1. Introduction:

The Chairman opened the meeting with a presentation of the present state of the Study Committee, addressing the following items, Fields of Activity, Summary of present activities, Study Committee Strategy, Future Outlook for A3 and Help of the A3 community to provide new ideas and to involve young engineers.

Based on 22 papers which have been selected by the special reporters prepared the questions.
We received 67 prepared contributions and 35 spontaneous contributions (questions and answers) during the session.

Many thanks to the authors, the contributions were of good quality and a great effort of synthesis has been done, in order to allow exchanges during the session.
Origin of the prepared contributions:

- Manufacturers 53%
- Utilities 26%
- Testing organization 7%
- Universities 7%
- Consultants 7%

Preferential Subject 1: Equipment design to facilitate network developments.
Ten Reports have been discussed.

Long gaps applied for UHV have been addressed and according to some authors this point seems not fully covered by IEC, but the conservative outcome of the IEC 60 approach, is inherent to the complexity of many factors that influence the LI and SI flashover voltage. Some improvements of the IEC standard are needed especially for long gap and high altitude.

Regarding the UHV VFTO during disconnector switching which may have peak values as high the BIL level. Several mitigations to reduce of VFTO crest value were given. Attention has to be taken for coupling between phases, especially in 3-phase GIS, which may lead to a higher value than 1.0 pu DC-charge, but this option is not applied for UHV application.

Contribution from INDIA 1200KV reported that AIS CVT will not be affected by VFTO due to is large capacitance.

A lot of interesting contributions have been presented on the HVDC breakers developments, showing several options and their interactions with HVDC networks were addressed. It seems to form an interesting new working area for both SC B4 and A3.

Several manufacturers presented their new designs and their results of tests for the VCB breaker as well as their first returns of experiences in service especially for 72kV level.

These first results seems cover the requirements of IEC standard and the market expectation.
Several contributions related to TLF, were presented, these new inputs are very valuable for CIGRE WG A3.28 as well as for the collaboration between CIGRE SC A3 & Standardization Bodies in order to improve the standard on this aspect if it is really needed.

Now CB-technology is going to the higher voltage levels. Some dielectric stresses, such as with capacitive current switching and out-of-phase conditions are still a challenge, especially for Back to Back case, but countermeasures are given such as reduction of inrush-current and adapted contact materials. WG A3.27. This topic is also addressed on PS 2 on paper A3-20.

3 Contribution related to internal arcs on inductive CT VT's, showing: tests, simulation and return of experience in service, to elaborate some counter measures for personnel safety and prevent damages to other equipments.

Among the new demands express by utilities regarding the increase of: Voltage, current, short-circuit currents, DC time constants, require that SC A3 to continue its activities analysing more deeply these new requirements.

**Preferential Subject 2: Reliability and lifetime of HV equipment**

*Six Reports have been discussed.*

Utilization of computer simulation tools is playing a dominant role in product development. This has assisted in reduction of the number of tests performed to design the circuit breaker and the time taken to develop the circuit breaker. It is well established that simulation cannot reflect the reality with an accuracy of 100% and cannot replace tests. Whilst the simulation of stresses has been seen to be accurate, the prediction of performance to withstand stresses, where performance has been proven by tests of similar design, but is not true for new designs. Output from working group A3.24 should provide further insight on this.

Protection and control devices can be applied for condition monitoring of new and old circuit breakers and specific examples has been provided for monitoring performance during first trip.

Controlled switching devices are being applied for circuit breaker condition monitoring and benefits for life time management can be realized through this. Application of specialized circuit breaker monitoring devices requires careful design and application of proven technology.
Increase in servicing intervals has been shown to increase the failure rates of circuit breakers. Observation is that whilst maintenance optimization may lead to increase in failure rate for particular equipment it has seen to have a positive influence on the reliability of the network.

It is now acknowledged that the GIS technology has improved over the time due to new design and return of experience. Dielectric failures reported in GIS have been mainly due to surface abrasion of operating rods in the disconnector and earth switches.

A multistage equipment model that utilizes maintenance data and human knowledge has been presented. Whilst not reported as being used by the utility right now it is a logical model that can be extended to predict condition and modulate future maintenance requirements.

Findings from survey undertaken by CIGRE working group A3.06 shows reliability of Gen CB’s and HV CB’s is comparable. Selection of generator circuit breakers needs to consider the difference in duty.

Experience from Japan on successful application of VCB’s for 72/84kV since 1980 has been presented. Various design considerations proposed including larger size of vacuum interrupters (to reduce field strength between contacts), an axial magnetic field electrode (to reduce level of surface damage) and utilization of contact material with a higher melting point. Specific testing consideration should also be given to SF6 or VCB technology installations where back to back switching resulting in high inrush current is possible. The work undertaken by WG A3.26 and A3.27 are relevant in this area. Two questions were raised, one on the need of a dedicated IEC standard for VCB and one regarding the level of x-ray emission for the highest voltages. Concerning the second question the answer provided by one expert has shown that the level will not exceed the requested values by the IEC standard.

The positive influence of adapted contact materials on performance of capacitive switching by vacuum circuit breakers was discussed. The working group A3.29 / A3.30 deal with on "Management of ageing and deterioration of HV equipment". There also exists potential for A3 to work with B3 and B5 on application of secondary equipment for effective life time management of HV equipment.
Preferential Subject 3: Environmental suitability of HV equipment.

Six Reports have been discussed.

The excellent performance of composite insulators under severe pollution conditions has been highlighted including for the insulators with the helical profile to IEC, despite the bad image coming from the old porcelain SPIRELEC insulators.

Only few problems were reported during the spontaneous contributions and some general explanations were provided by other experts during the session. In addition the return of experience under the harsh conditions of high power laboratories, confirm that explosion of composite insulators of auxiliary breakers are less detrimental to personnel and equipments in the vicinity than explosions of porcelain insulators.

The aggressive marine environment leads to more corrosion and a saline moisture layer on the conductive materials, such as connectors. A study on this problem has been presented showing the use of simulation tools for an improved design.

A well documented contribution regarding the Great East Japan Earthquake in Japan in 2011, showing that electrical equipment withstand this level of constraints due to safety factor of 2 or more that have been applied according to the Japanese standard JEAG-5003.

4 contributions addressing new gas breaking medium, showing an extensive work and now the CO2 breakers has been developed and are presently under field test. Ins and outs of CO2 versus SF6 were presented and seem that no "show-stopper" is foreseen. In one contribution Nitrogen has been compared with SF6, CO2 and vacuum, showing that CO2 seems at that time a better competitor for SF6 and vacuum than N2. Nevertheless, all gas medium remain possible and investigations are continuing.

Mark Waldron's for its last session SC A3 as chairman, thanked the Special Reporters, the SC Secretary and the Session Secretary; and also the authors, contributors and the audience.