



National Unit specification: general information

Unit title: Building Services Engineering Science (SCQF level 6)

Unit code: F1AL 12

Superclass: XH

Publication date: July 2011

Source: Scottish Qualifications Authority

Version: 02

Summary

This Unit will be suitable for candidates who have limited or no experience of Building Services Engineering Science.

It is designed to enable the candidate to develop a basic understanding of the fundamentals of fluid mechanics, thermal properties of solids, liquids, vapours and gases, psychrometry (behaviour of moist air), heat transfer and the combustion of fuels within the Building Services Engineering Industry.

Outcomes

- 1 Identify, describe and quantify the flow of fluids generated by pumps or fans in conduit systems.
- 2 Evaluate the thermal properties of solids, liquids, vapours and gases as applied in the Building Services Engineering Industry.
- 3 Analyse and quantify the principles of psychrometry as applied in the Building Services Engineering Industry.
- 4 Identify, describe and quantify modes of heat transfer and the combustion of fuels as applied in the Building Services Engineering Industry.

Recommended entry

Entry is at the discretion of the centre.

General information (cont)

Unit title: Building Services Engineering Science (SCQF level 6)

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.*

6 credit points, indicates a notional Unit design length of 40 hours of contact and 20 hours of self-directed learning.

Core Skills

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

The Unit provides opportunities for candidates to develop aspects of the following Core Skills:

- ◆ Numeracy at SCQF level 6

These opportunities are highlighted in the support notes of this Unit specification.

National Unit specification: statement of standards

Unit title: Building Services Engineering Science (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. The Appendix forms a part of this statement of standards.

Outcome 1

Identify, describe and quantify the flow of fluids generated by pumps or fans in conduit systems.

Performance Criteria

- (a) Identify and quantify the key characteristics and laws of fluid flow.
- (b) Identify and describe the main performance characteristics of pumps.
- (c) Identify and describe the main performance characteristics of fans.

Outcome 2

Evaluate the thermal properties of solids, liquids, vapours and gases as applied in the Building Services Engineering Industry.

Performance Criteria

- (a) Identify and describe the significant changes of state in solids, liquids, vapours and gases affected by temperature and pressure.
- (b) Identify and evaluate the main thermodynamic properties of solids, liquids, vapours and gases.
- (c) Apply gas laws to evaluate the key characteristics of 'Ideal gases'.

Outcome 3

Analyse and quantify the principles of psychrometry as applied in the Building Services Engineering Industry.

Performance Criteria

- (a) Analyse and quantify the main psychrometric properties of moist air using psychrometric charts.
- (b) Analyse and quantify simple air conditioning processes using psychrometric charts.

Outcome 4

Identify, describe and quantify modes of heat transfer and the combustion of fuels as applied in the Building Services Engineering Industry.

Performance Criteria

- (a) Identify and describe the key characteristics of the three modes of heat transfer (conduction, convection and radiation).
- (b) Describe the main properties and characteristics of fuels.
- (c) Describe and quantify the main properties in relation to the combustion of fuels.

National Unit specification: statement of standards (cont)

Unit title: Building Services Engineering Science (SCQF level 6)

Evidence Requirements for this Unit

The Appendix to this Unit details the mandatory content for each Outcome.

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

For Outcomes 1, 2, 3 and 4 written and/or oral evidence must be produced in open-book conditions. In this Unit an appropriate Instrument of Assessment could be a question paper consisting of a balance of multiple-choice, short answer, restricted response and structured questions. Candidates must not bring notes, textbooks or handouts to the assessment.

Candidates may be assessed on an Outcome by Outcome basis, combinations of Outcomes or by a single, holistic assessment covering Outcomes 1, 2, 3 and 4.

Assessments must be manageable and practicable for centres and candidates and a single assessment covering all Outcomes should not exceed 2 hours in duration.

The Assessment Support Pack for this Unit provides appropriate sample assessment materials. Where centres wish to develop their own assessment materials they should refer to the Assessment Support Pack to ensure a comparable standard.

National Unit specification: support notes

Unit title: Building Services Engineering Science (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

The Appendix to this Unit details the mandatory content for each Outcome.

This Unit is a mandatory Unit within the National Certificate in Building Services Engineering (SCQF level 6).

This Unit is a mandatory Unit of the National Certificate in Building Services Engineering, but can also be taken as a free-standing Unit.

This Unit introduces candidates to the fundamentals of fluid mechanics, thermal properties of solids, liquids, vapours and gases, psychrometry (behaviour of moist air), heat transfer and the combustion of fuels required to underpin applications in the technology Units of the National Certificate in Building Services Engineering (SCQF level 6).

Emphasis in the delivery of the Unit should be on familiarisation with terminology and basic concepts rather than detailed justification using fundamental principles.

Health and Safety and Sustainability are integral and key to the Building Services Engineering industry therefore throughout the Unit emphasis will be placed where appropriate on the application of Health and Safety and Sustainability. Safe working practices should be looked at in accordance with current safety codes of practice and regulations. Sustainability should include reference to criteria affecting sustainability, impact of not implementing sustainability on the environment and the legislation promoting sustainability.

Guidance on learning and teaching approaches for this Unit

When this Unit is delivered as part of the National Certificate in Building Services (SCQF level 6) it provides essential underpinning knowledge for the following technology Units and should be delivered before, or in parallel, with these Units:

- ◆ *Air Conditioning and Ventilation Technology* (SCQF level 6)
- ◆ *Refrigeration Technology* (SCQF level 6)
- ◆ *Heating and Plumbing Technology* (SCQF level 6)
- ◆ *Building Services Engineering Technology* (SCQF level 5)

Suggested teaching and learning methods for this Unit could include: the use of visual aids, ICT, group lectures and discussion, practical demonstrations, question and answer sessions, directed study, industrial/site visits.

Formative work for the Unit could specifically include group discussion. Such an approach could be particularly beneficial to candidates with no industrial experience.

National Unit specification: support notes (cont)

Unit title: Building Services Engineering Science (SCQF level 6)

Guidance on approaches to assessment for this Unit

To be read in conjunction with the **Evidence Requirements**.

Candidates should be made aware of what will be required of them in order to achieve credit for the Unit. They should be encouraged to discuss the work with the lecturer and their colleagues. Help and encouragement should be given throughout the Unit so that the candidates become confident in their ability to achieve the Performance Criteria.

Candidates may be assessed on an Outcome by Outcome basis, combinations of Outcomes or by a single, holistic assessment covering Outcomes 1, 2, 3 and 4. It is recommended that this Unit is assessed holistically with other Units from the Award of which it forms part.

In this Unit an appropriate Instrument of Assessment could be a question paper consisting of a balance of multiple-choice, short answer, restricted response and structured questions.

Preparation for assessment should include formative work with opportunities for constructive feedback.

Planning should allow time for re-assessment. Given that assessment for this Unit must be conducted under controlled conditions, centres should ensure that a different assessment is given for re-assessment purposes and that similar controlled conditions apply.

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 Communication 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)*.

Opportunities for developing Core Skills

Accuracy and confidence in interpreting and applying complex numerical and graphic information underpins the competencies developed in the Unit. Candidates could be provided with formative opportunities and support to enhance skills in the interpretation and presentation of numerical, statistical and graphic data in practical building services contexts. The emphasis of formative work should be on Numeracy as a tool to be used and applied efficiently and critically in building services and construction design solutions. Access to technology and appropriate software could provide useful support as candidates develop skills and learn to interpret numerical and graphical information in building services contexts.

National Unit specification: support notes (cont)

Unit title: Building Services Engineering Science (SCQF level 6)

Open learning

Where appropriate materials and facilities are available, this Unit could be delivered by distance learning which might include some degree of online support. Centres must ensure that for all modes of delivery the same assessment conditions, standards and quality assurance procedures apply to all candidates.

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.

National Unit specification: statement of standards

Unit title: Building Services Engineering Science (SCQF level 6)

Appendix — Content and Context for this Unit

The content specified in this Appendix is within the statement of standards, ie the mandatory requirements of the Unit.

Recommended time allocations to each Outcome are given as guidance on the depth of treatment which might be applied to each topic and are inclusive of time for teaching and assessment. This guidance has been used in the design of Assessment Support Pack material provided with the Unit.

- 1 Identify, describe and quantify the flow of fluids generated by pumps or fans in conduit systems (10 hours).
 - ◆ **Flow of Fluids**
 - Continuity equation for fluids, potential and kinetic energy in flowing fluids, Bernoulli's equation.
 - Application of continuity of flow and Bernoulli's equation.
 - Static and velocity pressure changes in ductwork installations and ductwork fittings, types of flow and Reynold's number, head loss in pipework with turbulent flow, D'Arcy's formula, Colebrook-White formula, Chezy formula, pressure loss due to fittings, in pipes and ducts, conversion of fitting resistance to 'equivalent length'.
 - ◆ **Pumps**
 - Performance and characteristics of centrifugal pumps, system characteristics, cavitation, pumps in series and parallel, methods of changing performance.
 - ◆ **Fans**
 - Fan types, performance and characteristics, simple fan laws.
- 2 Evaluate the thermal properties of solids, liquids, vapours and gases as applied in the Building Services Engineering Industry (10 hours).
 - ◆ **Change of State**

Kinetic theory of matter, reasons for change of state, sensible and latent heat, enthalpy.
 - ◆ **Thermodynamic properties and processes**

Relationship between pressure, saturation temperature and enthalpy, thermodynamic properties for water and refrigerants, use of tables and pH diagrams to solve problems, plotting processes and refrigeration cycles.
 - ◆ **Ideal Gases**

Relationship between pressure, temperature, volume and mass for ideal gases, application of general gas law, Boyles law, Charles law and characteristic gas equation, Doulton's law.

National Unit specification: statement of standards (cont)

Unit title: Building Services Engineering Science (SCQF level 6)

- 3 Analyse and quantify the principles of psychrometry as applied in the Building Services Engineering Industry (10 hours).
 - ◆ **Psychrometric properties**
Psychrometric terms and properties, psychrometric properties of air and water vapour mixtures by calculation, measurement, tables and charts.
 - ◆ **Air conditioning processes and cycles**
Psychrometric process lines for sensible heating and cooling, dehumidification and humidification (using different types of humidifiers), resulting condition from mixture of two air streams, plotting summer and winter psychrometric cycles for given arrangements of air conditioning plant and operating conditions, plant duties from psychrometric chart.

- 4 Identify, describe and quantify modes of heat transfer and the combustion of fuels as applied in the Building Services Engineering Industry (10 hours).
 - ◆ **Heat transfer**
Types of heat transfer, applications and significance in building services systems, conduction transfer through single slab and composite structures, convection transfer due to free/natural convection in air from vertical and horizontal panels and horizontal cylindrical objects, radiation heat transfer from plane surfaces.
 - ◆ **Fuels**
Properties and characteristics of common solid, liquid and gaseous fuels, products of complete and partial combustion and their implications, minimum air requirements for stoichiometric combustion, requirements for excess air and need for control of excess air quantities, causes of incomplete combustion.
 - ◆ **Determination of Natural Gas Pipe Sizes**
Conversion of heat inputs to gas flow rates. Use of published charts and graphical data for pipe sizing.
 - ◆ **Flueing and Ventilation Requirements**
 - Legislation requirements, operating principles of open and room sealed appliances, flue routes and terminal positions for open-flue and room sealed appliances.
 - Determination of combustion and compartment ventilation.

History of changes to Unit

Version	Description of change	Date
02	Update from 'closed-book' assessment to 'open-book' assessment.	14/07/2011

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