



PREMIER POWER SYSTEM PROTECTION COURSE



This is the Premier Course for Engineers to study Power System Protection. It is the Industry's best established course.

The Power System Protection Course is an important open learning product of AFAQ-ETA. It provides an in-depth study of all aspects of protection and is used extensively by a wide range of UK electricity companies together with overseas utilities.

The course is an acknowledged method of Continuing Professional Development.

THE COURSE - CONTENTS

BOOK 1: PRINCIPLES & COMPONENTS

Unit 1 - The Role Of Protection: Function, essential importance and basic aims. Power-system and substation layouts. Power-system and abnormalities requiring protection. System neutral earthing methods. Basic terms in protection. Protection reliability. Economic considerations.

Unit 2 - Protection Principles and Components: Discrimination methods; basic components of protective systems: consideration of the protection problems.

Unit 3 - Fault Calculations: Function and scope of fault calculations: factors affecting fault current and fault voltage; steady-state network analysis; balanced and simple unbalanced fault conditions; network analysers; computer analysis of load flow and faults. Transient conditions; Plant impedance data.

Unit 4 - Protective Transformers: Basic principles; operations, current transformers – steady-state theory; construction, testing voltage transformers, theory, construction, fusing and protection testing.

Unit 5 - Fuses: Categories; comparative role in protection; design and application; mechanism of fuse operation on small and large overcurrents; standard testing. Interpretation of time/current characteristics. I^2t and discrimination. Strikers.

Unit 6 - Relays: Principle types; design; relay cases; maintenance; application and characteristics; testing; design trends.

Unit 7 - Protection Signalling: Signalling and intertripping: communication media, performance requirements and problems; design principles; practical designs of equipment.

BOOK 2: SYSTEMS AND NETWORKS

Unit 8 – Overcurrent Protection: Overcurrent and earth fault systems. Principles of current and time grading. Current transformer requirements. Burdens and effective relay settings. Sensitive earth fault protection. High set overcurrent relays. Directional control. Relay connections: grading of protection for ring mains and parallel feeders.

Unit 9 – Feeder Protection: Distance Systems: History, operating principles. Impedance measuring elements (comparators) and their characteristics. Development of comparators. More complex relaying characteristics. Presentation of performance. Switched and polyphase distance protection. Distance protection schemes based on information links. Application of distance protection – practical considerations. Trends in distance protection.

Unit 10 – Feeder Protection: Power Frequency and Carrier-Current Differential Systems: Longitudinal differential systems of feeder protection; basic principles and modes of operation. Deriving information from the primary current; transmitting and comparing this information between ends, using either pilot wires or the main conductors. Examples of practical systems; some factors influencing their applications.

Unit 11 – Transient Overvoltage Protection: Basic phenomena of external (lightning) and internal overvoltages. Some fundamental aspects of travelling wave theory. The principles and relevant practice of insulation co-ordination and overvoltage protection. Statistical considerations of insulation co-ordination. Economic aspects.

Unit 12 – Protection of Generators, Transformers, Generator-Transformer Units and Transformer Feeders: Generation practice. Performance requirements for protection of generators, transformers. Arrangements for direct-connected generators. Generator/transformer units, transformers and transformers/feeder circuits.

Unit 13 – Busbar Protection: Principles concerning faults and protection. Unit high-impedance protection: principles, calculations c.t. and relay requirements, security and reliability, descriptions and schemes in detail. Biasing schemes. Frame leakage schemes. Back-up protection, overcurrent and earth fault protection, distance protection. Protection for small zones and section disconnectors. Breaker fail protection. Testing.

Unit 14 – Protection of Motors, Reactors, Boosters and Capacitors: Characteristics, application and protection of d.c. and a.c. motors. Purpose, application and protection of series and shunt connected reactors. Descriptions, uses and protection types of system voltage regulating equipment. Value of reactive compensation of the system. Applications and protection of series and shunt connected capacitors.

Unit 15 – Application of Protection to Rural Distribution Systems: Rural networks. Fuses. Automatic circuit reclosing. Equipment and relay schemes for reclosing. Sensitive earth fault protection. Arc suppression coils: performance cost comparisons. Protection of primary networks.

Unit 16 – Application of Protection to Urban and Metropolitan Systems: Urban distribution systems: protection of services, low-voltage distributors, distribution transformers, high voltage feeders and primary substations. Protection for parallel operation, systems having interconnected low voltage networks. Supplies to large point loads and H.V. customers, private generation.

Unit 17 – Application of Protection to Transmission Systems: Principles; system design consideration. Choice of protection: back-up, overcurrent, distance protection. Effect of c.t. location. Intertripping. Fault-throwing switches. Automatic switching schemes. Economics. Typical installations.

Unit 18 – Testing, Commissioning and Management of Protection: Commissioning, routine maintenance and fault investigation. Test equipment. Records. Restrictions on the transmission of continuous carrier signals. Maintenance and testing of busbar protection signalling equipment.

BOOK 4: ADVANCED UNITS (THESE 5 UNITS ARE COMPLETED AS ONE ASSIGNMENT)

Unit 19 – Digital Technology: Logic devices, Microprocessors (General description, Memory, Binary number representation, Programming). Analogue to Digital Conversion (Introduction, Digital to analogue converters, Ramp converters, Successive approximation converters, Sample and hold amplifiers, Multiplexers, Analogue to digital conversion in protection relays). Specialised Processors.

Unit 20 – Digital Signal Processing: Continuous Versus Discrete Waveforms, Sampling, Digital Filtering (Time domains and frequency domains, Filter descriptions, Types of digital filter). Special Analysis (Discrete Fourier Transform, Fast Fourier Transform). Digital Filtering in Numeric Protection Relays (Design constraints, Real-time considerations).

Unit 21 – Digital Communications and Fibre Optics: Digital Data Transmission (Introduction, Simplex, half duplex and full duplex transmission, Asynchronous and synchronous transmission, Error handling, Protocols and standards, Control system communication media and configurations). Fibre Optic Communications (Introduction, Fibre optic basics, Communications applications in power systems).

Unit 22 – Numeric protection: Numeric Relay Hardware (Typical relay hardware structure, Relay interfaces, Relay operating environment). Numeric Relay Algorithms (Overcurrent relays, Distance relays, Directional comparison relays, Differential relays). Fault Location (Apparent reactance method compensation for shunt capacitance, Hardware for fault locators, Phasor extractions). Software Considerations, Numeric Relay Testing (Relay test hardware, Digital power system fault simulation). Examples of Numeric Relays.

Unit 23 – Coordinated Control: Concepts of Modern Coordinated Control Systems, System Functionality, Man Machine Interfaces, Advantages of Coordinated Control Systems.

WHAT IS REQUIRED

Though interesting and rewarding, you are likely also to find the course demanding of your time. With a target of 23 units to complete over the period of 30-36 months it means a fairly constant committal of completing one unit almost every 6 weeks. Each study unit is on average 50 pages of technical text and an assignment of 5 questions.

To enrol you should have already acquired an educational qualification in Electrical Engineering and specifically you should have a knowledge of mathematics to HNC standard or its equivalent.

TO ENROL

To enrol simply complete AFAQ-ETA's Open Learning Courses Enrolment/Order Form, including details of how you will be paying and return it to Tyla Davis by e-mail, fax or post using the details at the bottom of the page.

Please note that unless an official purchase order has been raised, payment **must** be made (either by cheque or credit card) before the materials can be sent out.

For all our current prices, see our Open Learning Courses Enrolment/Order Form.

TUITION/STUDYING

On enrolment you will be sent the necessary Power System Protection Textbooks and relevant study material and stationery. Each study unit is a chapter comprising text, illustrations and bibliography. After studying the text you will be expected to complete the assignment questions and forward them to AFAQ-ETA who will pass them to the relevant tutor. The tutor will mark and make constructive comments on the papers and they will be returned to AFAQ-ETA for recording purposes after which they will be returned to you.

On completion of the course an Industry recognised certificate will be issued, detailing the units completed and the marks achieved.

Candidates who do not complete within 3 years of enrolling will be liable for an additional fee for any units they wish to complete after this time.

SUPPORT OFFERED

Most companies have designated mentors to help and encourage students, to monitor progress and to advise on study planning etc. Technical information is supplied to mentors by AFAQ-ETA.

Day to day administration is arranged directly between the student and AFAQ-ETA after the initial enrolment.

Frequently Asked Questions are available to students on request.

Students may submit their own queries regarding specific problems to AFAQ-ETA who will liaise with tutors to assist the students. Tutors may decide to speak directly to the students to answer enquiries.

For more information about any of our training products please contact Tyla Davis, Training & Development Manager, using the details below.

We also offer a range of courses in support of ISO certification – see our website for more details!



AFAQ-ETA

Regus House ■ Victory Way ■ Admirals Park ■ Crossways ■ Dartford ■ DA2 6QD ■ UK

Tel: +44 (0)1322 303356 Fax: +44 (0)1322 303357

E-mail: bill.fenton@afaq-eta.com

Web: www.afaq-eta.com



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