SQA Advanced Unit Specification

General information for centres

Unit title: Electrical Standby Systems

Unit code: HV53 48

Unit purpose: This unit has been developed to provide candidates' with an opportunity to develop knowledge and understanding about batteries, standby/emergency generators and UPS (uninterruptible power supplies).

On completion of the unit the candidate should be able to:

1. identify the operation, characteristics and applications of electrical batteries
2. outline the principal operating features and main performance characteristics of standby/emergency generator sets
3. analyse the construction, operation and performance characteristics of UPS (uninterruptible power supplies)

Credit points and level: 1 SQA Credit at SCQF level 8: (8 SCQF credit points at SCQF level 8*)

**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 National 1 to Doctorates.*

Recommended prior knowledge and skills: Candidates should have a knowledge and understanding of electrical machines and electronics. This may be evidence by possession of the following SQA Advanced Units: HT83 47 Electrical Machine Principles, HT7J 46 Analogue Electronics: An Introduction and HT7L 47 Digital Electronics. However, entry requirements are at the discretion of the centre.

Core skills: There may be opportunities to gather evidence towards the following listed core skill components in this unit, although there is no automatic certification of core skills or core skills components.

- Written Communication (reading) at SCQF level 6
- Written Communication (writing) at SCQF level 6
- Using Number at SCQF level 5
- Using Graphical Information at SCQF level 6
- Using Information Technology at SCQF level 7
- Critical Thinking at SCQF level 6
- Reviewing and Evaluating at SCQF level 6

Context for delivery: This unit has been developed for the SQA Advanced Diploma in Electrical Engineering. If the unit is delivered as part of another group award, it is recommended that it should be taught and assessed within the subject area of the group award to which it contributes.

Assessment: The assessment for this unit is as follows:

A single assessment paper covering Outcomes 1 to 3 which should be taken at a single assessment event lasting two hours and carried out under supervised, controlled conditions.

SQA Advanced Unit Specification: statement of standards

Unit title: Electrical Standby Systems

The sections of the unit stating the outcomes, knowledge and/or skills, and evidence requirements are mandatory.

Where evidence for outcomes is assessed on a sample basis, the whole of the content listed in the knowledge and/or skills section must be taught and available for assessment. Candidates should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion.

Outcome 1

Identify the operation, characteristics and applications of electrical batteries.

Knowledge and/or skills

- Construction and principle of operation of zinc/carbon battery
- Construction and principle of operation of lead-acid battery
- Comparison of characteristics and applications of batteries
- Batteries in series and parallel
- Maintenance of batteries
- Battery-charging circuits

Outcome 2

Outline the principal operating features and main performance characteristics of standby/emergency generator sets.

Knowledge and/or skills

- Categories of generators
- Prime movers
- Constructional features and operating principles of generator sets
- Key performance characteristics
- Control Systems
- Electrical Protection
- Safety
- Installation
- Maintenance

Outcome 3

Analyse the construction, operation and performance characteristics of UPS (uninterruptible power supplies).

Knowledge and/or skills

- UPS functions
- Constructional features and operating principle of UPS
- Categories of UPS
- Main performance characteristics
- Sizing a UPS
- UPS maintenance
- Closedown and monitoring software
- Communicating with UPS

Evidence requirements for the unit

Evidence for the knowledge and /or skills in Outcomes 1 to 3 will be provided on a sample basis. The evidence may be presented in responses to specific questions. Each candidate will need to demonstrate that she/he can answer correctly questions based on a sample of the items shown under the knowledge and skills items in all three outcomes. In any assessment of the outcomes **four out of six** knowledge and/or skills items should be sampled from Outcome 1, **five out of nine** knowledge and skills items from Outcome 2 and **four out of eight** knowledge and skills items for Outcome 3.

In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample of four out of six knowledge and/or skills items from Outcome 1, five out of nine knowledge and/or skills items from Outcome 2 and four out of eight knowledge and skills items from Outcome 3 are required each time the unit is assessed. Candidates must provide a satisfactory response to all items.

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

Outcome 1

- explain the constructional features and operation of a zinc/carbon battery
- explain the constructional features and operation of a lead-acid battery
- compare four different batteries types in terms of characteristics and applications
- perform one calculation on batteries in series and one calculation on batteries in parallel
- identify the main battery maintenance tasks
- explain, with the aid of circuit diagrams, the operation of at least two battery-charging circuits

Outcome 2

- identify different categories of generators
- identify different forms of prime movers used with standby/emergency generators
- explain, with the aid of a diagram(s), the main constructional features and operation of a typical standby/emergency generator
- explain the key performance characteristics of generators
- explain typical control system arrangements used with generators
- explain electrical protection used with generators
- identify main safety points associated with generator sets
- explain installation requirements associated with generator sets
- draw up a typical maintenance schedule for a generator set

Outcome 3

- explain the main functions of a UPS
- describe, with the aid of a diagram(s), the main constructional features and principle of operation of a UPS
- define the main categories of UPS
- identify key UPS performance features
- 'size' a UPS for a typical application
- describe typical UPS maintenance requirements
- explain the function of closedown and monitoring software
- explain computer networking arrangements for communicating with a UPS

Assessment for Outcomes 1 to 3 should be combined together to form one assessment paper using the sampling levels for knowledge and/or skills items specified previously. This single assessment paper should be taken at a single assessment event lasting two hours and carried out under supervised, controlled conditions. Assessment should be conducted under closed book conditions and as such candidates should not be allowed to bring any textbooks, handouts or notes to the assessment. Candidates should be permitted to use scientific, but not programmable, calculators during the assessment.

Assessment guidelines for the unit

The assessment paper should be composed of an appropriate balance of short-answer, restricted-response and structured questions.

Administrative information

Unit code: HV53 48

Unit title: Electrical Standby Systems

Superclass category: XK

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Source: SQA

SQA acknowledges the valuable contribution that Scotland's colleges have made to the development of SQA Advanced Qualifications.

For further information, please call SQA's Customer Contact Centre on 44 (0) 141 500 5030 or 0345 279 1000. Alternatively, complete our Centre Feedback Form.

SQA Advanced Unit Specification: support notes

Unit title: Electrical Standby Systems

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 unit has been written in order to allow candidates to develop their knowledge and understanding in the following areas:

1. Identification of the operation, characteristics and applications of electrical batteries
2. Outlining the principle operating features and main performance characteristics of standby/emergency generators
3. Analysing the construction, operation and performance characteristics of UPS (uninterruptible power supplies)

This unit has been written to provide SQA Advanced Diploma in Electrical Engineering candidates with an opportunity to develop a sound knowledge and understanding of the performance characteristics of standby supply systems. The Electrical Standby Systems Unit is a 1-credit unit at SCQF level 8 (8 SCQF credit points at SCQF level 8). It is included within the optional section of the SQA Advanced Diploma in Electrical Engineering Framework.

In designing this unit, the unit writer has identified the range of topics expected to be covered by lecturers. The writers have also given recommendations as to how much time should be spent on each outcome. This has been done to help lecturers to decide what depth of treatment should be given to the topics attached to each of the outcomes. While it is not mandatory for centres to use this list of topics it is strongly recommended that they do so to ensure continuity of teaching and learning. The list of topics is as follows and lecturers are advised to study this list of topics.

Outcome 1 (9 hours)

Identify the operation, characteristics and applications of electrical batteries

- Brief history of battery development
- Construction and principle of operation of zinc/carbon battery
- Construction and principle of operation of lead-acid battery
- Comparison of characteristics and applications of the following types of battery: zinc-carbon, alkaline, lithium, lead-acid, nickel-cadmium, nickel-metal hydride, lithium-ion, zinc-air, zinc-mercury oxide, silver-zinc and metal-chloride
- Calculations involving batteries in series and parallel
- Explanation of main battery maintenance tasks
- Explanation, with the aid of circuit diagrams, the operation of typical battery-charging circuits

Outcome 2 (16 hours)

Outline the principal operating features and main performance characteristics of standby/emergency generator sets

- Categories of generators (eg permanently installed versus portable, size ranges)
- Characteristics of different types of prime movers (petrol, diesel, steam/gas turbine driven)
- Fuel storage issues
- Constructional features and principle of operation of different generator types (eg brush or brushless design)
- Generator performance characteristics (continuous, maximum and surge ratings), voltage regulation, frequency regulation
- Generator starting
- Generator control systems (eg governor arrangements) as applied to portable and permanently installed generators
- Modern instrumentation used on generators
- Electrical protection arrangements as applied to permanently installed and portable generators
- Safety issues relating to generators and prime movers
- Installation of both permanently installed and portable generators
- Typical generator and prime mover maintenance schedules
- Requirements of BS7671 and Electricity Supply, Quality and Continuity Regulations for standby supplies

Outcome 3 (13 hours)

Analyse the construction, operation and performance characteristics of UPS (uninterruptible power supplies)

- Clarify the main functions of a UPS in relation to providing a standby supply (eg provide power for some time after mains power loss has occurred, smoothing out noisy power sources, absorb small power surges)
- Constructional features and principle of operation of UPS
- Different categories of UPS (eg off-line, line interactive, online and parallel redundant)
- Identification of key UPS performance characteristics (eg VA rating, quality of sinusoidal power output, how long does the UPS maintain power in the event of power failure)
- Typical UPS instrumentation features (eg instruments that identify how much power the equipment is drawing, battery life left and an indication of input power quality)
- Bypass switching arrangements (a manual bypass switch to pass power to equipment while the UPS is down or being serviced)
- Other possible features of a UPS
  - Automatic shut down of equipment during long power failures
  - Monitoring and logging of the status of the power supply
  - Restart equipment after a long power failure
  - Provide alarms on certain error conditions
  - Provide short circuit protection
- Sizing UPS in terms of the VA ratings of equipment
- UPS maintenance requirements and advisability of having a maintenance contract
- Explanation of the function of closedown and monitoring software
- Brief explanation of computer networking arrangements for communicating with a UPS

Written Test – 2 hours

Guidance on the delivery and assessment of this unit

The subjects of standby generators and UPS are both large and lecturers need to be realistic about what it is possible to deliver in the time available. Lecturers should select examples of standby generators and UPS which are typically used in modern industrial or commercial applications. Centres delivering this unit are strongly encouraged to allow candidates to view as many practical battery, generator and UPS systems as possible. This may be achieved through the presence of such systems in the centre or by visits to appropriate industrial or commercial premises. Good charts and other visual aids showing complete and disassembled parts of battery, generator and UPS systems will also be a good aid to candidate learning. The internet provides a rich source of information on batteries, standby/emergency generators and UPS, and candidates should be actively encouraged to explore sites which contain helpful information. Likewise manufacturers' catalogues and data sheets also contain useful sources of information particularly with regard to the performance characteristics of batteries, generators and UPS.

Information on evidence requirements and assessment guidelines is given after Outcome 3 in the SQA Advanced Unit specification: statement of standards section. The written assessment paper should take place after Outcomes 1 to 3 have been completed.

Open learning

This unit could be delivered by distance learning, which may incorporate some degree of online support. However, with regards to assessment, planning would be required by the centre concerned to ensure the sufficiency and authenticity of candidate evidence.

Arrangements would be required to be put in place to ensure that assessment, whether done at a single or multiple events, was conducted under controlled, supervised conditions.

To keep administrative arrangements to a minimum, it is recommended that for distance learning candidates the assessment paper is taken at a single assessment event.

Equality and inclusion

This unit specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence.

Further advice can be found on our website www.sqa.org.uk/assessmentarrangements.

General information for candidates

Unit title: Electrical Standby Systems

Standby, or back-up, systems are very important in Electrical Engineering as they ensure the maintenance of electrical energy when other power systems fail.

In this unit you will examine three types of back-up systems: namely batteries, generators and UPS (uninterruptible power supplies). Batteries come in many shapes and sizes and different battery types are more suitable for particular applications. In this unit you will learn about the construction and principles of operation of basic batteries and the characteristics and applications of a range of different battery types.

The subject of standby generators is very large and it would be impossible to teach you all about them in one unit. In this unit you will learn about the construction and principle of operation of different types of standby generator, how generators are driven, the key performance characteristics of generators, and other technical requirements relating to generator operation including control, electrical protection, installation, safety and maintenance.

UPS (uninterruptible power supplies) are used widely in industry and commerce. In this unit you will learn about the basic function of this type of power supply. How they are constructed and operate, what their key performance characteristics are, how to 'size' them to supply different types of equipment and how software can be used to control some of their operations.

There are plenty of good learning materials available both in paper format and via the internet on batteries, standby generators and UPS. Your lecturer is likely to strongly encourage you to explore manufacturers' catalogues, datasheets and investigate internet sites to find out more about batteries, generators and UPS.

Assessment for this unit will comprise of a two-hour written test following the delivery of Outcomes 1 to 3.