

Higher National Unit Specification

General information for centres

Unit title: Ship Stability: An Introduction

Unit code: F0LD 34

Unit purpose: This Unit is about applying the principles of ship stability for box and ship shape vessels to routine situations. It will develop knowledge of the principles of hydrostatics, loadline calculations, statical stability and transverse stability. It also gives an introduction to longitudinal stability. It is primarily aimed at candidates who intend to seek sea-going employment as a Merchant Navy Deck Officer. However it could also be studied by someone with an interest in the subject area.

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

- 1 Apply the basic principles of hydrostatics to loadline calculations.
- 2 Apply the principles of statical stability to interpret GZ curves.
- 3 Apply the principles of transverse stability to list calculations.
- 4 Apply the principles of longitudinal stability to draught calculations.

Credit points and level: 1.5 HN Credits at SCQF level 7: (12 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: Access to this Unit is at the discretion of the centre. However candidates would benefit most from this Unit if they have successfully completed the *Marine Induction Course* associated with the HNC/D Nautical Science and/or hold at least Standard Grade 2 in both *Mathematics* and *Physics* or a *General Science*.

Core Skills: The achievement of this Unit gives automatic certification of the following:

Using Number at SCQF level 6

There are also further opportunities to develop the Core Skill of:

Communication: Oral at SCQF level 4

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.

Assessment: Outcome 1 may be assessed means of a practical exercise in which a candidate physically obtains the density of a sample of water or on the use of the hydrometer. Basic hydrostatic principles and loadline calculations may be assessed using a closed-book assessment under supervised conditions or may be incorporated in an assessment covering Outcomes 1, 2, 3 and 4.

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

Apply the basic principles of hydrostatics to loadline calculations

Knowledge and/or skills

- (a) Vessel displacement
- (b) Mass, volume, density and relative density
- (c) Archimedes Principle, Hydrostatic data, displacement volume, displacement, buoyancy
- (d) Waterline length, breadth, draught, LBP, A_w , C_w , C_B , and freeboard
- (e) TPC, FWA and Dock Water Allowance
- (f) Displacement, Deadweight and TPC Tables
- (g) Load Line and draught marks
- (h) Loadline calculation
- (i) Hydrometer use

Evidence Requirements

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

- 1 Explain terms used in elements (b)–(e). One from each must be sampled.
- 2 Calculate the displacement of a box or shipshape vessel using principles from (b), (c) and (d). In any calculation:
 - ◆ A_w , C_w or C_B must be given.
 - ◆ Candidates must select appropriate components from (b), (c) and (d) and in order to do this, two components (from either b, c, or d) that are not appropriate must be included.
 - ◆ Candidates must arrive at the correct displacement calculation and be able to show workings/explanation that intermediate steps have been followed in a logical and meaningful sequence.

Higher National Unit specification: statement of standards (cont)

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3 Carry out a loadline calculation. Candidates must:

- ◆ Cover all knowledge and skills in (e), (f) and (g). This can be done in any combination depending on the value of the components that are given. Candidates must calculate the two components from TPC, FWA and DWA which have not been covered in the explanation in 1. The value of the component (TPC, FWA or DWA) covered in the explanation in 1 must be given.
- ◆ Arrive at the correct loadline calculation and be able to show workings/explanation that intermediate steps have been followed in a logical and meaningful sequence.

The same box or shipshape vessel used to calculate displacement in 2. can be used in the loadline calculation.

Evidence for Elements 1, 2 will be based on sampling and must be generated under supervised, open-book conditions. Open-book conditions refer to candidates being provided with sets of Displacement, Deadweight and TPC tables. No other materials may be used. A different sample must be used on each assessment occasion. For this reason, the calculation of, and value given for, TPC, FWA and DWA may differ on each assessment occasion.

4 Use a hydrometer to measure the density of water. Candidates must:

- ◆ Demonstrate the practical use of a hydrometer to determine the density of a water sample.
- ◆ Explain the use of the hydrometer to the assessor during the demonstration.
- ◆ Measure the density of the water correctly.

Assessment guidelines

Every opportunity should be made to relate the questions to tasks that the OOW could normally carry out on board ship. Questions may cover one or more of the Evidence Requirements depending on the nature of the problem set, however there must be opportunities for a candidate to demonstrate that they can satisfy all of the Evidence Requirements of this Outcome within any assessment.

Candidates may be given hydrostatic data tables and be asked to calculate the displacement of a vessel using a variety of hydrostatic principles, possibly including an exercise to obtain the draught from a specimen example of draught marks. Candidates may then be asked to calculate TPC, FWA and DWA, using information from the previous section of the question to determine the final draught and hence determine if the vessel complies with the loadline rules. Sufficient evidence to ensure that the candidate possesses the required knowledge and skills would be available in such a question. It would also be possible that each of the above requirements could be tackled as part of a different question.

There are multiple scenarios which could be used to provide such evidence and different scenarios should be used in each assessment, provided that there are still sufficient opportunities to comply with all the Evidence Requirements above.

Outcome 1 may be assessed by means of a practical exercise in which a candidate physically obtains the density of a sample of water or on the use of the hydrometer. Basic hydrostatic principles and loadline calculations may be assessed using a closed-book assessment under supervised conditions or may be incorporated in an assessment covering Outcomes 1, 2, 3 and 4.

Higher National Unit specification: statement of standards (cont)

Unit title: Ship Stability: An Introduction

Outcome 2

Apply the principles of statical stability to interpret GZ curves

Knowledge and/or skills

- ◆ Centre of Buoyancy, Centre of Gravity, Initial Transverse Metacentre, Righting Lever, Righting Moment, Metacentric Height
- ◆ Stable, Neutral and Unstable Conditions of Stability at small angles of heel
- ◆ GZ curves
- ◆ Stiff and Tender Vessels
- ◆ Angle of Loll

Evidence Requirements

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

- ◆ explain the terms relating to statical stability
- ◆ interpret GZ curves
- ◆ determine a vessel's state of stability

Opportunities to generate evidence could include multiple choice assessments to cover the terms relating to statical stability or alternatively a blank diagram on which a candidate will have to identify the terms listed in the first section of the knowledge and skills.

Alternatively all of the Evidence Requirements may be developed in one or more structured questions. Questions may be structured so that Evidence Requirements from more than one Outcome are combined, provided that successful completion of the question will ensure that the individual Evidence Requirements are clearly achieved.

Assessment guidelines

Outcome 2 will be sample assessed by an assessment under supervised conditions on statical stability and the interpretation of GZ curves. The use of computer software typically found aboard ship could be assessed by means of an assignment.

Outcomes 2, 3 and 4 may be combined for assessment purposes.

Higher National Unit specification: statement of standards (cont)

Unit title: Ship Stability: An Introduction

Outcome 3

Apply the principles of transverse stability to list calculations

Knowledge and/or skills

- ◆ Effect on G of loading, discharging and moving weights
- ◆ List
- ◆ Difference between List and Loll and the methods of correction
- ◆ Changes in stability during the voyage
- ◆ Free surface and the dangers and effect at small angles of heel
- ◆ Effect of tank subdivision and density on free surface
- ◆ Allowance for the effect of free surface

Evidence Requirements

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

- ◆ calculate the effect of altering the vertical and transverse distribution of weights
- ◆ explain the difference between loll and list and the methods of correction
- ◆ explain the dangers of free surface
- ◆ allow for the effect of free surface in the calculation stated above

Opportunities to generate evidence for this Outcome could include a single structured question in which the candidate is required to determine the angle of list acquired when weights are moved vertically and horizontally within the ship and which also includes free surface due to slack tanks. The question could conclude with the candidate being asked to explain the difference between list and loll.

Alternatively all of the Evidence Requirements may be developed by use of structured questions. Questions may be structured so that Evidence Requirements from more than one Outcome are combined, provided that successful completion of the question will ensure that the individual Evidence Requirements are clearly achieved.

Assessment guidelines

Outcome 3 may be assessed by means of an assessment under supervised conditions on transverse stability calculations, the dangers of free surface and the correction of angle of loll.

Outcomes 2, 3 and 4 may be combined for assessment purposes.

Higher National Unit specification: statement of standards (cont)

Unit title: Ship Stability: An Introduction

Outcome 4

Apply the principles of longitudinal stability to draught calculations

Knowledge and/or skills

- ◆ True Mean Draught (TMD), Longitudinal Centre of Flotation (LCF), Longitudinal Centre of Gravity (LCG), Longitudinal Centre of Buoyancy (LCB), Trimming Moment and Moment to Change Trim 1 cm (MCTC)
- ◆ Apply the principles of longitudinal stability to calculations involving the inter-relationship of draught, trim, weight and their positions

Evidence Requirements

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

- ◆ calculate the effect of altering the longitudinal distribution of weights

Opportunities to produce evidence may be developed by means of an assessment under supervised conditions. This could consist of a structured question using hydrostatic data from tables to determine the vessel's True Mean Draught and then calculate the final draughts of the vessel after loading, discharging and transferring weights within the vessel, using the principles of longitudinal stability.

Alternatively all of the Evidence Requirements may be developed by use of structured questions. Questions may be structured so that Evidence Requirements from more than one Outcome are combined, provided that successful completion of the question will ensure that the individual Evidence Requirements are clearly achieved.

NOTE: Calculations involving longitudinal stability should be carried out using the method of taking moments about the after perpendicular. The method of taking moments about the LCF should be discussed but in assessments only the former method should be given any credit.

Assessment guidelines

Outcome 4 could be assessed by an assessment under supervised conditions on longitudinal stability calculations.

Outcomes 1, 2, 3 and 4 may be combined for assessment purposes.

Administrative Information

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Unit title:	Ship Stability: An Introduction
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History of Changes:

Version	Description of change	Date
02	Core Skills Section Updated	June 2007

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Higher National Unit specification: support notes

Unit title: Ship Stability: An Introduction

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 60 hours.

Guidance on the content and context for this Unit

The content of this Unit forms part of the underpinning knowledge for the level 3 SVQ *Marine Vessel Operations* and reflects the content of International Maritime Organisation's *Standards of Training Certification and Watchkeeping (STCW)*.

The Unit is primarily intended for candidates who are new entrants to the Merchant Navy via one of the Merchant Navy Training Board (MNTB) approved deck cadet training schemes or for seafarers who are enrolled on a rating to Officer conversion course. Ideally candidates would have already accrued some shipboard experience prior to attempting this Unit, although this is not a prerequisite.

The knowledge and skills contained within the Unit cover all the requirements as laid down by Standards for Training and Certification of Watchkeepers (STCW) 95 at the Operational level aboard ship.

Completion of the Unit will also ensure that the candidate complies with all the requirements laid down by the UK Maritime and Coastguard Agency (MCA) for the issue of an Officer of the Watch Unlimited Certificate of Competency as a Deck Officer. The required knowledge and skills for MCA certification can be found in a document detailing the requirements for the issue of an Education and Training Certificate (A&B), which is available from the MNTB.

The following notes give additional information on the knowledge and skills for each of the four Outcomes.

Outcome 1

Candidates will understand the basic principles behind why vessels float in water and the relationship between the mass, volume of displacement and water density. This is initially done for box shaped vessels and the concepts required to transfer these principles to ship shapes will be developed.

Candidates will then apply this basic knowledge in different scenarios which will enable them to determine the draught at which a ship will float in water of a given density. The rate of change of draught with changing displacement will also be investigated, using both theoretical concepts and also information available in hydrostatic tables for a given vessel.

Candidates will be shown how the density of water is determined and will be required to demonstrate practically that they are able to use a hydrometer to determine the density of a water sample.

Higher National Unit specification: support notes (cont)

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Outcome 2

The criteria for vessels being in a stable or unstable condition or having neutral stability will be investigated. The effect on stability of vessels at small and large angles of heel will be determined and candidates will be able to represent this graphically in the form of a curve of statical stability given initial information available from hydrostatic tables. Candidates will also be aware of the various factors affecting the transverse stability of a vessel and in particular the factors which affect the shape of the curve of statical stability.

Outcome 3

This Outcome covers the effect of changing the distribution of weight within the vessel, but only in relation to the changes in the transverse stability of the vessel. The effect of vertical and horizontal movement of weight will be investigated and the changes to the statical stability of the vessel determined. The concept of Free Surface will be introduced and its importance in determining the final stability of the vessel emphasised. Understanding of the dangers of excessive free surface and how this may be minimised will be developed in the Outcome.

The concept of list due to a transverse shift of weight within the vessel will be investigated and candidates should be able to determine the angle of list (for small angles).

The implications of a vessel initially being in an unstable condition and the concept of an Angle of Loll will be considered and the difference between loll and list differentiated.

Outcome 4

Candidates will be introduced to the theory of longitudinal stability and will be able to calculate the draughts forward and aft using information obtained from hydrostatic data.

The effect of changes in the longitudinal distribution of weight will be considered and candidates will be required to perform calculations involving the loading and discharging of multiple weights using the method of taking moments about the after perpendicular of the vessel. (LCB–LCG Method)

Guidance on the delivery and assessment of this Unit

This Unit contains knowledge and skills which are critical to the safe operation of any vessel. It is therefore vital that all candidates are thoroughly familiar with the principles detailed above. It is suggested that the delivery follow the sequence of the Outcomes as they develop the required knowledge and skills in a sequential order.

Where candidates have some seagoing experience the contents of Outcome 1 may be familiar as they will have witnessed the concepts at first hand whilst loading and unloading the ship and may have carried out some of the practical work as part of their on board training.

Those candidates with no prior seagoing experience would benefit from practical demonstrations, where applicable, of the various concepts. This may be possible using models or simple beams showing the effect of transferring weights in a ship. Wherever possible diagrams should be used in explaining concepts regarding movement of weights and the use of presentations and ICT delivery would be of great benefit.

Higher National Unit specification: support notes (cont)

Unit title: Ship Stability: An Introduction

Use of stability calculation software can also be used to good effect as the changes can be shown almost instantaneously and candidates can see for themselves how changes can affect the stability of the vessel in both numeric and diagrammatic formats.

It is recommended that the hydrostatic data supplied to candidates taking the MCA written examinations at Officer of the Watch level be used in all calculations, in order that all candidates are fully conversant with the contents. MCA approved formula sheets should be made available to all candidates during assessment.

The knowledge and skills developed within the Unit should be applied in the context that will be encountered aboard ship, ideally leading the candidate towards the ability to be able to determine the stability of vessel at the completion of either loading or discharging.

Assessment of the Unit may be carried out Outcome by Outcome, however it would be advantageous if candidates were able to comply with the paragraph above on completion of the Unit. Consideration may be given to combining the Outcomes in a single assessment so that sampling of the skills and knowledge in each Outcome would include a practical ship loading exercise.

In view of the fact that successful completion of the HNC/D will give some candidates exemption from sitting the MCA written examinations it is suggested that the pass mark for all assessments in this Unit should be set at a minimum of 60%.

Opportunities for developing Core Skills

The achievement of this Unit gives automatic certification of the following:

Using Number at SCQF level 6

Use of graphical information will be developed by using graphs to obtain information that will be used in calculations or alternatively use numerical data to construct graphs and then use the graph to analyse the stability of a vessel and check that the vessel complies with minimum stability requirements prior to sailing.

The unit also provides the opportunity to develop the core skill component of Oral Communication at SCQF level 4. Oral communication can be developed by oral assessment of a candidate on the correct use of the hydrometer in determining the density of water.

Open learning

The preferred method of delivery is by attendance at college as the majority of candidates following this Unit will be on a training programme comprising alternating periods at college and at sea, the sea periods being utilised to put into practice knowledge and skills acquired.

Higher National Unit specification: support notes (cont)

Unit title: Ship Stability: An Introduction

Candidates with disabilities and/or additional support needs

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. Further advice can be found in the SQA document *Guidance on Assessment Arrangements for Candidates with Disabilities and/or Additional Support Needs* (www.sqa.org.uk).

General information for candidates

Unit title: Ship Stability: An Introduction

This Unit is about applying the principles of ship stability for box and ship shape vessels to routine situations and will develop knowledge of the principles of hydrostatics, loadline calculations, statical stability, transverse stability and an introduction to longitudinal stability.

On completion of this Unit you should be able to:

- ◆ apply the basic principles of hydrostatics to loadline calculations
- ◆ apply the principles of statical stability to interpret GZ curves
- ◆ apply the principles of transverse stability to list calculations
- ◆ apply the principles of longitudinal stability to draught calculations

You will be assessed on the use of the hydrometer and aspects of loadlines and by assessment under supervised conditions on loadline calculations, statical, transverse and longitudinal stability. The use of computer software typically aboard ship will be assessed by means of an assignment.