



A 2-Day Professional Development Seminar on

GENERATOR & POWER STATION PROTECTION



Who Should Attend

Technical personnel who are involved in planning, design, installation, operation and maintenance of protection system for generators and power stations, such as

- ◇ **Protection Design Engineers**
 - ◇ Planning Engineers
- ◇ **Operation & Maintenance Engineers**
 - ◇ Circuitry Design Engineers
- ◇ **Commissioning & Project Management Engineers**
 - ◇ Technicians

Organised By :



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The requirements of safety, minimisation of damage to faulted plant, minimisation of consequential damage to healthy plant and maintenance of a stable and secure supply of electricity are paramount to all protection designs. A generator may be exposed to three types of occurrence which require protection schemes to operate effectively and efficiently but in vastly different time frames.

- ◇ **Generator Fault** : This requires instantaneous tripping of the generator to minimise the damage caused. Generator multiphase fault levels may exceed 100kA, whereas, via high resistance earthing techniques, the same generator may have an earth fault level of only a few amperes.
- ◇ **Generator Event** : This is an event local to the generator which will not immediately cause damage but will eventually do so unless rectified. Protection initiates an alarm rapidly to alert the operator and to allow intervention and, if this is unsuccessful, finally tripping before actual generator damage occurs.
- ◇ **External Event** : This is a transmission system event which will not immediately cause damage to the generator and can be rectified by operator intervention. An alarm is generated rapidly to alert the operator of the condition, followed by tripping as necessary if appropriate action is not taken or is not successful. In particular, note that such events affect every generator within a particular power station, and even may affect generators over a wide area. Hence tripping must be delayed as long as possible to avoid widespread system shut-downs, but must nevertheless still provide protection for the affected generating plant.

In this seminar we will consider the application of protection to generators, considering the three occurrences mentioned above. This will facilitate an appreciation of generator protection, the coordination aspects of these protection schemes, and the information required to determine protection settings.

But, beyond the generator itself, the power station engineers and technicians need an intimate understanding of the protection schemes associated with the remaining plant, including busbars, transformers and the many large induction motors.

Thus the task, not only for the protection engineer, but for all engineers and technicians associated with the power station, is to ensure that planning, design, coordination, implementation, commissioning, operation and maintenance of protection systems optimises both the dependability and security of these schemes.

What You Will Learn?

This 2-day seminar focuses on the principles of generator and power station protection schemes, including their application to generator faults, generator events, external power system events, and power station motor, busbar and transformer faults.

Delegates will learn the principles of power station protection schemes, the art of scheme selection, and the generic processes associated with determination of optimal settings and configurations for the protection relays and schemes associated with power station generators, motors, busbars and transformers.

1. High Impedance Differential Protection

- *Application to Generators, Transformers and Busbars*

- High impedance differential protection principles
- Determination of setting voltage
- Determination of scheme primary operating current
- Application of series (stabilising) and shunt (de-sensitising) resistors
- Application of non-linear resistors (Metrosils and MOVs)
- CT supervision requirements
- Application of high impedance differential protection principles to plant other than busbars

2. Transformer Protection

- Introduction to Buchholz and Pressure Relief Devices (PRDs)
- Introduction to Positive, Negative and Zero Sequence Component Analysis, in particular:
 - Transformer Earth faults, sequence components and transformer phase shifts
 - Transformer Phase-Phase faults, sequence components and transformer phase shifts
- Biased differential protection
 - Inrush and magnetising currents
 - Over-excitation (excessive V/Hz) currents
 - CT connections for phase correction
 - CT connections for zero sequence current compensation
 - CT ratio selection
 - Phase angle, zero sequence and CT ratio compensation via microprocessor based relay applications
- Restricted Earth Fault (REF) protection of transformers
- Transformer delta connected windings and the application of earthing transformers
 - Earthing Transformer OC & EF protection
 - Effect on the overall transformer differential protection scheme
 - Zero sequence current consequences and compensation techniques

Barrie Moor, *B.E (Elec), RPEQ*



With over 35 years of experience in the Queensland electricity transmission industry, Barrie Moor has been involved in the design, coordination and implementation of protection schemes associated with Queensland's HV & EHV transmission systems since 1981. In particular, Barrie has extensive experience with the protection of large generating plants having designed and set the protection schemes associated with generators and ancillary plant at many of Queensland's major power stations. From 2000 to 2007, Barrie filled the role of Senior Engineer Protection Design as team leader of Powerlink's statewide Protection Design Team. Now in the role of Principal Consultant Substation Protection, Barrie provides specialist Protection Design and Fault Analysis services to support the Substation Design Teams, the Asset Management Group, and Asset Maintenance Groups within Powerlink.

Barrie also has more than 18 years experience within Australia and internationally in the provision of university post graduate training on the design and implementation of Generator, Power Station, and Transmission HV & EHV Protection Systems. Barrie has presented a number of papers on specialised aspects of protection design at conferences both within Australia and internationally.

Barrie has RPEQ registration with the Board of Professional Engineers Queensland. He has also represented Powerlink on CIGRE committee APB5, Power System Protection & Automation and is a corresponding member of Cigre and IEE working groups on Protection Systems.

Who Should Attend?

This seminar will assist both those whose day to day work involves them in the application of protection design, coordination and relay setting, and also to those in less directly associated areas of generator and power station protection system design. This seminar has been prepared specifically to meet the requirements of:

- ✦ **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
- ✦ **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 primary and/or secondary system 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 and Project Management Engineers**, to ensure the actual field installation of the protection scheme and associated relay settings meets the design requirements
- ✦ **Technicians**, to understand the importance of their role in installing, testing and maintaining effective, reliable, dependable and secure protection systems

3. Motor Protection

- Starting Current, Stalling Current, High Inertia Loads and Thermal Capability
- Number of Starts Limitation
- Effects of Unbalanced (Negative Phase Sequence) Events
- Earth Fault Protection – High impedance and core balance schemes
- RTD Protection
- Undervoltage Protection
- Loss of Load Protection
- Over Current Protection – via CBs, fuses and fuse contactors
- Differential Protection

4. Generator Protection

- Biased Differential and High Impedance Differential Protection Schemes
- Voltage Displacement Protection
- Stator Earth Fault Protection (100%, 95%, REF and 3rd harmonic schemes)
- Stator Interturn Protection
- Rotor Earth Fault Protection
- GCB Fail Protection
- Stator Overload Protection
- Negative Phase Sequence (NPS) Protection
- Over Voltage and Over Excitation Protection
- Under Excitation Protection
- Reverse Power Protection
- Under and Over Frequency Protection
- Out of Step Protection
- Embedded Generator Islanding Protection

CPD Recognition

This training program is designed to meet the Continuing Professional Development (CPD) needs of participants. A Certificate of Attendance will be awarded at the end of the program. This serves as evidence of your personal and professional commitment to building your career.

Customised In-House Course Available

This program can be customised to suit the specific needs of your organisation at significant savings details. Please contact us on (02) 8448 2078 or email: Enquiry@cpdint.com.au for more details.