

Higher National Unit Specification

General information for centres

Unit title: Utilisation of Electrical Energy in Buildings

Unit code: DN4A 35

Unit purpose: This Unit is designed to enable candidates to develop knowledge and competence related to the specification of services required for the utilisation of electrical energy in buildings. The Unit provides candidates with the opportunity to appreciate concepts of heating, lighting, ventilation and air-conditioning systems and to develop the skills necessary to solve design problems on these systems.

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

1. Specify the requirements and characteristics of electrical heating systems.
2. Specify the requirements and characteristics of lighting systems.
3. Specify the requirements and characteristics of ventilation and air-conditioning systems.

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: Candidates should have a broad knowledge and understanding of electrical principles and their application in a building services context. They should also have an understanding of the principles and applications of mathematics in an electrical environment. This may be evidenced by the possession of the following Higher National Units: DG54 34 Single Phase A.C. Circuits, DG4H 33 Mathematics for Engineering 1: Electronics and Electrical. However, entry requirements are at the discretion of the centre.

Core Skills: There may be opportunities to gather evidence towards the following listed Core Skills or Core Skills components in this Unit, although there is no automatic certification of Core Skills or Core Skills components:

- ◆ Written Communication (reading) at Higher
- ◆ Written Communication (writing) at Higher
- ◆ Numeracy at Higher
- ◆ Problem Solving at Higher

Context for delivery: This Unit was developed for the Electrical Engineering HND award. If the Unit is to be used in another group award, it is recommended that it be taught and assessed in the context of that particular group award.

General information for centres (cont)

Assessment: The assessment of **each** Outcome of this Unit will be by means of an assignment to measure the candidate's ability to determine the comfort requirements of persons functioning in a built environment and the requirements of the systems required to satisfy these. The assignments for Outcomes 1, 2 and 3 will relate to heating, lighting and ventilation/air conditioning systems respectively.

Candidates should be provided with manufacturer's data and specification sheets and relevant codes and psychrometric information.

Higher National Unit specification: statement of standards

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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

Specify the requirements and characteristics of electrical heating systems.

Knowledge and/or skills

- ◆ Know the terms relating to heat transfer.
- ◆ Apply the principles of heat transfer by conduction, convection and radiation.
- ◆ Calculation of conduction, convection and radiation heat transfer/loss.
- ◆ Description/characteristics of space heating appliances.
- ◆ Selection of space heating appliances to meet specific applications.

Evidence Requirements

Evidence for the knowledge and /or skills of Outcomes 1 is provided by a written assignment on the characteristics and requirements of an electrical space heating system. Each candidate will be provided with a specification for a room including (i) its intended function (ii) its dimensions (iii) its wall area (iv) its window area. The candidate will also be given data relating to the heat transfer through the wall and window surfaces and the temperature outside the room.

The candidate will determine a comfortable temperature level within the room and will calculate the rate of heat loss from the room. Using manufacturer's data sheets/specifications for heating appliances, the candidate will determine the rating of heating appliances required to maintain the room temperature at this comfort level and will design an appropriate space heating system. Candidates should be aware of the cost implications although this is not formally assessed.

Higher National Unit specification: statement of standards (cont)

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The assignment should ensure that the evidence provided is sufficient to meet the requirements for each knowledge and/or skill item by showing that the candidate is able to:

Outcome 1:

- ◆ Know terms relating to heat transfer
- ◆ Apply the principles of heat conduction by conduction, convection and radiation.
- ◆ Calculate heat transfer and losses due to conduction, convection and radiation.
- ◆ Use manufacturer's data sheets to assess the characteristics of space heating appliances.
- ◆ Select space heating appliances for given applications

Assessment guidelines

The candidate should be provided with the assignment specification at the commencement of the delivery of Outcome 1.

The design scheme report should be of between 500 - 750 words plus calculations, diagrams and appendices which should cover the evidence requirements points of Outcome 1.

Centres should make every reasonable effort to ensure the report is the candidate's own work. Where copying or plagiarism is suspected candidates may be interviewed to check their knowledge and understanding of the subject matter. A checklist should be used to record oral evidence of the candidate's knowledge and understanding

Outcome 2

Specify the requirements and characteristics of lighting systems.

Knowledge and/or skills

- ◆ Know the terms relating to illumination and lighting design.
- ◆ Application of Inverse square and Cosine laws
- ◆ Luminous intensity distribution diagrams (Polar Curves)
- ◆ Reflection: Specular, diffuse and spread
- ◆ Light distribution classification of luminaires
- ◆ Colour rendering of lamp types
- ◆ Glare and glare index
- ◆ Lumen method of interior lighting design
- ◆ Selection of appropriate luminaires from manufacturers' data.

Higher National Unit specification: statement of standards (cont)

Unit title: Utilisation of Electrical Energy in Buildings

Evidence Requirements

Evidence for the knowledge and /or skills of Outcome 2 is provided by a written assignment on the characteristics and requirements of an electric lighting system. Each candidate will be provided with a specification for a room including (i) its intended function (ii) its dimensions (iii) the height of working surfaces above floor level. The candidate will determine an appropriate illumination level on the working surfaces for the given room specification. Using manufacturers' data sheets/specifications for luminaires and appropriate illumination data, the candidate will determine the lumen output rating of luminaires required to maintain the required surface illumination level and will design an appropriate lighting system. Candidates should be aware of the cost implications although this is not formally assessed.

The assignment should ensure that the evidence provided is sufficient to meet the requirements for each knowledge and/or skill item by showing that the candidate is able to:

Outcome 2:

- ◆ Know terms relating to illumination and lighting design.
- ◆ Apply the 'Inverse Square' and 'Cosine' laws of illumination
- ◆ Plot the luminous intensity distribution diagram (Polar Curve) of a given luminaire
- ◆ Explain specular, diffuse and spread reflection
- ◆ Explain the light distribution classification of luminaires
- ◆ Explain colour rendering in relation to lamp types
- ◆ Explain what is meant by the terms glare and glare index
- ◆ Apply the lumen method to design a lighting scheme
- ◆ Select appropriate luminaires, using manufacturers' data sheets, to meet given illumination design requirements.

Assessment guidelines

The candidate should be provided with the assignment specification at the commencement of the delivery of Outcome 2.

The design scheme report should be of between 500 -750 words plus calculations, diagrams and appendices which should cover the evidence requirements points of Outcome 2

Centres should make every reasonable effort to ensure the report is the candidate's own work. Where copying or plagiarism is suspected candidates may be interviewed to check their knowledge and understanding of the subject matter. A checklist should be used to record oral evidence of the candidate's knowledge and understanding.

Outcome 3

Specify the requirements and characteristics of ventilation and air-conditioning systems.

Knowledge and/or skills

- ◆ Determination of thermal comfort levels.

Higher National Unit specification: statement of standards (cont)

Unit title: Utilisation of Electrical Energy in Buildings

- ◆ Reasons for heat loss in buildings.
- ◆ Natural and mechanical ventilation systems.
- ◆ Fresh-air and re-circulation systems
- ◆ Difference between ventilation and air-conditioning.
- ◆ Humidifiers and de-humidifiers.
- ◆ Selection of ventilation and air-conditioning systems

Evidence Requirements

Evidence for the knowledge and /or skills of Outcome 3 is provided by a written assignment on the characteristics and requirements of an electric ventilation/air-conditioning system. Each candidate will be provided with a specification for a room including (i) its intended function (ii) its dimensions (iii) its rate of air change. The candidate will use psychrometric charts to determine an appropriate comfort temperature level in the room.

Using manufacturers' data sheets/specifications for ventilation/air-conditioning appliances, the candidate will determine the rating of appliances required to maintain the comfort temperature level and will design an appropriate ventilation/air-conditioning system. Candidates should be aware of the cost implications although this is not formally assessed.

The assignment should ensure that the evidence provided is sufficient to meet the requirements for each knowledge and/or skill item by showing that the candidate is able to: -

Outcome 3:

- ◆ Use psychrometric charts to determine thermal comfort level.
- ◆ Explain the reasons for heat loss in buildings.
- ◆ Describe the advantages and limitations of natural and mechanical ventilation systems.
- ◆ Explain the differences between fresh-air and re-circulation systems
- ◆ Explain the difference between ventilation and air-conditioning systems.
- ◆ Explain the need for humidifiers and de-humidifiers.
- ◆ Select ventilation and air-conditioning systems for given applications

Assessment guidelines

The candidate should be provided with the assignment specification at the commencement of the delivery of Outcome 3.

The design scheme report should be of between 500 -750 words plus calculations, diagrams and appendices which should cover the evidence requirements points of Outcome 3

Centres should make every reasonable effort to ensure the report is the candidate's own work. Where copying or plagiarism is suspected candidates may be interviewed to check their knowledge and understanding of the subject matter. A checklist should be used to record oral evidence of the candidate's knowledge and understanding.

Administrative Information

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Unit title:	Utilisation of Electrical Energy in Buildings
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Higher National Unit specification: support notes

Unit title: Utilisation of Electrical Energy in Buildings

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 written in order to allow candidates to develop their knowledge and understanding in the following areas:-

1. Electrical heating systems.
2. Lighting systems.
3. Ventilation and air-conditioning systems.

In designing this Unit, the Unit writer has identified the range of topics expected to be covered by lecturers. The writer has also given recommendations as to how much time should be spent on each Outcome. This has been done to help lecturers decide what depth of treatment should be given to the topics attached to each of the Outcomes. Whilst it is not mandatory for centres to use this list of topics, it is recommended that they do so since the assessment exemplar pack for this Unit is based on the knowledge and/or skills and list of topics in each of the Outcomes.

A list of topics for each Outcome is given below. Lecturers are advised to study this list in conjunction with the assessment exemplar pack so that they can get a clear indication of the standard of achievement expected of candidates in this Unit.

1. Specify the requirements and characteristics of electrical heating systems (16 hours)

The topics listed may be related to a particular application be it industrial, commercial or domestic as appropriate. Factors to be considered in the selection of a heating system should include the materials used in the building structure, transmission coefficients, number of air changes required, internal temperature required, areas of doors, walls, windows etc.

- ◆ Definition of terms: ‘Sensible heat’, ‘Latent heat’ (Fusion and Evaporation),
- ◆ ‘Specific heat capacity’.
- ◆ Calculation of specific heat capacity in terms of heat energy transferred, mass of substance and temperature change.
- ◆ Principles of heat transfer by conduction, convection and radiation.
- ◆ Definition of ‘Thermal Conductivity’.
- ◆ Calculation of conduction heat loss through building structures.
- ◆ Definition of ‘Black Body’ and ‘Emissivity’ in terms of heat transfer by radiation.
- ◆ Stefan-Boltzman Law.
- ◆ Calculation of radiation heat loss from a surface.
- ◆ Definition of ‘Heat Transfer Co-efficient’.
- ◆ Calculation of natural convective heat transfer.
- ◆ Description of typical electric space heating appliances.
- ◆ Characteristics/ratings of space heating appliances

Higher National Unit specification: support notes (cont)

Unit title: Utilisation of Electrical Energy in Buildings

- ◆ Matching of space heating appliance to given application.

2. Specify the requirements and characteristics of lighting systems (17 hours)

The topics listed may be related to typical lighting installations such as retail outlets (e.g. supermarkets), commercial premises (e.g. office suites), leisure facilities (e.g. swimming pools), educational buildings, small factory units. The use of tables and data from the CIBSE 'Code for Lighting' and from manufacturers' lighting catalogues is required.

- ◆ Definition of terms: 'Luminous intensity', 'luminous flux', 'Illumination',
- ◆ 'Luminance', 'Lumen',
- ◆ Inverse square law and Cosine law.
- ◆ Distribution of Luminous Intensity (Polar diagrams)
- ◆ Definition of terms: 'Direct ratio' and 'Room index' and the relationship between them. (BZ Classification)
- ◆ Definition of terms applied to luminaires: 'Flux fraction', 'Flux fraction ratio',
- ◆ 'Light output ratio' (upward and
- ◆ downward), 'Luminous area'
- ◆ Specular reflection, diffuse reflection and spread reflection.
- ◆ Light distribution classifications of luminaires: direct, semi-direct, general diffusing, semi-indirect, indirect.
- ◆ Manufacturers' data.
- ◆ Spacing of lamps.
- ◆ Colour rendering of various lamp types and colour rendering index.
- ◆ Efficacy of lamps
- ◆ Glare: Disability glare, discomfort glare and glare index.
- ◆ Calculation of glare index. (Symmetrical and Asymmetrical distributions)
- ◆ Interior lighting design: reflectance from surfaces, room index, and utilisation factors.
- ◆ Lumen method of design.
- ◆ Selection of luminaires from manufacturers' data

3. Specify the requirements and characteristics of ventilation and air-conditioning systems. (7 hours)

The topics listed may be related to typical ventilation and air-conditioning installations in buildings. The principles of cooling, humidification and de-humidification may be presented by block diagram treatment and the use of psychrometric charts and comfort level data should be used.

- ◆ Environmental factors affecting thermal comfort.
- ◆ Use of psychrometric charts to determine comfort level.
- ◆ Heat loss by air infiltration and ventilation.
- ◆ The need for ventilation in buildings.
- ◆ Sources of information for ventilation requirements.
- ◆ Advantages and limitations of natural ventilation.
- ◆ Description of natural ventilation methods.
- ◆ Operation of mechanical ventilation systems by extract, input and combined extract and input.

Higher National Unit specification: support notes (cont)

Unit title: Utilisation of Electrical Energy in Buildings

- ◆ Distinction between fresh air and re-circulation systems.
- ◆ Distinction between ventilation and air-conditioning.
- ◆ Description of humidifying and de-humidifying.
- ◆ Function of air filters.
- ◆ Selection of relevant systems for appropriate applications.

Guidance on the delivery and assessment of this Unit

The Unit has been developed as a mandatory Unit within the Mandatory section of the HND Electrical Engineering award. The Unit entitled Electrical Installation Design is also included within the Mandatory section of the Electrical Engineering HND and this Unit may be taught in conjunction with it.

Details on approaches to assessment are given under Evidence requirements and Assessment guidelines under each Outcome in the Higher National Unit Specification: statement of standards section. It is recommended that these sections be read carefully before proceeding with assessment of candidates.

Open learning

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 the assessment, which is required to be at a single event, was conducted under controlled, supervised conditions.

For information on normal open learning arrangements, please refer to the SQA guide *Assessment and Quality Assurance of Open and Distance Learning* (SQA 2000)

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: Utilisation of Electrical Energy in Buildings

This Unit has been designed to allow you to develop your knowledge and understanding of the space heating, lighting and ventilation/air-conditioning systems in buildings. It provides you with the opportunity to develop the skills necessary to solve design problems on these systems.

Outcome 1 considers the factors which relate to the design of space heating systems in buildings and gives you an appreciation of how heat energy is transmitted through various mediums e.g. air, walls windows etc. You will gain an understanding of the heating requirements of a particular application and will be able to use manufacturer's data to select the most appropriate space heating appliance to satisfy these requirements.

Outcome 2 deals with the factors and terminology of lighting systems and allows you to become familiar with lighting design concepts. You will be able to relate lighting requirements to factors such as the room dimensions and the application for which an area is to be used and will develop your design skills in selecting the most appropriate luminaires and the correct level of illumination for a given application. You will also come to appreciate the effects of glare and colour rendering within your design considerations.

Outcome 3 allows you to develop your understanding of ventilation and air-conditioning systems and to appreciate the need for such systems to provide a comfortable environment.

By the time you have completed this Unit you will have gained a greater understanding of the various building services in buildings and will be able to specify and select the most appropriate appliances for the heating, lighting and ventilation/air-conditioning of such premises.

The assessments for this Unit will be undertaken at the end of each Outcome. You will be expected to undertake an assignment for each of the three Outcomes to show your appreciation of the features of space heating, lighting and ventilation/air-conditioning systems and to design systems which maintain appropriate conditions in a given environment. These assignments will be undertaken by you during the delivery period of the relevant Outcome. You will be provided with manufacturer's data and specification sheets and relevant codes and psychometric information during the assessment.