Higher National Unit Specification

General information for centres

Unit title: Air Conditioning A

Unit code: DP0V 34

Unit purpose: This Unit is designed to develop the candidate understanding of the principles of design, installation and operation and of air conditioning equipment and plant. It will provide an opportunity to experience the process of completing air conditioning designs in complex industrial and commercial applications. It will enable candidates to interpret the air conditioning requirements of a building, to develop practical air conditioning schemes for a range of environments and to evaluate the effectiveness of alternative schemes.

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

- Evaluate the ventilation and air conditioning needs for commercial/industrial buildings.
- Determine cooling loads and energy requirements for buildings and peak summertime temperatures for spaces without air conditioning.
- Produce and evaluate a design to satisfy the ventilation and air conditioning needs of commercial/industrial buildings.
- Select appropriate cooling plant and associated equipment for air conditioning systems.

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.

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 in Building Services Engineering. If this Unit is delivered as part of another group award (s), it is recommended that it should be taught and assessed within the context 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: Air Conditioning A

Unit code: DP0V 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

Outcome 1

Evaluate the ventilation and air conditioning needs for commercial/industrial buildings.

Knowledge and/or skills

- Analysis and interpretation of requirements for commercial/industrial buildings
- Establishing a balance between client needs and design restraints
- Factors influencing the decision between ventilation or air conditioning
- Inter-relationship between ventilation and air conditioning

Evidence requirements

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

- establish client and building requirements for ventilation and air conditioning.
- evaluate alternative strategies for providing ventilation and air conditioning systems.
- establish ventilation and air conditioning design parameters and standards.
- produce design specifications for ventilation and air conditioning systems.

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 four** 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.

Higher National Unit specification: statement of standards (cont)

Unit title: Air Conditioning A

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.

Outcome 2

Determine cooling loads and energy requirements for buildings and peak summertime temperatures for spaces without air conditioning.

Knowledge and/or skills

- Solar geometry
- Cooling loads due to solar radiation
- Total cooling load and cooling plant capacity
- Peak summertime temperatures in non air conditioned spaces

Evidence requirements

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

- calculate total sensible and latent cooling loads for a location.
- describe methods of reducing solar gain to a building.
- calculate peak summertime temperatures for non air-conditioned spaces.
- determine peak building cooling loads and cooling plant capacity for multi-zoned buildings.

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 four** 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: Air Conditioning A

Outcome 3

Produce and evaluate a design to satisfy the ventilation and air conditioning needs of commercial/industrial buildings.

Knowledge and/or skills

- Design of ventilation systems
- Design of air conditioning systems
- Comparisons of air conditioning systems

Evidence requirements

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

- calculate summer and winter cycles for air conditioning plant
- explain the operation of air conditioning plant in common use within the Building Services Industry
- compare the merits of the various types of central and packaged type air conditioning plants with reference to performance, space requirements, capital and operating costs.

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.

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.

Outcome 4

Select appropriate cooling plant and associated equipment for air conditioning systems.

Knowledge and/or skills

- Vapour compression refrigeration cycles
- Refrigeration and heat pump system components
- Refrigerant properties

- Environmental factors

Evidence requirements

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

- describe the components used in refrigeration and heat pump plant commonly used within the building services industry.
- evaluate plant performance using tables and charts.
- compare the desirable properties, their effect on the environment and the safety aspects of a range of refrigerants currently 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 **three out of four** 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: DP0V 34

Unit title: Air Conditioning A

Superclass category: TH

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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: Air Conditioning A

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 allows candidates to develop knowledge, understanding and skills in the following areas:

- evaluating the ventilation and air conditioning needs for commercial/industrial buildings
- determining the cooling loads and energy requirements for buildings and peak summertime temperature for spaces without air conditioning
- producing and evaluating a design to satisfy the ventilation and air conditioning needs of commercial/industrial buildings
- selecting appropriate cooling plant and associated equipment for air conditioning systems.

This Unit may be linked with Heating A and may well use the same buildings as the basis of any project work. It is anticipated that most candidates studying this Unit will also be studying the Thermofluids and Acoustic Criteria. It is strongly recommended that this Unit be integrated with supporting outcomes in Services Science and Thermofluids and Acoustic Criteria .

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 candidate's understanding of the principles of design, installation, operation and commissioning of air conditioning equipment and systems. It will allow an opportunity to experience the process of completing air conditioning designs in complex industrial and commercial applications. It will enable candidates to interpret the air conditioning requirements of a building, develop practical air conditioning schemes for a range of environments and evaluate the effectiveness of alternative schemes.

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. Ventilation and air conditioning needs (8 hours)

Specification and Requirements

Analysis and interpretation:	Clients requirements
	Building operational requirements
	Ventilation
	Air conditioning
	Design standards and publications
	Commercial buildings
	Industrial buildings

Higher National Unit specification: support notes

Unit title: Air Conditioning A

Balance between:	Client's needs
	Commercial restraints
	Health and safety
	Aesthetic considerations
	Energy requirements
Factors influencing the decision:	Mechanical ventilation only
	Air conditioning
	Natural ventilation
Inter-relation between:	Ventilation
	Air conditioning
	Mechanical engineering building services
	Electrical engineering building services

2. Cooling loads and energy requirements (14 hours)

Solar Radiation

Solar geometry and terminology:	Direct
	Diffuse
	Vertical surfaces
	Horizontal surfaces
	Pitched surfaces
	Calculation of solar irradiance
	Use of tables and reference data

Cooling Loads due to Solar Radiation

Transmission of solar radiation through:	Glass
	Building structure
	Use of shading

Cooling loads due to solar gain.
Impact of alternative design temperature indices and method of cooling on cooling loads.

Total Cooling Load and Cooling Plant Capacity

Factors contributing to cooling plant capacity for an air-conditioned building:

- Fabric load
- Occupancy
- Lighting
- Electrical equipment
- Solar gain
- Steady state and cyclic gain
- Use of tables and charts
- For rooms or zones of the building

Peak Summertime Temperatures

Assessment of peak summertime temperatures anticipated in the absence of air conditioning:

- Use of tables
- Reference data

3. Ventilation and air conditioning systems for commercial/industrial buildings (10 hours)

Design of Ventilation Systems

For commercial and industrial buildings:	Natural ventilation
	Mechanical ventilation
	Mixed flow
	Displacement ventilation
	Fume and dust extraction
	Combination of ventilation and air conditioning

Design of Air Conditioning Systems

Classifications:	All air systems
	Air-water systems
	Unitary systems
	Low velocity
	High velocity
Systems in use:	Central plant
	Terminal re-heat
	Dual duct
	Perimeter induction
	Chilled beam
	Multi-zone
	Fan coil
	VAV systems
	Split systems
	VRV systems
	Packaged equipment
	Selection for application/building
Design implications:	Space required
	Maintenance
	Commissioning
	Capitol
	Operating costs
Comparisons:	Centralised plant
	Packaged equipment

4. Cooling Plant and Associated Equipment (8 hours)

Vapour Compression Refrigeration Cycles

Refrigeration/heat pump systems:	Construction
	Operation characteristics
	Features of the major components
	Commercial air conditioning
	Lubrication principles
	Plant sizing
	Use of tables and charts
	Manufacturers data
	Basic control systems

Higher National Unit specification: support notes (cont)

Unit title: Air Conditioning A

Refrigerant Properties and Utilisation
For commercially available refrigerants: Properties

Characteristics
Thermodynamic performance
Health and safety
Environmental implications
Legislation
Safe handling and disposal
Compatibility with lubrication oils
Criteria for selection
Procedures for use e.g. charging a system

Guidance on the delivery and assessment of this Unit

Opportunities for developing Core Skills

As this Unit is a specialist optional unit that has links with the Building Services Engineering Science, optional units Thermofluids and Acoustic Criteria and Heating A it is recommended that it be delivered after or integrated 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.

Where available, evidence from the workplace can also be incorporated to enhance the learning outcomes, provided that this evidence is appropriate and authenticated as the candidate's own work.

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: Air Conditioning A

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: Air Conditioning A

On completion of the Unit you should be able to:

- Evaluate the ventilation and air conditioning needs for commercial/industrial buildings.
- Determine cooling loads and energy requirements for buildings and peak summertime temperatures for spaces without air conditioning.
- Produce and evaluate a design to satisfy the ventilation and air conditioning needs of commercial/industrial buildings.
- Select appropriate cooling plant and associated equipment for air conditioning systems.

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.