

National Training Materials

FOR THE
MARITIME INDUSTRY



Ship Knowledge (Master 4)

ABF543

Facilitator's Guide

Managing Agent: Department of Training and Education Co-ordination (DTEC)

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GPO Box 5347BB, MELBOURNE, Victoria 3001, Australia

Telephone +61 03 9630 9836 or 9630 9837

Facsimile +61 03 9639 4684

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1. Introduction to the Facilitators Guide

This Facilitator's guide will provide the module facilitator with information on how best to deliver this module. It contains information about suggested teaching strategies for each of the learning outcomes, suggested assessment strategies and required module resources.

2. Facilitators Role

As a Facilitator you will be responsible for :

- suitable study accommodation for learners
- paper-based material, references and handouts etc.
- equipment for demonstrations and explanations
- field trips to vessels, workshops, and drydock/slipway facilities as required
- supporting participants and assisting them to carry out written and practical activities
- arranging for workplace experts if required
- conducting participant's assessment
- recording participant's achievement in the record book

2.1 Provider-related information

The facilitator will need to ensure that all learners receive the information the course provider wants them to have.

For example:

- a module training plan (for on the job / off the job components)
- specialist support services available from the provider
- key contact persons
- administrative forms the learner should fill in
- information on how to borrow books, apply for recognition of prior learning (RPL) etc
- details about workshops, project work, practical sessions and the like
- sample exam papers

3. Module Overview

This module will provide the learner with the knowledge required by the Master of a vessel of less than 80 metres in length to manage:

- hull and superstructure inspections and maintenance programs relating to the watertight and weathertight integrity of a vessel under way;
- the structural related requirements to maintain a vessel in survey;
- the stability in routine operations and the stability in emergency circumstances.

On successful completion of this module, the participant will be able to:

- describe and explain the functions of the major structural components of the hull and superstructure;
- explain the arrangements to restrict the spread of fire;
- explain the arrangements to control flooding;
- explain the arrangements to maintain watertight and weathertight integrity;
- explain the method of tank and bulkhead testing for watertightness;
- explain the conditions of assignment of load lines and the use of load lines;
- explain the terms and use centre of gravity, centre of buoyancy, metacentric height, righting levers, righting moments, range of stability, stiff and tender, period of roll. Explain synchronisation and free surface effect, and relate the terms to ship stability,
- perform statical stability calculations based on simplified stability data.

In achieving the learning outcomes of this module the following areas should be thoroughly addressed through a range of theoretical and practical exercises:

Ship Construction

- The principal structural members of a vessel less than 80 metres in length.
- The conditions of assignment of loadlines.
- Arrangements for restricting the spread of fire.
- Watertight testing of tanks and bulkheads.
- Maintaining water and weathertight integrity.
- Basic hull and superstructure maintenance.
- Types of construction related surveys.

Ship Stability

- Centre of gravity
- Centre of buoyancy
- Reserve buoyancy
- Metacentric height
- Righting moments and levers
- Range of stability
- Stiff and Tender vessels
- Period of roll.
- Synchronisation.
- Free Surface Effect.
- Effects of changes to the condition of loading of a vessel and the use of ship's gear for loading and unloading.
- Use of stability data

4. Module learning outcomes

Learning Outcome 1

The learner will be able to describe and explain the functions of major structural components of hull and superstructure.

Learning Outcome 2

The learner will be able to explain the measures to restrict the spread of Fire and retain the watertight integrity of a vessel.

Learning Outcome 3

The learner will be able to plan the periodic maintenance and survey requirements for vessels of less than 80 metres in length

Learning Outcome 4

The learner will be able to explain the conditions of assignment of load lines, their maintenance and use.

Learning Outcome 5

The learner will be able to explain the effect of the movement of weights on the stability of a vessel.

Learning Outcome 6

The learner will be able to perform statical stability calculations using simplified stability data.

5. Module Assessment

5.1 Assessment Method

The focus for assessment will be the module purpose. Assessment will aim at determining the learner's overall ability to deal operationally with the range of day to day issues that relate to the structure and stability of the vessel. The practical nature of this module facilitates the use of observation and oral assessment. In addition, assessing an ability to use procedures or conduct some aspects of operations may also be achieved through the use of short answer questions, computer simulation and computer managed testing.

5.2 Conditions of Assessment

Learners will need to be provided with access to a suitable vessel in survey. Models may be used to assess outcomes requiring structural knowledge or descriptive skills in assessment criteria. Students will have access to ship's plans and survey records.

6. Module resources

6.1 Human Resources

The minimum qualifications for people facilitating the delivery of this module are:

- possession of a valid Certificate of Competency at the level of Master Class 3 or above,
- and formal teaching/training qualifications that are at least at the levels specified in national competencies for trainers and assessors.

6.2 Physical Resources

The registered training provider should have access to:

- A suitably equipped theory teaching space with white board and video facilities.
- A vessel in survey which should be less than 80 metres in length.
- Magnetic board with coloured magnetic tape
- Table top models and models of vessels for use in a flotation tank.
- Simplified ship stability data

7. Strategies for teaching the module

Section 1: Vessel Structure

Learning outcome 1

On completion of this learning outcome the learner will be able to describe and explain the functions of major structural components of hull and superstructure.

Assessment Criteria:

- Describe or identify major structural components
- Explain the function of the structural components.
- Explain deck and point loading limits.

Learning Outcome 2

On completion of this learning outcome the learner will be able to explain the measures to restrict the spread of fire and retain the watertight integrity of a vessel.

Assessment Criteria:

- Explain the arrangements to restrict the spread of fire.
- Explain the arrangements to control flooding.
- Describe the requirements to maintain watertight and weathertight integrity to survey requirements.
- Describe the method of tank and bulkhead testing for watertightness to survey requirements.

Conditions:

Learning and assessment will take place on a vessel, in the classroom, at a slipway/drydock and other suitable study environments. Part of the learning will take place during a field trip to an appropriate vessel where the learner will inspect ship's plans and survey records and structural parts.

The learning outcome may be assessed on the job or off the job through :

- a written test involving the use of sketching, diagram interpretation, short answer questions, multiple choice questions and/or computer testing.
- oral questioning.

The learner will be provided with :

- suitable classroom environment and answer booklet for written assessment.
- access to a suitable computer for computer testing

The learner will provide:

- writing and drawing instruments for written test.

Suggested Delivery Strategy

Classroom instruction and a field trip may be substituted by distance learning and a field trip. In every case outcomes need to be assessed. Access to a vessel is required to ensure that the learner recognises examples of the components, that are the subject of learning outcomes, and their application to the overall structural integrity of the vessel.

Where learners are required to have access to a vessel, they must be made aware of relevant workplace health and safety issues as distinct from regulations applicable to shore based establishments. In particular, learners should be properly supervised when carrying out practical activities that may involve inspection or entry to confined and enclosed spaces.

The following resources may be of assistance :

- Doors or hatches able to be 'hose tested' or 'chalk tested' for watertightness.
- A vessel's capacity plan or other plans showing deck loading limits.
- A vessel's fire-control plan
- A vessel's General Arrangement plan
- Scale models of structural components

The text makes numerous references to the USL Code, therefore the latest amended version of the Code should be available for perusal by the learners. Relevant State Marine Acts and other legislation applicable to the vessel on which learning is to take place, may also be provided.

Feedback to Activities and Check Your Progress Exercises

Where applicable, feedback is provided at the end of the learner's guide.

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Section 2: Maintenance & Survey

Learning outcome 3

On completion of this learning outcome the learner will be able to plan the periodic maintenance and survey requirements for vessels of less than 80 metres in length.

Assessment Criteria

- Identify the potential for corrosion/deterioration in vessel structures and describe the procedures and materials used for preventative and corrective maintenance.
- Itemise the statutory survey requirements of the State marine acts and regulations.
- Explain in general terms the routine maintenance of deck and hull fittings.
- Prepare a maintenance program for a vessel of less than 80 metres in length including all survey requirements.
- Describe the methods of docking or slipping the vessel for maintenance including the safety precautions and pollution control requirements associated with each method.
- Prepare a slipping or docking program indicating:
 - preparations before slipping, docking the vessel
 - requirements during the process of slipping or docking
 - preparations prior to undocking the vessel
 - precautions and inspections required during and immediately after undocking
 - identification of maintenance/repairs that require the vessel to be removed from the water and those that can be performed afloat.

Conditions:

Learning and assessment will take place in the classroom, on a vessel, at a slipway/drydock, and other suitable study environments.

The learning outcome may be assessed on the job or off the job through :

- a written test involving the use of sketching, diagram interpretation, short answer questions, multiple choice questions and/or computer testing.
- written assignments.
- oral questioning.

The learner will be provided with :

- suitable classroom environment and answer booklet for written assessment.
- access to a suitable computer for computer testing

The learner will provide:

- writing and drawing instruments for written test.

Suggested Delivery Strategy

Learners will need to be have access to a vessel in survey and a drydock/slipway facility where a vessel that is out of water, can be inspected. Where possible, learners should witness or take part in an actual operation when a vessel is removed from the water.

Learner's attention should be directed to areas of vessel that show major signs of corrosion/deterioration. Procedures and materials used for preventative and corrective maintenance should be demonstrated. The learners should be shown samples of paints and preservatives, and the equipment used for their application. Samples of sacrificial anodes can also be provided.

Details of survey schedule and maintenance program of a vessel on which learning is taking place, will be useful.

Feedback to Activities and Check Your Progress Exercises

Where applicable, feedback is provided at the back of the Learner's Guide.

This section contains two assignments for which specific feedback is not provided in the learner's guide.

Written activity 4 is in the form of an assignment in which learners are asked to prepare a maintenance schedule for a vessel including all survey requirements. To complete this activity learners will need to be provided with at least the following information about a vessel:

- Vessel usage pattern
- Survey records and documentation
- Inventory of equipment on board
- Maintenance Instructions from equipment manufacturers.

The maintenance schedule should be prepared for the maximum length of survey cycle. Specific maintenance of machinery items can be excluded, but all survey items should be included.

Check your progress exercise number 14 is also in the form of an assignment. For this assignment, learners are asked to prepare a slipping/docking program. To make this activity as realistic as possible, learners should have access to:

- A vessel in survey
- Vessel's particulars and plans
- Survey details
- Loading Condition of the vessel
- Requirements of Dock Authorities.

Section 3: Loadlines

Learning outcome 4

On completion of this learning outcome, the learner will be able to explain the conditions of assignment of load lines, their maintenance and use.

Assessment Criteria:

- Explain the general conditions of assignment of loadlines.
- Given the mean draft undertake freeboard, draft, displacement, deadweight, dock allowance and tonnes per centimetre immersion calculations.
- Describe assigned marks and draft marks.

Conditions:

Normally learning and assessment will take place in the classroom, on a vessel, and other suitable study environments.

The learning outcome may be assessed on the job or off the job through:

- a written test involving the use of sketching, diagram interpretation, calculations, short answer questions and/or computer testing
- oral questioning

The learner will be provided with:

- suitable classroom environment and answer booklet for written assessment
- simplified stability data
- access to a suitable computer for computer testing

The learner will provide:

- writing and drawing instruments for written test
- simple calculator

Suggested Delivery Strategy

This section is primarily theoretical in nature however, the following resources may help the learners to understand the concepts :

- a vessel whose drafts can be read in varying weather conditions.
- a vessel or a floating model with loadlines and associated stability information that can be used to demonstrate the results of draft, freeboard, displacement, deadweight, dock water allowance, and tonnes per centimetre immersion calculations.

Feedback to Activities and Check Your Progress Exercises

Where applicable, feedback is provided at the back of the Learner's Guide.

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Section 4:

Statical & Dynamical Stability

Learning outcome 5

On completion of this learning outcome, the learner will be able to explain the effect of the movement of weights on the stability of a vessel.

Assessment Criteria:

- Explain the terms used in statical stability calculations.
- Explain the effect of adding and removing and moving weights on the centre of gravity and centre of flotation, draft, trim and stability of a vessel.
- Explain the effect of free surface on the stability of a vessel and the measures to allow for that effect.
- Explain the effect on stability when ship's gear is used to handle weights.
- Explain the effect of heel and list on the stability of a vessel.

Conditions:

Learning and assessment will take place in the classroom, or laboratory where a floating model can be used, or onboard a vessel with appropriate tanks, pumping arrangements and cargo gear.

The learning outcome may be assessed on the job or off the job through:

- a written test involving the use of sketching, diagram interpretation, short answer questions and/or computer testing
- oral questioning

The learner will be provided with:

- suitable classroom environment and answer booklet for written assessment
- access to a suitable computer for computer testing

The learner will provide:

- writing and drawing instruments for written test

Suggested Delivery Strategy

Learners will need to have access to a suitable vessel in survey that has stability data available or access to an equipment laboratory that is able to simulate actual stability conditions. Scale models representing vessels with associated stability information, able to be floated in tanks with appropriate means to load, discharge and transfer liquids and solid weights, may be used.

Stability principles should be demonstrated in such a way that the learners are able to clearly recognize the effect on stability when weights are added, removed, or shifted on the vessel. As far as practicable, learners should be provided with GZ curves for every condition so as to make a full appraisal of the stability of the vessel or model.

Where possible, rolling test should be conducted using an actual vessel so that the learners become familiar with the logistics of the operation. Assessment is probably better achieved in a simulated environment without placing an actual vessel at risk.

Feedback to Activities and Check Your Progress Exercises

Where applicable, feedback is provided at the back of the Learner's Guide.

Section 5: Simplified Stability Data

Learning outcome 6

On completion of this learning outcome the learner will be able to perform statical stability calculations using simplified stability data.

Assessment Criteria:

- Conduct stability calculations, using ship's simplified stability data and plans.
- Interpret the results of statical stability calculations.
- Demonstrate the validity of stability calculations by predetermining the response of a floating model, or actual vessel.

Conditions:

Learning and assessment will take place in the classroom, or laboratory where a floating model can be used, or onboard a vessel with appropriate tanks, pumping arrangements and cargo gear.

The learning outcome may be assessed on the job or off the job through :

- a written test involving the use of sketching, diagram interpretation, calculation, short answer questions.
- assessment by observation and oral questioning during practical exercises on a vessel and/or equipment laboratory with simulation equipment.

The learner will be provided with :

- suitable classroom environment and answer booklet for written assessment
- access to a vessel under survey and/or equipment laboratory with simulation equipment for practical exercises
- simplified stability information

The learner will provide:

- writing and drawing instruments for written test
- calculator
- protective clothing complying with workplace health and safety regulations for practical exercises

Suggested Delivery Strategy

This module is delivered most effectively when a floating model with associated stability information is used in conjunction with classroom instruction. Training with a model requires that the learner uses stability data related to a model vessel in such a way that the learner predicts outcomes from stability calculations and then demonstrates and explains why the floating model behaves in a certain way.

Feedback to Activities and Check Your Progress Exercises

Where applicable, feedback is provided at the back of the Learner's Guide.

8. Resource kit

A disk containing diagrams that have been used in the learner's guide and appropriate for making overhead transparencies, is available with this facilitator's guide.

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Assessment Package

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1. Introduction to the Assessment Package

2. Facilitators Role

As a Facilitator you will be responsible for :

- suitable study accommodation for learners
- paper-based material, references and handouts etc.
- equipment for demonstrations and explanations
- field trips to vessels, workshops, and drydock/slipway facilities as required
- supporting participants and assisting them to carry out written and practical activities
- arranging for workplace experts if required
- conducting participant's assessment
- recording participant's achievement in the record book

2.1 Provider-related information

The facilitator will need to ensure that all learners receive the information the course provider wants them to have.

For example:

- a module training plan (for on the job / off the job components)
- specialist support services available from the provider
- key contact persons
- administrative forms the learner should fill in
- information on how to borrow books, apply for recognition of prior learning (RPL) etc
- details about workshops, project work, practical sessions and the like
- sample exam papers

3. Module Overview

This module will provide the learner with the knowledge required by the Master of a vessel of less than 80 metres in length to manage:

- hull and superstructure inspections and maintenance programs relating to the watertight and weathertight integrity of a vessel under way;
- the structural related requirements to maintain a vessel in survey;
- the stability in routine operations and the stability in emergency circumstances.

On successful completion of this module, the participant will be able to:

- describe and explain the functions of the major structural components of the hull and superstructure;
- explain the arrangements to restrict the spread of fire;
- explain the arrangements to control flooding;
- explain the arrangements to maintain watertight and weathertight integrity;
- explain the method of tank and bulkhead testing for watertightness;
- explain the conditions of assignment of load lines and the use of load lines;
- explain the terms and use centre of gravity, centre of buoyancy, metacentric height, righting levers, righting moments, range of stability, stiff and tender, period of roll. Explain synchronisation and free surface effect, and relate the terms to ship stability,
- perform statical stability calculations based on simplified stability data.

4. Module learning outcomes

Learning Outcome 1

The learner will be able to describe and explain the functions of major structural components of hull and superstructure.

Learning Outcome 2

The learner will be able to explain the measures to restrict the spread of Fire and retain the watertight integrity of a vessel.

Learning Outcome 3

The learner will be able to plan the periodic maintenance and survey requirements for vessels of less than 80 metres in length

Learning Outcome 4

The learner will be able to explain the conditions of assignment of load lines, their maintenance and use.

Learning Outcome 5

The learner will be able to explain the effect of the movement of weights on the stability of a vessel's terms calculations.

Learning Outcome 6

The learner will be able to perform static stability calculations using simplified stability data.

5. Module Assessment

5.1 Assessment Method

The focus for assessment will be the module purpose. Assessment will aim at determining the learner's overall ability to deal operationally with the range of day to day issues that relate to the structure and stability of the vessel. The practical nature of this module facilitates the use of observation and oral assessment. In addition, assessing an ability to use procedures or conduct some aspects of operations may also be achieved through the use of short answer questions, computer simulation and computer managed testing.

5.2 Conditions of Assessment

Learner's will need to be provided with access to a suitable vessel in survey. Models may be used to assess outcomes requiring structural knowledge or descriptive skills in assessment criteria. Students will have access to ship's plans and survey records.

6. Module resources

6.1 Human Resources

The minimum qualifications for people facilitating the delivery of this module are:

- possession of a valid Certificate of Competency at the level of Master Class 3 or above,
- and formal teaching/training qualifications that are at least at the levels specified in national competencies for trainers and assessors.

6.2 Physical Resources

The registered training provider should have access to:

- A suitably equipped theory teaching space with white board and video facilities.
- A vessel in survey which should be less than 80 metres in length.
- Magnetic board with coloured magnetic tape
- Table top models and models of vessels for use in a flotation tank.
- Simplified ship stability data

7. Resource Kit

Section 1: Vessel Structure

Learning outcome 1

On completion of this learning outcome the learner will be able to describe and explain the functions of major structural components of hull and superstructure.

Assessment Criteria:

- Describe or identify major structural components
- Explain the function of the structural components.
- Explain deck and point loading limits.

Learning Outcome 2

On completion of this learning outcome the learner will be able to explain the measures to restrict the spread of fire and retain the watertight integrity of a vessel.

Assessment Criteria:

- Explain the arrangements to restrict the spread of fire.
- Explain the arrangements to control flooding.
- Describe the requirements to maintain watertight and weathertight integrity to survey requirements.
- Describe the method of tank and bulkhead testing for watertightness to survey requirements.

Conditions:

Assessment will take place on a vessel, in the classroom, at a slipway/drydock and other suitable study environments.

The learning outcome may be assessed on the job or off the job through :

- a written test involving the use of sketching, diagram interpretation, short answer questions, multiple choice questions and/or computer testing.
- oral questioning.

The learner will be provided with :

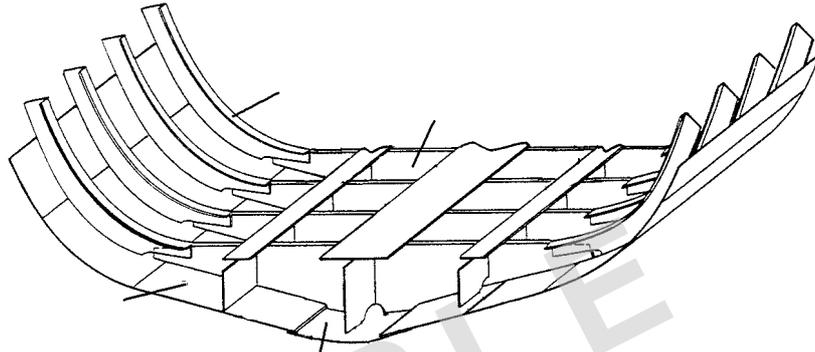
- suitable classroom environment and answer booklet for written assessment.
- access to a suitable computer for computer testing

The learner will provide:

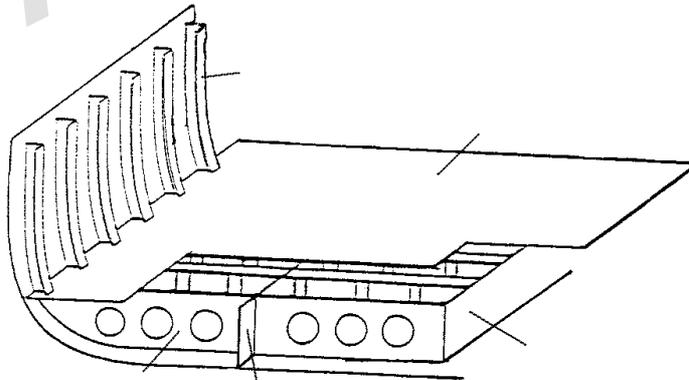
- writing and drawing instruments for written test.

Sample Test Questions

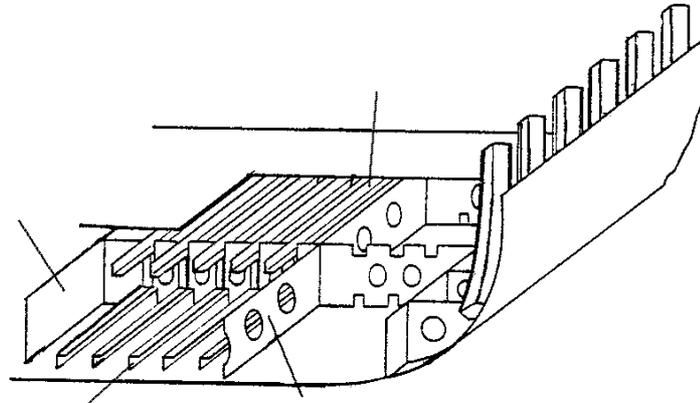
1. In the following sketch, label the parts indicated by (———).



2. In the following sketch, label the parts indicated by (———).



3. In the following sketch, label the indicated by (———).



4. Explain the function of double bottom on a vessel.
5. What is meant by Panting?
6. With the aid of a sketch, describe a typical arrangement to resist panting at the fore end of a vessel.
7. Describe the arrangements to resist pounding.
8. With the aid of sketches, explain what is meant by the terms “hogging” and “sagging”.
9. Describe the function of shell plating.
10. Describe the cause and effect of point loading.
11. What arrangements are made to ensure watertight Integrity when a ventilation trunk or a pipe passes through a watertight bulkhead?
12. Explain the arrangements provided to control massive flooding of a vessel.

In the following questions, circle the most correct answer.

13. The Duct Keel is used for
- a) carrying pipework
 - b) storing fuel
 - c) storing ballast water
14. The bottom shell plating is stiffened by
- a) transverse & longitudinal frames
 - b) transverse beams
 - c) double bottom
15. Double bottom constructions are found
- a) on very small vessels
 - b) on large vessels
 - c) only on tankers
16. The stem is the
- a) aftermost part of the vessel
 - b) the foremost part of the vessel
 - c) the end of the mast
17. Panting results from
- a) incorrect loading of the vessel
 - b) incorrect ballasting of the vessel
 - c) pitching of the vessel
18. The shell plating at the after end
- a) terminates at the sternframe
 - b) terminates at the rudder stock
 - c) terminates in the aft peak tank

19. Information regarding point loading limits can be obtained from a vessel's :
- a) Fire Control Plan
 - b) Capacity Plan
 - c) Master
20. The superstructure of a vessel is provided for:
- a) carrying extra cargo
 - b) protection of propulsion machinery
 - c) protection of openings in the freeboard deck
21. A vessel's hull is subdivided into watertight compartments by
- a) Watertight bulkheads
 - b) Partial bulkheads
 - c) Watertight doors
22. The collision bulkhead is located
- a) just aft of the engine room
 - b) at the forward end of the vessel
 - c) at the aft end of the vessel
23. A cargo vessel of less than 60 metres in length, and machinery space aft, must have a minimum of
- a) 3 watertight bulkheads
 - b) 4 watertight bulkheads
 - c) 5 watertight bulkheads
24. The collision bulkhead must extend to
- a) the highest point on a vessel
 - b) first deck above the load waterline
 - c) uppermost continuous deck

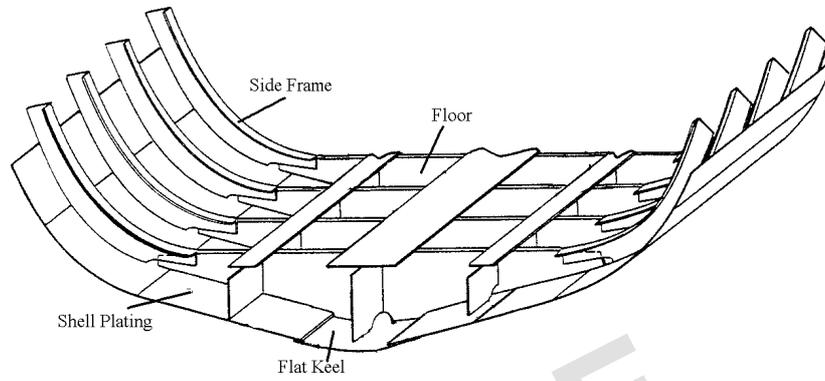
25. Openings in watertight bulkheads must be
- a) as large as possible
 - b) as small as possible
 - c) fitted with sliding doors
26. Fore peak and aft peak bulkheads are tested for watertightness by
- a) hose test
 - b) chalk test
 - c) filling the peaks with water up to the top of the air pipe.
27. Watertight bulkheads of compartments not forming boundaries of liquid carrying spaces are tested by
- a) hose test
 - b) chalk test
 - c) filling the compartments with water up to the top of the air pipe.
28. When a hatchway is cut into the deck of a vessel
- a) the corners are rounded
 - b) the corners are squared
 - c) the corners can be any shape
29. Doors providing access from the main deck to lower compartments
- a) must be of the sliding type
 - b) must have sills
 - c) must be as large as possible
30. In most cases, hatch covers are made weathertight by a gasket resting against
- a) wedges
 - b) cleats
 - c) compression bar

31. Accommodation spaces must be separate from machinery space
- a) only by fire retardant bulkheads
 - b) only by fire retardant decks
 - c) by fire retardant bulkheads and decks
32. An 'A' class division is made of
- a) timber
 - b) steel
 - c) fibre glass
33. On a steel vessel of 40 metres length, accommodation spaces should be separated from cargo spaces by
- a) 'A' class bulkheads and decks
 - b) 'B' class bulkheads and decks
 - c) 'C' class bulkheads and decks

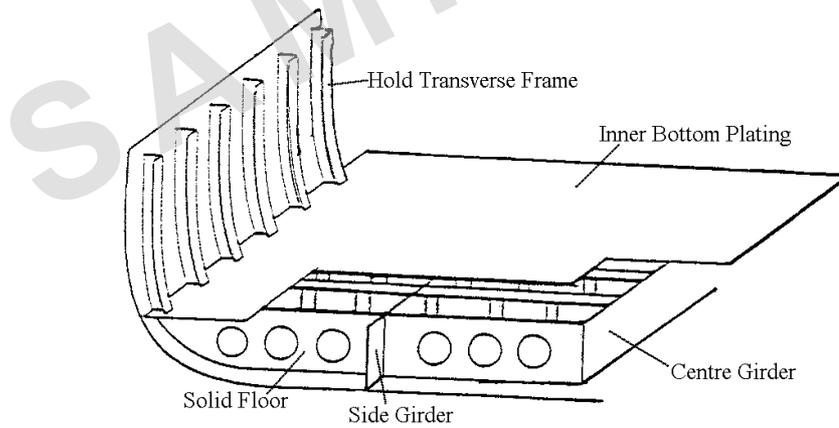
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Answers

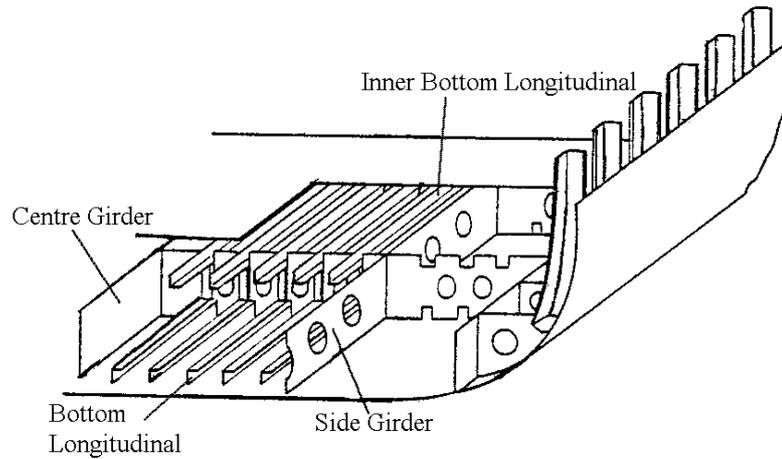
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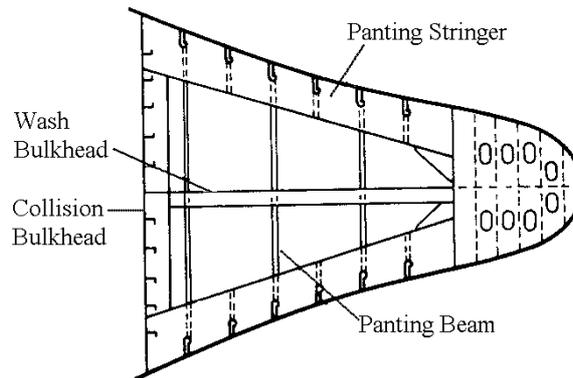


3.



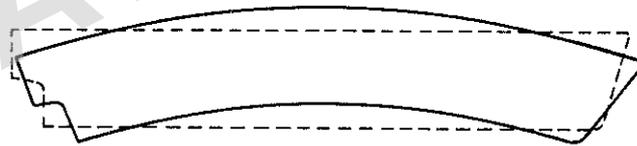
4. The double bottom space can be used for carrying fuel, ballast and fresh water. In addition it provides an extra margin of safety, since in the event of bottom shell damage only the double bottom space may be flooded.
5. Panting is the in-and-out movement of a vessel's shell plating that results from variations in water pressure as a vessel pitches in a seaway.
6. Panting arrangements include:
- horizontal plates welded to the sides of the vessel (known as panting stringers)
 - transverse beams extending from side to side (known as panting beams)
 - partial bulkheads

On some vessels, panting beams are replaced by perforated flats. Perforated flats are flat plates, similar to decks, with round holes cut in them.

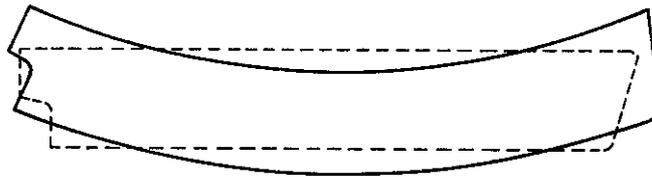


7. To resist pounding the shell plating is increased in thickness, frame spacing is reduced, and additional side girders and solid plate floors are fitted in the forward region.
8. Hogging is a condition where the ends of a vessel are deeper in water than amidships.

Sagging is a condition where the amidships region of a vessel is deeper in the water than the ends.



Hogging



Sagging

9. The weather deck, bottom, and side shell plating form a watertight envelope that provides the buoyancy to keep the vessel afloat. The shell plating is subject to static water pressure, as well as dynamic effects of pitching, rolling and wave action, Stiffening against compressive forces of the sea is provided by transverse or longitudinal frames. Additional plate thickness is provided at the forward and aft ends of the vessel to withstand local stresses.

10. Point loading occurs when the mass of an object is distributed over a very small area. This can cause temporary or permanent distortion of the vessel's structure.
11. Wherever possible, piping and ventilation trunks should not pass through watertight bulkheads. Where this cannot be avoided, the following measures must be adopted.
 - Pipes must be flanged to the bulkhead, not pass through it.
 - Ventilation trunks must be fitted with a watertight shutter.
 - If the collision bulkhead is to be pierced by a pipe, a valve must be fitted at the bulkhead. This valve should normally be kept closed and may be operated by remote control and/or an extended spindle.
12. A vessels hull is subdivided into a number of large watertight compartments by means of watertight bulkheads. The purpose of these bulkheads is to prevent rapid and massive flooding and hence rapid sinking should the vessel be holed below the waterline, by containing the flooding in the compartment that has been holed.
13. a)
14. a)
15. b)
16. b)
17. c)
18. a)
19. b)
20. c)
21. a)
22. b)
23. a)
24. c)
25. b)
26. c)
27. a)
28. a)
29. b)
30. c)
31. c)
32. b)
33. a)

Section 2: Maintenance & Survey

Learning outcome 3

On completion of this learning outcome the learner will be able to plan the periodic maintenance and survey requirements for vessels of less than 80 metres in length.

Assessment Criteria

- Identify the potential for corrosion/deterioration in vessel structures and describe the procedures and materials used for preventative and corrective maintenance.
- Itemize the statutory survey requirements of the State marine acts and regulations.
- Explain in general terms the routine maintenance of deck and hull fittings.
- Prepare a maintenance program for a vessel of less than 80 metres in length including all survey requirements.
- Describe the methods of docking or slipping the vessel for maintenance including the safety precautions and pollution control requirements associated with each method.
- Prepare a slipping or docking program indicating:
 - preparations before slipping, docking the vessel
 - requirements during the process of slipping or docking
 - preparations prior to undocking the vessel
 - precautions and inspections required during and immediately after undocking
 - identification of maintenance/repairs that require the vessel to be removed from the water and those that can be performed afloat.

Conditions:

Assessment will take place in the classroom, on a vessel, at a slipway/drydock, and other suitable study environments.

The learning outcome may be assessed on the job or off the job through :

- a written test involving the use of sketching, diagram interpretation, short answer questions, multiple choice questions and/or computer testing.
- written assignments.
- oral questioning.

The learner will be provided with :

- suitable classroom environment and answer booklet for written assessment.
- access to a suitable computer for computer testing

The learner will provide:

- writing and drawing instruments for written test.

Sample Test Questions

35. Give 5 examples of the parts of a vessel that are most liable to corrosion.
36. Describe two ways of preventing corrosion.
37. Describe in general terms the surface preparation required prior to painting the surface.
38. Explain in general terms the routine maintenance of watertight doors.
39. Explain in general terms the routine maintenance of hatch covers.
40. Explain in general terms the routine maintenance of cargo handling equipment.
41. Explain in general terms the routine maintenance of mooring and anchoring equipment.
42. List the survey items that require a vessel to be removed from water.
43. List the items checked by a surveyor during an annual loadline survey.
44. Describe the method of removing a vessel from the water using a patent slip.
45. Describe the method of removing a vessel from the water using a graving dock.
46. Describe the method of removing a vessel from the water using a floating dock.

47. Describe the method of removing a vessel from the water using a Synchrolift.
48. Describe the method of removing a vessel from the water using a travel lift.
49. Describe the method of removing a vessel from the water by careening.
50. Describe the method of removing a vessel from the water by heaving down.
51. Describe the general precautions to be observed in a dry dock.
52. List the undocking checks that should be carried out prior to returning a vessel to the water.
53. Explain the difference between preventative and corrective maintenance.

In the following questions, circle the most correct answer.

54. Saltwater encourages corrosion because
 - a) it is an excellent conductor of electricity
 - b) it is denser than fresh water
 - c) it dissolves paint
55. Sacrificial anodes are usually found
 - a) near the propeller
 - b) inside cargo holds
 - c) on the main deck

56. The drying of paint can be retarded by
- a) high temperatures
 - b) low humidity
 - c) pollutants in the air
57. Propellers and rudders are inspected during
- a) annual surveys
 - b) two yearly surveys
 - c) four yearly surveys
58. Life saving and fire-fighting appliances are surveyed during
- a) annual surveys
 - b) two yearly surveys
 - c) four yearly surveys
59. Anchors and cables are surveyed during
- a) annual surveys
 - b) two yearly surveys
60. A loadline certificate is usually valid for
- a) one year
 - b) three years
 - c) five years
61. During an annual loadline survey, the surveyor checks
- a) the watertight integrity of the vessel
 - b) the condition of life-saving appliances
 - c) the condition of fire-fighting appliances

62. When a vessel is removed from the water using a graving dock, the critical moment for stability occurs
- a) just before the water level starts falling
 - b) just before the vessel settles on the keel blocks
 - c) just after the dock is completely dry
63. Prior to dry-docking, the dockmaster should be informed about
- a) the vessel's last port of call
 - b) the location of echo sounder transducers
 - c) the vessel's maneuvering characteristics
64. One advantage of planned maintenance is that
- a) it involves less paperwork
 - b) there are fewer breakdowns and repairs
 - c) the vessel has to be dry-docked less often

Answers

- 34 *Chemical corrosion* is the attack of metals by solutions of acids or alkalines which will chemically combine with the metal to form entirely new products. The material can be considered as being dissolved in the solution. Such attack is usually caused by spillage of liquids such as battery acids, galley refuse, or in toilet areas.

Electrochemical corrosion is the most common type of corrosion. It is caused by very small electrical currents flowing between one metallic area to another. These electrical currents cause the material which is being corroded to change to a completely different substance; for example, steel changes to rust.

35. Parts of a vessel that are especially liable to corrosion include:
- Ballast tanks.
 - Bilges.
 - Hull plating between light and load waterline.
 - In vicinity of scuppers and overboard discharges.
 - Areas where water can accumulate (eg stringers used for stiffening).
 - Stern in the vicinity of propeller.
 - Storerooms.
 - Below wood deck sheathing.
 - Areas not easily accessible for maintenance.
- 36.
1. By providing a piece of material which will corrode in preference to the vessel. Such a substance is usually found attached to the hull near the propeller or attached inside a tank, in the form of a sacrificial anode.
 2. By coating the surface with a substance such as paint. Paints prevent the electrolyte from coming into contact with the metal.
37. In general, surfaces can be prepared for painting by:
- Cleaning and, where necessary, degreasing the surface.
 - Removal of corrosion products (rust) and/or defective paint coats by abrasive blast cleaning, mechanical or hand cleaning.
 - Using rust converters/inhibitors.
 - Roughening of the old paint where needed.
 - Removal of dust.
 - Drying the surface.
38. Examine closely the packing and rims and keep free from rust and scale. Keep packing clean of paint. All clips should be free, and hinges well oiled so the opening can be closed rapidly and efficiently.

39. Paintwork aside, the primary object in the successful maintenance of hatch covers is to keep them weathertight. To this end, careful attention must be paid to the heavy rubber sealing strips on the underside of the hatches. These must be kept firmly bonded in place with no gaps between the segments. The packing channels should be kept clear of rust, and the packing itself free of grease and paint. When the hatch is closed for sea, (battened down) check for a good seal. If there is a gap, you must open the hatch and find out why it hasn't sealed tight. Keep the trackways and compressor bars clean - if this is not the problem, replace the offending packing segment.
40. In Australia, the Marine Orders govern the use and maintenance of vessels' cargo handling gear. It is of vital importance to see that all moving parts are kept thoroughly lubricated so that they don't seize up in service. A regular, comprehensive greasing routine is the only answer. Periodic inspections and examinations will enable any faults to be quickly spotted and rectified, and should be carried out:
- Before starting to use the gear.
 - At regular intervals while the gear is in use.
 - As per the vessel's maintenance program and survey requirements.
41. Windlasses, capstans, mooring winches, roller fairleads, anchor chains and mooring lines (rope and wire) all have to be in good working order. A comprehensive lubrication and maintenance program should be instituted to care for this equipment. It is not sufficient just to pump grease into the machines, they should be carefully examined at the same time. Windlass and winch brakes should be operated to see that they are working correctly; fairleads spun so they don't freeze. Periodically the gear should be stripped down and cleaned off - old grease and paint removed, bearings examined, grease nipples and cups cleaned out and the unit relubricated.
42. Inspection of hull externally, sea cocks and valves, bilge injection valves and overboard discharge valves, propellers, rudders and underwater fittings, screw and tube shafts.

43. During the Annual Periodic Survey the surveyor checks:
- (a) the position of the load line marks;
 - (b) if the structural strength has deteriorated;
 - (c) the water tight integrity of the hull;
 - (d) whether any alterations have been made to the hull or superstructure;
 - (e) the condition of the fittings and appliances for the protection of openings, guard rails, freeing ports and means of access to crew's quarters; and
 - (f) if the vessel has on board the following:
 - i) Stability Information Booklet
 - ii) Conditions of Assignment
44. The patent slip is basically a sloping, reinforced concrete runway which extends well below the low water mark. On the slip itself is built a set of railway tracks set well apart. Wheeled carriages run on these tracks and depending on the size of the vessel being dry docked, carriages can be linked together to form a single unit. *Cradles* are fitted onto these carriages with keel blocks on the centre line atop the carriage. The entire assembly is made up to suit the vessel being dry docked.

The vessel is manoeuvred onto the cradle under its own power and is secured with “springs”. As the vessel settles onto the cradle bed, wedges are inserted to keep the vessel upright. The entire assembly is slowly winched up the slipway. As the vessel takes to the keel blocks, securing beams are drawn tight and any shores, if required, are fitted. The vessel now secure in its cradle on the carriage is slowly winched out of the water.

45. The graving dock is excavated from the land and closed to the sea by means of a large watertight door or gate known as the “Caisson Gate”. The edge of the dock bottom beneath the gate is referred to as the sill. The dock bottom has a very rigid construction and is usually made of reinforced concrete. The dock bottom always has a slight slope towards the sill to aid drainage. The sides of the dock are usually terraced to enable side shoring.

Along the centre line of the dock are blocks of concrete topped up with timber. They form the *keel blocks*. Two parallel rows of blocks on either side form the *bilge blocks* or *side blocks*. **Depending on the** size of the vessel and the shape of the underwater hull, the blocks are repositioned to suit the particular vessel.

On the sides of the dock at ground level are rails on which winches travel along the length of the dock. Wires from the winches are used, two on the forward beam and two on the after beam, to help position the vessel over the keel blocks when the vessel is brought in. Cranes are used for heavy lifting.

When the vessel is in position the lock gates are shut and pumping out commences. A diver may be employed to ensure that the vessel’s keel is in line with the keel blocks. As water is pumped out the diver keeps checking that the vessel is taking to the blocks as planned. Sometimes blocks are shifted so that maintenance can be done on a sea chest valve, drain plug, etc.

46. The basic structure of the floating dry dock is a very strong and rigid double walled “U”. The bottom is constructed very similar to the bottom structure of ships. The sides of the dock are vertical wing tanks. Keel blocks and bilge blocks are laid on top of the double bottomed structure. The whole dock forms a floating, watertight structure which can be submerged by flooding the double bottom and wing tanks.

The vessel to be dry docked is simply floated into the dock and positioned above the keel and bilge blocks by use of mooring lines. Shores are fitted to provide support and as the dock tanks are pumped out the dock rises until the pontoon deck is dry.

47. The vessel is floated in over a submerged platform and is then lifted clear of the water by raising the platform. The synchrolift is a land-based platform which is lowered into the water by a series of synchronised winches lining either side of the dock.
48. A narrow dock is excavated and then opened to the sea. The vessel to be lifted manoeuvres slowly into the dock and secured temporarily with mooring lines while a mobile straddle carrier is positioned above the vessel. Broad slings which will eventually distribute the weight of the hull are then put in place. The weight is taken up by the slings. The moorings are released and the vessel is lifted clear of the water. The straddle crane, under its own power, carries the slung vessel to a suitable position in the shipyard, where it is lowered on blocks and shored and the slings removed.

The main advantage of this system is that many vessels can be docked at the same time and the slipping facility is not laid up for the duration of the vessel's stay.

49. This method does not require a slipway or dry dock, so it is suitable for repairs in an isolated area or in an emergency. The only requirement is a tidal range greater than the vessel's draught.

The vessel is driven to a flat, cleared section of the beach or river bank and positioned parallel to the shore or bank, to give even support along its length as the water level falls and rises. The bank should not be too steep, and must be clear of obstructions. The vessel *must* fall up hill if flooding on the incoming tide is to be avoided. It may be positioned between poles driven into the bed or simply weighted to fall up hill. Hawser lines may be tied to solid sections of the vessel, eg. the foot of a mast, and secured to points on-shore to help prevent the vessel from falling downhill. When the water level is low enough, shoring is installed on the downhill side to prevent rolling over.

50. In this method, a vessel is heeled over, while afloat, by means of tackles set up between its masts and another ship, or shore attachments. This method is not as successful as careening in exposing the hull, but since the vessel is afloat, there is little hull stress, and the dangers, through touching the bottom, or damage to the hull and the intakes, are minimal. It must be remembered that by heeling a vessel you increase its draft, and you should be sure that there is sufficient under-keel clearance for the job.
- 51.
- Echo Sounder, Log, and Sonar transducers should be covered with grease and then masking tape to prevent them from being painted over.
 - Remove drain (docking) plugs from all tanks that need to be drained. Put them in a safe place and keep a written record of which plug goes where. Ensure that plugs are all replaced prior to flooding the dock or entry into the water.
 - Ensure that safe access is provided to and from the vessel.
 - Ensure that fire safety precautions are adhered to.
 - Ensure that all tanks, void spaces etc are opened, vented and ready for inspection by surveyors at the appropriate time.
 - Ensure that all pollution control requirements are met. (Remember that sewage and garbage cause pollution too.)
52. Ensure that:
- all docking plugs have been replaced
 - all intake gills/grates have been replaced
 - all transducers are uncovered and wiped clean
 - all tanks are boxed up (manhole/inspection covers are replaced)
 - anchors are secured
 - all loose gear is secured
 - new paint is dry to manufacturer's specifications
 - there is sufficient water depth to unslip
 - there is no distribution of weights on board that would cause the vessel to take up an unwanted list or trim when it takes to the water.
 - preferably the vessel should be in the same stability condition for undocking as it was at docking.

53. *Preventative* maintenance is aimed at preventing failures or discovering a failure at an early stage. *Corrective* maintenance is aimed at repairing failures that were expected, but were not prevented because they were not critical for safety or economy.
54. a)
55. a)
56. c)
57. b)
58. a)
59. c)
60. c)
61. a)
62. b)
63. b)
64. b)

SAMPLE

Section 3: Loadlines

Learning outcome 4

On completion of this learning outcome, the learner will be able to explain the conditions of assignment of load lines, their maintenance and use.

Assessment Criteria:

- Explain the general conditions of assignment of loadlines.
- Given the mean draft undertake freeboard, draft, displacement, deadweight, dock allowance and tonnes per centimetre immersion calculations.
- Describe assigned marks and draft marks.

Conditions:

Normally assessment will take place in the classroom, on a vessel, and other suitable study environments.

The learning outcome may be assessed on the job or off the job through:

- a written test involving the use of sketching, diagram interpretation, calculations, short answer questions and/or computer testing
- oral questioning

The learner will be provided with:

- suitable classroom environment and answer booklet for written assessment
- simplified stability data
- access to a suitable computer for computer testing

The learner will provide:

- writing and drawing instruments for written test
- simple calculator

Sample Test Questions

65. Explain what is meant by 'Conditions of Assignment of Loadlines'.
66. Sketch the typical loadline marks as marked on a vessel trading solely in Australia.
67. Draw a sketch to show how draft marks are marked on a vessel and give the dimensions of the marks.
68. A vessel of length 72 metres, and breadth 10.5 metres is floating in salt water at a draft of 2.4 metres. The vessel's block coefficient of fineness is 0.71. Find the displacement of the vessel in tonnes.
69. A vessel has a mean draft of 2.6 metres. The load draft is 3.2 metres, and TPC of the vessel for this draft is 1.8 tonnes. Calculate the amount of cargo that can be loaded so that the vessel will float at its load draft.
70. A vessel is loading in dock water of density 1010 kg/m³. Its fresh water allowance is 150 mm. By what amount can it submerge its summer loadline?
71. M.V. Box Barge is floating at a draft of 1.4 metres. Using the hydrostatic particulars provided, find the new draft if 105 tonnes of cargo is loaded.

| Draft (m) | Displacement (tonnes) | TPC | MCT 1 cm (t-m) | LCF | KM (m) |
|-----------|-----------------------|-----|----------------|------|--------|
| 0.7 | 109 | 1.7 | 2.7 | 1.5 | 6.0 |
| 0.8 | 126 | 1.7 | 2.7 | 1.6 | 5.3 |
| 0.9 | 144 | 1.8 | 3.0 | 1.2 | 4.9 |
| 1.0 | 160 | 1.8 | 3.3 | 0.9 | 4.6 |
| 1.1 | 179 | 1.9 | 3.7 | 0.5 | 4.4 |
| 1.2 | 199 | 2.0 | 4.1 | 0.0 | 4.3 |
| 1.3 | 219 | 2.0 | 4.7 | -0.5 | 4.2 |
| 1.4 | 239 | 2.1 | 4.9 | -0.7 | 4.0 |
| 1.5 | 261 | 2.1 | 5.2 | -0.9 | 3.8 |
| 1.6 | 282 | 2.2 | 5.5 | -1.2 | 3.6 |
| 1.7 | 306 | 2.2 | 5.5 | -1.4 | 3.5 |
| 1.8 | 328 | 2.2 | 5.6 | -1.1 | 3.4 |
| 1.9 | 351 | 2.2 | 5.6 | -1.1 | 3.3 |
| 2.0 | 373 | 2.2 | 5.7 | -1.0 | 3.2 |
| 2.1 | 395 | 2.2 | 5.7 | -1.0 | 3.1 |

72. M.V. Box barge is floating at a mean draft of 1.6 metres and freeboard 1.8 metres, What will be the new mean draft and freeboard if 45 tonnes of cargo is discharged.

In the following questions, circle the most correct answer.

73. The summer loadline mark should not be submerged
- a) in a Tropical zone
 - b) in a Summer zone
 - c) in Port
74. A seasonal zone is one that
- a) is associated with good weather all the year round
 - b) is associated with bad weather all the year round
 - c) changes its name at different times of the year
75. A vessel loaded to full draft in a winter zone will have a waterline
- a) at the top of the winter loadline mark
 - b) at the bottom of the winter loadline mark
 - c) at the top of the plimsoll mark.
76. The letters on either side of the loadline disc indicate
- a) the name of the vessel
 - b) the initials of the vessel's owner
 - c) the initials of the survey authority
77. Draft is the distance from
- a) the keel to the waterline
 - b) the keel to the freeboard deck
 - c) the keel to the highest point on the vessel.

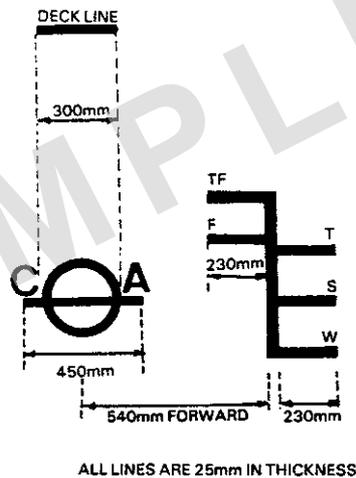
78. A vessel's forward draft is 1.6 metres and aft draft is 2.4 metres. The vessel's trim is:
- 1.2 metres
 - 0.8 metres
 - 2.0 metres
79. A vessel's forward draft is 1.2 metres and aft draft is 2.1 metres. The vessel's mean draft is:
- 1.8 metres
 - 1.65 metres
 - 1.5 metres
80. Hydrostatic draft is the true mean draft measured at:
- the centre of flotation
 - amidships
 - aft draft marks
81. The specific gravity of a substance is the ratio between its density and
- the density of steel
 - the density of fresh water
 - the density of salt water
82. Fresh water allowance is the number of millimetres by which a vessel's mean draft changes when
- the vessel loads 1 tonne of fresh water
 - the vessel loads 1 tonne of salt water
 - the vessel passes from salt water to fresh water.
83. TPC for a given draft can be obtained from a vessel's
- capacity plan
 - trim and stability booklet
 - loadline certificate

Answers

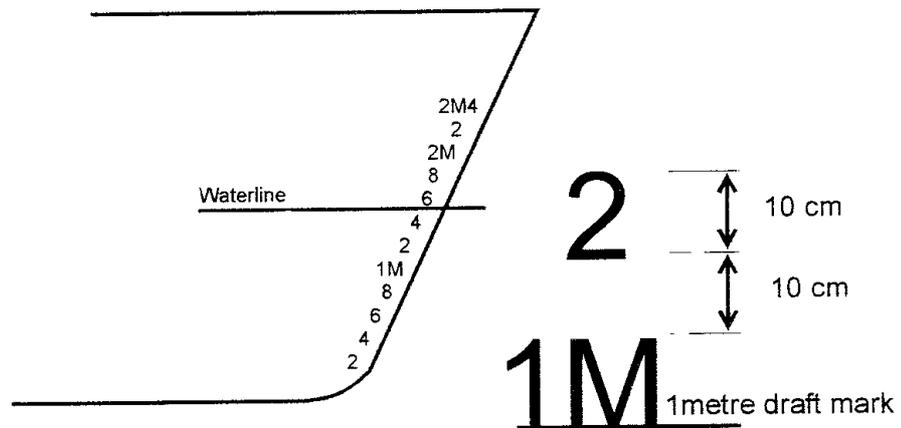
65. Conditions of assignment are regulations to ensure that a vessel is provided with efficient means:

- of protection for all openings to the hull and superstructure
- for the protection of crew in heavy weather, and
- for the rapid freeing of water from the weather decks

66.



67.



68. Displacement = 1320.43 tonnes

69. Amount of cargo = 108 tonnes

70. It can submerge its loadline by 90 mm.

71. New draft = 1.9 metres

72. New draft = 1.36 metres

New freeboard = 2.04 metres

73. b)

74. c)

75. a)

76. c)

77. a)

78. b)

79. b)

80. a)

81. b)

82. c)

83. b)

Section 4: Statical & Dynamical Stability

Learning outcome 5

On completion of this learning outcome, the learner will be able to explain the effect of the movement of weights on the stability of a vessel.

Assessment Criteria:

- Explain the terms used in statical stability calculations.
- Explain the effect of adding and removing and moving weights on the centre of gravity and centre of flotation, draft, trim and stability of a vessel.
- Explain the effect of free surface on the stability of a vessel and the measures to allow for that effect.
- Explain the effect on stability when ship's gear is used to handle weights.
- Explain the effect of heel and list on the stability of a vessel.

Conditions:

Assessment will take place in the classroom, or laboratory where a floating model can be used, or onboard a vessel with appropriate tanks, pumping arrangements and cargo gear.

The learning outcome may be assessed on the job or off the job through:

- a written test involving the use of sketching, diagram interpretation, short answer questions and/or computer testing
- oral questioning

The learner will be provided with:

- suitable classroom environment and answer booklet for written assessment
- access to a suitable computer for computer testing

The learner will provide:

- writing and drawing instruments for written test

Sample Test Questions

84. Explain the meaning of the term KG of a vessel.
85. Explain the meaning of the term LCG of a vessel.
86. What is meant by the term 'Displacement' of a vessel?
87. What is meant by the term 'Deadweight' of a vessel?
88. Define MCT 1 cm.
89. With the aid of a sketch, explain the meaning of the term 'metacentric height' (GM) of a vessel.
90. With the aid of a sketch, explain the meaning of the term 'righting lever' (GZ) of a vessel.
91. With the aid of a sketch, explain the effect on a vessel's centre of gravity when a weight is added to the vessel.
92. With the aid of a sketch, explain the effect on a vessel's centre of gravity when a weight is removed from the vessel.
93. With the aid of a sketch, explain the effect on a vessel's centre of gravity when a weight is shifted on the vessel.
94. With the aid of sketches, explain how the relative positions of LCG and LCB determine the way a vessel trims.
95. Explain the effect of change in freeboard on the stability of a vessel.
96. Explain what is free surface effect.

97. How is free surface effect minimised at the design stage of a vessel?
98. Describe the operational practices that will minimise free surface effect.
99. Explain the effect on stability when a vessel is heeled by wind.

In the following questions, circle the most correct answer.

100. GM can be obtained from the following formula
 - a) $GM = KG - KM$
 - b) $GM = KM - KG$
 - c) $GM = KM + KG$
101. GM gives an indication of initial stability up to about
 - a) 5 degrees heel
 - b) 15 degrees heel
 - c) 25 degrees heel
102. The true measure of a vessel's stability can be obtained from its
 - a) GZ curve
 - b) GM
 - c) KM
103. The 'range of stability' defines all angles of heel for which a vessel has
 - a) positive righting lever
 - b) zero righting lever
 - c) negative righting lever
104. The angle to which a vessel must be heeled before water could enter the hull through openings that have been left open, is called
 - a) actual angle of immersion
 - b) actual angle of flooding
 - c) potential angle of flooding

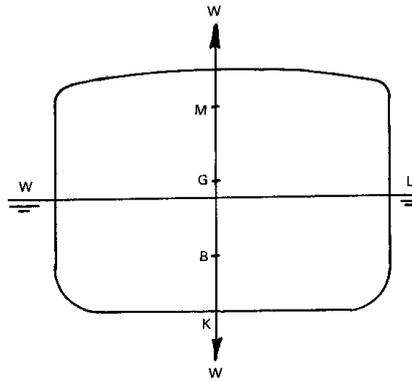
105. On a GZ curve, the point of deck edge immersion shows up as the point where
- the curve starts to get steeper
 - the curve begins to get less steep, and starts to level off
 - the curve becomes a straight line
106. When a weight is added on a vessel, its centre of gravity moves
- towards the added weight
 - away from the added weight
 - vertically upwards
107. When a weight is discharged from a vessel, its centre of gravity moves
- towards the point from where the weight was discharged
 - away from the point from where the weight was discharged
 - vertically downwards
108. When a weight is added on a vessel, its
- draft decreases and freeboard increases
 - draft increases and freeboard decreases
 - draft and freeboard remain unchanged
109. A reduction in freeboard is associated with
- increased stability
 - no effect on stability
 - decreased stability
110. When freeboard is increased, the angle of heel at which the deck edge immerses is
- increased
 - decreased
 - unaffected

111. When a vessel's centre of gravity is raised, its stability is
- a) increased
 - b) decreased
 - c) unaffected
112. If a vessel's LCB is aft of LCG, the vessel will
- a) trim by the bow
 - b) trim by the stern
 - c) not trim at all
113. If a vessel's LCB is forward of LCG, the vessel will
- a) trim by the bow
 - b) trim by the stern
 - c) not trim at all
114. The longitudinal centre of flotation (LCF) is the centre of a vessel's
- a) underwater volume
 - b) main deck area
 - c) water plane area
115. When a vessel trims, it rotates about the
- a) LCG
 - b) LCB
 - c) LCF
116. When a weight is lifted by a crane, the centre of gravity of the weight is transferred to
- a) the point of suspension
 - b) the base of the crane
 - c) the actual position of the weight

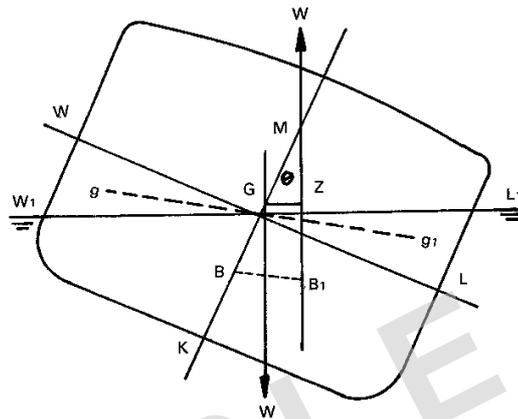
117. The main factor affecting free surface effect of liquid in a tank is
- a) the quantity of liquid in the tank
 - b) the depth of liquid in the tank
 - c) the free surface area of the liquid in the tank
118. A stiff vessel has a
- a) negative GM
 - b) large GM
 - c) small GM
119. A tender vessel has a
- a) negative GM
 - b) large GM
 - c) small GM
120. A vessel's roll period is governed by its
- a) GM
 - b) length over all
 - c) LCF
121. If a vessel's GM is reduced, its roll period
- a) becomes shorter
 - b) becomes longer
 - c) is unaffected
122. A stiff vessel
- a) is more likely to experience synchronous rolling
 - b) is less likely to experience synchronous rolling
 - c) will not experience synchronous rolling
123. List or heel will cause
- a) an increase in the range of stability
 - b) a decrease in the range of stability
 - c) no change to the range of stability

Answers

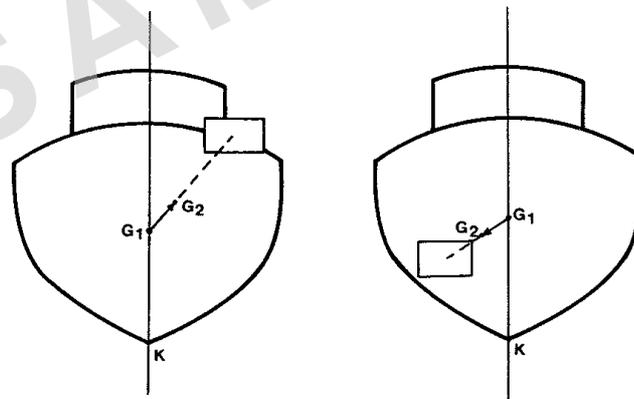
84. KG is the vertical distance of the centre of gravity from the base line. The base line is a line drawn through the lowest part of the keel parallel to the designed waterline of the vessel.
85. LCG is the horizontal distance of the centre of gravity from amidships.
86. Displacement is the total weight of the vessel at any draft.
87. Deadweight is the total weight of the contents of individual fuel and water tanks, cargo, crew and effects, stores, provisions, etc.
88. It is the moment required to cause a one centimetre change of trim in the vessel.
89. The Metacentric height (GM) is the vertical distance between the metacentre and the centre of gravity.



90. GZ is the righting lever. When a vessel is heeled by an external force, the centre of buoyancy moves towards the lowside, the force of buoyancy acts vertically upwards through B, (the centre of buoyancy), the force of gravity (weight) acts vertically downwards through G. The horizontal distance between the vertical lines drawn through these points is the size of the righting lever (GZ).

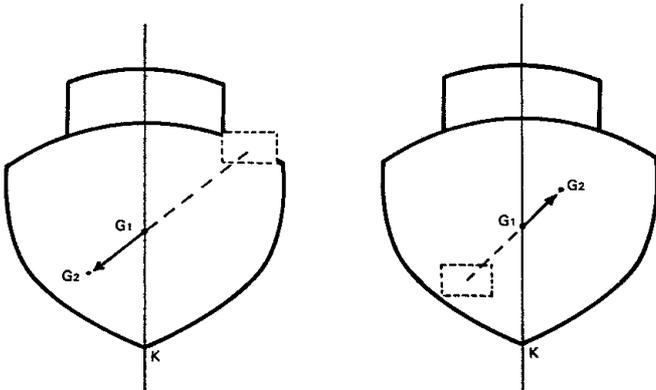


91. The centre of gravity moves towards an added weight.



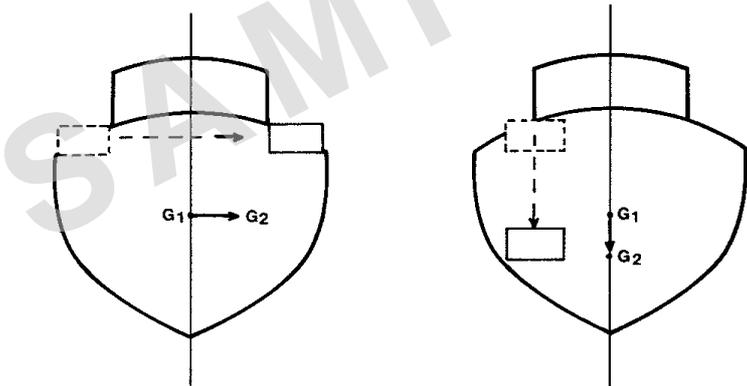
Weight Added

92. The centre of gravity moves away from a discharged weight.



Weight Removed

93. The centre of gravity moves parallel to the movement of a weight which is already on board.



Shifting Weights

94. If the position of LCG and LCB are as shown in Fig. 1, then the actions of buoyancy and weight will cause the vessel to rotate as shown by the arrow. The stern will sink deeper, the bow will rise higher. As the vessel rotates, the shape of the underwater volume will change and LCB will move to the new centre.

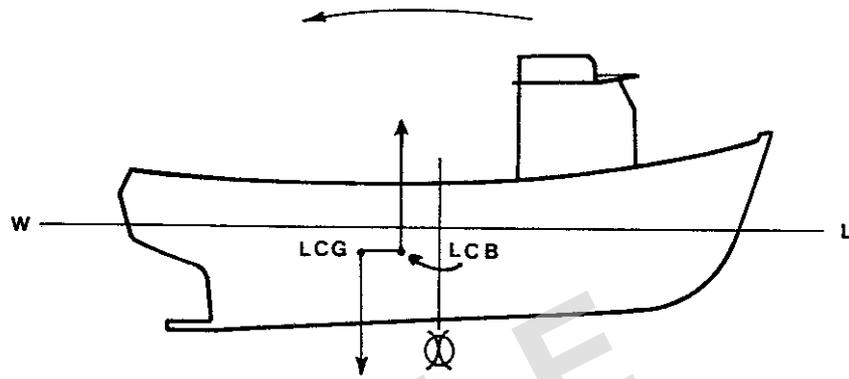


Figure 1

LCB Forward of LCG - Vessel trims by the stern

When LCG and LCB are in the same vertical line, the rotation will stop, the vessel will be trimmed by the stern as shown in Fig 2

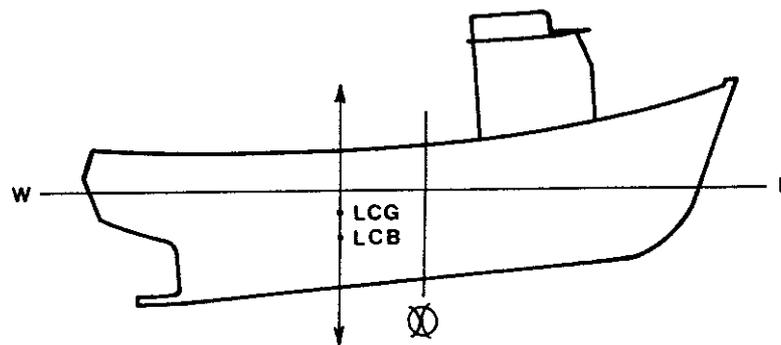


Fig 2

LCG and LCB in same vertical line - no trimming moment.

If the vessel had started with LCB aft of LCG then the rotation would cause a trim by the bow.

95. An increase in freeboard is associated with an increase in stability. Conversely, a decrease in freeboard is associated with a decrease in stability.
96. Free surface effect is the reduction in stability of a vessel caused by shifting water in slack tanks. Free surface effect reduces the size of GM. Therefore the size of GZ is reduced, and consequently the ability of the vessel to return to the upright position is reduced.
97. Free surface effect is minimised by partitioning tanks longitudinally. Where tanks are not divided by watertight divisions, there are usually longitudinal wash bulkheads which act as baffle plates. While these do not stop the sideways motion of fluids in the tank, they are designed to retard the flow so that the heeling force caused by the free surface effect is out of phase with the rolling of the vessel.
98. Free surface effect can be reduced by keeping the number of slack tanks to a minimum. As many tanks as possible should either be completely full or completely empty.
99. Heeling lever caused by wind pressure has the effect of reducing the righting lever and the range of stability.
100. b)
101. b)
102. a)
103. a)
104. c)
105. b)
106. a)
107. b)
108. b)
109. c)
110. a)
111. b)
112. a)

- 113. b)
- 114. c)
- 115. c)
- 116. a)
- 117. c)
- 118. b)
- 119. c)
- 120. a)
- 121. b)
- 122. a)
- 123. b)

SAMPLE

Section 5: Simplified Stability Data

Learning outcome 6

On completion of this learning outcome the learner will be able to perform static stability calculations using simplified stability data.

Assessment Criteria:

- Conduct stability calculations, using ship's simplified stability data and plans.
- Interpret the results of static stability calculations.
- Demonstrate the validity of stability calculations by predetermining the response of a floating model, or actual vessel.

Conditions:

Assessment will take place in the classroom, or laboratory where a floating model can be used, or onboard a vessel with appropriate tanks, pumping arrangements and cargo gear.

The learning outcome may be assessed on the job or off the job through :

- a written test involving the use of sketching, diagram interpretation, calculation, short answer questions.
- assessment by observation and oral questioning during practical exercises on a vessel and/or equipment laboratory with simulation equipment.

The learner will be provided with :

- suitable classroom environment and answer booklet for written assessment
- access to a vessel under survey and/or equipment laboratory with simulation equipment for practical exercises
- simplified stability information

The learner will provide:

- writing and drawing instruments for written test
- calculator
- protective clothing complying with workplace health and safety regulations for practical exercises

Sample Test Questions

124. A vessel with a light displacement of 1150 tonnes and KG 4.2 metres, loads the following cargo:

- tonnes deck cargo KG 7.5
- containers, total weight 24 tonnes, KG 8.5
- tonnes Packaged cargo, KG 4.5
- tonnes Fuel, KG 1.8
- tonnes water, KG 2.4

Calculate the final KG of the vessel

125. A vessel displacing 970 tonnes, KG 3.4 metres, carries out the following operations :

Loads

- dry cargo 40 tonnes, KG 1.8 metres
- Ballast water 75 tonnes, KG 1.1 metres
- Fresh water 25 tonnes, KG 2.1 metres

Discharges

- cargo 74 tonnes, KG 2.4 metres
- ballast 22 tonnes, KG 0.9 metres

Consumes

- fuel 12 tonnes, KG 1.5 metres

Calculate the final KG of the vessel

126. MV Twosuch is in condition 6 at sea and about to return to port when another vessel asks you to transport an engine back to port. The engine (weight 5.0 tonnes) will be lifted on board using your lifting boom, height 11.4 metres. What will be the Kgf and LCG the moment the weight is taken by the boom and would you consider this operation to be safe?

127. MV Twosuch is in condition 6, except that the catch is 50% and all the fish are stowed at the aft end of the hold at a KG of 2.6 metres and a LCG of -1.1 metres. Find the Kgf and LCG and state whether the vessel meets the requirements.
128. MV Twosuch is in condition 8 except that the catch is 50% and all the fish are stored at the aft end of the hold at KG of 2.6 metres and a LCG of -1.1 metres. Find the Kgf and the LCG and state whether the vessel meets the requirements.

Answers

124. Final KG = 4.12 metres

125. Final KG = 3.28 metres

126. Kgf = 3.52

LCG = -0.62

The operation is unsafe because the vessel does not meet the requirements.

127. Kgf = 3.36

LCG = -0.67

The vessel meets the requirements

128. Kgf = 3.34

LCG = -0.83

Kgf is within limits but LCG is a borderline case.