Study Committee B1 (Insulated Cables)

Special Report 2021

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(Special Reporter)

INTRODUCTION

Study Committee (SC) B1 is responsible for AC and DC insulated power cable systems for power transmission, distribution and generation connections on land and in submarine applications, as well as for power cable systems associated with micro-grids and the integration of distributed resources. Within its technical field of activity, Study Committee B1 addresses theory, design, applications, manufacture, installation, testing, operation, maintenance and diagnostic techniques.

The strategic directions given by the Cigre Technical Council serve as a basis for the performed work

For the 2020 Group Discussion Meeting were not possible to conduct in the normal matter due to Covid-19 restrictions. The papers were presented as videos at the e-CIGRE session. The GDM and the discussion around this Special Report will take place during the Centennial Session in 2021.

Three preferential subjects were proposed to stimulate discussions considering the strategic directions. A total of 47 papers has been published.

PAPER SUMMARIES, DISCUSSIONS AND QUESTIONS ON EACH PREFERENTIAL SUBJECT

1 Preferential Subject 1 (PS1), Cables for future power systems

- Innovative cables and systems
- Prospective impacts on cable life-cycle from use and implementation of Big Data and Industry 4.0.
- New functionalities expected from cable systems.

1.1 Papers for PS1

B1-101: This paper summarizes the utility experiences with two pipe-type cable circuits that were initially installed in 1961 in Bridgeport, Connecticut (USA) and have experienced various studies and evaluations to extend the useful life of the systems beyond the initial design life of 40 years. This provides a historical perspective of these circuits, the utility's various studies that have been performed to verify and, later, increase the power transfer capacity, and some of the decision processes that are now being implemented to assess end-of-life criteria for some of the increased power flow methods previously implemented.

B1-102: This paper reviews the development and testing of a new dry type high-voltage outdoor cable termination that uses no fillers and is designed to be self-supporting. It uses capacitive screens to control the electrical potential gradient at the contact area between the stress sleeve and the capacitive insulation sleeve as well as at the external surface, making the electrical potential gradient of both the inner and outer insulation very uniform. The result is a cable termination with an improved voltage withstand capability and increased flashover voltage.

B1-103: The ALEGrO project is the first interconnector between Belgium and Germany that is being built. The paper gives a short overview of the ALEGrO project and describe the different test programs and the main conclusions resulting from those tests more in detail. This interconnector will connect the HV grid of Amprion (Germany) and Elia (Belgium) and will be capable to transmit a power of 1000 MW at an operational DC voltage of 320 kV. Additional tests were included to verify the behaviour of the cable systems related to TOV (Transient Over Voltages) from either converter (VSC) or cable failures.

B1-104: This paper presents some characterization tests made on submarine cable power cores made by longitudinally welded copper sheath bonded to polyethylene jacket. Tensile tests were performed to test the strain capacity of the material. Low cycle fatigue and high cycle fatigue tests were performed to characterize the material for fatigue calculations. This was done to simulate operational and installation conditions for dynamic and deep-water applications. The scope is for AC cables above 72 kV.

B1-105: Even though the high capabilities of computer aided engineering, the established methods still face difficulty in boundary conditions and the accurate modelling of the surrounding soil. Furthermore, environmental influences (solar radiation, precipitation etc.) are normally not taken in account even though they have a significant effect on the temperature and therefore on the ampacity of high voltage cable systems. In this paper investigations were conducted on an actual 400 kV cable system, to verify calculations more than 70 different sensors were fitted. The experiment was conducted for two years to obtain, with calculations tools, a "Digital twin".

B1-106: This paper aims to present a reliable and robust online condition monitoring thermal prognostic indicator system which can reduce the risk of failures in a power system network. The above-mentioned system has been installed in HV/MV substation in Cyprus and is operational for the past three years.

B1-107: In Europe, a considerable number of HV External Gas Pressure Cable Systems are still in service today at HV/EHV. In the Netherlands, two types of External gas-pressure cable systems have been installed in the seventies and eighties: The paper covers the following topics: description of the retrofit cable designs, based on single core and three core extruded cables; accessories designs; Type tests, real-scale pulling tests in a steel pipe system.

B1-108: This paper focuses on the work to enable multi-terminal DC power transmission system for promoting offshore wind power generation in Japan. The main focus is; (1) a cable optimization based on dynamic rating technology and on a factory joint technique for multi-size conductor cables, (2) an inter-company connection joint for providing expandability to the project, and (3) a high speed installation method for cable and protection tube.

B1-109: This publication describes work for using unsupervised Machine Learning (ML) algorithms to predict future temperature development for different sections of the cable. As the models only uses historic DTS measurements as basis, it is only suitable for short-term predictions. The outcome of these ML algorithms is compared to actual DTS measurements for a windfarm in UK and gives good correlations.

B1-110: The report presents the results of the development of a DC superconducting line for the power system of St. Petersburg. The main attention is paid to the study of possible emergency conditions associated with malfunctions in the cryogenic system. The analysis of the data obtained during the tests of emergency regimes of two-circuit cryogenic system of the cable line is presented. The possible time of transmission of rated power in the event of various failures of the cryogenic system was estimated. Recommendations for improvement of the reliability of operation in different regimes were given. Experience of operation of experimental and demonstration HTS cable lines (HTS CL) showed that the reliability of the operation largely depends on the stability of maintaining a predetermined temperature range along the length of the cable line.

B1-111: In this paper, a novel self-healing material (Poly-CD-PHEA) is described. The self-healing mechanism of the material is that when it is mechanically damaged. With the co-action of chain entanglement and host-guest interaction, the material finally completes self-healing.

B1-112: This paper describes several Superconducting Cable systems in Korea that are based on commercial operation. Such as 1 km/ 23 kV AC/50 MVA and 120 MVA and even longer links. The designs are both "Tri-ad configuration" and Coaxial designs.

1.2 Discussion of PS1.

The papers submitted for the Preferential Subject No 1 are about **Cables for future power systems.** This PS covers Innovative cables and systems; Prospective impacts on cable life-cycle from use and implementation of Big Data and Industry 4.0, New functionalities expected from cable systems.

For the expansion of HV DC transmission grids for offshore wind power generation a drive for standardisation of accessories/interfaces might be sensible as the available space on offshore stations is very limited. This would enable grid owners larger flexibility for selecting manufacturers.

Testing for different transient over-voltages is a new challenge with different grid topographies compared to the more traditional approach. This is now being addressed by CIGRE JWG and will hopefully suggest more standardisation.

There is a big drive to incorporate gathered data of cable status such as temperature into predictive models for more effective use of cables in terms of transmission capacity. The models used have a large complexity and have large output of data. Trading systems for exchange of power would probably benefit from incorporating such data for more optimum grid performance. In addition such Big Data and Industry 4.0 may also be used for early detection of possible component failures. Several such systems has been presented in the submitted papers. So far these systems have been specialised and customised, however there will probably be a drive for more standardized systems.

The development of new materials have sparked a drive to try to introduce self-healing materials. Typically for cables no such solutions have been available, however it is now been reported accessories that exhibit such features that would reduce the grow-rate of electrical trees. In addition self-healing properties of outer-jacket for mechanical damages is also reporter.

High Temperature Super Conducting Cable systems are now, in special cases, commercially viable. The previous issues with the cryogenic systems seem to be solved and very reliable cable systems are now in operation. The use of cryogenic systems might also allow for alternative use of cable systems in addition to the normal electrical power exchange.

1.3 Questions for PS1.

PS1-Q1: Is standardisation of accessories likely to occur in HV DC systems? If so, how would such standardisation entail?

PS1-Q2: Are trading systems for power exchange able to utilize the load prediction systems and modelling? And what would be the difficulties of incorporating such "digital twins"?

PS1-Q3: What new active monitoring systems could help power transmission lines to become "intelligent" and to support the digital transformation?

PS1-Q4: New materials with self-healing properties, how to test the enhanced properties in cable systems to prove the effectiveness? Would this need standardisation?

PS1-Q5: HTS has proven feasible for short stretches with constraints that make high power transfer with conventional cables difficult. Can these systems be expected for "normal" installation? And as it already includes a cryogenic system will hydrogen transport be integrated?

2 Preferential Subject 2 (PS2), Recent experiences with existing cable systems:

- Design, manufacturing, installation techniques and operation.
- Advances in testing, including failure location, and relevant experience.
- Lessons learnt from permitting, consent and implementation.

2.1 Papers for PS2

B1-201: This paper summarizes the various technical details for construction characteristics of each of the trenchless methods that could be considered most appropriate for cable systems, the characteristics of the materials involved (high-density polyethylene, fusible PVC, steel, and resin-reinforced fiberglass), an overview of the impact of deep cable installations on ampacity from the standpoint of native soil characteristics, water table elevation, burial depth and ambient soil temperature, and locations where trenchless methods are most appropriate to apply. A summary of the known maximum lengths where trenchless methods have been applied will also be provided to illustrate the current status within the industry.

B1-202: This article presents the feasibility studies and the solutions to implement a 230 kV mixed transmission line. It has an overhead stretch of 10 km, a 13 km submarine section, and an underground length of 4 km. It interconnects the existing substation of Biguaçu, in the continent, and the Ratones substation to be implanted, in the Santa Catarina island located in the southern region of the Brazilian country.

B1-203: The paper contains a detailed description of the 420 kV cable system Smestad – Sogn, in Norway. It includes; cable design, test set-ups, the findings during testing. This project incorporates 2 circuits of approximately 4 km each, installed in a single-purpose tunnel which is built by using drill and blast technology.

B1-204: This paper presents a case study of reoccurring fiber optic cable faults in a land cable system. The land cable section (cross-bonded) is part of a larger submarine cable system. Measurement results from the site while the system is in operation show induced voltages on the joint's earthing grid and the subsequent fiber optic cable failure. No single general solution as possible and a case-by case analysis is advisable.

B1-205: Cancelled

B1-206: This paper presents the cable design applied in the Evia-Andros-Tinos project, with a novel armour design consisting of flat wires with high strength synthetic fibres. To illustrate the benefits from the adoption of the high strength synthetic fibre armour, in this paper a comparison is performed with a galvanised steel double armour design. Synthetic fibre armour could be necessary for future cable links in the Mediterranean Sea with water depths up to 5000 m and at lower armour losses.

B1-207: This paper presents a new method of calculating the effective soil thermal resistance by employing the finite element method. The proposed methodology can be applied to any type and shape of multilayer or backfilled soil, for both land or submarine cables. The calculation can be used for calculating cable current capacity using the IEC 60287 Standard. The proposed approach is also compared to alternative methods, such as analytical and numerical solutions.

B1-208: For the protection of the outer sheath of HVDC unground cables against inadmissible high over-voltages, the metallic screen of the cable must be grounded at suitable intervals (sealing end and joints). Predictive maintenance may need the grounding points to be accessible. At densely populated regions (Western Europe) this has a high cost. Detailed analysis is therefore presented to determine the maximum admissible distance between two grounding points.

B1-209: This paper describes the installation of the two 220 kV cable circuits under the sea between two islands in Bahrain. Following the evaluation of possible crossing methods, Horizontal Directional Drilling (HDD) was chosen as the subsea ducting method. The 1250 metre crossing is located between Prince Khalifa Bin Salman Park and Juffair district in Manama. It is one of the longest known power cable installations ever undertaken under the water, using horizontal directional drilling.

B1-210: Since around 25 years, obtained data has been collected from PQ, type tests and Test After Installation, enabling analysis of the various statistics and trends related to the failure and non-conformities during those tests. The report summarises the fault types according to voltage class, accessory and failure mode. Furthermore, this includes insight in during which tests most issues occur and which cable system parts are most affected. Such findings can help designers focus on possible weak points and focus on quality assurance and control during the design phase.

B1-211: Induced voltages from long parallel cable circuits from Offshore Wind Farms must be considered. This Paper will describe the problem and how it is handled in the context of two large offshore windfarms HOW01 and HOW02. The induced voltages will impact installation and repair work.

B1-212: This paper deals with different joint bay configurations, such as; Accessible joint-bays, non-accessible bays, and hybrid: New hybrid joint bay design: combines the advantages of the previously-mentioned models. It is like the design of a joint bay that is not accessible but enables civil work to be carried out independently of the laying stage of the cable and the making of accessories. Right of Way (ROW), either permanent or temporary ROW can determine the type of joint bay to be used. Permanent ROW will limit the available area for joint bay implementation and temporary ROW may determine the construction method to apply.

B1-213: This paper describes experiments for using Damped AC voltage testing with PD measurements to detect different failure modes for installed cables. Simulated failure modes include (1) cable termination has no stress control tube, (2) knife cuts in the XLPE insulation, (3) incorrect using the insulation tape as the semi-conductive adhesive tape, (4) metal particles on the surface of XLPE insulation in the joint. The PD characteristics were used for recognising the different failure modes by using BP neural network for pattern recognition.

B1-214: In this paper there is a brief introduction of an offshore windfarm which connect several wind farm plants to the mainland by a HVDC converter and ±400 kV extruded HVDC cable with the conductor cross-section area of 1600 mm2. The qualification process of the cable system designed for the project is reported. This may give a total capacity of 1100 MW for the complete system.

B1-215: The main objective is to develop a deeper understanding of the physics behind the cable losses, including armour losses, to develop guidelines for FEM modelling of cables and analytical formulae for WG B1.64 coming Technical Brochure. Comparing simulation results with measured values and the analytical formula give good to very good accordance for all cable cross sections and measurement configurations while most of the calculations done by IEC standards give far too high losses.

B1-216: The purpose of this report is to propose a non-destructive protocol for the Verification of Absence of Voltage of Insulated Cable Systems, which avoids spiking the cable. It contains practical feedback from HVAC projects, in addition to new experiment to improve the new methods. It will follow up of the 2018 French report about "Safe work on HV extruded insulation cable systems under induced voltages".

B1-217: Upgrading and expanding the grid in major cities are challenging as many cities are not designed to support large scale underground cables. This report describes the challenges and solutions for the city of Bangkok. It's many rivers and canals with the high water-table causes difficulties and Large-diameter Horizontal Directional Drilling (Maxi HDD) has been used in several crossings. Maximum of 29 meter depth has been necessary under particular bridge foundations.

B1-218: This report of advances in new materials for use in Pre-Molded Joints. Electrical trees will often cause breakdown in the insulation. A new functional material with self-healing properties were tested by using needle electrode specimen. The results confirm that the electric tree was suppressed for a certain period, and the rate of progress was reduced compared with commercial silicon.

B1-219: In wind power generation, submarine cable of maximum 66kV (Um = 72.5kV) plays an important role in power translation and becomes an essential product for the cable manufacturers. Wet type water tree retardant cross-linked polyethylene (TR-XLPE) insulated cable has been studied. The cable was successfully subjected to regime B test in accordance with the CIGRE TB 722.

B1-220: To increase the electricity transmission capacity of MI-Kraft paper cables, due to the limit of permissible temperature, other material for lapped insulation has been tested. As full-scale testing is very expensive, a numerical simulation is used to understand the time variant electric field distribution under load cycle test by use of the model of MI-PPLP HVDC cable (poly-propylene).

B1-221: For site testing it is often necessary to be able to connect the Gas Insulated Switchgear to outdoor test equipment. A special back-to-back GIS solution has been developed to allow connection between GIS and a XLPE cable with outdoor termination. This can be fitted to GIS that does not have any gas-to-air bushings. The system is developed for 420 kV systems and tested in India.

B1-222: This study will help in finding solutions for reduction of old cable replacement cost by increasing aging period of cables. Several parameters that affect the ageing process is examined and compared to replacement cost. In addition, it will explore how to utilize phased out old aged cables on lower operating voltages instead of abandoned them.

B1-223: During on-site testing of the grounding system, cable cores were damaged at the GIS cable termination. This occurred on a 110 kV XLPE cross-bonded three core ground cable system. The damage was caused by the steel tube of the FO element that touched the inner walls of the metal casing causing a un-intended grounding and current path.

2.2 Discussion of PS2.

The papers submitted for the Preferential Subject No 2 addresses **Best use of existing cable systems.** This covers design, manufacturing, installation techniques and operation; advances in testing, including failure location, and relevant experience; lessons learnt from permitting, consent and implementation.

Replacing old but functional cables is going on in a large scale, from an environmental point this is not desirable as Life Cycle Analysis (LCA) often will favour operating older cables as long as possible. The industry must start using proper LCA in the decisioning making process.

Right of Way is often a big challenge during installation, several solutions are being shown that includes joint bay solutions and trenchless technologies. For trenchless technologies there are some constraints that seems to be challenging, such as increased thermal resistance and short distances.

Installation in congested cities and delicate environmental areas are challenging, often trenchless technologies are used for particular crossings, however for longer stretches more conventional methods must be employed, such as tunnelling, open trenches or ducted systems.

Examples of more exotic materials are presented, such as synthetic fibre for armour. The benefit is lower losses and larger installation depths. Aluminium is also widely used for submarine cables to reduce weight and increase installation depths.

Several papers are about issues with fibre optic cables that are embedded in the power cables. Detailing safe methods for this are now part CIGRE working groups.

The advantages of being able to predict cable temperatures has been shown, this is in combination with online temperature measurements. Several papers show how to example of such modelling and comparison with real life measurements. Such modelling is not constricted to temperature predictions, but also electric field simulations.

2.3 Questions for PS2

PS2-Q1: Instead of scrapping old cables, are there examples of extended cable life by different methods, such as lowering operating voltage or by other means? The TB 689-Life Cycle Assessment of underground cables was issued in 2017 are there examples in which this has been actively used?

PS2-Q2: There are several examples of Trenchless technologies, some of up to 1250 meter length, are there studies or examples of longer stretches? What are the most difficult constraints for such long installations? Are temperature constrains going to be a limiting factor for using trenchless technologies wider?

PS2-Q3: More conventional installations are used in new ways, are there other examples such longer installations in sensitive areas? Also are there examples of multi-purpose tunnels that has been used?

PS2-Q4: The benefit from using synthetic fibre armour is low losses, are there other examples of exotic material or cable designs use that has similar or new advantages.

PS2-Q5: Modelling of cable behaviour, is there enough info to make such reliable models? And is it likely that these models can be standardized or will they be custom for each installation?

3 Preferential Subject 3 (PS3), Environmental challenges, asset management, and resilience of cable systems

- Environmental challenges in current, planned, and future cable systems.
- Quality, monitoring, condition assessment, diagnostic testing, upgrading methodologies, and relevant management.
- Safety considerations, cyber and physical security and Internet of Things, including case studies.

3.1 Papers for PS 3:

B1-301: This paper presents drivers, thought process and challenges for the developers and users of AR, with focus on custom AR applications for cable terminations and joints. In close collaboration with selected team of AR programmers and developers, project team has developed pilot applications for two different AR platforms and set of functionalities; Tablet for detailed views to aid maintenance and replacement of components. AR goggles for training of jointers.

B1-302: This paper presents the state of the art in the monitoring of Partial Discharges of underground cables with XLPE insulation in service. The system condition is displayed on a map with the georeferenced points, where all monitored points and their statuses with a traffic light approach (green, yellow or red) are displayed. The stored and translated information contributes to the increase of the effectiveness of the actions that involve the maintenance and operation of the cables, having a complete vision of the system condition. In this way, it is possible to obtain greater efficiency in the decision making and always based on the condition of the asset.

B1-303: After the installation of the first DTS/RTTR applications, large differences were observed between the calculated temperatures by the RTTR and the measured temperatures of the DTS system. The RTTR system revealed several issues in the theoretical thermal model (wrongly simulated external Earth Continuity Conductors) and installation issues (e.g. cable ducts not properly sealed and filled with bentonite anymore). In the paper the output of the RTTR system before and after the reparation of the HV cable system and the adjustment of the theoretical model is explained. The results are also compared with measurement from PT-100 sensors.

B1-304: The design and qualification testing of deep water 500 kV HVDC MI, 600 MW cable system is shown. The cable system with submarine and underground cable, factory, transition and repair joints and terminations were type tested. Sea-trial for 1200 m water depth was also performed.

B1-305: The purpose of this article is to present the experimental results from testing of cable losses conducted on a full-scale three-core XLPE submarine cable in a simulated but realistic environment. It includes a comparison between the measured data, prevailing standards' theoretical predictions, and the predictions of a numerical algorithm made specifically for this purpose. This could allow for temporary and controlled overloads, without the risk of overheating the cable, by taking advantage of the significant thermal inertia of buried cables.

B1-306: This article elaborates on how QA and QC can help to improve the reliability of EHVDC power cable systems. This is a key issue in a future in which power cable systems will increasingly be used for large scale energy transmission. Technology specific Quality Assurance (QA) and Quality Control (QC) methods during the development, design, manufacturing and installation phase of the cable systems can help significantly to further reduce the likelihood of cable failures.

B1-307: This paper deals with a new approach in monitoring and centralizing the main parameters of cable lines from a TSO. This integrated system consists of several sub-systems, which are presented in the paper; some of them have consolidated technology, while others are based on innovative solutions: Distributed Acoustic Sensing (DAS), Sheath Current System (SCS), Partial Discharge System (PDS), Fluid Pressure System (FPS) and Distributed Temperature Sensing (DTS).

B1-308: An unprecedented volume of 33kV cable faults was recorded in summer 2018 (between May and July). High fault volumes across the same months were also observed in 2016 and 2017, with a notable annual increase. These faults have been attributed to a type of cold shrink transition trifurcating joint procured between 2002 and 2010. Changing ambient temperatures during day/night has been a contributing factor for moisture ingress and subsequent failures. Data for ambient temperature conditions, from the MetOffice, has been a vital tool for the assessment. Voltage reduction was used in the critical times during the day, hence greatly reducing the number of failures/day.

B1-309: CANCELLED

B1-310: This paper explains how critical cable links are protected by fibre optic acoustic/vibration sensors during the installation phase. The Fibre Sense element detectors are tuned to mechanical activity (excavators, borers), pit activity, cable movement and cable break. In case of possible dangerous mechanical activities are detected, a dispatching patrol will arrive on-site for investigations.

B1-311: This paper will present on-line automated criterion for identification and localization of defects for underground cable sheaths. The system is based on collecting and handling the data obtained from measuring the cable sheath current. The system is designed to work both on cross-bonded system, with or without cable transposition. The system will be installed on 220 kV cable system for verification.

B1-312: Fibre optic sensors for PD measurements in accessories are reported. A sensor of the optical equipment consists of a fluorescence silicone fiber (2 mm in diameter) and should be embedded in the transparent/translucent stress cones of accessories during manufacture. The method is immune against electromagnetic disturbances and works both for AC and DC voltages. Automated software for recognising PD pattern are under development.

B1-313: This paper describes how fire safety technologies and new regulation are affecting High Voltage (HV) cables links. After an overview of consequences on HV implementation of European regulation and through a series of experiences done on HV cables, the report will propose some technical solutions to address utilities' new needs and specifications. Fire performance are now classified according to "EUROCLASSES" with associated test methods and requirements.

B1-314: In this paper there is an overview of the common frame of reference for Distributed Fibre Optic Sensing (DFOS) technology. Methods that are discussed include Distributed Temperature Sensing (DTS) for condition monitoring and load management, fault finding with DTS and Distributed Acoustic Sensing (DAS), potential for Distributed Stain Sensing (DSS). DSS is possibly the next evolution in terms of offshore cable monitoring, especially for dynamic installations (floating wind) at larger water depths.

3.2 Discussion of PS 3

The papers submitted for the Preferential Subject No 3 covers **Environmental challenges, asset management, and resilience of cable systems.** This includes Environmental challenges in current, planned, and future cable systems; Quality, monitoring, condition assessment, diagnostic testing, upgrading methodologies, and relevant management; Safety considerations, cyber and physical security and Internet of Things, including case studies.

The reduction in cost of equipment for Augmented Reality and Virtual Reality has now enabled this use for other arenas than gaming and advanced training. This can be very beneficial in the training of fitters and planning for cable installations in congested substations.

In the field of Online Asset management several cases have been presented. These systems are still new and the real experience is rather limited, however there is a hope that these systems will prevent failures and help with replacement strategies. The methods presented covers PD supervision, vibration, temperature and sheath currents.

As cable systems are most vulnerable during installation phase, either by the installation process or by third party damages. The fibre optic acoustic/vibration sensing can help the early detection or prevention of damages. In addition, this technique could also be used as online monitoring of cables during service.

3.3 Questions for PS 3

PS3-Q1: Only a few examples of AR/VR have been shown and these were specialised cases, is it likely that these new techniques will be more widespread? How would this modelling be simplified?

PS3-Q2: Online Asset management, the presented solutions either developed by Asset owners, or by manufacturers. All these systems are complex and tailormade to each specific case. Will this technology be more widespread or is it too complex to standardize?

PS3-Q3: Supervision of cables under installation by using fibre optic solutions, are there examples of this? Will this kind of fibre optic supervision be integrated in Online Asset management systems?

PS3-Q4: Fibre optic sensing have many benefits and is suitable for underground cables and moderate submarine cable lengths. Are these techniques suitable for the very long cables (> 200 km)? Are there examples of other fibre optic methods for cable supervision, apart from the more commonly used (temperature, vibration or acoustic)?

PS3-Q5: What best practices in Safety could take advantage from the race to digitalization?

ANSWERS TO QUESTIONS FROM THE SPECIAL REPORT

UPDATED – BASED ON FULLY VIRTUAL EVENT – READ CAREFULLY

Please kindly note that contributions should be uploaded on the Registration Page within July 15th 2021 for a prior screening and a good organization of the B1 Group Discussion Meeting. The number of accepted contributions will be limited, based on their relevance and quality.

Intended Contributors should upload their contribution in the “Contributions to Group Discussion Meetings” section – using their existing account and own credentials. Important: access to contribution uploading is given only to duly registered delegates. As a consequence, registration to CIGRE Session should be finalized before uploading any contribution. Contributions uploading should be open at the beginning of June. If not opened yet, keep it checked.

Contributions will be made available to Study Committee Chair and Special Reporter for reviewing and comments. Contributors are encouraged to visit their account on the Registration Platform to see the result of this review.

A guide for contributors as well as templates and sample pages will be available on the CIGRE *Centennial website* – see Group Discussion Meetings in the top menu bar.