

## **Tutorial Delivered and Presented in the Past within SC A<sub>3</sub> (High Voltage Equipment)**

- 1 Introduction to HV circuit breakers; Shunt reactor switching; Capacitive current switching; Metal oxide surge arrester application; Introduction to controlled switching; Life management of circuit breakers
- 2 Surge Arresters: IEC 60099-4 standard; Metal oxide surge arresters; Overvoltage protection of shunt capacitor banks; SiC arresters: ageing phenomena and monitoring procedures; Metal oxide surge arresters for distribution systems; Transmission line arrester applications, installations and designs; Experience in TLA application; Energy handling capability of ZnO arresters; ZnO varistors: physics and technology; Special 500 kV transmission line switching: surge arrester specification and duties; Performance of distribution class arresters under certain climatic conditions; CEMIG's experience with surge arrester monitoring for 69 and 138 kV systems; Brazilian experience in the improvement of transmission line performance using line arresters; Polymer technologies and application on high voltage systems
- 3 High voltage circuit breakers
- 4 Statistical analysis of electric stress in service; Controlled switching: Progress of IEC 62271-100 and application guide: Fault current limitation; Metal oxide surge arrester application and insulation coordination; Current interruption using high voltage disconnectors
- 5 Circuit breaker application: different considerations for different duties
- 6 Reliability of HV equipment: Maintenance and reliability theory; Past cigre surveys on reliability of HV equipment; Structure of present Cigre survey; Preliminary results from present Cigre survey - circuit breakers, disconnectors/earthing switches, instrument transformers and GIS; Use of Cigre survey: improvement of internal utility reporting procedures; Substation risk failure assessment; Failure case studies; Maintenance procedure assessment; Measurement of equipment life and life extension
- 7 Current interruption in atmospheric air
- 8 Recent developments in distribution switchgear standards
- 9 Circuit Breaker Seminar - Standards and Guidelines: Introduction to Cigre application guide; Introduction to IEC standards; TRV: General considerations: Terminal faults; Generator CBs; Short line faults; Three phase faults; ITRV; Out-of-phase; Selection of circuit breakers for TRV: X/R and asymmetrical faults; Inductive current switching; Synthetic testing; Capacitive current switching; Harmonization of international standards; Controlled switching; Circuit breaker selection
- 10 Use and Application of Optical Instrument Transformers
- 11 Reliability of HV Equipment: World reliability study - intermediate results for circuit breakers, disconnectors, earthing switches, instrument transformers, GIS; Use of reliability survey data; Use of Cigre Survey to improve CEPS reporting system about equipment reliability; Statistical processing; High voltage equipment monitoring - a summary and evaluation of various data sources; Japanese improvement activities for the reliability of HV equipment; Reliability improvement of GIS based on analysis of failure cases
- 12 Overvoltage Protection for Distribution Systems
- 13 Selection and Application of Surge Arresters

- 14 **Modeling and Testing of Transmission and Distribution Switchgear**
- 15 **Fault Current Limiters; Reliability of High Voltage Equipment; Surge Arresters; High Voltage Vacuum Switchgear**
- 16 **Reliability of High Voltage Equipment - Results of Global Survey**
- 17 **Reliability of High Voltage Equipment**