SC B5 DISCUSSION SUMMARY 2008
PREFERENTIAL SUBJECT 2

by Special Reporter
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"Life Cycle Management of Protection and Control Systems"

Seventeen (17) papers by authors from fifteen (15) countries were submitted under this preferential subject and five (5) main topics for discussion were identified:

A. Testing methods for PCS
B. Impact of IEC 61850 on testing and asset management of PCS
C. Lifetime management of PCS
D. Remote management of PCS
E. Exploitation of PCS.

Forty-six (46) prepared contributions were received and presented at the session, in response to the ten (10) questions posed by the Special Reporter.

A. TESTING METHODS FOR PROTECTION AND CONTROL SYSTEMS

Five countries have contributed with four papers related to this topic. Paper B5-203, outlines a method to speed up functional testing of new feeders in liberalized electricity markets. Paper B5-204, reports the experience of the Romanian Transmission and System Operator in commissioning numerical protection and control systems. Paper B5-214, overviews the spectrum of distance protection testing, from individual elements to complex functional schemes. Paper B5-215, overviews the designs of two types of distributed bus bar protections, based on current balance on the bus, or on directional comparison detected by remote units. Testing of these systems require the sequential testing of merging and remote units, followed by the central unit.

Concerning Question 1, about test reduction strategies, contributions focused mainly on the use of portable substitute relays, with standardized removable connectors, and event analysis to reduce testing. One utility reported the use of complete acceptance and field tests during commissioning to avoid periodic tests, replaced by on-load checks and event analysis. Duplicated protections are also tested individually, with no service interruption.

Question 2, about coordination of distributed testing, generated contributions related to testing of specific distributed systems. Special Protection Schemes are tested by downloading simulated data, synchronizing their clocks and testing devices simultaneously. Double distributed busbar protections with sampling synchronization are tested by checking each terminal unit in sequence. One contribution reported the use of coordination of overlapping partial tests, avoiding the simultaneous test of the entire distributed system. On small stations, it suggests the use of device test modes to avoid de-energizing. Another contribution recommends that distributed tests could be done like individual tests, using multiple test sets synchronized by GPS.

B. IMPACT OF IEC 61850 ON TESTING AND ASSET MANAGEMENT

Five countries have contributed with four papers related to this topic. Paper B5-201, summarizes the testing of systems based on IEC 61850, and their requirements for maintenance. Paper B5-206, reviews the main aspects of testing PCSs, including IEDs, wiring and interfaces, during commissioning, repair, maintenance, upgrade, expansion and component replacement. Paper B5-209, describes an ongoing research project to develop a Test Lab to support teaching and testing of IEC 61850 based systems. Paper B5-216, describes a UML formalization and extension under development by EDF R&D of parts of IEC 61850 standard.

Regarding Question 3, about the use of software models and simulations, contributions reported the application of PC based simulations for testing every design phase in parallel with manufacturing. During FAT and commissioning, they are used to simulate items not built. Real IEDs used on the tests should not distinguish simulated from real data. It was emphasized that different models and simulators are required for different purposes, functions and devices. In general, models help in the design, evaluation and teaching of new systems and concepts. Specifically, UML models allow the automation of specification and testing of new systems.

One contribution addressed the topic of question 4, about methods to reduce the risk of testing. It suggests that tests should be based on general principles, like being structured, incremental, evolutionary, re-usable, and apt to regression testing.

C. LIFETIME MANAGEMENT OF PROTECTION AND CONTROL SYSTEMS

Three countries have contributed with three papers related to this topic. Paper B5-202, discusses the main issues related to life cycle management of Substation Automation Systems (SAS), with emphasis on hardware and software obsolescence. Paper B5-211, reports on Iberdrola and REE experience in refurbishing the protection schemes of the Spanish transmission network. Paper B5-217, reports a cooperative study of Japanese utilities and manufacturers about current practices of operation and maintenance of relay systems.

Answering question 5, about spare parts dimensioning methods, contributions from utilities focused mainly on empirical methods, like keeping stocks proportional to installed base. Few utilities use statistical methods to limit chances of batch failure. Suggested criteria for dimensioning spare parts involve items like location, MTTR/MTBF, obsolescence, installed base, design and expected lifetime. Japan reported an agreement among utilities and manufacturers to keep spare parts for 10 years stocked by manufactures, for out-of-product items. One utility reported also the store of out of product relays.

Contributions related to question 6, about criteria for selecting maintenance interval, were centered mainly on general principles adopted by utilities or suggested by manufacturers. Optimum test frequency relies mainly on expected reliability, fault probability, and techno-economic trade-offs. Most utilities base their test interval on experience or manufacturer suggestions, ranging typically from 2 to 6 years. Most expanded their test intervals to 6 years for numerical relays, replacing tests by monitoring and reliability analysis.

D. REMOTE MANAGEMENT OF PROTECTION AND CONTROL SYSTEMS

Five countries have contributed with three papers related to this topic. Paper B5-205, describes the architecture and requirements of a remote system for managing PCS and its application at the Dutch utility NUON. Paper B5-208, presents the result of a joint work of CEPEL and utility LIGHT S.E.S.A, to develop an automated analysis system to evaluate operation of protective relays. Paper B5-213, describes the ongoing development of an Intelligent Operative Maintenance Management system at Elektro Ljubljana in Slovenia.

Question 7, about remote management systems, received contributions describing systems used to supervise and control relays and DFR, fault and settings, statistics and maintenance actions. Japan reported the use of distinct networks for real time and on-line monitoring. Advanced use of remote management systems were reported covering automatic event analysis and independent testing, and the use of expert system rules to attain reduced time requisites for fault analysis. In general, most utilities plan to control settings and hardware information in a near future, using remote management systems.

With regard to question 8, about remote change methods and grid rules, contributions revealed the reduced use of this method by utilities and system operators, for protection systems. Brazil reported that remote changes of protection settings are used only in specific situations; while supervisory data is usually changed remotely. Japan also reported that remote changes are currently not used. One utility in Japan plans to use dedicated networks for changing settings activated by SCADA. No grid rules were reported about this topic. The Netherland defends that no new grid rule is necessary, suggesting the implementation of ICT best practices, processes and roles to regulate remote changes. Further discussion will be necessary on this topic, as remote changing of protection settings proliferate among utilities and operators.

E. EXPLOITATION OF PROTECTION AND CONTROL SYSTEMS

Six countries have contributed with three papers related to this topic. Paper B5-207, reports on the key aspects of protecting 1000kV, 600km UHV transmission lines under construction in China. Paper B5-210, addresses the issue of increasing complexity of protection systems, and their impact on human errors, against a simplified standardized solution. Paper B5-212, raises the issue of the impact of a correct determination and use of K-factor, the ground impedance matching factor and mutual coupling on the performance and reliability of distance protection.

Regarding the reduction of human intervention, the subject of question 9, contributions focused on four different approaches. The first, related to technology, suggests the application of digital relays, as shown by a 9 year statistics from Brazilian utilities, showing the reduction of accidental trips after the introduction of digital systems. The second approach relates to the policies adopted by utilities, suggesting the specialization of teams for complex tasks, and requiring maintenance guides, detailed tests and training for new PCS. The third approach suggests maximizing the use of software and FAT to minimize hardwiring and SAT; designing for easy upgrade, use of watchdogs and fault analysis. Specific tools like configuration generators and protection emulators for testing are recommended also. The fourth approach suggests keeping new designs as simple as possible, using black-box approach and IEC 61850. Standardization of hardware and setting criteria is also recommended to simplify current systems and reduce human intervention.

Regarding question 10, about measurement of line parameters, contributions described experiences of agreements between calculated and off-load measured parameters of submarine cables in Japan, and disagreements on overhead line parameters in South Africa. On-line measurement made in Brazil, for overhead lines, using internal PMUs of relays, also showed disagreements with calculated values. France has reported the use of a unique database of line parameters that is validated by load flow studies and checked during grid events avoiding the need for testing. Research projects were announced, in Japan and Brazil, for on-load measurement of line parameters, using synchronized waveforms and DFRs.

CONCLUDING REMARKS

From the contributions received and the discussions in the session, a number of conclusions can be drawn.

Life cycle management of protection and control systems presents distinct requirements from traditional lifetime management. Contrary to conventional physical assets, software plays an increasing role on PCS as compared with hardware. Virtualization and distribution of IED functions is steadily under course, while standardization of hardware is a possibility in the future. Traditional methods of lifecycle management are mainly oriented to hardware administration, lacking adequate tools to manage software assets. Human intervention is a major cause of accidental outages, raising questions about design complexity and adequacy of current methods for testing distributed systems.

To cope with these tendencies, new tools for managing software based PCS are needed. Capabilities to use software models, administration of changing user requirements, configuration databases, distributed real time applications, local and wide area networking, software versioning, remote access, automated testing and security issues are novel requirements not found in traditional asset management tools, current grid rules or on the protection engineer toolbox. Developments are demanded in these areas.