



Higher National Unit specification: general information

Unit title: Marine Engineering: Electrical Distribution Systems

Unit code: H0EL 35

Superclass: XQ

Publication date: January 2012

Source: Scottish Qualifications Authority

Version: 01

Unit purpose

This Unit is designed to enable candidates to further develop knowledge and understanding of marine power distribution systems, its generation and utilisation. The Unit will also further develop the knowledge of generators, transformers and motors used within distribution systems.

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

- 1 Evaluate and discuss the construction and operation of ac generators.
- 2 Evaluate and solve problems on distribution systems and transformers.
- 3 Discuss and appraise the construction, operation and use of three phase motors.

Recommended prior knowledge and skills

Access to this Unit is at the discretion of the centre. However, it would benefit the candidates to have completed the HNC Unit *Marine Engineering: Electrical Motors and Generators* and have a knowledge and understanding of Mathematics and/or Physics at SCQF level 6.

Credit points and level

1 Higher National Unit 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.*

General information (cont)

Core Skills

There are opportunities to develop the Core Skills of *Numeracy*, *Working with Others* and *Communication* at SQCF 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.

Higher National Unit specification: statement of standards

Unit title: Marine Engineering: Electrical Distribution Systems

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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

Evaluate and discuss the construction and operation of ac generators.

Knowledge and/or Skills

- ◆ Construction details of ac generators.
- ◆ Differences in construction of ac generators.
- ◆ Electro Motive Force of a generator.
- ◆ Load sharing — kW, kVA, kVA_r.
- ◆ Automatic Voltage Regulation.
- ◆ Generator protection devices.
- ◆ Earthed and insulated neutral systems.

Evidence Requirements

Evidence for the Knowledge and/or Skills items in Outcome 1 should be provided on a sample basis. Each candidate will need to demonstrate that they can answer correctly questions based on a sample of the knowledge and skills items listed in the Outcome. In any assessment of this Outcome, **four out of seven** Knowledge and/or Skills items should be sampled. When reassessment takes place an alternative sample should be used.

In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample of **four out of seven** Knowledge and/or Skills items are required each time the Unit is assessed. Candidates must provide a satisfactory response to all items.

Higher National Unit specification: statement of standards (cont)

Unit title: Marine Engineering: Electrical Distribution Systems

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing the candidate is able to:

- ◆ Discuss the arrangement of armature winding to produce three phase emf
- ◆ Appraise salient pole and cylindrical ac generators, explaining the reasons for the differences
- ◆ Calculate the emf of an ac generator
- ◆ Explain connection of a three phase generator to live bus bars and solve problems relating to load sharing
- ◆ Explain why an AVR is required and appraise excitation methods
- ◆ Analyse the need for, and operation of, protection devices for ac generators that may operate in parallel
- ◆ Appraise the earthed and insulated neutral systems by means of their advantages and disadvantages for a Marine distribution system

Where calculations are performed the candidate must:

- ◆ apply appropriate formulae
- ◆ apply the principles of the calculation
- ◆ show all working through a calculation
- ◆ ensure their answer derives from the application of the formula and correct application of the principles of the calculation

Evidence should be generated through assessment in supervised conditions. Assessment should be conducted under closed-book conditions and as such candidates should not be allowed to bring any textbooks, handouts or notes to the assessment. Candidates will be permitted to use scientific calculators during the assessment.

Higher National Unit specification: statement of standards (cont)

Unit title: Marine Engineering: Electrical Distribution Systems

Outcome 2

Evaluate and solve problems on distribution systems and transformers.

Knowledge and/or Skills

- ◆ Three phase, three and four wire systems.
- ◆ Neutral current in a three phase four wire unbalanced system.
- ◆ Transformer in an ac distribution system.
- ◆ Phasor diagrams for single phase transformer.
- ◆ Three phase transformers
- ◆ Three phase transformers problems
- ◆ Auto-transformers problems
- ◆ Efficiency of a transformer
- ◆ Operation of instrument transformers.
- ◆ Earth fault detection for three phase distribution systems

Evidence Requirements

Evidence for the Knowledge and/or Skills items in Outcome 2 will be provided on a sample basis. The evidence may be presented in responses to specific questions. Each candidate will need to demonstrate that they can correctly answer questions based on a sample of **five out of ten** of the knowledge and skills items listed in the Outcome. When reassessment takes place an alternative sample should be used.

In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample of **five out of ten** Knowledge and/or Skills items are required each time the Unit is assessed. Candidates must provide a satisfactory response to all items.

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing the candidate is able to:

- ◆ Describe three phase Marine distribution systems, three wire and four wire systems.
- ◆ Calculate the value of the neutral current in a three phase, four wire unbalanced system.
- ◆ Explain the function of transformers in Marine distribution systems.
- ◆ Solve problems using phasor diagrams for single phase transformer on and off load, lag pf only.
- ◆ Sketch three phase transformer connections in different formats, explain the need for the different formats.
- ◆ Solve problems relating to three phase transformers using turns and voltage ratios.
- ◆ Solve problems on auto-transformers involving voltages, turns and tapping point.
- ◆ Calculate the efficiency of a transformer given load condition and losses.
- ◆ Explain the operation of instrument transformers including earthing.
- ◆ Describe earth fault detection for three phase distribution systems.

Higher National Unit specification: statement of standards (cont)

Unit title: Marine Engineering: Electrical Distribution Systems

Where calculations are performed the candidate must:

- ◆ apply appropriate formulae
- ◆ apply the principles of the calculation
- ◆ show all working through a calculation
- ◆ ensure their answer derives from the application of the formula and correct application of the principles of the calculation

Evidence should be generated through assessment in supervised conditions. Assessment should be conducted under closed-book conditions and as such candidates should not be allowed to bring any textbooks, handouts or notes to the assessment. Candidates will be permitted to use scientific calculators during the assessment.

Outcome 3

Discuss and appraise the construction, operation and use of three phase motors.

Knowledge and/or Skills

- ◆ Operation of three phase motors
- ◆ Construction of single, double-cage, slip ring motors
- ◆ Torque/slip curves
- ◆ Direct-on-Line (DOL), Star/Delta, slip-ring starters.
- ◆ Methods of varying the speed of ac motors.
- ◆ Operation of a synchronous motor.
- ◆ Synchronous motor starting methods.
- ◆ Power factor correction

Evidence Requirements

Evidence for the Knowledge and/or Skills items in Outcome 3 will be provided on a sample basis. The evidence may be presented in responses to specific questions. Each candidate will need to demonstrate that they can correctly answer questions based on a sample of the knowledge and skills items listed in the Outcome. In any assessment of this Outcome, **five out of eight** Knowledge and/or Skills items should be sampled. When reassessment takes place an alternative sample should be used.

In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample of **five from eight** Knowledge and/or Skills items are required each time the Unit is assessed. Candidates must provide a satisfactory response to all items.

Higher National Unit specification: statement of standards (cont)

Unit title: Marine Engineering: Electrical Distribution Systems

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing the candidate is able to:

- ◆ Calculate rotor output and motor efficiency
- ◆ Discuss and appraise the construction of single, double-cage, slip ring motors
- ◆ Sketch torque/slip curves for single, double-cage, slip ring motors
- ◆ Compare and appraise, with sketches, DOL, Star/Delta, slip-ring starters
- ◆ Appraise methods of varying the speed of ac motors
- ◆ Explain the operation of a synchronous motor
- ◆ Describe synchronous motor starting methods
- ◆ Solve problems relating to synchronous motors being used for power factor correction

Where calculations are performed the candidate must:

- ◆ apply appropriate formulae
- ◆ apply the principles of the calculation
- ◆ show all working through a calculation
- ◆ ensure the answer derives from the application of the formula and correct application of the principles of the calculation

Evidence should be generated through assessment in supervised conditions. Assessment should be conducted under closed-book conditions and as such candidates should not be allowed to bring any textbooks, handouts or notes to the assessment. Candidates will be permitted to use scientific calculators during the assessment.

Higher National Unit specification: support notes

Unit title: Marine Engineering: Electrical Distribution Systems

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 could be delivered by a combination of class teaching, tutorial work and practical laboratory work where appropriate. The latter is seen as particularly important as it provides candidates with an opportunity to relate theoretical knowledge to a practical marine electrical/electronic context. The Unit has been designed to incorporate sufficient time to allow lecturers to teach all the core electrical principles in the Unit.

As this Unit provides develops core electrical/electronic principles that underpin much of the studies in other areas of the HND Marine Engineering award.

Where this Unit is incorporated into other Group Awards it is recommended that it be delivered in the context of the specific occupational area(s) that the award is designed to cover.

The Unit has been written such that there is sufficient time built in to allow candidates to practise what they have learnt through appropriate formative assessments or laboratory work.

Guidance on the delivery of this Unit

This Unit is best delivered in conjunction with *Marine Engineering: Electrical Power* (H0EH 35).

Guidance on the assessment of this Unit

Each of the Outcomes may be assessed separately or a combined assessment may be used. It is anticipated that assignments and formal tests will be used to assess the Outcomes.

The assessment of this Unit could be a combined paper for all three Outcomes. This single assessment paper could be taken at a single assessment event lasting no more than two hours and carried out under supervised, controlled conditions.

Assessment should be conducted under closed-book conditions and as such candidates should not be allowed to bring any textbooks, handouts or notes to the assessment. Candidates will be permitted to use scientific calculators during the assessment.

If a candidate requires to be re-assessed, a different selection of questions must be used from all sections. A significant proportion of the questions used in the re-assessment must be different from those used in the original test.

Higher National Unit specification: statement of standards (cont)

Unit title: Marine Engineering: Electrical Distribution Systems

Assessment Guidelines

Outcome 1

The assessment of this Outcome can be combined together with that for Outcomes 2 and 3 to form a single assessment paper.

Outcome 2

The assessment of this Outcome may be combined together with that for Outcomes 1 and 3 to form a single assessment paper.

Outcome 3

The assessment of this Outcome may be combined together with that for Outcomes 1 and 2 to form a single assessment paper. This single assessment paper could be taken at a single assessment event lasting no more than two hours. Questions used to elicit candidate evidence should take the form of an appropriate balance of short answer, restricted response and structured questions. Each Outcome may also be assessed separately.

An assignment based assessment may be more applicable for Outcome 3, which would involve candidates producing their assignments under controlled conditions. The assignment could involve the students collecting data from three phase induction motors either in the workplace or under workshop conditions and, by evaluation and analysis of the results, appraise their operation.

Online and Distance Learning

Although this Unit could be delivered by distance learning, it would require a considerable degree of planning by the centre to ensure the sufficiency and authenticity of candidate evidence. Arrangements would have to be made to ensure that the closed-book test for Outcomes 1, 2 and 3 is delivered in a supervised environment.

Higher National Unit specification: support notes (cont)

Unit title: Marine Engineering: Electrical Distribution Systems

Opportunities for developing Core Skills

There are opportunities to develop the Core Skills of *Numeracy* SQCF level 6 and *Communication* at SCQF level 6 in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

The delivery and assessment of this Unit may contribute towards the Component 'Using Number' of the Core Skill of *Numeracy* at SQCF 6 in Outcomes 1, 2 and 3. The specific skills required for the component at SQCF 6 include: working confidently with a numerical/statistical concept; deciding on the numerical operations to be carried out; and carrying out complex calculations on a number of sustained calculations. This is likely to fit in with a variety of the topics in all Outcomes (eg Calculate the efficiency of a transformer given load condition and losses, etc). It is also likely that the component 'Using Graphical Information' could also be developed in the context of Outcome 2. The specific skills of: analysing and interpreting complex graphical information; and selecting an appropriate form and communicating information can be found in Outcomes 2 and 3 (eg Solve problems using phasor diagrams for single phase transformer on and off load). This Core Skill could be developed here without formal certification.

The component 'Read and understand complex written communication' of the Core Skill of *Communication* SCQF level 6 could also be developed in this Unit in the work for Outcomes 1, 2, or 3. This may be developed in the underpinning knowledge and in formative assessments for these Outcomes in identifying and summarising information, ideas and supporting information. There may also be opportunities to develop the component 'use a structure which takes account and audience and links major and minor points in ways in ways which assist the clarity and impact of the writing' in the formative assessment of these Outcomes. The candidate is required to explain concepts and principles in a logical and effective order and also to use conventions which are effective. Evidence could be obtained for both these components through written essay type formative assessments, particularly in Outcomes 1, 2 and 3. This Core Skill could be developed here without formal certification.

This Unit may allow candidates to complete laboratory work and formative assessment which may allow candidates to develop 'Working Co-operatively with Others' of the Core Skill *Working with Others* at SCQF level 6. Through the candidate's laboratory work and formative assessments this may allow them to develop the specific skills 'Analyse own role and the roles that make up the activity and/or activities and relationship between them' and 'Organise own role to contribute effectively to the activity and/or activities, adapting own role as necessary'.

Higher National Unit specification: support notes (cont)

Unit title: Marine Engineering: Electrical Distribution Systems

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

History of changes to Unit

Version	Description of change	Date

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General information for candidates

Unit title: Marine Engineering: Electrical Distribution Systems

This Unit has been designed to allow you to further develop knowledge, skills and understanding of Marine electrical distribution systems found on board ships.

The Unit will also allow you the opportunity to develop the necessary knowledge and skills to evaluate the operation of distribution systems in marine applications.

It is good to gain sound theoretical knowledge and understanding but it is also important that you are able to set your theoretical knowledge within a practical Electrical context. Thus, it is likely during the Unit you will be provided with the opportunity to relate theory to practice by doing practical experiments.

The formal assessment for this Unit may consist of a single assessment paper lasting no more than two hours. The assessment will be conducted under closed-book conditions in which you will not be allowed to take notes, textbooks etc into the assessment. However, you will be allowed to use a scientific calculator. You may sit this assessment paper at the end of the Unit.

The Outcomes you will study are -

- 1 Evaluate and discuss the construction and operation of ac generators.
- 2 Evaluate and solve problems on distribution systems and transformers.
- 3 Discuss and appraise the construction, operation and use of three phase motors.

There are opportunities for you to develop the Core Skills of *Numeracy*, *Working with Others* and *Communication* at SQCF level 6 in the teaching and assessment approaches used in this Unit.