a discussion Group Meeting, several presentations and discussions on CIGRE WGs during ICC meetings, the delivery of tutorials and exchange of information between WGs dealing with common topics.

In the past 10 years the relation CIGRE B1-ICC has become stronger, without frustrating their own identity (ICC and CIGRE are different and will remain different) and both organizations should continue with further developed cooperation according to the present lines of action.

Wim Boone was warmly thanked for the work done and handed over to Walter Zenger (US).

## 8.4 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"
- **JWG D1/B1.20** " 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"

## 8.5 B1 AORC

The 7<sup>th</sup> B1 AORC meeting was held last June in the Daejeon KEPCO Research Centre (KR) under the sponsorship of the Korean CIGRE power cables Committee. A tutorial on accessories was delivered by Pierre Argaut (FR). During the meeting, they reviewed SC B1 issues and discussed regional matters. This meeting is now more than a panel and is not far from being a WG.

The main highlights from the 2010 meeting were:

- Electrical Degradations and Ageing of XLPE – China
- EHV projects in Japan – Japan
- Degassing of XLPE cables – Thailand
- PD monitoring – China
- Long length AC cable – Australia
- Korean HV projects and development

There was also a technical visit to the Gochang test centre.

The 8<sup>th</sup> meeting will be organized in China around the SC B1 meeting.

## 8.6 IEC

During the SC B1 meeting in August 2010, the IEC TC 20 Chairman, Vic Banks (UK), introduced IEC TC 20 and its 4 WGs:

- WG 16: High voltage cables
- WG 17: Low voltage cables
- WG 18: Burning characteristics of electric cables
- WG 19: Current rating and short-circuit limits of cables

He emphasized the importance to maintain close liaison between both organizations as IEC TC20 needs CIGRE SC B1 expertise for the development of particular technical matters necessary for either the preparation of new standards or the maintenance and revision of existing standards.

He was very happy with the excellent relations, and confirmed the need for the Chairmen to attend the annual meetings of the partner organization.

The IEC Chairman presented how the B1 work becomes an input in the different IEC WGs. It is clear that the future standards or their revisions will take benefit of SC B1 work. He gave some examples and asked a specific need of information on partial discharge testing (IEC 60885-3).

He also informed that his term of office should finish after the next meeting to be held in the Netherlands on November 4-5.

IEC TC 20 thanks CIGRE SC B1 for all their technical support to date and consider it highly advisable that the close liaison is continued in the future

Fredrik Rüter thanked Vic Banks from attending the SC B1 meeting where he is most welcome and hoped the cooperation will continue on the same trend in the coming years. As in the past years, SC B1 would send a representative at the next IEC meeting.

IEC TC 20 meeting took place in Netherlands in early November 2010 with the same friendly discussion. Focus was given to the progress of WG B1.25, B1.27, B1.31, B1.34, and B1.35.