National Unit Specification: general information

UNIT Building Services Engineering: Thermofluids (SCQF level 6)

CODE F1AX 12

SUMMARY

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

This Unit is designed to develop the candidate's fundamental knowledge and understanding of the principles governing the behaviour of compressible and incompressible fluids in a Building Services Engineering environment. The Unit is designed to introduce candidates to the characteristics of fluid flow when subjected to pressure, and of the appropriate techniques and equipment used to measure such fluids. It will further develop the candidates' knowledge and understanding of the thermodynamic properties of fluids and of the components and equipment selected from system design practices.

OUTCOMES

1 Explain fluid flow characteristics in specific contexts.
2 Interpret fluid pressure and use pressure measurement techniques.
3 Describe fluid flow characteristics, apply appropriate formulae and calculate energy distribution in simple building services systems.
4 Use fluid flow system design methodology relating to friction and turbulent energy losses to design pipework systems.
5 Describe the operation of compressors, fans and pumps.

RECOMMENDED ENTRY

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

- Standard Grade Science at General level

Administrative Information

Superclass: XH

Publication date: February 2007

Source: Scottish Qualifications Authority

Version: 01

National Unit Specification: general information (cont)

UNIT Building Services Engineering: Thermofluids (SCQF level 6)

CREDIT VALUE

1 credit at Higher (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 components of the following Core Skills:

- Numeracy (SCQF level 6)
- Problem Solving (level 5)

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

National Unit Specification: statement of standards

UNIT Building Services Engineering: Thermofluids (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 the Scottish Qualifications Authority. The Appendix forms a part of this statement of standards.

OUTCOME 1

Explain fluid flow characteristics in specific contexts.

Performance Criteria

(a) Identify accurately the characteristics of ideal and real fluids.
(b) Identify the distinguishing characteristics of laminar and turbulent flow conditions.
(c) Explain the key characteristics of compressible and incompressible fluid flow.

OUTCOME 2

Interpret fluid pressure and use pressure measurement techniques.

Performance Criteria

(a) Use appropriate pressure measurement techniques to record fluid pressures within building services applications.
(b) Interpret accurately the results of pressure measurements in fluids recorded from building services applications.

OUTCOME 3

Describe fluid flow characteristics, apply appropriate formulae and calculate energy distribution in simple building services systems.

Performance Criteria

(a) Describe the key characteristics of fluid flow within simple Building Services Engineering systems.
(b) Describe accurately the distribution of energy in simple Building Services Engineering fluid flow systems.
(c) Apply Bernoulli's equation to fluid flow to accurately calculate energy distribution in systems.

National Unit Specification: statement of standards (cont)

UNIT Building Services Engineering: Thermofluids (SCQF level 6)

OUTCOME 4

Use fluid flow system design methodology relating to friction and turbulent energy losses to design pipework systems.

Performance Criteria

(a) Calculate accurately energy losses due to friction in fluid flow.
(b) Calculate accurately energy losses due to turbulence in fluid flow.
(c) Design appropriate pipework systems using fluid flow design practices.

OUTCOME 5

Describe the operation of compressors, fans and pumps.

Performance Criteria

(a) Identify and describe the main operating characteristics of compressors.
(b) Identify and describe the main operating characteristics of fans and pumps.

EVIDENCE REQUIREMENTS FOR THIS UNIT

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

Evidence must be produced to demonstrate that **all** Outcomes and Performance Criteria have been achieved.

For Outcomes 1, 2, 3, 4 and 5 written and/or oral evidence must be produced in controlled, supervised, closed-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, 4 and 5.

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

National Unit Specification: support notes

UNIT Building Services Engineering: Thermofluids (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 designed to further develop candidate knowledge and understanding of principles governing the behaviour of compressible and incompressible fluids and their effects within building services systems in relation to energy consumption caused by frictional or turbulent flow conditions. The Unit develops candidate understanding of applications to building services engineering systems.

Emphasis in the delivery of the Unit should be on familiarisation with terminology and basic concepts to allow candidates to converse technically in the design of simple systems using fluids of a compressible and incompressible nature and to enable candidates to take cognisance of pressure monitoring techniques and the interpretation of the recorded data from such monitoring. In delivering the Unit, appropriate learning and teaching environments will mainly be classroom based with access to laboratories/workshops adventitious to facilitate observation of monitoring techniques.

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 & 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.

Delivery should recognise that candidates will apply knowledge and skills from this Unit when developing solutions to technological problems. Outcomes from this Unit should therefore be taught in the context of applied technology topics.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

This Unit has links with Building Services Science, it is recommended therefore that when delivered as part of the National Certificate in Building Services (SCQF level 6) it be delivered after the Science Unit. Given that Thermofluids is an integral component in understanding the principles and applications encountered within the listed Units below, it is suggested that it is either taken before, or in parallel with any one of the following Units. The Units listed below themselves are not referenced in any sequential order, the emphasis being on the recommendation to undertake Thermofluids prior to or in parallel with at least one of the following:

UNIT Building Services Engineering: Thermofluids (SCQF level 6)

- *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)

The content of this Unit will benefit from candidate observational activities within a laboratory, workshop or other practical demonstration environment. The demonstrations will permit candidates to observe the techniques used to monitor pressures required to enhance their knowledge and understanding of such activities, thereby allowing the candidate to apply this knowledge in designing simple building services systems.

Discussion of case studies in formative work could examine and evaluate all factors impacting on the design of pipework systems including the impact of such factors as friction and turbulence on energy loss.

Opportunities for developing Core skills

Accuracy in interpreting complex numerical and graphic information and the ability to calculate, apply and present complex data is an aspect of best practice across the award. Numeracy involves a wide range of skills which underpin a flexible approach to building services technology. These skills should be encouraged and developed as candidates interpret, apply and evaluate fluid flow information. The emphasis should be on Numeracy as a tool to be used and applied efficiently and critically.

Group work could provide opportunities to enhance problem solving skills and place knowledge and skills developed in an appropriate building services context. Integrative assignments and project work will help to link this Unit with other related Units.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

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

Candidates may be assessed on an Outcome by Outcome basis, combinations of Outcomes or by a single, holistic assessment. In this Unit an appropriate instrument of assessment could be a question paper consisting of a balance of short answer, restricted response and structured questions.

Preparation for assessment should include formative work with opportunities for constructive feedback. Well planned assignments and project work will also be useful preparation.

Where the Unit is taken as part of the National Certificate in Building Services Engineering (SCQF level 6), there will be opportunities to integrate the assessments for this Unit with other appropriate Units. For example:

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

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

Open learning

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

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)**.

Appendix

National Unit Specification: statement of standards

UNIT Building Services Engineering: Thermofluids (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 Explain fluid flow characteristics in specific contexts (6 hours).

Fundamental Definitions

- Fundamentals:
  - Process
  - Ideal fluid
  - Real fluid
  - Laminar flow
  - Turbulent flow
  - Reynolds' number
  - Steady flow
  - Unsteady flow
  - Uniform flow
  - Non-uniform flow
  - Streamline
  - Boundary layer
  - 1, 2 and 3 dimensional flow

Fluids

- Basics:
  - Compressible
  - Incompressible

2 Interpret fluid pressure and use pressure measurement techniques (6 hours).

Pressure Definitions

- Definitions and units:
  - Pressure
  - Atmospheric pressure
  - Gauge pressure
  - Absolute pressure
  - Units
  - Head pressure
  - Total, static and velocity pressure

National Unit Specification: statement of standards (cont)

UNIT Building Services Engineering: Thermofluids (SCQF level 6)

Pressure Measurement

- Equipment:
  - Barometers
  - U-tube manometers
  - Simple and differential manometers
  - Inclined manometers
  - Pressure gauge
  - Compound gauge
  - Pitot-static tube

3 Describe fluid flow characteristics, apply appropriate formulae and calculate energy distribution in simple building services systems (8 hours).

Principles

- Fluid flow basics:
  - Conservation of energy theory
  - Steady flow energy equation (SFEE)
  - Energy forms
    - PE potential energy
    - KE kinetic energy
    - U internal energy
    - Pv flow energy
    - Q heat
    - W work
  - Continuity equation
  - Bernoulli's equation

Practices

- Problem solving:
  - Use of Bernoulli
  - Orifice plates
  - Venturi meters
  - Viscosity effects

National Unit Specification: statement of standards (cont)

UNIT Building Services Engineering: Thermofluids (SCQF level 6)

4 Use fluid flow system design methodology relating to friction and turbulent energy losses to design pipework systems (10 hours).

Principles

- Basic information:
  - Head loss
  - Modification to Bernoulli
  - D'Arcy's formula
  - Fanning's formula
  - Chezy's formula
  - Friction factor
  - Pipe friction
  - Stanton diagram
  - Commercial piping
  - Pipe friction charts
  - Colebrook and White
  - Moody diagram
  - Fitting loss
  - Pressure loss factor
  - Equivalent length
  - Pipe and duct sizing charts

5 Describe the operation of compressors, fans and pumps (10 hours).

Thermodynamics

- Fundamentals:
  - Thermodynamic properties
  - Cycle
  - First law
  - Flow and non-flow process
  - Non-flow energy equation
  - Internal energy and enthalpy
  - Processes:
    - Constant volume
    - Constant pressure
    - Polytropic
    - Adiabatic
  - SFEE

National Unit Specification: statement of standards (cont)

UNIT Building Services Engineering: Thermofluids (SCQF level 6)

Gas Laws

- Boyle's law
- Charles law
- Combined gas law
- Compression processes

Fluid Moving Devices

- Basic operation:
  - Reciprocating compressors
  - Rotary compressors
  - Axial flow fans
  - Centrifugal fans
  - Pumps