Higher National Unit specification

General information for centres

Unit title: Small Scale Rural Electrical Energy Systems

Unit code: F2Y9 34

Unit purpose: The purpose of this Unit is to allow candidates to develop basic knowledge and understanding of rural electrical systems. The Unit is intended for candidates who wish to be involved in the field of energy efficiency and/or in the marketing and project planning of small-scale electrical energy systems which may use renewable energy sources.

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

1 Investigate features of electrical power supply to rural sites.
2 Investigate the operating characteristics and applications of electrical equipment in a rural context.
3 Investigate the applications of selected electrical and electronic systems in a rural context.

Credit points and level: 1 HN credit at SCQF level 7: (8 SCQF credit points at SCQF level 7*)

**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.*

Recommended prior knowledge and skills: Entry is at the discretion of the centre. Although there is no specialist prior knowledge required, it would be beneficial if the candidate had achieved two NQ Units in scientific or technical subjects (for example Physics, Chemistry, Technological Studies) at SCQF level 6 or equivalent, or substantial relevant work experience. While not essential, it would be an advantage if candidates had a knowledge and understanding of basic electrical technology. This knowledge and understanding may be evidenced by possession of the following HN Unit F1Y8 34 *Farm Power*.

Core Skills: There are opportunities to develop the Core Skill element 'Working with Numbers' of the Core Skill Numeracy and the Core Skill element 'Critical Thinking of the Core Skill Problem Solving, both at SCQF level 5 in this Unit, and the Core Skill Communication at SCQF level 6 although there is no automatic certification of Core Skills or Core Skills components.

Context for delivery: If this Unit is delivered as part of a Group Award, it is recommended that it should be taught and assessed within the subject area of the Group Award to which it contributes.

General information for centres (cont)

Assessment: The assessment for Outcomes 1, 2 and 3 should be combined as an assignment in which candidates' evidence is in the form of a submission of 2,000–2,500 words or equivalent plus diagrams. It is recommended that the compilation of the submission is staged throughout the delivery of the Unit.

Higher National Unit specification: statement of standards

Unit title: Small Scale Rural Electrical Energy Systems

Unit code: F2Y9 34

The sections of the Unit stating the Outcomes, Knowledge and/or Skills, and Evidence Requirements are mandatory.

Please refer to *Evidence Requirements for the Unit* after the Outcomes.

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

Investigate features of electrical power supply to rural sites

Knowledge and/or Skills

- Terms and quantities used in ac electrical systems
- Factors affecting the efficiency of electrical power transmission (ac and dc) in a rural context
- Renewable energy sources in electrical energy systems

Investigate the operating characteristics and applications of electrical equipment in a rural context

Knowledge and/or Skills

- Electric generators
- Induction motors and associated circuitry
- Electrical wiring installation and protection
- Transformers

Outcome 3

Investigate the applications of selected electrical and electronic systems in a rural context

Knowledge and/or Skills

- Electrochemical cells
- Photovoltaic cells
- Power electronics systems
- Microprocessor-based control systems

Higher National Unit specification: statement of standards (cont)

Unit title: Small Scale Rural Electrical Energy Systems

Evidence Requirements for the Unit

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can investigate rural electrical energy systems and:

Outcome 1

- explain basic terminology of ac electrical power systems - terms to include impedance, inductance, capacitance and power factor
- compare ac and dc systems in terms of the losses in the transmission of electrical power over a distance
- explain the special requirements when intermittent renewable energy sources are used for the supply of electricity in a rural setting

Outcome 2

- explain the operating principle and performance characteristics of an ac or dc electrical generator and provide an example of an application for an electrical generator in a rural context
- explain the operating principle, the starting and running characteristics and associated electrical circuitry required for two contrasting ac induction motor types and provide an example of an application for an ac induction motor in a rural context
- describe the wiring arrangements and control and protection required in a typical electrical wiring installation within a group of rural buildings
- explain the operating principle of a single phase transformer and provide an example of an application for a single phase transformer in electrical power systems in a rural context

Outcome 3

- state the characteristics of primary and secondary electrochemical cells and state one application of each
- describe the operating characteristics of a photovoltaic cell in the context of a typical application
- describe the operating and main performance characteristics of each of the following devices: a rectifier, an inverter, an uninterruptible power supply (UPS), and identify an application for each
- explain the concept and at least one application of a microprocessor-based control system

The assessment for Outcomes 1, 2 and 3 should be combined as an assignment in which candidates' evidence is in the form of a submission 2,000–2,500 words or equivalent plus diagrams. Candidates should have access to course notes, relevant textbooks, papers, reports and the Internet while completing their report.

Centres should make every reasonable effort to ensure the submission is the candidate's own work. Where copying or plagiarism is suspected candidates may be interviewed to check their knowledge and understanding of the subject matter. A checklist should be used to record oral evidence of the candidate's knowledge and understanding.

Higher National Unit specification: statement of standards (cont)

Unit title: Small Scale Rural Electrical Energy Systems

Assessment Guidelines for the Unit

It is recommended that the completion of the submission is staged throughout the delivery of the Unit. Centres may wish to provide candidates with guidance on how to structure their submission.

Administrative Information

Unit code: F2Y9 34

Unit title: Small Scale Rural Electrical Energy Systems

Superclass category: XK

Original date of publication: January 2008

Version: 01

History of changes:

Version	Description of change	Date

Source: SQA

SQA acknowledges the valuable contribution that Scotland's colleges have made to the development of Higher National qualifications.

Additional copies of this Unit specification can be purchased from the Scottish Qualifications Authority. Please contact the Customer Contact Centre for further details, telephone 0845 279 1000.

Higher National Unit specification: support notes

Unit title: Small Scale Rural Electrical Energy 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 is a mandatory Unit within the HND in Green Technology but may also be offered on a free standing basis where candidates have a basic knowledge and understanding of electrical technology.

The Unit can be viewed as complementary to HN Unit F1Y8 3434 *Farm Power*, which covers, amongst other things, farm electrical distribution systems from the standpoint of safety, electrical protection and running costs.

The intended context of this Unit is small to medium scale rural enterprises in the UK with an interest or involvement in energy efficiency and small-scale renewable energy systems.

Outcome 1 builds on the basic concepts of electricity covered in the HN Unit F1Y8 34 *Farm Power* by investigating the relationship between voltage and current in, principally, ac circuits, and therefore incorporates the concepts of capacitance, inductance, impedance and power factor. Power in ac circuits will be looked at from the point of view of efficiency of transmission over distances, and compared to power transmission in dc circuits. Some of the investigation can be done in the laboratory, where these electrical quantities can be measured and from which further quantities, such as electrical energy, electrical power, power factor etc. can be calculated. Finally, in this Outcome, the special requirements (back-up power sources, switching arrangements) for using intermittent energy sources such as wind or solar (photovoltaic) as a source of electrical power will be covered.

Outcome 2 covers electrical machines. Fundamental to all electrical machines is the principle of electromagnetic induction - the interaction of electrical currents and magnetic fields. Study of electromagnetic induction will lead on to consideration of rotating electrical machinery. Once the principles of electrical generators are understood, the relationships between input speed and torque, and output frequency and power can be investigated and similarly for electric motors, where it is the relationship between speed, torque and current that is important. Two contrasting motor types will be compared: for example, three-phase with single phase induction motors. The means of starting an electric motor is critical, and so the different types of motor starter: DOL, star-delta, variable frequency, are covered. This will lead into the control and protection devices that are required on electrical circuits. This Outcome concludes with study of single phase transformers in terms of their construction and important operational parameters such as turns ratio and kVA rating. This can then be linked back to the transmission of ac electrical power in Outcome 1.

Outcome 3 moves away from electrical machines and on to look at some specific electrical and electronic systems of importance in a rural context. Coverage of the basic mechanism of electrochemical cells will lead into to an overview of the characteristics of different types of secondary cell, as these are important in many applications: portable electrical devices, uninterruptible power supplies (UPSs), back-up energy storage systems. Another source of dc electrical energy, the photovoltaic cell, will be investigated.

Higher National Unit specification: support notes (cont)

Unit title: Small Scale Rural Electrical Energy Systems

Ac/dc conversion is key to small-scale electrical energy systems, especially those using renewable sources, so rectifiers and inverters will be examined with particular reference to their efficiency and the quality of their output. Also important in this context are microprocessor-based control systems, so the function of such control systems and typical applications will be investigated.

Guidance on the delivery and assessment of this Unit

This Unit may be delivered by a combination of lecturing, group work, investigation (including the use of the Internet), case studies and visits to rural sites.

Ideally this Unit should be delivered using a variety of media with an emphasis on effective ways to help visualisation of electrical concepts and effects. This might be via practical exercises, demonstrations or possibly audio-visual or multi-media presentations.

Details on the approaches to assessment are given under Evidence Requirements and Assessment guidelines after Outcomes 3 in the Higher National Unit specification: statement of standards section. It is recommended that this sections be read carefully before proceeding with assessment of candidates.

Opportunities for developing Core Skills

Candidates will have opportunities to develop reading communication skills at SCQF Level 6 while reading materials on electrical technology from both paper-based and electronic sources. Lecturers may choose to ask candidates questions on the materials they have read to check understanding. Candidate may develop the Core Skill Communication at SCQF level 6 through the preparation of the submission.

There may be opportunities to develop the Core Skill component ‘Using Number’ of the Core Skill Numeracy and the Core Skill component ‘Critical Thinking of the Core Skill Problem Solving, both at SCQF level 5 in this Unit. Candidates will need to take measurements and perform calculations relating to energy. Additionally the types of teaching approaches and assessments used may present Core Skills development opportunities. For example, in Outcome 1, candidates are asked to explain mathematical relationships between different elements of ac and dc circuits, and they are asked to use instruments to measure electrical quantities in ac and dc circuits, and to use the collected information to calculate power and energy.

Open learning

This Unit could be delivered by distance learning. However, it would require planning by the centre to ensure the sufficiency and authenticity of candidate evidence.

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)**.

General information for candidates

Unit title: Small Scale Rural Electrical Energy Systems

Electricity is a very important and versatile form of energy which is vital to all aspects of modern life. Increasing concerns over climate change have focused attention on its efficient use, but also on its small scale and local generation from renewable sources.

In this Unit you will be given an understanding of what electricity is and how and why it behaves the way it does. This will be applied to everyday electrical transmission and distribution systems in a practical context. Rotating electrical machines, namely generators and motors, are key to small scale production and use of electricity. You will investigate these, as well as looking at the principle behind the electrical transformer, a device for changing the voltage of ac electrical supplies.

You will investigate the electrochemical cell (the battery). You will also look at the concept behind some simple electronic devices, in particular photovoltaic cells, which are used to generate electricity from sunlight. Finally, you will investigate the application of more complex electronic devices used in the control of small-scale electrical energy systems.

The Unit will normally be delivered in a classroom environment, but with opportunities to do practical investigative work and make visits to rural sites.

Assessment is in the form of one submission covering all Outcomes, completed throughout the duration of the Unit.