



## Higher National Unit specification

### General information for centres

**Unit title:** Sustainable Building Services Engineering

**Unit code:** F77Y 35

**Unit purpose:** To create a broad based awareness of the factors contributing to the environmental cost of services applied to buildings. Improvement of sustainability over typical buildings should be a key objective of any new design, and a thorough understanding of the science underpinning services engineering is important to enable an evaluation of the impact of any proposed installation. This Unit focuses on these issues together with an appreciation of the principles of sustainability, current best practice and how the science may be applied to a wide range of building types.

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

- 1 Explain the integration of building services in to buildings in order to enhance sustainability.
- 2 Evaluate the factors influencing the sustainability of thermal and mechanical building services.
- 3 Evaluate the factors influencing the sustainability of pipe and duct services in buildings.

**Credit points and level:** 1 HN 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 Access 1 to Doctorates.*

**Recommended prior knowledge and skills:** It would be an advantage for candidates to have a basic understanding and knowledge of building services or building services engineering science and technology. Such understanding and knowledge may be evidenced by the possession of DW4P 33 *Building Services: An Introduction* or by a level 6 or 7 qualification in *Building Services Engineering* or a related discipline.

The Unit includes all the principles necessary to allow candidates possessing other qualifications or experience to succeed in this Unit.

**Core Skills:** There are opportunities to develop the Core Skills of *Numeracy*, *Problem Solving* and *Communication* all at SCQF level 6 in this Unit, 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:** It is possible to assess candidates either on an individual Outcome basis, which is suggested for Outcome 1, or step wise as the detailed information for the each of the Evidence Requirements is mastered. This latter approach is suggested for Outcomes 2 and 3. The assessment paper/s should be composed of an appropriate balance of short answer, restricted response and structured questions. Assessment should be conducted under supervised, controlled conditions. A single assessment event covering one Outcome should not exceed 1 hour in duration.

## **Higher National Unit specification: statement of standards**

**Unit title:** Sustainable Building Services Engineering

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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**

Explain the integration of building services in to buildings in order to enhance sustainability

#### **Knowledge and/or Skills**

- ◆ Integrating building fabric and services
- ◆ Sustainable technologies
- ◆ Environmental design checking
- ◆ Commissioning and handover

#### **Evidence Requirements**

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- ◆ explain a suitable process whereby a building's fabric, its services and sustainable technologies may be effectively integrated in a design
- ◆ explain the use of sustainability benchmarks in design checking
- ◆ describe the commissioning and handover process and the impact that this can have on the future sustainability of the design

#### **Assessment Guidelines**

The evidence for this Outcome could be generated by means of a closed-book test or report using a range of short answer, restricted response and extended response questions.

## **Higher National Unit specification: statement of standards (cont)**

**Unit title:** Sustainable Building Services Engineering

### **Outcome 2**

Evaluate the factors influencing the sustainability of thermal and mechanical building services

#### **Knowledge and/or Skills**

- ◆ Boiler efficiency assessment
- ◆ Heat recovery systems
- ◆ Cooling systems
- ◆ Building transport systems
- ◆ Plant control strategies
- ◆ Building management systems

#### **Evidence Requirements**

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- ◆ evaluate the financial and environmental consequences of a boiler change in either a domestic or small commercial setting
- ◆ explain the mode of operation of two contrasting heat recovery systems
- ◆ evaluate the recoverable heat and the environmental benefit from a heat recovery system
- ◆ explain how a given cooling load might be delivered with low environmental cost
- ◆ predict the energy cost of a building transport system
- ◆ explain the principles of operation of two contrasting plant control strategies
- ◆ explain how building management systems may be deployed to reduce the environmental impact of a building

#### **Assessment Guidelines**

This Outcome can be assessed by means of a structured pro forma workbook which the candidate completes as an open-book exercise as they progress through the Unit. Where appropriate successful evaluations should be contingent on showing correct workings.

## **Higher National Unit specification: statement of standards (cont)**

**Unit title:** Sustainable Building Services Engineering

### **Outcome 3**

Evaluate the factors influencing the sustainability of pipe and duct services in buildings

#### **Knowledge and/or Skills**

- ◆ Steam systems
- ◆ Compressed air services
- ◆ Fluid flow in pipework
- ◆ Fans and duct systems

#### **Evidence Requirements**

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- ◆ explain the mode of operation of a steam plant for space heating and one processing function
- ◆ evaluate the environmental benefit of two improvements to the thermal efficiency of steam plant
- ◆ evaluate, in comparative terms, the environmental cost of producing compressed air to two defined air quality standards
- ◆ select a suitable pump to deliver a required flow against a calculated head loss in a simple hot water pipework system
- ◆ select conduits to resolve a gravitational flow problem associated with roof water recovery or domestic water supply
- ◆ explain the operational characteristics of an axial flow and a centrifugal fan and the impact of duct design on their energy performance

#### **Assessment Guidelines**

The individual Evidence Requirements of this Outcome may be assessed separately by an open-book assessment consisting of a restricted or extended response question to be completed within a specified time frame. There need be no restriction on the resources the candidates can use but the time frame must be short such that only those candidates who understand the issues can complete the given tasks in the time available. The time should be representative of the time required by a competent building services engineer at this level.

## Administrative Information

**Unit code:** F77Y 35  
**Unit title:** Sustainable Building Services Engineering  
**Superclass category:** TA  
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### History of changes:

Version	Description of change	Date

**Source:** SQA

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## Higher National Unit specification: support notes

### Unit title: Sustainable Building Services Engineering

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 designed to provide candidates with a detailed consideration of the science that underpins building services engineering. A sustainable built environment is going to be largely dependent upon the way in which the building services systems that provide heat, ventilation, air conditioning, refrigeration, water supply, drainage and lighting are incorporated or integrated into the structure and fabric. It is these systems that have a cost to building owners and managers both in financial and environmental terms. The environmental cost being mainly excessive resource use, carbon emissions and ozone depletion potential.

There are three Outcomes in the Unit.

Outcome 1 will be taught with reference to the importance of connecting building services and the building structure and fabric. Design is a process of synthesis, which is to say, putting together various parts of an overall system or building solution. The details of Outcome 1 teaching and learning might include location and type of boiler in a building design strategy, location of fuel stores (eg wood pellets in a bunker) and the means of transporting it to the boiler (eg an enclosed auger, again in the case of wood pellets) pipework routes for water supply, pipework insulation and surface condensation, natural ventilation stacks, light pipes, underfloor heating pipes, locating renewable engineering technology appropriately for optimum benefit with due regard to wind direction, sunpath or water course flow rate, and, heat pumps and garden or landscape destruction and restoration. Also in Outcome 1, there will be the need to check that a design is worthwhile from a sustainability point of view, ie environmental benefit and financial benchmark checking. And, finally, in Outcome 1, the important matter of commissioning and testing installed building services engineering components will be dealt with.

Outcomes 2 and 3 will involve teaching and learning associated with mechanical building services engineering, split into two parts. Outcome 2 is concerned with thermal energy in buildings and building transportation systems. Outcome 3 is about sustainability in distribution duct and pipework services in buildings. **In both Outcomes the focus should be clearly on the candidate exploring which of the factors that influence energy requirements are the more significant, and considering how system design can be manipulated to reduce the environmental cost of the installed system.**

Outcome 2's sustainability focus is on boiler efficiency, heat transfer in buildings, and opportunities for heat recovery, for example from air/air or air/water heat exchangers, condensing boilers and heat transfer efficiency increases from flat to finned surfaces and from using materials of different heat transfer coefficients. Outcome 2 will also look at the efficiencies in building transportation systems such as escalators and elevators. The energy cost of these will be evaluated and discussed for improvement options.

## Higher National Unit specification: support notes (cont)

### Unit title: Sustainable Building Services Engineering

Outcome 3 looks at distribution ducts and pipe networks. The work will consider the engineering fundamentals of air flow in ducts, fan assisted and natural flow, flow characteristics (laminar and turbulent), water flow in pipes, water pressure, head, pump power input and output and calculated efficiencies, compressed air, air pressure, gas flow, pipework design, steam characteristics, steam tables and steam systems.

### Guidance on the delivery and assessment of this Unit

The Unit is specifically designed for use as part of a Group Award in sustainable building design and it is best studied in this context, though it would have applicability for other programmes and industries that require an intimate knowledge of the engineering factors influencing the sustainability of selected buildings services. The Unit is expected to be delivered primarily in a classroom environment. However, every opportunity should be sought to investigate machines and systems in a working environment or failing this to use models and simulations. For example, pipeline flow can be studied as a paper exercise and then reinforced by participating in a laboratory test exercise. Site visits to locations using steam plant and compressed air can be used as the background to developing an understanding of the relevant sustainability issues in a theoretical classroom session. There may be opportunities to link this module to programmes leading to skills certification in installation work.

The assessment of Outcome 1 may be assessed using a variety of question types including restricted response, short answer and extended response. It is best conducted as a closed-book test as this information should be available for instant recall by the building services practitioner. By contrast Outcomes 2 and 3 may be assessed by means of a structured exercises conducted in an open-book situation as much of the evaluation work will require access to data that would be unnecessarily difficult to provide in a closed-book assessment. Nevertheless candidates should be encouraged to learn the principles behind the information as in the workplace only access to the data, rather than the method, would be expected. It is important to ensure the assessments are structured as far as possible. Thus it would be sensible to link questions on say heat recovery with steam systems rather than with questions on gravitational flow.

Although not specifically addressed or assessed in this Unit the health and safety implications of the content can be made clear to candidates. For example the potential for *Legionella* in a water based heat recovery system has an impact on the design and operation and this can be pointed out during the progress through the work of the Unit.

#### ***Opportunities for developing Core Skills***

The pump selection, fan specification and gravitational flow investigation work of this Unit means there is ample opportunity to develop the component Using Graphical Information of the *Numeracy* Core Skill. Successful completion of this Unit may allow candidates to develop of the Core Skill of *Numeracy* at SCQF level 6, however this is not certificated.

Candidates will have an opportunity to analyse systems within both Outcome 2 and Outcome 3. The analysis of a heat recovery system and the analysis of a pipe head loss are both assessed and this may give candidates the opportunity to develop the component Critical Thinking of the Core Skill *Problem Solving* at SCQF level 6. Candidates may analyse a pump and fan and justify why it may be used in a particular situation. The general skill that candidates may have to complete is 'Analyse a complex situation or issue'.



## **Higher National Unit specification: support notes (cont)**

### **Unit title:** Sustainable Building Services Engineering

Assessment of this Unit may allow candidates to develop the Reviewing and Evaluating component of the Core Skill *Problem Solving* at SCQF level 6. Candidates may have opportunities to gather evidence to support their evaluation and to draw conclusions. Candidates are able to gather their own evidence for Outcomes 2 and 3 and to draw conclusions regarding the energy and environmental cost of their decisions relative to the assessment task. The general skill that candidates may have to complete is 'Review and evaluate a complex problem solving activity'.

There are opportunities for the candidate to develop Written Communication at SCQF level 6 in the assessment of all Outcomes. As candidates complete written work for each Outcome they will have an opportunity to develop the general skill 'Produce well structured written communication on complex topics'.

### **Open learning**

It is possible for this Unit to be delivered by distance learning. Candidates may require access to suitable data charts and training apparatus and access to these would require a degree of planning by the centre. The assessments could be completed on-line.

### **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](http://www.sqa.org.uk/assessmentarrangements)

## General information for candidates

### Unit title: Sustainable Building Services Engineering

This Unit has been written to provide you, the candidate, with an understanding of the factors of influence in sustainable building design and construction and a broad understanding of the fundamental science of building services engineering. The main learning topics may include integrating building fabric and services, opportunities for renewables, environmental design checking, commissioning and handover, heat recovery systems, boiler efficiency assessment, building transport systems, plant control strategies, fans and duct systems, fluid flow in pipework, compressed air services and steam systems. The Unit is intended for candidates targeting a career in, or associated with, the built environment sector.

On successfully completing the Unit you should be able to:

- 1 Explain the integration of building services in to buildings in order to enhance sustainability.
- 2 Evaluate the factors influencing the sustainability of thermal and mechanical building services.
- 3 Evaluate the factors influencing the sustainability of pipe and duct services in buildings.

The Unit is likely to be delivered using lectures, site visits, practicals, group work, investigation, including the use of technical journals and a range of other written and electronic media, and building project case studies.

The formal assessment for this Unit could consist of a single assignment project, or of separate pieces of work to become evidence of competence on your part. The assessments will be conducted under controlled conditions of timescale and other aspects of education quality. You should expect to have to submit work at the end of relevant Outcome teaching or at the end of the Unit teaching as a whole.

There are opportunities to develop Core Skills in *Communication*, *Numeracy* and *Problem Solving* in this Unit. For example Outcome 1 requires the description and explanation of several building features to be provided for the assessed work. This work may be structured to enable Core Skills development to be identified. Both Outcome 2 and 3 have a strong focus on *Numerical* and *Problem Solving* work and the assessed work may be structured to enable *Numeracy* development to be noted and for the ability to rationalise information to problem solve. However, the Core Skills are not formally assessed or certificated in this Unit.