Year 2007

Progress Report of Study Committee A3

by E. Kynast, Secretary of SC A3

Field of Activities

Study Committee A3 is dealing with the theory, design, construction, and application of high voltage equipment for both AC and DC systems. Any kind of substation equipment (with the exception of power transformers) such as switching devices, surge arrestors, capacitors, bushings, instrument transformers, insulators are within the responsibility of Study Committee A3. According to the mission statement the SC reacts on emerging problems within the given scope but the SC also is proactive to deal with future technologies and their possible impact on standards and changes in the power system.
The current work of the SC can be roughly described by the following major areas:

- Reliability of equipment
- Interaction between network changes and equipment development
- Support for standardisation
- Apparatus technology

Below a brief summary of the according Working Group activities is given.

A major role of the Study Committee is to perform preparatory work for international standards. The necessary cooperation with the standardizing bodies is given by various personal contacts and the engagement of the active A3 Members in the relevant standardization organizations.

The dissemination of the technical information developed within the SC and its Working Groups is conducted by workshops, colloquia and tutorials in coordination with local CIGRE organizations or outside of CIGRE in conjunction with adequate technical events.

CIGRE SC A3 Colloquium– Rio de Janeiro 2007

Taking into account the invitation made by the Brazilian member of SC A3, Mr. Jorge Amon Filho, two years before, the Brazilian National Committee of CIGRÉ, in joint cooperation with the international Study Committee A3, organized in Brazil an International Technical Colloquium on HV equipment entitled "HV Equipment Technologies and System Requirements" on September 12th –13th, 2007. In the

sequence, the SC A3 also held its annual meeting and the following SC A3 Working Groups and Task Force also took this opportunity and held their scheduled meetings on September 10th-11th, 2007: WG A3.16, WG A3.17, WG A3.20, WG A3.22 and TF A3.06.01. All these activities took place at the Copacabana Sofitel Hotel, Rio de Janeiro – Brazil.

The Technical Colloquium was mainly directed towards utilities (GENCO, TRANSCO and DISCO), manufacturers, design engineers, system operators, transmission operators, research centres, as well as academic organizations involved in any way on electric power systems and HV equipment issues and concerns. About 130 registrations were made.

The SC A3 Technical Colloquium addressed the 3 following topics, as preferential subjects (PS) of the scheduled presentations:

- PS1 "Optimized Asset Management Techniques for HV Substation Equipment"
- PS2 "Impact of Challenging System Conditions on HV Substation Equipment"
- PS3 "Developments in HV Substation Equipment (Excluding Switching Devices)"

For these three Preferential Subjects, 40 international articles were selected, coming from 12 different countries.

During the opening session the Brazilian National Committee of CIGRÉ was represented by Mrs. Maria de Fátima Gama, member of the directory board, to transmit the welcome message on behalf of the President. Also during the opening ceremony, Mr. Mark Waldron, chairman of the international SC A3, gave the welcome message as well.

From the technical point of view and the importance of the subjects presented, the colloquium can be considered as a successful and profitable meeting for those who could attend it.

Working Group Activities

WG A3.06 Reliability of HV Equipment

WG A3.06 has launched a worldwide enquiry on service experience on high voltage equipment. The survey includes several types of high voltage components: Circuit breakers, disconnectors and earthing switches, instrument transformers and gas insulated substations (GIS). As GIS equipment is also considered the work is in close cooperation with SC B3. The ongoing work is to collect population and failure information from participating utilities, check the information, and bring it into the database. Further efforts are necessary to get participation from some “major” countries, which participated in previous studies but not jet this time. A paper with intermediate results has been presented at the SC A3 Colloquium in Rio de Janeiro 2007.

WG A3.12 Circuit-breaker Controls

The reliability of control circuits of HV AC circuit breakers was investigated in a worldwide enquiry by WG A3.12. For failure analysis the secondary control system of a breaker was broken down very detailed into its subsystems and components. Some key conclusions are the following:

- Major and minor failures were approximately equal in number in this survey.
- The number of failures does not increase significantly with the number of operations.
- There was a trend observed for a higher tendency for failures in the first 1-2 years following a maintenance operation. This was interpreted as an indication of the potential for human error when maintenance work is performed on circuit breakers.

The WG finished their work with the publication of the Technical Brochure No. 319: "Circuit Breaker Controls - Failure Survey on Circuit Breaker Controls Systems". WG A3.12 was disbanded in 2007.

WG A3.13 Changing Network Conditions

WG A3.13 was installed to investigate the impact upon substation equipment of recent network developments. Special attention was given to the consequences of the growth in distributed generation and to the consequences of long distance AC transmission leading to voltage problems and the need for reactive power compensation. In both cases the interaction between protection and control systems on one hand and the network dynamics on the other hand will play a dominant role in the severity and probability of the phenomena that have to be withstood by the applied primary HV AC equipment.

The results of theses investigations were described in two Technical Brochures "Changing Network Conditions and System Requirements, Part I: The impact of distributed generation on equipment rated above 1 kV" (TB 335) and "Part II: The impact of long distance transmission on HV equipment" (TB 336). WG A3.13 was disbanded in 2007.

WG A3.15 Non Conventional Instrument Transformers

The use of digital communication in control and protection systems favors electronic current and voltage transformers. Working Group A3.15 discusses sensing technology, practical application aspects as calibration, maintainability and reliability, as well as the integration of NCIT´s in control and protection communication architectures. NCIT´s use a variety of technology options ranging from optical sensing technology, Rogowski coils and capacitive voltage sensors to low-power transformers. Each option offers advantages for integration in specific primary apparatus. The group compiles a technology survey and discusses past and present field applications.

WG A3.16 Fault Current Limiters

Major goal of the WG A3.16 was to get an answer how the use of fault-current limiters has an impact on the protection schemes and functions in electric power systems. Depending on the current limiting technique used, today's protection concepts have to be adapted or revised to ensure proper network protection selectivity. A relationship

between fault-current limiters and protection schemes should be established by taking into account both protection and network specific issues, such as the impact of different FCL technologies, existing and new protection concepts, selectivity and innovative network configurations. The results will be published in the Technical Brochure "Guideline on the impacts of fault current limiting devices on protection systems" in the beginning of 2008. A rough overview on the subject was presented at the A3 Colloquium 2007 in Rio.

WG A3.17 Surge Arresters

Since the first experience of gapless MO-Surge arresters, mainly porcelain housed types, there was progress in the material development for the MO-material itself and especially in non-ceramic insulating materials. The matured MO-material and new possibilities for the design opened the way for new applications. The WG A3.17 deals with the new developments and the future trends, especially with a critical revision of the actual standard IEC 60099-4. The understanding of the phenomena around energy dissipation of MO-surge arresters is also a main topic. Different tests exist to prove the energy capability of arresters and to use different ways for the energy input.

Two papers on behalf of A3.17 have been presented at the A3 Colloquium 2007 in Rio: "A critical review of the actual standard IEC 60099-4: Metal-oxide surge arresters without gaps for a.c. systems" and "Energy handling capability of High-Voltage Metal-Oxide Surge Arresters-A Critical Review of International Arrester Standards"

WG A3.18 Grading Capacitors

A few unexplained failures of grading capacitors were reported in the past. Therefore WG A3.18 collected information about reliability and failure history of grading capacitors by interviewing utility representatives around the world. Many reported about leaks on capacitors which had been in service for 20 years or more. Some instances of disruptive dielectric failure of grading capacitors were also reported - mostly associated with circuit-breakers that had been switching low inductive currents. Simulations show excessive over voltages during switching operations for this special application.

Beside the gathering of the service experience the mechanical and electrical stresses were discussed with the aim to give recommendations for test procedures since neither standards nor common procedures for the qualification of grading capacitors are available today. The results will be published in a Technical Brochure in the beginning of 2008.

WG A3.19 3Phase line fault TRVs

Three phase fault tests performed by a US-utility and verified by EMTP and analytical theory confirmed that the first pole to clear has a significant higher TRV than the last pole to clear, which may result in a higher first peak than presently required by circuit-breaker standards. WG A3.19 was installed to answer the question whether a revision of standards is necessary.

The WG is searching for test duties, which can cover the discussed three-phase faults. Intense discussions were carried out on the ability to in general, envelope the TRV capability required for 3 phase line faults by combining aspects of the tested capabilities

for single phase short line faults and 3 phase terminal faults. Result may be that only minor changes are necessary to the existing standards.

WG A3.20 Simulations and Calculations

WG A3.20 carried out an inventory of stresses to which A3 components are subjected to in service. An assessment has been made to determine to what degree such stresses can be simulated.

A dielectric benchmark study has been carried out between different software tools used by major manufacturers. It has shown that different software tools used by major manufacturers predict almost identical dielectric stresses. But the prediction of withstand voltage varied widely. At the present time, it is not envisaged that simulation can replace type tests. Only performance prediction can be possible in cases where performance is proven by tests of similar designs.

WG A3.21 Application of Non-Ceramic Insulators

WG A3.21 is analysing the application of polymeric insulation to external insulation of apparatus and components. Technical details were gathered concerning the classification of insulators and manufacturing processes. Advantages and precautions in the use of polymeric insulators were discusses. The present standards will be analyzed concerning their applicability to apparatus and components with polymeric housings. The influence of the equipment active parts on the short and long terms electrical performances will be investigated, especially the interaction of the electrical field and thermo-mechanical, as well as chemical interactions.

WG A3.22 UHV Equipment

The WG gathered the technical specifications/requirements and their background of all substation equipment applied to various national / international projects exceeding 800kV. The survey covers 800kV and 1050/1100/1200kV systems with circuit breakers, earthing switches, disconnectors, high-speed grounding switches and surge arresters. Transformers, current- and voltage transformers will be investigated in a further step.

The state-of-the-art specification of exceeding 800kV substation equipment, the experience of the projects and proposals for the existing standards will be published in a Technical Brochure in the beginning of next year.