

SQA Advanced Unit Specification

General information for centres

Unit title: Ship Stability: An Introduction (SCQF level 7)

Unit code: HW6J 47

Superclass: XQ

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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 introduces longitudinal stability. It is primarily aimed at learners 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.

Outcomes

On completion of the unit the learner 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 SQA Credits at SCQF level 7: (12 SCQF credit points at SCQF level 7)

Recommended entry to the unit

Access to this unit is at the discretion of the centre. However, learners would benefit most from this unit if they have successfully completed the Level 3 Diploma in Shipping and/or hold at least National 5 in both Mathematics and Physics or a General Science.

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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	Critical Thinking at SCQF level 6 Using Number at SCQF level 6 Using Graphical Information at SCQF level 5

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.

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.

SQA Advanced 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

Apply the basic principles of hydrostatics to loadline calculations.

Knowledge and/or skills

- ◆ Vessel displacement
- ◆ Mass, volume, density and relative density
- ◆ Archimedes principle, hydrostatic data, displacement volume, displacement, buoyancy
- ◆ Waterline length, breadth, draught, LBP, AW, CW, CB, and freeboard
- ◆ TPC, FWA and dock water allowance
- ◆ Displacement, deadweight and TPC tables
- ◆ Load line and draught marks
- ◆ Loadline calculation
- ◆ Hydrometer use

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

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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

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 for this unit

Written and/or oral recorded evidence is required for Outcomes 1 to 4 and will be under supervised open-book conditions. Outcomes 1 and 2 should be combined for assessment lasting no longer than two hours. Outcomes 3 and 4 should be combined for assessment lasting no longer than two hours.

MCA approved formula sheets should be made available to all learners during assessment.

All knowledge and skills within each outcome will be assessed however there is sampling within some of the knowledge and skills. A different sample should be used on each assessment occasion.

Outcome 1

Learners will need to produce written and or/oral recorded evidence to demonstrate their knowledge and/or skills by showing that they can:

- 1 Explain terms used in knowledge and skills (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) AW, CW or CB must be given.
 - (b) Learners 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.

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- (c) Learners 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.
- 3 Carry out a loadline calculation. Learners must:
- (d) 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. Learners 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.
- (e) Arrive at the correct loadline calculation and can 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.
- 4 Use a hydrometer to measure the density of water. Learners must:
- (f) Demonstrate the practical use of a hydrometer to determine the density of a water sample.
- (g) Explain the use of the hydrometer to the assessor during the demonstration.
- (h) Measure the density of the water correctly.

Evidence for elements 1, 2 above will be based on sampling and learners should be 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.

Outcome 2

Learners will need to produce written and or/oral recorded evidence to demonstrate their knowledge and/or skills by showing that they can:

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

Outcome 3

Learners will need to produce written and or/oral recorded evidence to demonstrate their knowledge and/or skills by showing that they can:

- ◆ 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

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Outcome 4

Learners will need to produce written and or/oral recorded evidence to demonstrate their knowledge and/or skills by showing that they can:

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

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.

SQA Advanced Unit support notes

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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 60 hours.

Guidance on the content and context for this unit

The content of this unit reflects the content of International Maritime Organisation's Standards of Training Certification and Watchkeeping (STCW '78 as amended).

The unit is primarily intended for learners 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 learners 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 '78 as amended) at the operational level aboard ship.

Completion of the unit will also ensure that the learner 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

Learners 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.

Learners 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.

Learners 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.

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 learners will be able to represent this graphically in the form of a curve of statical stability given initial information available from hydrostatic tables. Learners will also

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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 learners 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

Learners 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 learners 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 approaches to delivery of this unit

This unit contains knowledge and skills which are critical to the safe operation of any vessel.

The unit could be delivered by combination of class teaching, tutorial work and practical application cargo loading equipment.

It is therefore vital that all learners are thoroughly familiar with the principles detailed above. It is suggested that the delivery follows the sequence of the outcomes as they develop the required knowledge and skills in a sequential order.

Learners should be able to draw on the knowledge gained from the qualifications or units recommended as prior knowledge as well as experience gained from service at sea. Where learners 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 learners 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.

Use of stability calculation software scenarios on loading equipment in the cargo handling simulators to see the effect as the changes can be shown almost instantaneously and learners can see for themselves how changes can affect the stability of the vessel in both numeric and diagrammatic formats. The learner can apply their theoretical knowledge and

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analyse the practical application of ship's stability and trim calculations in various seagoing conditions of intact stability of the ship.

It is recommended that the hydrostatic data supplied to learners taking the MCA written examinations at Officer of the Watch level be used in all calculations, in order that all learners are fully conversant with the contents. MCA approved formula sheets should be made available to all learners 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 learner towards the ability to be able to determine the stability of vessel at the completion of either loading or discharging.

Guidance on approaches to assessment of this unit

Written and or/orally recorded evidence is required for Outcomes 1 to 4 and will be under supervised open-book conditions. Outcomes 1 and 2 should be combined for assessment lasting no longer than two hours. Outcomes 3 and 4 should be combined for assessment lasting no longer than two hours.

All knowledge and skills will be assessed however there is sampling within some of the knowledge and skills. A different sample should be used on each assessment occasion.

Since this is a safety subject indicated by MCA for STCW Certificate of Competency, it is suggested that the pass mark for all assessments in this unit should be set at a minimum of 60%.

Outcome 1

Evidence for elements 1, 2 of Outcome 1 will be based on sampling and learners should be 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.

Outcome 2

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 learner must 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, if successful completion of the question will ensure that the individual evidence requirements are clearly achieved.

Outcome 3

Opportunities to generate evidence for this outcome could include a single structured question in which the learner 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 learner being asked to explain the difference between list and loll.

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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, if successful completion of the question will ensure that the individual evidence requirements are clearly achieved.

Outcome 4

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, if successful completion of the question will ensure that the individual evidence requirements are clearly achieved.

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 learner to demonstrate that they can satisfy all of the evidence requirements of this outcome within any assessment.

Learners 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. Learners 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 learner 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 learner 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 an open-book assessment under supervised conditions or may be incorporated in an assessment covering Outcomes 1, 2, 3 and 4.

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.

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.

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

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Outcomes 1 and 2 should be combined for assessment lasting no longer than two hours.
Outcomes 3 and 4 should be combined for assessment lasting no longer than two hours.
Outcomes 1, 2, 3 and 4 may be combined for assessment purposes.

Evidence for the above may be reproduced by the learner using typical stability software packages to investigate a proposed loading plan for the vessel in question. Alternatively learners could be asked what the input/output parameters are for typical stability software packages.

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

This unit has the Using Number and Using Graphical Information components of Numeracy, and the Critical Thinking component of Problem Solving embedded in it. This means that when learners achieve the unit, their Core Skills profile will also be updated to show they have achieved:

- ◆ Critical Thinking at SCQF level 6
- ◆ Using Number at SCQF level 6
- ◆ Using Graphical Information at SCQF level 5

History of changes to unit

Version	Description of change	Date

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SQA acknowledges the valuable contribution that Scotland's colleges have made to the development of SQA Advanced Qualifications.

FURTHER INFORMATION: Call SQA's Customer Contact Centre on 44 (0) 141 500 5030 or 0345 279 1000. Alternatively, complete our [Centre Feedback Form](#).

General information for learners

Unit title: Ship Stability: An Introduction (SCQF level 7)

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, static 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 static stability to interpret GZ curves
- ◆ apply the principles of transverse stability to list calculations
- ◆ apply the principles of longitudinal stability to draught calculations

Assessment could be two question papers using hydrostatic ship particulars. Each assessment should last no longer than two hours.

You will be assessed on the use of the hydrometer and aspects of loadlines, structural, transverse and longitudinal stability under supervised conditions. The use of computer software used typically aboard ship may be used.

It's at the discretion of the centre that some elements of the unit may be assessed on cargo loading equipment under supervised conditions.

Learners will develop Using Number through calculations involving several variables and multiple interdependent steps. Using Graphical Information will be developed at SCQF level 6 by constructing 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. This may be assessed with the unit assessment but there is no automatic certification of Core Skills implied.

This unit has the Using Number and Using Graphical Information components of Numeracy, and the Critical Thinking component of Problem Solving embedded in it. This means that when you achieve the unit, your Core Skills profile will also be updated to show you have achieved:

- ◆ Critical Thinking at SCQF level 6
- ◆ Using Number at SCQF level 6
- ◆ Using Graphical Information at SCQF level 5