



## National Unit Specification: general information

**UNIT** Switchgear and High Voltage Protection (SCQF level 6)

**CODE** F5JX 12

### SUMMARY

This Unit is designed to allow candidates to develop knowledge and understanding of switchgear and high voltage (HV) protection.

The candidate will be given opportunities to describe the constructional features, operation and applications of high voltage switchgear, types of HV protection systems, types of fault and the factors that determine system fault levels. Candidates will learn the operational characteristics and application of protective devices.

This Unit is suitable for candidates wishing to gain employment in the power utility sector or progress to more advanced studies in high voltage engineering.

This Unit may form part of a National Qualification Group Award or may be offered on a free-standing basis.

### OUTCOMES

- 1 Describe the operation, construction and application of HV switchgear.
- 2 Describe types of HV protection systems.
- 3 Describe types of fault and the factors affecting fault level.
- 4 Explain the operational characteristics and application of protective devices.

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#### Administrative Information

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## National Unit Specification: general information (cont)

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### RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates would normally be expected to have attained one of the following, or equivalent:

- ◆ Standard Grade Mathematics — Credit Level
- ◆ Standard Grade Physics — Credit Level
- ◆ A science subject — Credit Level
- ◆ NQ Unit *Electrical Power Systems* SCQF level 6 or suitable industrial experience of high voltage and switchgear systems

### CREDIT VALUE

1 credit at SCQF level 6 (6 SCQF credit points at SCQF level 6\*).

*\*SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from Access 1 to Doctorates.*

### CORE SKILLS

There is no automatic certification of Core Skills in this Unit.

This Unit provides opportunities for candidates to develop aspects of the following Core Skill:

- ◆ Communication (SCQF level 6)

These opportunities are highlighted in the Support Notes of this Unit Specification.

## **National Unit Specification: statement of standards**

### **UNIT        Switchgear and High Voltage Protection (SCQF level 6)**

Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the Unit Specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

#### **OUTCOME 1**

Describe the operation, construction and application of HV switchgear.

##### **Performance Criteria**

- (a) Explain correctly the limitations of switching high voltage equipment using circuit breakers, switches and fuses.
- (b) Describe correctly opening and closing mechanisms for HV switchgear.
- (c) Describe clearly an HV circuit breaker in terms of its construction, operation, arc quenching medium and application.
- (d) Identify correctly the component parts of a high voltage High Rupturing Capacity (H.R.C) fuse.

#### **OUTCOME 2**

Describe types of HV protection systems.

##### **Performance Criteria**

- (a) Describe clearly the principle of differential protection.
- (b) Describe clearly a transformer protection device.
- (c) Describe correctly the characteristics of an auto reclosing system for a rural HV distribution network.
- (d) Describe clearly a surge protection method.

#### **OUTCOME 3**

Describe types of fault and the factors affecting fault level.

##### **Performance Criteria**

- (a) State correctly the different types of fault that can occur on HV systems.
- (b) Describe clearly the effects on the HV system of a short circuit current under symmetrical fault conditions.
- (c) Describe clearly the factors affecting fault severity.
- (d) Describe clearly the nature and forms of transient faults that can occur on HV systems.

## **National Unit Specification: statement of standards (cont)**

### **UNIT        Switchgear and High Voltage Protection (SCQF level 6)**

#### **OUTCOME 4**

Explain the operational characteristics and application of protective devices.

#### **Performance Criteria**

- (a) Describe clearly the time-current operating characteristics of an Inverse Definite Minimum Time (I.D.M.T.) relay and an H.R.C. fuse.
- (b) Explain correctly a combined overcurrent and earth fault protection system.
- (c) Explain correctly the principle of directional relay protection.
- (d) State correctly the advantages of electronic relays over electromechanical relays.

#### **EVIDENCE REQUIREMENTS FOR THIS UNIT**

Written and/or recorded oral evidence is required to demonstrate that candidates have achieved all Outcomes and Performance Criteria.

#### **Outcomes 1, 2, 3 and 4:**

Written and/or recorded oral evidence is required which demonstrates that the candidate has achieved Outcomes 1, 2, 3 and 4 to the standards specified in the Outcomes and Performance Criteria. This evidence should be obtained under controlled, supervised conditions.

Outcomes may be assessed on an individual basis, as a combination of Outcomes or as a single assessment covering all four Outcomes. Regardless of which approach is taken the total assessment time should not exceed two hours.

Assessment/s should be conducted under controlled, supervised, closed-book conditions in which candidates should not be allowed to bring any notes, handout, text books or any other relevant materials into the assessment.

With regard to Outcome 1:

- ◆ candidates should describe ONE opening and closing mechanism for an item of HV switchgear
- ◆ candidates should describe ONE circuit breaker from Air, Oil, Vacuum, and SF<sub>6</sub>

With regard to Outcome 2:

- ◆ candidates should describe ONE transformer protection device from Buchholtz relay, pressure relief, winding temperature or oil temperature devices
- ◆ candidates should describe auto reclosing in terms of dead times, reclaim times and number of shots for a pole mounted auto recloser system
- ◆ candidates should describe ONE surge protection method from spark gaps, rods or surge arrestors

## **National Unit Specification: statement of standards (cont)**

### **UNIT        Switchgear and High Voltage Protection (SCQF level 6)**

With regard to Outcome 3:

- ◆ candidates should state **THREE** faults on high voltage systems
- ◆ candidates should state **TWO** factors from source conditions, power system configuration, neutral earthing and the nature and type of fault
- ◆ candidates should state **TWO** types of transient fault

With regard to Outcome 4:

- ◆ candidates should explain combined overcurrent and earth fault protection using a three overcurrent and earth fault arrangement
- ◆ candidates should explain directional relay protection from a given diagram for a HV parallel feeder
- ◆ candidates should describe **THREE** advantages of electronic relays compared to electro mechanical relays

## **National Unit Specification: support notes**

### **UNIT        Switchgear and High Voltage Protection (SCQF level 6)**

This part of the Unit Specification is offered as guidance. The support notes are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 40 hours.

#### **GUIDANCE ON THE CONTENT AND CONTEXT FOR THIS UNIT**

This is an optional Unit within the National Qualification Group Award in Electrical Engineering at SCQF level 6 but may also be offered as a free-standing Unit.

The Unit has specialised content aimed at gaining knowledge of HV switchgear and HV protection systems. Successful completion of this Unit enhances the employability skills for candidates to gain employment in the power utility sector or with a high voltage switchgear manufacturer or a large industrial employer with a high voltage distribution network.

This Unit also provides the opportunity for candidates to develop their knowledge of switchgear and high voltage protection to prepare for industry level high voltage courses.

This Unit could be taught in conjunction with other HV Units such as *Electrical Power Systems* SCQF level 6 and *Transformers* SCQF level 6.

#### **GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT**

This Unit may be delivered by a combination of lectures, tutorials, investigations (including Internet) and demonstrations. An organised visit to a high voltage electrical substation would be beneficial to the candidates in achieving the above Outcomes of this Unit.

Physical examination of component parts such as fuses, switches, surge arrestors and the different forms of switchgear is recommended. The use of reproduced manufacturers diagrams, system diagrams and protection scheme diagrams such as relay and CT connection diagrams would emphasise the factors that influence the construction and operation of HV switchgear and HV protection systems.

Examination of protective devices such as electromechanical current relays and their electronic equivalent are useful to assist in the learning of the operational characteristics of these devices.

#### **OPPORTUNITIES FOR CORE SKILL DEVELOPMENT**

As candidates demonstrate understanding of the principles of operation of high voltage switchgear and protection, Communication skills will be naturally enhanced. Diagrams and Graphical data are interpreted and applied to protective devices such as HRC fuses and IDMT relays. Formative activities could be designed to focus on the interpretation, application and presentation of number and graphics in practical electrical engineering contexts.

## **National Unit Specification: support notes (cont)**

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### **GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT**

#### **Opportunities for the use of e-assessment**

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by information and communications technology (ICT), such as e-testing or the use of e-portfolios or e-checklists. Centres which wish to use e-assessment must ensure that the national standard is applied to all candidate evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. Further advice is available in *SQA Guidelines on Online Assessment for Further Education (AA1641, March 2003)*, *SQA Guidelines on e-assessment for Schools (BD2625, June 2005)*.

Outcome 1, 2, 3 and 4 require written and/or recorded oral evidence and can be individually set or combined in the form of a short answer, restricted response and structured questions to give the candidate an opportunity to display knowledge of high voltage switchgear and protection systems and to demonstrate knowledge of protective devices and their applications.

Outcomes may be assessed on an individual basis, as a combination of Outcomes for example Outcome 1 and Outcome 2 may be combined, or as a single assessment covering all four Outcomes. Regardless of which approach is taken the total assessment time should not exceed two hours.

#### **CANDIDATES WITH DISABILITIES AND/OR ADDITIONAL SUPPORT NEEDS**

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering alternative Outcomes for Units. Further advice can be found in the SQA document *Guidance on Assessment Arrangements for Candidates with Disabilities and/or Additional Support Needs* ([www.sqa.org.uk](http://www.sqa.org.uk)).