Higher National Unit specification

General information

Unit title: Marine Engineering: Naval Architecture (SCQF level 8)

Unit code: HJ47 35

Superclass: XQ

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Source: Scottish Qualifications Authority

Version: 02

Unit purpose

This Unit is designed to enable learners to further develop their knowledge and understanding of Naval Architecture. The Unit will allow learners to apply the principles of Naval Architecture in ship construction and management of vessel operations. It is targeted at merchant navy engineer officer cadet trainees and those who wish to achieve STCW engineer certification at management level.

Outcomes

On successful completion of the Unit the learner will be able to:

1 Calculate small and large angle stability in marine vessels.
2 Calculate ship powering and resistance from model test data.
3 Calculate ship fuel consumption from propeller dimensions.
4 Discuss constructional details used to resist stress.

Credit points and level

2 Higher National Unit credits at SCQF level 8 (16 SCQF credit points at SCQF level 8)

Recommended entry to the Unit

Recommended entry is at the discretion of the centre. However, learners should have knowledge of Mathematics and Physics. This may be demonstrated by possession of Mathematics and/or Physics at SCQF level 6 or possession of an HNC Marine Engineering Group Award at SCQF level 7. Students recommended to have already completed the unit *Marine Engineering: Stability and Structure for Merchant Ships*.

Higher National Unit specification: General information (cont)

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Core Skills

Achievement of this unit gives automatic certification of the following Core Skills component:

Complete Core Skill None

Core Skill component Using Number at SCQF level 6

There are also opportunities to develop aspects of Core Skills which are highlighted in the support notes of this unit specification.

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.

The Assessment Support Pack (ASP) for this Unit provides assessment and marking guidelines that exemplify the national standard for achievement. It is a valid, reliable and practicable assessment. Centres wishing to develop their own assessments should refer to the ASP to ensure a comparable standard. A list of existing ASPs is available to download from SQA's website **(http://www.sqa.org.uk/sqa/46233.2769.html)**.

Equality and inclusion

This Unit specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence.

Further advice can be found on our website **www.sqa.org.uk/assessmentarrangements**.

Higher National Unit specification: Statement of standards

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Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the Unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

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. Learners 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

Calculate small and large angle stability in marine vessels.

Knowledge and/or Skills

- Inclining Experiment
- GZ Curves
- Wall Sided Formula
- Longitudinal Stability
- Bilging
- Simpsons Rule

Outcome 2

Calculate ship powering and resistance from model test data.

Knowledge and/or Skills

- Shear force and bending moment diagrams
- Shear force and bending moment calculations
- Frictional Resistance
- Residual Resistance
- Model testing
- Admiralty Coefficient

Outcome 3

Calculate ship fuel consumption from propeller dimensions

Knowledge and/or Skills

- Fuel consumption
- Propeller calculations involving slip, thrust, torque and efficiency
- Relationship between powers
- Propeller cavitation
- Rudder balance and principle forces
- Rudder problems involving angle of heel

Higher National Unit specification: Statement of standards

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Outcome 4

Discuss constructional details used to resist stress.

Knowledge and/or Skills

- Stresses in ship's structures
- Structural components
- Fore and aft end construction
- Framing
- Ship's cross sections
- Bulkheads
- Rudders

Evidence Requirements for this Unit

Written and/or oral evidence should be generated through closed-book assessment of one hour duration per Outcome under supervised conditions. It may be assessed Outcome by Outcome (four separate one hour assessments), or using any combination of different Outcomes and assessed together up to a maximum of three Outcomes per single assessment (three hour assessment).

Where calculations are performed the learner must:

- apply appropriate formulae.
- apply the principles of the calculation.
- show all working through a calculation.
- ensure the answer should derive from the application of the formula and correct application of the principles of the calculation.
- formula sheets may be used during this Outcome.
- use of scientific calculators is allowed.

Outcome 1

Written and/or oral evidence for the Knowledge and/or Skills items in Outcome 1 should be provided on a sample basis. In any assessment of this Outcome, **three out of six** Knowledge and/or Skills items should be sampled.

In order to ensure that learners will not be able to foresee what items they will be questioned on, a different sample of three out of six Knowledge and/or Skills items are required each time the Unit is assessed.

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

- calculate the GM and KG from inclining experiment data
- use cross curves of stability and construct vessel GZ curves to determine vessel range of stability and righting level for any angle
- calculate large angle stability using the Wall Sided Formula
- calculate longitudinal stability and calculate trim and end draughts due to changes in loading (moving, removing & adding mass)
- analyse the effect of bilging on vessel stability and calculate new end draughts/angle of heel.
- calculate area, volume and displacement using Simpson's rule as well as first and second moments.

Outcome 2

Written and/or oral evidence for the Knowledge and/or Skills items in Outcome 2 will be provided on a sample basis. In any assessment of this Outcome, **four out of six** Knowledge and/or Skills items should be sampled.

In order to ensure that learners will not be able to foresee what items they will be questioned on, a different sample of four from six Knowledge and/or Skills items are required each time the Unit is assessed.

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

- sketch load, shear force and bending moment diagrams for vessels of simple geometric form and load conditions.
- calculate SF and BM for vessels of simple geometric form and load conditions.
- explain frictional resistance.
- explain residual resistance.
- calculate vessel resistance from model test data.
- calculate power using the admiralty coefficient.

Outcome 3

Written and/or oral evidence for the Knowledge and/or Skills items in Outcome 3 will be provided on a sample basis. In any assessment of this Outcome, **four out of six** Knowledge and/or Skills items should be sampled.

In order to ensure that learners will not be able to foresee what items they will be questioned on, a different sample of four from six Knowledge and/or Skills items are required each time the Unit is assessed.

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

- apply propeller calculations involving true and apparent slip, thrust, torque and efficiency.
- describe the relationships between powers measured at points between the ship's engines and the propeller.
- describe the phenomenon of propeller cavitation, its causes, effects and methods of reduction.
- calculate the variation in daily fuel consumption with speed and the fuel requirements for a given voyage.
- evaluate balanced, semi-balanced and unbalanced rudders and calculate the principal forces acting on the ship and rudder when helm is applied.
- calculate vessel heeling angle due to rudder helm being applied.

Outcome 4

Written and/or oral evidence for the Knowledge and/or Skills items in Outcome 4 should be provided on a sample basis. In any assessment of this Outcome, **four out of seven** Knowledge and/or Skills items should be sampled.

In order to ensure that learners 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.

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

- describe stresses in the ship's structure and classify stress compensating elements.
- describe structural components and relate with ship stresses for a selection of the following areas:
  - double bottom
  - side shell
  - decks
  - watertight bulkheads
  - hatches
  - watertight doors.
- describe fore and aft end construction, including bulbous bow and relate with ship stresses.
- compare framing systems, explain and relate with different ship's types, for example:
  - general cargo
  - bulk dry cargo carrier
  - petroleum, gas and chemical tankers
  - OBO carrier
  - Container ship
  - Ro-Ro ship.

Higher National Unit specification: Statement of standards (cont)

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- sketch ship's cross sections and indicate stress compensating elements.
- compare bulkheads and relate with ship stresses and different ship's types.
- explain the reasons for using different types of rudders including:
  - unbalanced
  - semi-balanced
  - balanced
  - spade
  - hinged.

Higher National Unit Support Notes

Unit title: Marine Engineering: Naval Architecture (SCQF level 8)

Unit Support Notes are offered as guidance and are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 80 hours.

Guidance on the content and context for this Unit

This Unit has been written in order to allow learners to develop knowledge, understanding and skills in the following areas:

1 Calculate small and large angle stability in marine vessels.
2 Calculate ship powering and resistance from model test data.
3 Calculate ship fuel consumption from propeller dimensions.
4 Discuss constructional details used to resist stress.

In designing this Unit the Unit writers have identified the range of topics they would expect to be covered. It is recommended that each Outcome should be given 20 hours contact time. This should help lecturers to decide what depth of treatment should be given to the topics attached to each of the Outcomes. Whilst it is not mandatory for a centre to use this list of topics it is strongly recommended that it does so to ensure continuity of teaching and learning across the Naval Architecture Unit. The list of topics is given below. Lecturers are advised to study this list of topics in conjunction with the Knowledge/Skills section of this document so that they can get a clear indication of the standard of achievement expected of learners in this Unit.

1 Calculate small and large angle stability in marine vessels

- Calculate the GM and KG of a vessel using data from an inclining experiment (mass and distance moved causing deflection of a pendulum).
- Construct GZ curves based off readings from cross curves of stability or large movement of mass.
- Calculate righting moment at large angles of stability using the wall sided formula, initial GM of an unstable vessel using the angle of loll.
- Derive MCT1cm and calculate a vessels new end draughts after adding, removing and moving multiple mass.
- Calculate new end draughts or angle of hell due to bilging compartments off midship/ centreline. Problems to include compartment permeability.
- Calculate area, volume and displacement using Simpsons rule.
- Calculate first moments of area using Simpsons rule and use to find the positions of centroids (LCF, LCB, KB).
- Calculate second moments of area using Simpsons rule and use in relation to vessel stability.

Higher National Unit Support Notes (cont)

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2 Calculate ship powering and resistance from model test data

- Sketch load, shear force and bending moment diagrams for box barges with relatively simple load conditions.
- Calculate shear force and bending moments for box barges with relatively simple load conditions or load requirements based upon maximum bending moment.
- Explain frictional resistance components and how it can change with component changes (frictional coefficient, wetted surface area, speed, etc).
- Explain residuary resistance components and how it can change with component changes (wave making, form, eddy, air).
- Calculate the total resistance of a vessel including using froudes law of proportionality between model data and vessel data.
- Calculate power using the admiralty coefficient.

3 Calculate ship fuel consumption from propeller dimensions

- Perform propeller calculations involving true and apparent slip, thrust, torque and efficiency.
- Describe the relationships between powers measured at points between the ship's engines and the propeller (ip, sp, dp, tp).
- Describe the phenomenon of propeller cavitation, its causes, effects and methods of reduction.
- Calculate the variation in daily fuel consumption with speed and the fuel requirements for a given voyage.
- Evaluate balanced, semi-balanced and unbalanced rudders and calculate the principal forces acting on the ship and rudder when helm is applied.
- Calculate vessel heeling angle due to rudder helm being applied, including centrifugal forces.

4 Discuss constructional details used to resist stress

- Describe stresses in the ship’s structure and classify stress compensating elements.
- Describe structural components and relate with ship stresses for a selection of the following areas:
  - double bottom
  - side shell
  - decks
  - watertight bulkheads
  - hatches
  - watertight doors.
- Describe fore and aft end construction, including bulbous bow, and relate with ship stresses.
- Compare framing systems, explain and relate with different ship’s types:
  - general cargo
  - bulk dry cargo carrier
  - petroleum, gas and chemical tankers
  - OBO carrier
  - Container ship
  - Ro-Ro ship.

- Sketch ship's cross sections and indicate stress compensating elements.
- Compare bulkheads and relate with ship stresses and different ship's types.
- Explain the reasons for using different types of rudders:
  - unbalanced
  - semi-balanced
  - balanced
  - spade
  - hinged.

This Unit is primarily aimed at learners who intend to seek sea going employment as a Merchant Navy Engineering Officer and the Unit will meet the Merchant and Coastguard Agency (MCA) requirements up to Class 1 Certificate of Competency.

Guidance on approaches to delivery of 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 learners with an opportunity to relate theoretical knowledge to a practical context. The Unit has been designed to incorporate sufficient time to allow lecturers to teach all the core Naval Architecture principles.

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 in such a way that there is sufficient time built in to allow learners to practise what they have learnt through formative assessments.

Details on the approaches to assessment are given under Evidence Requirements and Assessment Guidelines of the Higher National Unit specification: statement of standards section. It is recommended that this section is read carefully before proceeding with assessment of learners.

Guidance on approaches to assessment of this Unit

Evidence can be generated using different types of assessment. The following are suggestions only. There may be other methods that would be more suitable to learners.

Centres are reminded that prior verification of centre-devised assessments would help to ensure that the national standard is being met. Where learners experience a range of assessment methods, this helps them to develop different skills that should be transferable to work or further and higher education.

Assessment should be carried out in supervised conditions. Each Outcome could be assessed separately in a paper which lasts no more than one hour. However, the assessment could take place as one assessment event which combines up to a maximum of three Outcomes. Each Outcome could comprise of two questions taken on a sample basis as laid out in the Evidence Requirements for each Outcome. The written assessments should then be marked and second marked by subject specialists.

Higher National Unit Support Notes (cont)

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Assessment Guidelines

Outcome 1
Outcome 1 could comprise of two questions taken on a sample basis as laid out in the Evidence Requirements for each Outcome.

Outcome 2
Outcome 2 could comprise of two questions taken on a sample basis as laid out in the Evidence Requirements for each Outcome.

Outcome 3
Outcome 3 could comprise of two questions taken on a sample basis as laid out in the Evidence Requirements for each Outcome.

Outcome 4
Outcome 4 could comprise of two questions taken on a sample basis as laid out in the Evidence Requirements for each Outcome.

Opportunities for e-assessment

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by Information and Communication Technology (ICT), such as e-testing or the use of e-portfolios or social software. Centres which wish to use e-assessment must ensure that the national standard is applied to all learner evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. The most up-to-date guidance on the use of e-assessment to support SQA's qualifications is available at **www.sqa.org.uk/e-assessment**.

Opportunities for developing Core and other essential skills

In all Outcomes each of the assessments require the learner to be able to solve problems. This will give the learner the opportunity to develop the component Using Numbers of the Core Skill Numeracy at SCQF level 6. The specific Core Skill elements that the learner will have to complete are 'Decide on the steps and operations to be carried out to solve a complex problem' and 'Carry out a number of sustained, complex calculations'.

In completing each Outcome learners may have the opportunity to develop the component Problem Solving and Working with Others at SCQF level 6.

In Outcome 2 learners will explain frictional and residuary resistance, and in Outcome 3 describe the phenomenon of propeller cavitation. This will allow learners to develop the component Written Communications of the Core Skill Communication at SCQF level 5 and 6. Learners will develop the specific elements 'Present all essential ideas/information and supporting detail in a logical and effective order' and 'Use conventions which are effective in achieving the purpose of the piece and adapted as necessary for the target audience'.

This unit has the Using Number component of Numeracy embedded in it. This means that when learners achieve the unit, their Core Skills profile will also be updated to show they have achieved Using Number at SCQF level 6.

General information for learners

Unit title: Marine Engineering: Naval Architecture (SCQF level 8)

This section will help you decide whether this is the Unit for you by explaining what the Unit is about, what you should know or be able to do before you start, what you will need to do during the Unit and opportunities for further learning and employment.

This Unit has been designed to allow you to develop knowledge, skills and understanding in Naval Architectural principles and concepts as used in Marine Engineering.

This Unit will also allow you the opportunity to develop the necessary knowledge and skills in numeracy, literacy and drawing applied to ship stability, resistance, fuel consumption and construction to evaluate Naval Architecture as used in marine applications.

Assessments may be conducted Outcome by Outcome (four separate one hour assessments), or using any combination of different Outcomes and assessed together up to a maximum of three Outcomes per single assessment (three hour assessment).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 and formula sheets for each Outcome. You may sit assessment papers at the end of each Outcome.

This Unit will develop your Core Skills and include *Numeracy, Problem Solving, Communication, Working with Others*, planning and enable you to:

1 Calculate small and large angle stability in marine vessels.
2 Calculate ship powering and resistance from model test data.
3 Calculate ship fuel consumption from propeller dimensions.
4 Discuss constructional details used to resist stress.

This unit has the Using Number component of Numeracy embedded in it. This means that when you achieve the unit, your Core Skills profile will also be updated to show you have achieved Using Number at SCQF level 6.

History of changes to unit

Version	Description of change	Date
02	Core Skills component Using Number at SCQF level 6 embedded.	01/06/17