National Unit specification: general information

Unit title: Domestic Fuel Cell Technology Systems

Unit code: FF2V 12

Superclass: YC

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Summary

This Unit is designed to provide candidates with knowledge and understanding on the provision of fuel cell technology. The Unit will introduce candidates to the basic design principles, systems components and function of fuel cell technology systems. The Unit will also introduce candidates to fundamental health and safety and installation requirements for fuel cell technology systems.

This Unit is suitable for candidates who are undertaking this study for the first time or wish to obtain a basic knowledge of fuel cell technology. The Unit will allow for those currently employed in the building services industry to develop further knowledge specifically related to fuel cell technology systems.

Outcomes

1 Describe the basic principles of fuel cell technology systems.
2 Describe the basic characteristics of fuel cells and the function of their component parts.
3 State the relevant Standards and Regulations used for the design, installation, commissioning and maintenance of fuel cell technology systems.

Recommended entry

Entry is at the discretion of the centre.

National Unit specification: General information (cont)

Unit title: Domestic Combined Heat and Power Systems

Credit points and level

1 National Unit 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

Opportunities to develop aspects of Core Skills are highlighted in the support notes of this Unit specification.

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

National Unit specification: statement of standards

Unit title: Domestic Combined Heat and Power Systems

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 basic principles of fuel cell technology systems.

Performance Criteria

(a) Describe clearly the basic electrochemical reaction in hydrogen fuel cells.
(b) Describe clearly the operating principles of fuel cells.
(c) Describe clearly applications of fuel cell technology systems.
(d) State accurately the main advantages of fuel cell technology systems.
(e) State accurately the main disadvantages of fuel cell technology systems.

Outcome 2

Describe the basic characteristics of fuel cells and the function of their component parts.

Performance Criteria

(a) Show clearly by means of a diagram the location of the main component parts of a single fuel cell.
(b) Describe clearly the function of the main component parts of a fuel cell technology system.
(c) Describe clearly the basic characteristics of Proton Exchange Membrane fuel cells.
(d) Describe clearly the basic characteristics of Direct Methanol fuel cells.

Outcome 3

State the relevant Standards and Regulations used for the design, installation, commissioning and maintenance of fuel cell technology systems.

Performance Criteria

(a) State clearly the basic planning requirements and procedures in relation to the design and installation of fuel cell technology systems.
(b) State clearly how Standards and Building Regulations apply to fuel cell technology systems.
(c) State clearly how to minimise the risk to personnel and building occupiers when installing fuel cell technology systems.
(d) State clearly the basic commissioning and maintenance requirements of a fuel cell technology system.

National Unit specification: statement of standards (cont)

Unit title: Domestic Combined Heat and Power Systems

Evidence Requirements for this Unit

Evidence is required to demonstrate that candidates have achieved all Outcomes and Performance Criteria.

Written and/or recorded oral evidence should be produced to demonstrate that the candidate has achieved all the Outcomes and Performance Criteria. The evidence should be produced under 'open-book' supervised and controlled conditions.

Outcome 1

(a) The candidates must correctly describe the basic electrochemical reaction in hydrogen fuel cells This description must include:

- atomic structure of hydrogen
- the basic properties of hydrogen
- anode reaction $2H_2 \rightarrow 4H_+ + 4e_-$
- cathode reaction $O_2 + 4H_+ + 4e_- \rightarrow 2H_2O$
- net Reaction $2H_2 + O_2 \rightarrow 2H_2O$ + Energy
- the production of direct current

(b) The candidates must correctly describe the operating principles of fuel cells. This description must include:

- hydrogen as an energy carrier
- the need for fuel replenishment
- sourcing of hydrogen from electrolysis

(c) The candidate must correctly describe three applications of fuel cell technology systems. This description must include:

- power generation
- backup power
- transportation

(d) The candidate must clearly state at least three advantages of fuel cell technology systems. This description must include three of the following:

- reduction in pollutant emissions
- fuel Cells can be used in a wide range of sectors
- fuel Cells can be used as a store for renewable energy
- no moving parts
- relative efficiency of fuel cells

(e) The candidate must clearly state three disadvantages of fuel cell technology systems. This description must include three of the following:

- cost of fuel cells
- hydrogen containment issues
- durability and reliability issues

Outcome 2

(a) The candidate must show by production of a diagram the location of the main component parts of a single fuel cell. The diagram must indicate:

- anode
- cathode
- electrolyte
- catalyst
- fuel inputs and outputs
- electrical circuit and load

(b) The candidate must correctly describe the function of the main component parts of a fuel cell technology system. This description must include:

- anode
- cathode
- electrolyte
- catalyst
- fuel inputs and outputs
- electrical circuit and load
- fuel cell processor
- stack
- inverter

(c) The candidate must correctly describe the basic characteristics of Proton Exchange Membrane fuel cells. This description must include:

- water and air management
- temperature management
- electrical output range
- quick start up

(d) The candidate must correctly describe the basic characteristics of Direct Methanol fuel cells. This description must include:

- water and carbon dioxide management
- electrical output range
- fuel management (Cartridge)

National Unit specification: statement of standards (cont)

Unit title: Domestic Combined Heat and Power Systems

Outcome 3

(a) The candidate must correctly state the basic planning requirements and procedures in relation to the design and installation of fuel cell technology systems. Design and installation factors must include:

- siting of fuel cell installations
- hydrogen containment and piping
- air intake, exhaust outlets and ventilation requirements
- safety and separation distances
- positioning of hydrogen sensors

(b) The candidate must state clearly how Standards and the Building Regulations apply to fuel cell technology systems. This must include the following:

- Gas Safety Regulations
- Pressure Equipment Regulations
- Engineering Standards

(c) The candidate must clearly state the measures required to minimise risk to personnel and building occupiers when installing fuel cell technology systems. This must include the following:

- avoidance of fire and explosion
- avoidance of pressure related hazards
- avoidance of thermal hazards
- avoidance of electric shock

(d) The candidate must clearly state the basic commissioning and maintenance requirements of a fuel cell technology system and the importance of the following:

- installation and commissioning checklists
- maintenance and servicing plans

National Unit specification: support notes

Unit title: Domestic Combined Heat and Power 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

Outcome 1

Candidates must be able to demonstrate knowledge of the atomic structure of hydrogen of one proton and one electron and the basic properties of hydrogen specifically the ease of combination with other atoms and the properties of being colourless, odourless and light. Candidates must be able to demonstrate an understanding of the basic electrochemical reaction in hydrogen fuel cells including anode, cathode and net reaction formulae.

Candidates must be able to demonstrate an understanding of the operating principles of fuel cells and demonstrate knowledge of hydrogen as an energy carrier, the need for fuel replenishment and the sourcing of hydrogen fuel from electrolysis.

Candidates must also understand and demonstrate knowledge of three applications of fuel cell technology systems and their use in power generation, backup power and transportation.

Candidates must be able to clearly state at least three advantages of fuel cell technology systems from the following; reduction in pollutant emissions, fuel cells can be used in a wide range of sectors, fuel cells can be used as a store for renewable energy, no moving parts and the relative efficiency of fuel cells.

Candidates must be able to demonstrate knowledge of the main disadvantages of fuel cells in particular the cost of fuel cells, hydrogen containment issues and the durability and reliability of some types of fuel cell.

Outcome 2

Candidates must be able to demonstrate knowledge of the location and function of the main component parts of a single fuel cell. Components to be identified and located in a diagram are the anode, cathode, electrolyte, catalyst, fuel inputs and outputs and the electrical circuit and load.

The candidates must also be able to describe the function of each of these components. Candidates must be able to demonstrate knowledge of the function of the fuel cell processor, stack and inverter.

Candidates must be able to describe the basic characteristics of Proton Exchange Membrane fuel cells in particular water and air management, temperature management, electrical output range and the quick start up of these types of fuel cell.

National Unit specification: support notes (cont)

Unit title: Domestic Combined Heat and Power Systems

Candidates must be able to demonstrate a knowledge and understanding of the basic characteristics of Direct Methanol fuel cells specifically water and carbon dioxide management, electrical output range and the use of cartridges for fuel replenishment.

Outcome 3

Candidates must be able to state the basic planning requirements and procedures for the design and installation of fuel cell technology systems. Design and installation factors will include the siting of fuel cell installations, hydrogen containment and piping, air intake and exhaust outlets and their ventilation requirements, safety and separation distances and the positioning of hydrogen sensors.

Candidates must be able to describe how the building regulations apply in particular the Regulations for Gas Safety, Pressure Equipment and Engineering Standards.

Candidates must also demonstrate awareness of the measures required to minimise risks when designing and installing fuel cell technology systems. In particular, the following risks should be detailed and avoidance measures described: avoidance of fire and explosion, avoidance of pressure related hazards, avoidance of thermal hazards and the avoidance of electric shock.

Candidates will be able to demonstrate an understanding of the installation and maintenance of fuel cell technology systems and the importance of installation and commissioning checklists and maintenance and servicing plans.

Guidance on learning and teaching approaches for this Unit

It is recommended that the Outcomes are delivered in the sequence presented in the Unit specification. The Unit may be delivered by a combination of lectures, tutorial work and practical laboratory work. The Unit should be taught very much in an electrical engineering/energy context and as such relevant engineering/energy examples should be used throughout Unit delivery.

While the majority of the Unit can be delivered in a classroom, centres should allow candidates to undertake practical experiments so that they have opportunities to relate theory learnt in the classroom to practice. For example, where Fuel Cell Technology equipment exists candidates should be allowed to carry out simple performance tests on these systems.

The Internet contains a rich source of materials on Renewable Energy and Fuel Cell Technology Installations. Candidates should be aware of the different regulations, climates etc when using non UK based web sites.

Small Fuel Cell Technology kits can be used to support the learning. Candidates can assemble and test small systems and form opinions/evaluations on the merits or otherwise of fuel cell technology.

National Unit specification: support notes (cont)

Unit title: Domestic Combined Heat and Power Systems

The Unit should be fully supported with relevant learning materials (e.g. handouts in paper and electronic form, textbooks, on-line materials etc.)

This Unit is not intended to endorse successful candidates as competent operatives of fuel cell technology systems.

Opportunities for developing Core Skills

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

Elements of *Numeracy* at SCQF level 5 may be developed in Outcome 1 particularly when carrying out calculations associated with the electrochemical reactions of fuel cell technology. Using Graphical Information at SCQF level 5 may be developed in Outcome 1 where candidates are given graphical information to interpret hydrogen as an energy carrier.

The Core Skill *ICT* at SCQF level 5 may be developed in Outcome 1 where candidates may access and interpret information, research and select differing applications of fuel cell technology.

The Critical Thinking component of *Problem Solving* at SCQF level 5 may be developed in Outcome 2 while candidates are interpreting drawings and diagrams associated with component parts of fuel cell technology. The Planning and Organisation component of *Problem Solving* at SCQF level 5 may be developed in Outcome 3 as candidates develop basic planning procedures for the design and installation of fuel cell technology systems.

Elements of *Working with Others* Core Skill at SCQF level 4 may be developed in Outcome 3 while candidates develop design factors and work co-operatively with others. Although candidates do not have to demonstrate practical skills, formative activities could enhance the skills of working with others. Candidates could be given constructive feedback to encourage review and evaluation of their approaches to practical work including their contribution to team working

Guidance on approaches to assessment for this Unit

Centres are encouraged to use formative assessment extensively as it plays a particularly important role in allowing candidates to develop a sound knowledge and understanding of Fuel Cell Technologies.

Summative assessment may take the following form:

Outcomes 1 and 2

Assessment may comprise of a single assessment paper covering the outcome and performance criteria requirements for both Outcomes. The assessment paper should be taken at a single assessment event lasting 1 hour and comprise of a suitable balance of short answer, restricted response or structured questions.

National Unit specification: support notes (cont)

Unit title: Domestic Combined Heat and Power Systems

Outcome 3

Assessment may comprise of a single assessment paper covering the outcome and performance criteria requirements. The assessment paper should be taken at a single assessment event lasting 1 hour and comprise of a suitable balance of; multiple choice, short answer, restricted response or structured questions.

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)*.

Disabled candidates and/or those with additional support needs

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering whether any reasonable adjustments may be required. Further advice can be found on our website **www.sqa.org.uk/assessmentarrangements**.

History of changes to Unit

Version	Description of change	Date

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