PROTECTION OF HV & EHV TRANSMISSION SYSTEMS

22 – 25 AUGUST 2016, KUALA LUMPUR, MALAYSIA

PAST TESTIMONIAL

“If you want to learn the concepts & principles, and how protection relays really operate, and as a protection engineer have a deeper appreciation and understanding of what you do at work, then this will be very valuable. Especially if you want to know how relay protection is related to all formulas and concepts you have learned from your electrical engineering course in school.” Senior Engineer, NGCP

“Excellent” –Electrical Engineer, TOYO Engineering & Construction Sdn Bhd

“A very useful course to attend. Full of new information, knowledge regarding the protection in transmission system” –Technician, Sarawak Energy Berhad

“Overall discussion, materials trainers, venue and everything are all excellent. Very useful for system operations & commissioning, relay setting & protection relay engineers.” Engineer, NGCP

“A well-structured course module that meet the target group nicely” –Maintenance Engineer, Sarawak Energy Berhad

“Recommended for any protection engineer. Very clearly explained and detailed that is definitely useful for those who work in power industry.” Protection Engineer, Sarawak Energy Berhad

Expert Course Faculty Leader

BARRIE MOOR
About This Training Course

With specific reference to High Voltage (HV) and Extra High Voltage (EHV) electricity transmission systems, this 4 day seminar is designed to provide the delegates with a comprehensive understanding of the philosophy of protection scheme selection, protection scheme configuration, and the non-relay specific principles associated with the determination of scheme and relay settings.

Protection of today’s sophisticated Electricity Generation, Transmission and Distribution Systems is necessary to maximise safety for the public and electricity industry employees alike, to disconnect faulted plant from the system, and to maintain quality of supply to customers. Reliability of these protection schemes is important to ensure damage to the power system is minimised, faulted plant is disconnected, system stability is maintained, security is optimised, and to ensure unfaulted plant is not inadvertently tripped from service.

Especially with respect to HV & EHV electricity transmission systems, the modern trend is for these networks to be operated closer and closer to their limits of performance. This requires the associated protection systems to be optimized: to be simultaneously coordinated, to be fast operating, to be secure and to be reliable. These are conflicting requirements, but nevertheless their implementation is critical to the optimal performance of national and international electricity systems. In addition the protection systems associated with HV & EHV Transmission Networks must maintain power system stability while not constraining inter or intra-regional power flows.

This seminar, “Protection of HV & EHV Transmission Systems”, provides a comprehensive understanding of the sophisticated protection systems used to protect HV & EHV transmission and distribution systems. The seminar also covers the application of modern micro-processor based relay technology, as well as covering the application of older electronic and electromechanical relays, this latter group being the majority of devices still in service.

“Protection of HV & EHV Transmission Systems” is designed to provide attendees with an advanced understanding of the full range of protection equipment, including differential and distance protection schemes.

Course Learning Outcome

On completion of this seminar you will be able to:

1. Describe the principles, specify the functionality and determine the high-level (i.e. non-relay specific) protection schemes and settings associated with transmission and distribution power system plant, including high voltage busbars, transformers and feeders (differential protection).
2. Specify a current transformer (CT) to cope with fault currents that include exponentially decaying transient DC components.
3. Describe and explain the implications of voltage transformer (VT) transient performance.
4. Design and implement distance relay protection schemes, in particular:
   - Select a suitable relay characteristic based on an understanding of relay comparator operation.
   - Allow for various starter characteristics.
   - Develop a grading plan to ensure coordination with protection relays elsewhere on the power system.
   - Allow for the effects of mutual coupling with other feeders on the same easement.
   - Design protection schemes and set relays for teed feeder configurations.
   - Design protection schemes and set relays for bridged feeder configurations.
   - Allow for the effects of arc and/or fault resistance.
   - Describe and explain the application of VT supervision, healthy phase polarizing, Switch OnTo Fault (SOTF) logic, power swing blocking logic, ensure load encroachment does not cause inadvertent tripping and ensure healthy phase fault currents do not degrade distance relay performance.
5. Specify and explain the application of distance relay protection signalling schemes.
Who Should Attend

This seminar has been prepared specifically to provide this crucial knowledge for:
- Planning Engineers, to identify the difficulties in providing protection for various power system configurations under review
- Maintenance Engineers, to ensure that system protection is not compromised as plant is removed from service during maintenance
- Circuitry Design Engineers, to ensure that protective schemes are implemented in a manner to provide optimum performance
- Commissioning Engineers, to ensure the actual field installation of the protection scheme and associated relay settings meets the design requirements.
- Field Technicians, to understand the importance of their role in installing, testing and maintaining effective, reliable, dependable and secure protection systems.
- Protection Design Engineers, to identify protection implications and to ensure design, coordination and relay setting principles provide the necessary levels of speed, security, dependability and safety.

4 Day Course Outline

Day 1

High Impedance Differential Protection
- Basic principles
- Principles of relay setting determination
- Voltage and current relay based schemes
- Use of Ratio Correction CTs (RCCTs)
- Use of voltage limiting non linear shunt elements (Metrosils)
- Determination of primary operating current
- Application of Bus Zone Check schemes
- Back-up requirements
- Application of HZ schemes to other plant

Transformer Biased Differential Protection
- Effects of transformer turns ratio
- Effects of transformer phase shifts
- Effects of transformer zero sequence currents
- Determination of CT connections for older style relays
- Determination of relay configurations for microprocessor based relays
- Basic relay setting principles
- Biased differential protection including:
  - Earthing transformers
  - Earthed delta windings

Day 2

Application Of Biased Differential Schemes To Busbars
- Schemes types
- CT requirements
- Special features

Feeder Differential Protection
Pilot Wire Schemes
- Application of summation transformers
- Application of pilot wire supervision
- Application of overcurrent and earth fault checking
- Application of unstabilising and intertripping

Feeder Differential Protection
Current Differential Schemes
- Synchronisation of relays (ping pong topology)
- Principles of relay setting selection
- “Alpha Plane” Systems
- Scheme applications
## Day 3

### Distance Protection: Voltage and Current Transformers
- IEC60044 Specification of VTs
- Capacitor VTs
- Transient Performance of VTs
- Class P & PX CTs to IEC60044
- Transient Performance of CTs

### Distance Protection: Fundamentals
- Basic operation principles
- Amplitude comparators
- Phase angle comparators
- Impedance and Mho characteristics
- Production of complex characteristics (Quad etc.)
- Load encroachment
- Detection of Multi phase faults
- Detection of Earth Faults (Ko residual compensation)

## Day 4

### Protection Signalling
- Direct & Series Intertripping
- Distance acceleration
- Permissive intertripping
- Underreaching schemes
- Overreaching schemes
- Unblocking schemes
- Blocking schemes
- Directional earthfault schemes
- Use of Power Line Carrier (PLC systems)

### Distance Protection: Advanced Aspects
- Mutual Coupling
- Distance Relays & Teed Feeders
- Distance Relays & Bridged feeders
- Distance Relays & Fault resistance
- VT supervision
- Polarisation
- Switch On To Fault (SOTF) performance
- Power Swing Blocking (PSB)

### Basic Principles of Reach (Setting) Selection
- Zone 1
- Zone 2
- Back-up Zones
- Reverse Zones

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This training course has a limited attendance for up to 20 participants only.

Sessions commence at 9am on all days, with short intervals at 10.30am and 3.30pm respectively. Refreshments will be provided in the short intervals. Lunch will be provided at 12:30pm for 1 hour. Sessions will end at 5pm on all days.
Your Expert Course Trainer: Barrie Moor

PowerEDGE is proud to present this seminar in conjunction with our Australian associate, Power System Protection Training. PSPT is an ASIC (Australian Securities and Investment Commission) registered partnership, focusing specifically on the provision of professional development seminars in the discipline of Power System Protection.

This seminar will be prepared and conducted by their Principal Engineer, Mr. Barrie Moor.

Mr. Moor’s experience in this field is based on

- **39 years in the Queensland Electricity Supply Industry in Australia**, with the transmission corporation of Powerlink Queensland and its predecessors of QEC, QEGB & SEAQ. Mr. Moor also has some experience in the Planning and Substation design disciplines, but has been devoted to Protection Design since 1981. Having, over the years, performed protection design and settings for all of the Queensland electricity transmission network, including major generating stations, he then for 7 years was the team leader responsible for the entire design team. Mr. Moor stood down from that team leader position in 2007 to allow him to take a more active technical involvement in the position of Principal Consultant Substation Protection.

- **CIGRE** – for 7 years Mr. Moor represented Powerlink on the Australian CIGRE panel APB5 (Power System Protection & Automation). He also served as a corresponding member of the international CIGRE working group WG21.

- **IET** – Mr. Moor remains as a corresponding member for the IET International Conference on Developments in Power System Protection (DPSP 2014 held in Copenhagen).

- **QUT** – Mr. Moor has also been involved in the Queensland University of Technology (QUT) Post Graduate Electricity Supply Training Course (QUT PESTC) for more than 20 years, preparing and delivering 2 modules on power system protection. These are 15 hour modules delivered over a period of 2.5 days. Apart from thus making more than 80 presentations at QUT over the past 2 decades, he has also presented these QUT modules in Singapore, Malaysia, and New Zealand.

- **AUSTRALIAN POWER INSTITUTE (API) ** – Mr. Moor has been the guest speaker at the Australian Power Institute (API) Summer School on the topic of “Protection Fundamentals and Best Practice” for the past 5 years.

- **POWER SYSTEM PROTECTION TRAINING (PSPT)** – From 2007 Mr. Moor has also been presenting seminars on Protection Design, with now more than 50 seminars presented in the public arena as well as more than 20 seminars custom designed and delivered in-house to major transmission, distribution and engineering corporations throughout Australia and internationally.

After nearly 40 years of industry experience, Mr. Moor left Powerlink in 2012, allowing him to be more focused on the QUT PESTC courses and the many PSPT seminars that he now presents either in-house to major transmission, distribution and engineering corporations, or in the public arena, as noted above.
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