Higher National Unit Specification

General information for centres

Unit title: Thermofluids and Acoustic Criteria

Unit code: DP0T 34

Unit purpose: This unit is designed to enable candidates to extend their knowledge and understanding of the principles used in the analysis and application of fluid flow, heat transfer and acoustics in the design of Building Services Systems.

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

- Analyse and apply modes of **heat transfer**
- Apply **dimensional analysis** to fundamental and empirical formulae with special reference to heat exchanger design and performance
- Investigate the performance of **refrigeration plant** and thermodynamic cycles
- Investigate **acoustic criteria** and apply suitable design methodology.

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: It would be an advantage for candidates to have a basic understanding and knowledge of building services engineering science and technology.

Such understanding and knowledge may be evidenced by the possession of a National Certificate in Building Services Engineering or a related subject.

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

This Unit is supported by Building Services Engineering Science and as such should be studied after or integrated with that Unit. There are strong links with Air Conditioning A, Air Conditioning B, Heating A and Heating B.

Core skills: There may be opportunities to gather evidence towards core skills in this Unit, although there is no automatic certification of core skills or core skills components.

Context for delivery: This unit was developed for the HNC Building Services Engineering. If this Unit is delivered as part of another group award, it is recommended that it should be taught and assessed within the subject area of the group award(s) to which it contributes.

General information for centres (cont)

Assessment: It is possible to assess candidates either on an individual Outcome basis, combinations of Outcomes or by a single holistic assessment combining all Outcomes. 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 covering all outcomes should not exceed 2 hours in duration. It should be noted that candidates must achieve all the minimum evidence specified for each Outcome in order to pass this Unit.

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.

An exemplar instrument of assessment and marking guidelines has been produced to provide examples of evidence required to demonstrate achievement of the aims of this unit.

Higher National Unit specification: statement of standards

Unit title: Thermofluids and Acoustic Criteria

Unit code: DP0T 34

The sections of the Unit stating the Outcomes, knowledge and/or skills, and evidence requirements are mandatory.

(If you think holistic assessment is the best assessment strategy for the Unit and you wish to state *Knowledge and/or Skills* and *Evidence requirements* for the Unit as a whole, please add the following statement here: 'Please refer to *Knowledge and/or skills for the Unit* and *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

Analyse and apply modes of **heat transfer**

Knowledge and/or skills

- Modes of heat transfer
- Heat transfer by convection
- Heat transfer by radiation

Evidence requirements

Candidates will need evidence to demonstrate their knowledge and/or skills by showing that they can:

- solve simple heat transfer problems for processes and equipment
- apply basic principles to heat transfer equipment used within the Building Services Industry

Evidence for the knowledge and /or skills for this Outcome will be provided on a sample basis. In any assessment of this Outcome a minimum of **two out of three** knowledge and/or skills items should be sampled. In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample of knowledge/skill items is required each time the Outcome is assessed. Candidates must provide a satisfactory response to both items assessed.

Evidence should be generated through assessment undertaken in controlled, supervised conditions. Assessment should be conducted under closed book conditions and as such candidates should not be allowed to bring textbooks, handouts or notes to the assessment.

Assessment guidelines

Questions used to elicit candidate evidence should take the form of an appropriate balance of short answer, restricted response and structured questions.

The assessment for this outcome might be combined with that for Outcomes 2, 3, 4 to form a single assessment paper.

Higher National Unit specification: statement of standards (cont)

Unit title: Thermofluids and Acoustic Criteria

Outcome 2

Apply **dimensional analysis** to fundamental and empirical formulae with special reference to heat exchanger design and performance

Knowledge and/or skills

- Identification of units and dimensions
- Dimensionless groups
- Application of dimensional analysis
- Heat exchanger basics
- Heat exchanger performance

Evidence requirements

Candidates will need evidence to demonstrate their skills and/or knowledge by showing that they can:

- explain the significance of dimensionless groups in fluid flow and heat transfer applications related to building services engineering plant
- describe the types and basic design layouts for heat exchangers used within the building services industry
- explain the factors affecting heat exchanger performance
- solve heat exchanger design problems.

Evidence for the knowledge and /or skills for this Outcome will be provided on a sample basis. In any assessment of this Outcome a minimum of **three out of five** knowledge and/or skills items should be sampled. In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample of knowledge/skill items is required each time the Outcome is assessed. Candidates must provide a satisfactory response to all three items.

Evidence should be generated through assessment undertaken in controlled, supervised conditions. Assessment should be conducted under closed book conditions and as such candidates should not be allowed to bring textbooks, handouts or notes to the assessment.

Assessment guidelines

Questions used to elicit candidate evidence should take the form of an appropriate balance of short answer, restricted response and structured questions.

The assessment for this outcome might be combined with that for Outcomes 1, 3, 4 to form a single assessment paper.

Higher National Unit specification: statement of standards (cont)

Unit title: Thermofluids and Acoustic Criteria

Outcome 3

Investigate the performance of **refrigeration plant** and thermodynamic cycles

Knowledge and/or skills

- Refrigeration and thermodynamic cycles
- T-s and P-h diagrams
- P-h chart plotting
- Performance analysis of refrigeration plant and heat pumps
- Theoretical and actual cycles
- Compression and expansion devices
- Ideal and actual pressure volume diagrams

Evidence requirements

Candidates will need evidence to demonstrate their knowledge and/or skills by showing that they can:

- evaluate the performance of refrigeration and or heat pump plant commonly used within the Building Services Industry
- use pressure volume diagrams to analyse power cycles and to calculate work outputs and efficiencies.

Evidence for the knowledge and /or skills for this Outcome will be provided on a sample basis. In any assessment of this Outcome a minimum of **five out of seven** knowledge and/or skills items should be sampled. In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample of knowledge/skill items is required each time the Outcome is assessed. Candidates must provide a satisfactory response to all five items.

Evidence should be generated through assessment undertaken in controlled, supervised conditions. Assessment should be conducted under closed book conditions and as such candidates should not be allowed to bring textbooks, handouts or notes to the assessment.

Assessment guidelines

Questions used to elicit candidate evidence should take the form of an appropriate balance of short answer, restricted response and structured questions.

The assessment for this outcome might be combined with that for Outcomes 1, 2 4 to form a single assessment paper.

Higher National Unit specification: statement of standards (cont)

Unit title: Thermofluids and Acoustic Criteria

Outcome 4

Investigate **acoustic criteria** and apply suitable design methodology.

Knowledge and/or skills

- Noise criteria and effect
- Noise rating and noise criteria curves
- Internal and external environments
- Noise control
- Noise control in Building Services applications

Evidence requirements

Candidates will need evidence to demonstrate their knowledge and/or skills by showing that they can:

- use noise rating (NR) and noise criteria (NC) curves to solve problems in building services engineering plant and equipment.
- apply sound attenuation techniques.
- provide noise control solutions to building services engineering plant and equipment.

Evidence for the knowledge and /or skills for this Outcome will be provided on a sample basis. In any assessment of this Outcome a minimum of **three out of five** knowledge and/or skills items should be sampled. In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample of knowledge/skill items is required each time the Outcome is assessed. Candidates must provide a satisfactory response to all three items.

Evidence should be generated through assessment undertaken in controlled, supervised conditions. Assessment should be conducted under closed book conditions and as such candidates should not be allowed to bring textbooks, handouts or notes to the assessment.

Assessment guidelines

Questions used to elicit candidate evidence should take the form of an appropriate balance of short answer, restricted response and structured questions.

The assessment for this outcome might be combined with that for Outcomes 1, 2, 3 to form a single assessment paper.

Administrative Information

Unit code: DP0T 34

Unit title: Thermofluids and Acoustic Criteria

Superclass category: RC

Date of publication: August 2005

Version: 01

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: Thermofluids and Acoustic Criteria

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 xx hours.

Guidance on the content and context for this Unit

This unit has been written in order to allow the candidates to develop knowledge, understanding and skills in the following areas:-

- the modes of heat transfer
- dimensional analysis with special reference to heat exchanger design and performance
- thermodynamic cycles with application to refrigeration and heat pump plant
- noise criteria and noise control.

The unit has been developed as a specialist optional unit that appears within the framework for HVAC, Plumbing and Refrigeration HN qualification pathways.

This unit is to develop the principles established in the Building Services Engineering Science and to extend the candidates understanding of the principles used in the analysis and application of fluid flow, heat transfer and acoustics in the design of building services plant and equipment. The unit examines thermodynamic laws and process cycles which are specific to systems and equipment that is commonly used within the building services industry.

Recommended time allocations to each outcome are given as guidance towards the depth of treatment which might be applied to each topic. This guidance has been used in the design of the assessment exemplar material provided with the unit.

1. Analyse and apply modes of heat transfer (8 hours)

Modes of heat transfer:
Kinetic theory of heat transfer
Modes of heat transfer and their suitability for building services equipment and processes.

Convection:

Temperature parameters:	Mean Bulk Arithmetic mean temperature difference (AMTD) Log mean temperature difference (LMTD) relevant to free and forced convection processes
Application of:	Grashoff (Gr) Nusselt (Nu) Reynolds (Re) Prandtl (Pr) Other dimensionless groups

Heat transfer coefficients and heat flux for heated/cooled surfaces

Radiation:	Reflectivity Transmissivity Absorptivity Emissivity with respect to thermal radiation for different surfaces
Waveform:	Amplitude Frequency Wavelength for electromagnetic radiation.
The variation of black body emissive power:	Wavelength Absolute temperature
Emission from:	Black Grey Selective surfaces

Application of form factors to determine radiant heat exchange.
Application of radiant heat transfer principles to Building Services heat transfer equipment.

Discomfort due to:	Asymmetric radiation Plane radiant temperature Vector radiant temperature.
Solar radiation:	Solar constant Implications of solar intensity on surfaces for Building Services Applications

2. Dimensional analysis (14 hours)

Identification of Units and Dimensions
Identification of units and dimensions in commonly used terms and parameters:

Force
Energy
Mass flow
Volume flow
Acceleration
Density
Viscosity
Specific heat capacity
Specific enthalpy
Cubical expansion
Thermal conductivity
Heat flux
Rotation
Heat transfer coefficient
Velocity
Area and others as required.

Higher National Unit specification: support notes (cont)

Unit title: Thermofluids and Acoustic Criteria

Identify dimensionless groups in rational and empirical formulae from known variables:

- Reynolds Number
- Grashof Number
- Nusselt Number
- Prandtl Number
- Other dimensionless groups.

Application of Dimensional Analysis

Geometric and dynamical similarity.

Derivation of appropriate rational and empirical formulae from known variables:

- Pump/fan Laws
- Darcy equation for turbulent flow
- Heat transfer equations for free convection
- Heat transfer equations for forced convention.

Application of dimensional analysis to solve appropriate problems related to Building Services systems.

Heat Exchangers

Heat exchanger basics: Construction	Characteristics Applications Fluid flow paths Pressure drop limitations Design e.g. shell and tube, shell and coil, plate etc. Types Classifications
Heat transfer:	Pipe wall resistance Film coefficients Overall heat transfer coefficient Fouling factors
Log mean temperature difference:	Parallel flow Counter flow Cross flow
Performance:	Effectiveness Capacity Ratio Number of Transfer Units (NTU) Evaporating and condensing fluids

3. Refrigeration Plant (10 hours)

Refrigeration and Thermodynamic Cycles
Construction of vapour compression diagrams for heating and cooling.
Use of T-S and P-h diagrams to construct refrigeration cycles.

Thermodynamic processes:	Refrigeration Cycles Heat pumps Heat engines.
Use, application and comparison:	Vapour Gas Power cycles appropriate to industry specific, Building Services/Refrigeration applications.
Performance analysis of refrigeration/heat pumps:	Cooling Heating By formulae Tables Charts Various refrigerants
Theoretical and actual cycles:	Mass flow rates Input power Refrigeration Effect and evaporator duty Heat rejection Coefficient of Performance (COP)

Compression and Expansion Devices

Ideal and actual pressure-volume diagrams:	Reciprocating Roto-dynamic compressions devices Isothermal Adiabatic Polytropic compression and expansion curves.

4. Acoustic Criteria (8 hours)

Noise Criteria and Effect

Noise Rating/Criteria curves and their application:	Acoustic design Privacy criteria Speech intelligibility Statutory and local regulations Internal and external environments

Evaluation of sound and vibration effects on the environment in a building
Design criteria in a building environment.

Higher National Unit specification: support notes (cont)

Unit title: Thermofluids and Acoustic Criteria

Noise Control

Attenuation characteristics:	Materials Components Systems associated with Building Services applications.
Acoustic enclosures Noise control solutions:	Building Services applications Pipe-work/ductwork Grilles and diffusers Prime movers/compressors.

Guidance on the delivery and assessment of this Unit

Opportunities for developing Core Skills

As this Unit is a specialist optional unit that expands upon the Building Services Engineering Science Unit. It is recommended that it be delivered after or integrated with the Services Science Unit. There are strong links with other optional Units and as such it may be delivered in tandem with these Units.

It is recommended that evidence for learning outcomes is achieved through well-planned course work, assignments and projects. Assessment may be formative and summative and both may feature as part of the process. Although assessments must be focused on the individual achievement of each candidate, group work and role-play activities may contribute to the assessment. Integrative assignments and project work will help to link this unit with other related units.

The volume of evidence required for each assessment should take into account the overall number of assessments being contemplated within this unit and the design of the overall teaching programme.

In designing the assessment instrument/s, opportunities should be taken to generate appropriate evidence to contribute to the assessment of Core Skills units.

Open learning

Given that appropriate materials exist this unit could be delivered by distance learning, which may incorporate some degree of on-line support. However, with regard to assessment, planning would be required by the centre concerned to ensure the sufficiency and authenticity of candidate evidence. Arrangements would be required to be put in place to ensure that assessment/s were conducted under controlled, supervised conditions.

Higher National Unit specification: support notes (cont)

Unit title: Thermofluids and Acoustic Criteria

Candidates with additional support needs

This Unit specification is intended to ensure that there are no artificial barriers to learning or assessment. 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. For information on these, please refer to the SQA document *Guidance Assessment Arrangements for Candidates with Disabilities and/or Additional Support Needs*, which is available on the SQA website www.sqa.org.uk

General information for candidates

Unit title: Thermofluids and Acoustic Criteria

On completion of the Unit you should be able to:

- Analyse and apply modes of heat transfer
- Apply dimensional analysis to fundamental and empirical formulae with special reference to heat exchanger design and performance
- Investigate the performance of refrigeration plant and thermodynamic cycles
- Investigate acoustic criteria and apply suitable design methodology.

Evidence that you can satisfy the knowledge and skill elements of this unit will be obtained by assessment in controlled, supervised conditions to which you will not be allowed to bring textbooks, handouts or notes to the assessment.